Analytical Tool for Force Planning Scenarios User Guide Version 2.0

Larry Cochran; Doug Hales; Peter Race
CAE Professional Services (Canada) Inc.

Shaye K. Friesen
DRDC CORA

Defence R&D Canada
Centre for Operational Research & Analysis

Strategic Analysis Section

National Defence   Défense nationale

Canada

Analytical Tool for Force Planning Scenarios User Guide Version 2.0

Larry Cochran
Doug Hales
Peter Race
CAE Professional Services (Canada) Inc.

Shaye K. Friesen
DRDC CORA

Defence R&D Canada – CORA

Contract Report
DRDC CORA CR 2010-113
June 2010

Principal Author

Original signed by L. Cochran; D. Hales; P. Race; S. Friesen

L. Cochran; D. Hales; P. Race; S. Friesen

CAE Professional Services (Canada) Inc.; DRDC CORA

Approved by

Original signed by Stephane Lefebvre

Stephane Lefebvre

DRDC CORA Section Head Strategic Analysis

Approved for release by

Original signed by Dean Haslip

Dean Haslip

DRDC CORA Chief Scientist

Sponsor: Chief Force Development

Defence R&D Canada – Centre for Operational Research and Analysis (CORA)

Abstract

Force Planning Scenarios serve as the key input to conducting capability-based planning and force development efforts. As such, the characterization and selection of these scenarios warrants the application of available analytical tools and techniques to ensure an objective and defensible scenario set. To meet these needs, a force planning scenario framework and methodology was developed, identifying the most relevant dimensions of force planning scenarios to support analysis and development. In an effort to apply this framework for characterizing force planning scenarios, a desktop software application was developed. This contractor report serves as a user's guide to this desktop software application. It provides a detailed description of the tool's main functions and instructions on its use. It is anticipated that this document be read in conjunction with the contractor report (DRDC CORA CR 2010-17) that more thoroughly describes the framework and methodology, "Development of a Framework for Force Planning Scenarios." This document covers the second iteration of the Force Planning Scenario analytical tool, and covers the additional functions of extending and comparing frameworks. This document is covered in two volumes. The first volume provides guidance to standard tool users. The second volume covers the programming background of the Force Planning Scenario analytical tool.

Résumé

Les scénarios de planification des forces sont les principales données que les chercheurs utilisent dans leurs efforts de planification fondée sur les capacités et de développement des forces. À l'étape de la caractérisation et de la sélection de ces scénarios, ils doivent utiliser les outils et les techniques d'analyse disponibles pour produire une série de scénarios objectifs et défendables. À cette fin, un cadre et une méthodologie de création de scénarios de planification des forces ont été développés, et les dimensions les plus pertinentes des scénarios de planification des forces ont été identifiées pour appuyer l'analyse et le développement des scénarios. Pour appliquer ce cadre à la caractérisation des scénarios de planification des forces, un outil logiciel a été mis au point. Le présent rapport de l'entrepreneur sert de guide de l'utilisateur pour cet outil logiciel. Il donne une description détaillée des fonctions principales de cet outil logiciel, ainsi que des instructions sur son utilisation. Ce document doit être lu en conjonction avec un autre rapport de l'entrepreneur (RDDC CARO CR 2010-17) qui décrit plus en détail le cadre et la méthodologie, et qui s'intitule « Mise au point d'un cadre pour les scénarios de planification des forces ». Ce document porte sur la deuxième version de l'outil analytique des scénarios de planification des forces, et il décrit deux fonctions additionnelles : l'élargissement et la comparaison des cadres. Ce document comporte deux volumes. Le premier volume donne des directives aux utilisateurs de l'outil logiciel standard. Le deuxième volume porte sur la programmation de l'outil analytique des scénarios de planification des forces.

This page intentionally left blank.

Executive Summary

Analytical Tool for Force Planning Scenarios User Guide Version 2.0:

L. Cochran, D. Hale, P. Race, S. Friesen; DRDC CORA CR 2010-113; Defence R&D Canada – CORA; June 2010.

Background: Force Planning Scenarios serve as the key input to conducting capability-based planning and force development efforts. As such, the characterization and selection of these scenarios warrants the application of available analytical techniques to ensure an objective and defensible scenario set. To meet these needs, a scenario framework and methodology was developed, identifying the most relevant dimensions of scenarios to support analysis and development. In an effort to apply this framework for characterizing force planning scenarios, a desktop application was developed. As the scenario development process evolved, additional functions were identified to support the evolution of frameworks as well as comparative analysis of multiple frameworks. A second iteration of the desktop software application was developed, including the means to add and modify different frameworks, evaluate historical case studies, as well as the means to conduct comparative analysis of frameworks.

Results: This document provides a step-by-step guide for applying the scenario framework using a modified field anomaly relaxation process, a form of morphological analysis. By enabling an examination of all driving dimensions, the full realm of potential scenarios can be documented and analyzed. The end result is a set of prioritized scenario combinations that can guide the development of a representative set of scenarios to effectively cover these dimensions. It allows users to characterize both historical case studies and force planning scenarios against frameworks, and also support evolution of frameworks as the future security environment evolves. The core functions of the tool were validated with the user community, as described in associated DRDC CORA contractor reports.

Significance: The analytical rigour of analyzing scenarios provides a method for selecting and justifying scenario development and evolution to meet capability-based planning. By visualizing the coverage of driving scenario dimensions, a balanced scenario set can be developed and maintained to ensure the development of CF capabilities across the spectrum of roles and environments.

Future plans: This application is designed to apply the force planning scenario framework in its current form. However, the framework is designed to evolve based on new research and users. It is anticipated that this tool will evolve based on such research and be adopted to serve a larger audience. As the need arises, the tool can be offered as a web service, and can be extended to support domain-specific frameworks in areas, such as intelligence and disruptive technologies.

Sommaire

Analytical Tool for Force Planning Scenarios User Guide Version 2.0:

L. Cochran, D. Hale, P. Race, S. Friesen; DRDC CORA CR 2010-113; R & D pour la défense Canada – CARO; Juin 2010.

Introduction ou contexte: Les scénarios de planification des forces sont les principales données que les chercheurs utilisent dans leurs efforts de planification fondée sur les capacités et de développement des forces. À l'étape de la caractérisation et de la sélection de ces scénarios, ils doivent utiliser les techniques d'analyse disponibles pour produire une série de scénarios objectifs et défendables. À cette fin, un cadre et une méthodologie de création de scénarios ont été développés, et les dimensions les plus pertinentes des scénarios ont été identifiées pour appuyer l'analyse et le développement des scénarios. Pour appliquer ce cadre à la caractérisation des scénarios de planification des forces, un outil logiciel a été mis au point. À mesure que le processus de développement des scénarios a évolué, des fonctions additionnelles ont été identifiées pour appuyer l'évolution des cadres ainsi que l'analyse comparative des divers cadres. Une deuxième version de l'outil logiciel a été développée, y compris de nouvelles fonctions qui permettent d'élargir et de modifier les différents cadres, de faire des études de cas, et de procéder à l'analyse comparative des cadres.

Résultats: Le présent document contient un guide « étape par étape » pour l'utilisation d'un cadre de création de scénarios à l'aide d'un processus FAR (field anomaly relaxation) modifié, qui est une forme d'analyse morphologique. Grâce à l'examen de toutes les dimensions pertinentes, l'ensemble des scénarios potentiels peuvent être documentés et analysés. Le résultat final est une série de combinaisons de scénarios priorisées qui peut guider le développement d'un ensemble représentatif de scénarios, afin de couvrir efficacement toutes ces dimensions. Cette série permet aux utilisateurs de caractériser les études de cas antérieures et les scénarios de planification des forces à l'intérieur de chaque cadre, et elle facilite le développement des cadres à mesure que le contexte de sécurité évolue. Les principales fonctions de l'outil logiciel ont été validées par les utilisateurs, comme l'indiquent les rapports des entrepreneurs de RDDC CARO.

Importance: La rigueur de l'analyse des scénarios permet d'établir une méthode de sélection des scénarios et de justification de leur développement qui répond aux besoins de la planification basée sur les capacités. En visualisant la couverture des dimensions pertinentes des scénarios, on peut élaborer et tenir à jour un ensemble de scénarios équilibré, ce qui assure le développement des capacités des Forces canadiennes dans l'ensemble du spectre des rôles et des environnements.

Perspectives: Cette application est conçue pour s'appliquer au cadre de création de scénarios de planification des forces dans sa forme actuelle. Toutefois, ce cadre est conçu pour évoluer en fonction des nouvelles recherches et des utilisateurs. On prévoit que l'outil logiciel va évoluer en fonction de ces recherches, et qu'il sera adapté afin de servir une plus vaste clientèle. Au besoin, l'outil logiciel pourra être offert sous forme de service Web, et il pourra être élargi pour appuyer des cadres spécifiques dans des domaines comme le renseignement et les technologies.

Table of Contents

List of Figures

1   Introduction

The defence Force Planning Scenarios (FPS) provide a representative range of domestic, continental and international situations in which the Canadian Forces (CF) anticipates conducting operations. Developing the best possible set of FPS requires a definitive set of criteria to test and evaluate which scenarios should be considered for use in the Chief of Force Development's (CFD) Capability-Based Planning (CBP) process. A systematic process was developed to enhance CBP by ensuring a defensible and objective set of scenarios that makes best use of analytical methods and techniques. To realize this goal, this project developed a scenario methodology, framework and supporting application to support FPS evaluation and development.

The Force Planning Scenario Framework tool applies the FPS framework to support the identification, evaluation and development of a scenario set for CBP. Based on the research conducted by DRDC CORA and CAE Professional Services, this tool focuses on supporting the application of the FPS framework through field anomaly relaxation (FAR), a form of morphological analysis (MA). To facilitate research into the range of relationships between scenario dimensions, this tool provides a relational database and mechanisms for comparing and evaluating scenarios across multiple dimensions. The result is a plausible set of scenarios capable of being refined into a balanced FPS set.

The tool was developed using Microsoft (MS) Access. Making use of a readily-available commercial off the shelf (COTS)-based application, MS Access was well-suited to meet system requirements for current and future users. It has been customized to include a set of unique forms, tables and queries to meet user requirements. It is designed for users with little experience with MS Access or databases. The tool has been preconfigured with the dimensions developed as a part of this study. The driver, descriptor and derivative dimensions are contained in separate tables, as they are drawn upon as part of separate tool functions. The associated tables allow filtering and manipulation of data from several sources to meet the user's needs. The framework within the tool has been defined and justified within the project's final report, which serve as accompanying documents to this user's guide.[1]

This user's guide is broken into three sections. The first section covers the process of selecting, modifying and creating a framework. The second section outlines the process for conducting FAR. The third section reviews how to add, characterize and analyze a scenario using the framework.

1.1   A Note for MS Access 2007 Users

The original database was developed for use in MS Access 2003 or higher. In MS Access 2007, the database will often open as a blank screen, as required macros are automatically disabled by

---

[1] Cochran, Larry, Doug Hales, Peter Race, Neil Chuka, Shaye K. Friesen, Charles Morrissey, LCdr Darren Harnett, *Development of the Force Planning Scenario Framework*, DRDC CORA CR 2010-017, Defence Research & Development Canada – CORA, February 2010; Cochran, Larry, Doug Hales, Peter Race, Shaye K. Friesen, *Analysis Tool for Force Planning Scenarios: User's Guide*, DRDC CORA CR 2010-018, Defence Research & Development Canada – CORA, February 2010.

Microsoft's security settings. Upon opening the file, the Switchboard will display as a blank page with one button. Along the top of the screen will be a security warning banner (Figure 1). Click on "Options…" to adjust security settings.
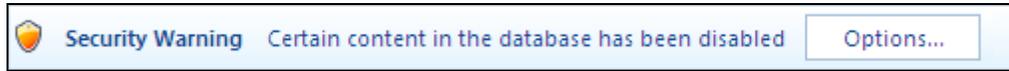
Figure 1: Microsoft Security Warning

If this security warning does not appear but the switchboard is still bank, contact your local information technology (IT) administrator for assistance in enabling macros for MS Access.

After clicking on "Options…", the Microsoft Office security window will open up, prompting the user to assign security settings for the database (Figure 2). Select "Enable this content" and click OK. The Switchboard will now appear with all active functions.

Figure 2: Adjust Microsoft Security Options

2 Selecting, Modifying and Adding a Framework

A scenario framework was developed as part of the FPS effort, and revised based on two validation workshops for its suitability in evaluating scenarios. The initial framework was embedded in the original iteration of the FPS tool. The new iteration of the tool (FP Scenarios Version 2.0) was designed to more easily modify the framework based on user needs and requirements, or accommodate the addition of new drivers and variables to reflect changes in, for example, defence policy or the future security environment. Given this situation, the development of a second version of the FPS tool was required in order to improve the overall usability (i.e., easy to use) and utility (i.e., useful) to support building a comprehensive scenario set.

2.1 Selecting a Framework

1. The tool is set to execute the original FPS framework (Baseline Framework). On opening the tool, if there is no desire to either modify the baseline FPS framework or select an alternative framework, there is no need to select to this option on the main switchboard.

2. Once the tool opens, the first display is the main switchboard (Figure 3 below). It is the interface for navigating through all of the tool's main functions. If you need to return to a closed form, the switchboard will allow you to return to the necessary interface.

Figure 3: Main Switchboard

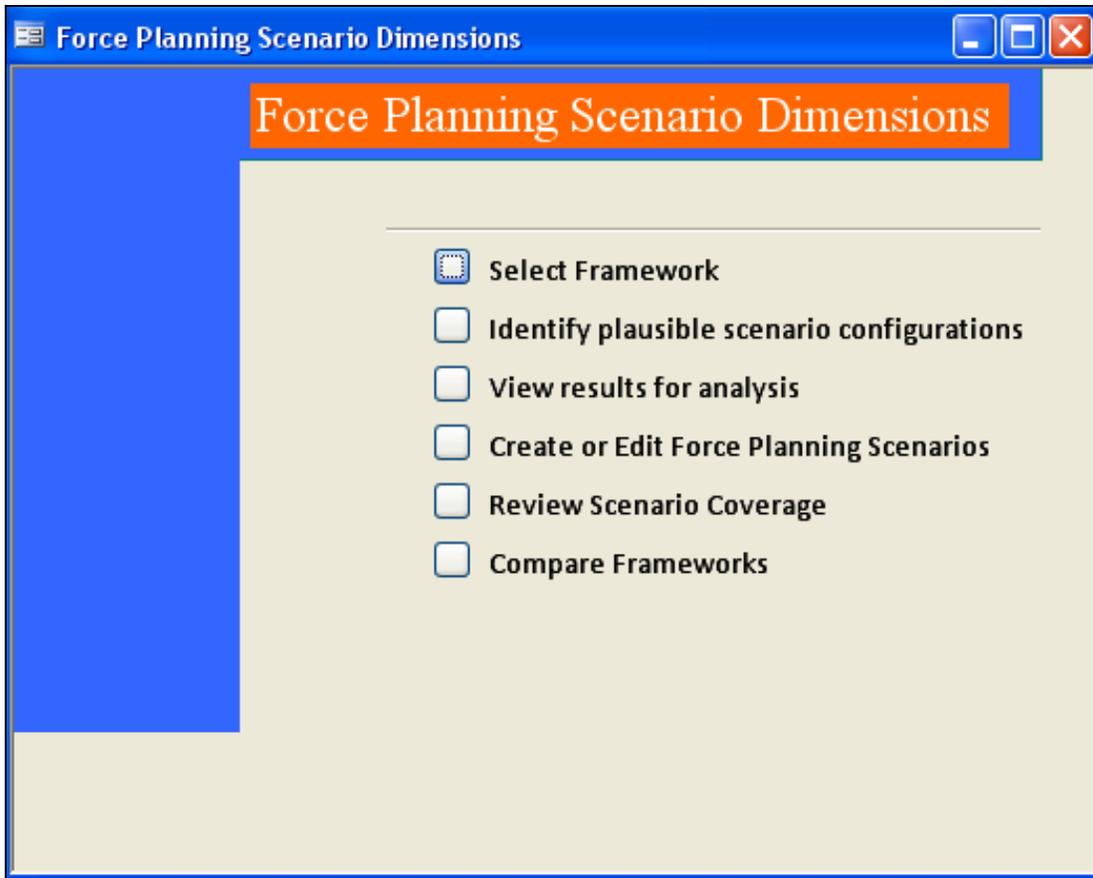3. To select an alternate framework or modify a framework, select the "Select Framework" option from the main switchboard. A new window will open, with a dropdown of all available frameworks (Figure 4).

4. Select a framework from the drop-down menu. Once selected, it is set as the active framework, and displayed at the bottom of the form. If there is no need to edit the framework, click "Exit".
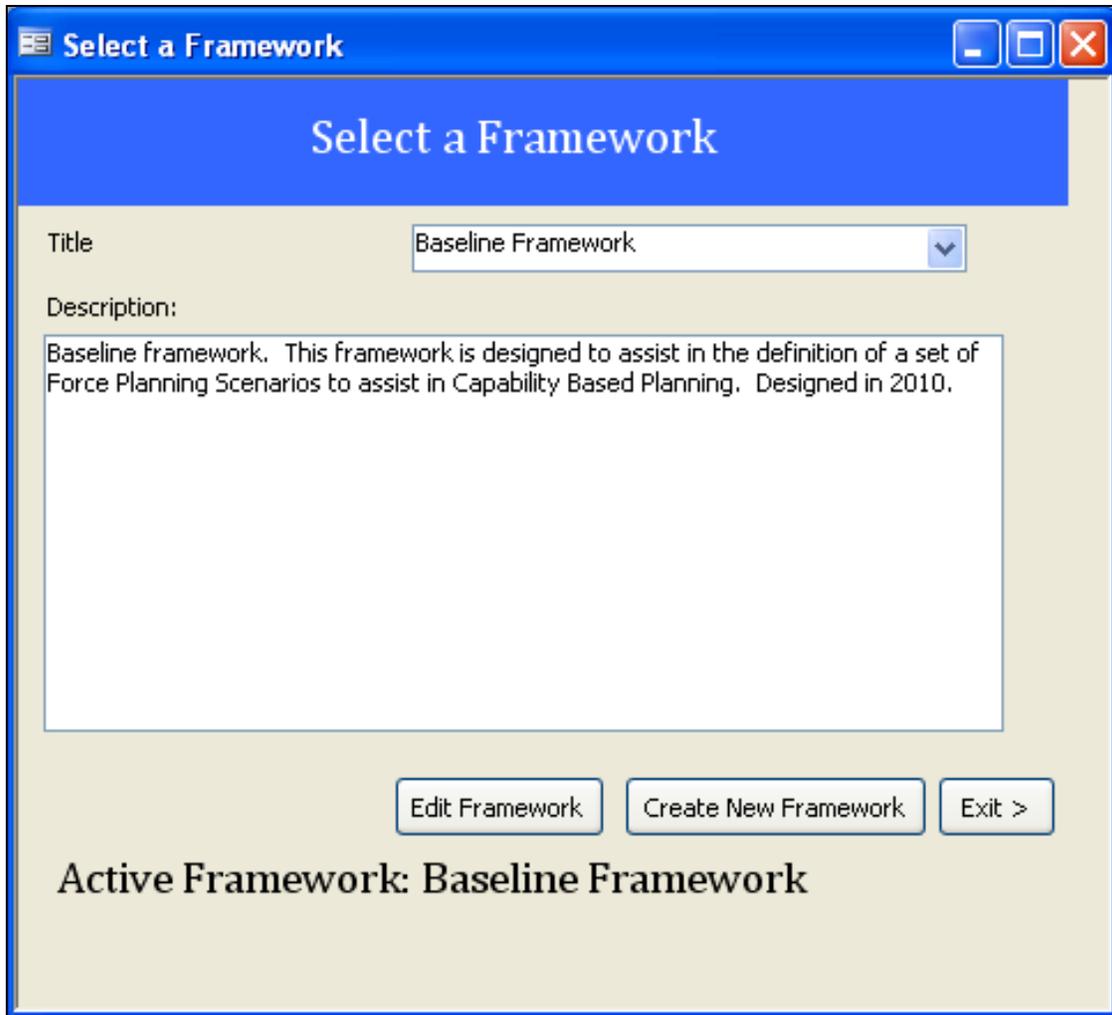
Figure 4: Select a Framework

5. Should you need to edit the framework, or to review the framework's contents, select "Edit Framework". A new window will appear displaying all of the dimensions, factors and variables within the framework (Figure 5).

6. The window opens with all dimensions along the left. The middle section displays all factors associated with the highlighted dimension. Likewise, the right side of the window displays the highlighted factor's variables. Clicking on a dimension or factor has a cascading effect, updating all three sections.
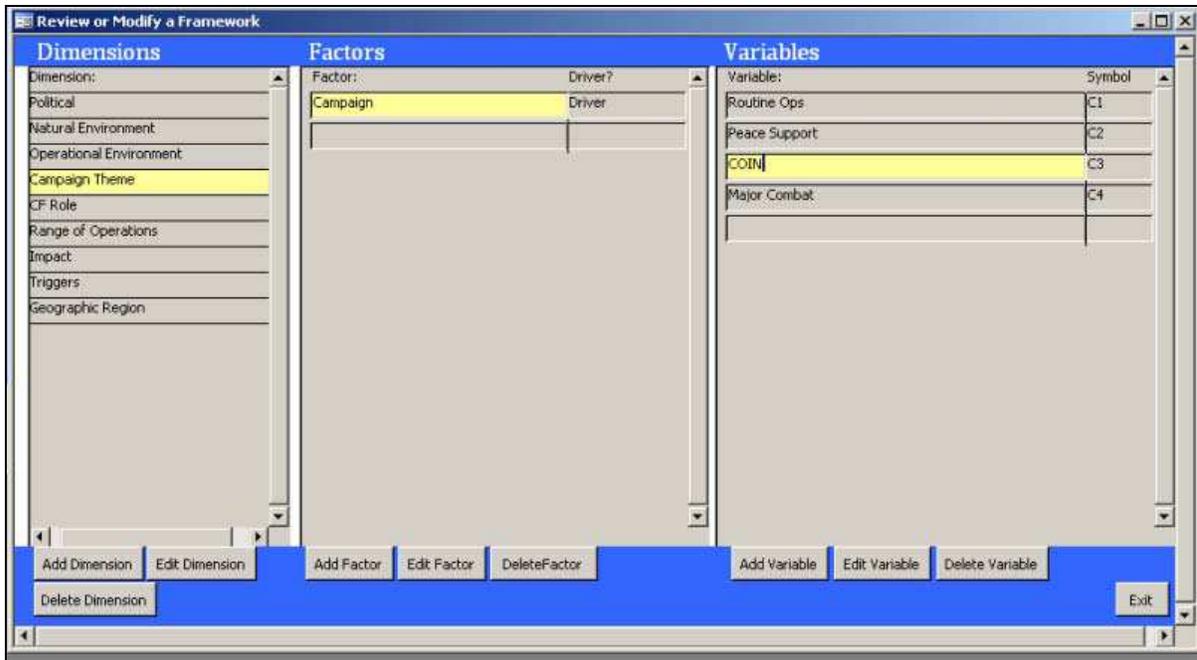
Figure 5: Review or Modify the selected framework

7. To add or modify a dimension, factor or variable, select the relevant button from the bottom of the screen. Each is added to the framework depending on the highlighted values in the open window. For example, by selecting "Add Dimension", a window opens to allow the user to add a new dimension to the selected framework. In the case of Figure 5, the selected framework is the baseline framework.

8. When modifying a dimension, factor or variable, the same window opens, but it includes the title and description of the highlighted element. Figure 6 demonstrates the editing of the Terrain factor. The separate window allows the user to change the title, description, or whether it is a driver, descriptor or derivative. Once complete, the factor can be saved by selecting "Save New Factor".
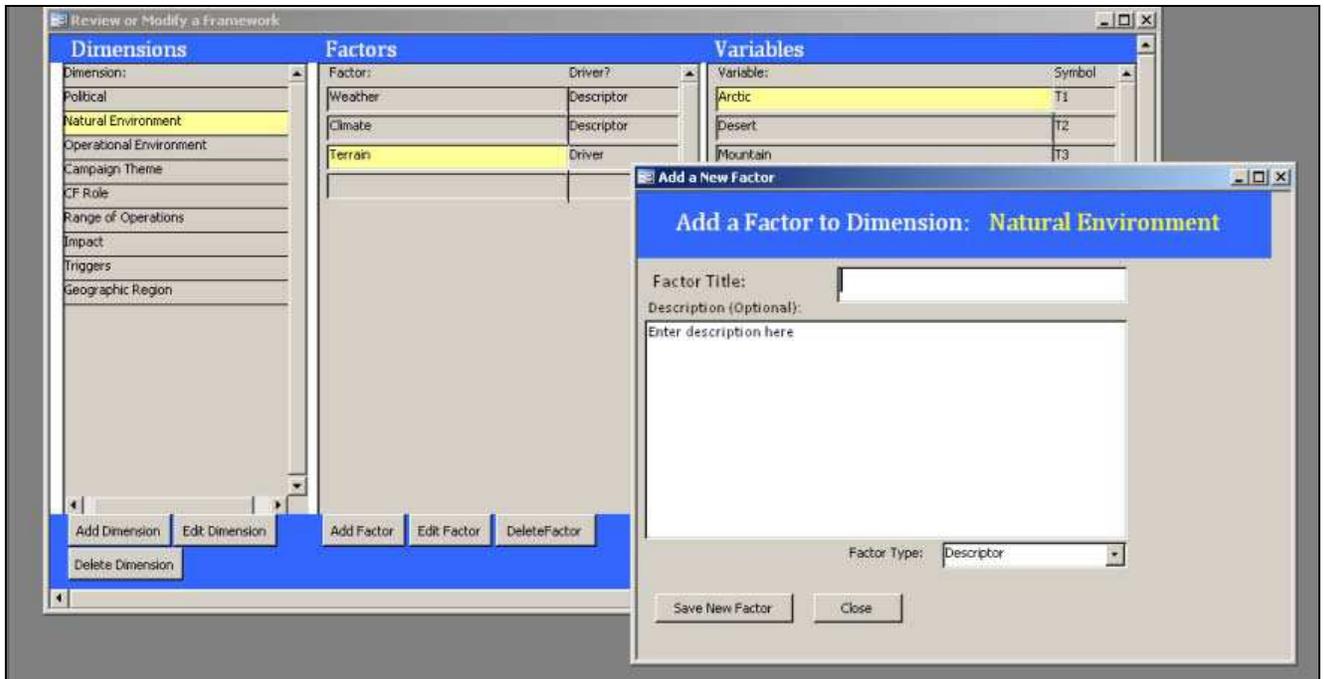
Figure 6: Edit Factor

9. When adding or editing a driver factor and its associated variables, that factor and its variables are added to the Field Anomaly Relaxation process, outlined in Section 3. For any variables associated with a driver factor, a symbol needs to be added to allow for identification within the matrix. The default symbol for all new variables is "nil".

10. When deleting a dimension, factor or variable, a pop-up window will be displayed, prompting the user to acknowledge the deletion. Deletion of a dimension will delete any associated factors and variables. When deleting a factor, all associated variables are also removed from the database. Variables, when deleted, are removed from three separate tables: the main variables table ("tblVariables"); the variable matrix table, where FAR results are retained ("tblVariableMatrix"); and the scenario table, where all Force Planning Scenarios characterizations are stored ("tbl_FPS"). As such, the user will receive three separate prompts when deleting variables.

11. Once the framework editing is complete, click "Close" to return to the main switchboard.

3 Scenario Analysis using the FPS Framework

The baseline FPS Framework was developed to support the sorting and filtering, displaying, searching, analyzing and selecting of scenarios. It was designed to be expanded and extended to capture new information and scenarios, and grow to meet new users and new requirements. It was realized early on that a relational database would provide the ability to manipulate data related to individual scenarios and support analysis. The database within the FPS Framework application was configured with the same hierarchical relationships as the FPS Framework outlined in the project report. The highest level in a framework is the *dimensions*, which decompose into *factors* and *variables* as illustrated in Figure 7. The factors are also grouped as drivers (red), descriptors (green) and derivatives (yellow) within the framework.
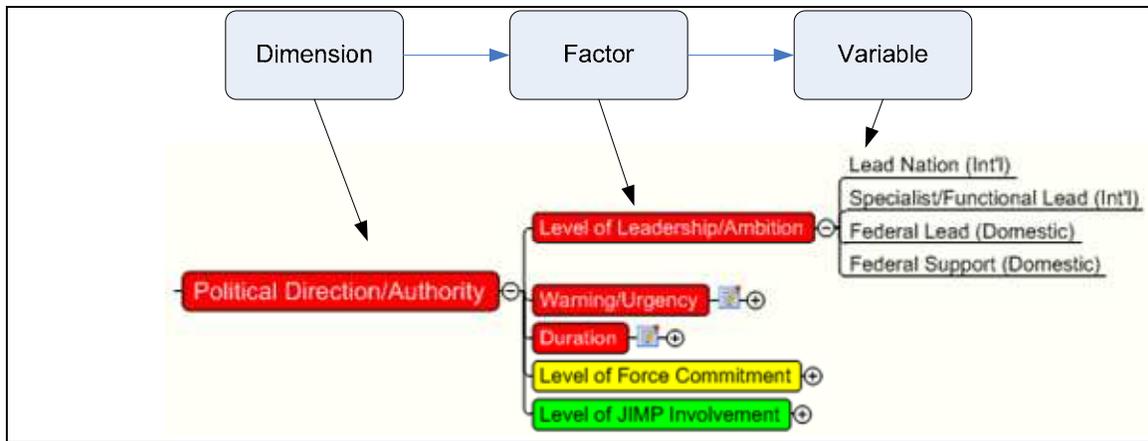
Figure 7: Framework Decomposition

To identify the range of plausible scenarios for developing the FPS set, this tool was designed to employ FAR methods. A form of MA, FAR involves a process of both pair-wise comparisons and filtrations to arrive at a final set of plausible scenario combinations. This process allows for the identification of all logical scenario combinations across a range of sectors and factors. The FAR process has four steps, as shown in Figure 8.
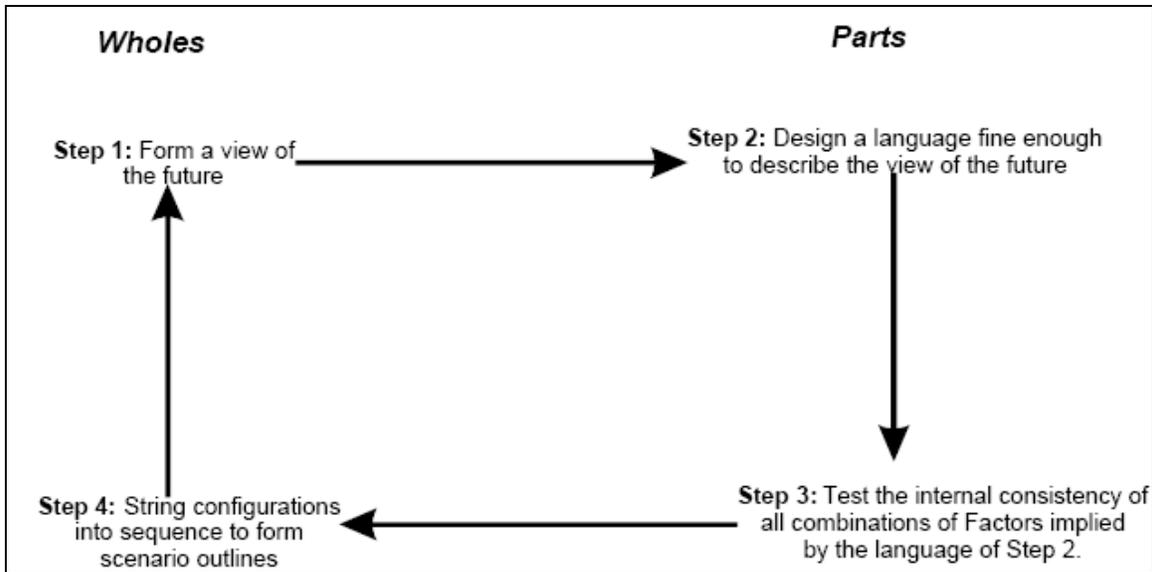
Figure 8: FAR Process

The tool applies FAR, in a modified form, to identify of a set of plausible scenarios. The first step is outlined by policy and doctrine, and is treated as an input into the development of the FPS Framework. For example, the Canada First Defence Strategy (CFDS) provided the initial insight and assumptions into the dimensions to be used for FAR. For step two of the process, the future is described by applying the dimensions, factors and variables from the FPS Framework.

The typical FAR taxonomy is not used within this study; however, this has no impact on the analytical process. A mapping of terms is included in Figure 9 below:
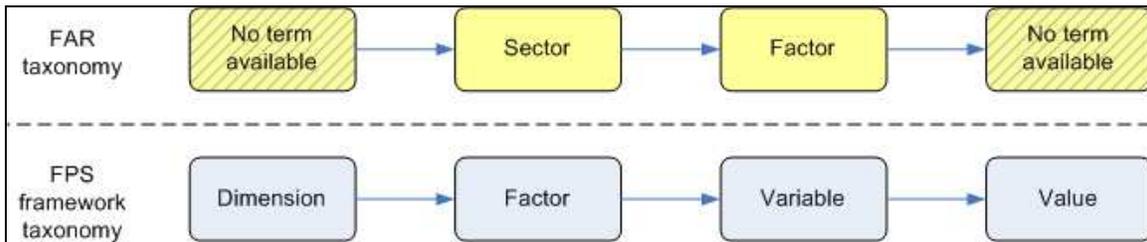
Figure 9: Comparison of FAR and FPS Taxonomy

For the third step, the internal consistency of combinations is evaluated through pair-wise comparisons. This constitutes the bulk of the analytical process, with each variable within a given factor being compared against every other driving factor within the framework. A compatibility value is then assigned to the comparison. For example, a routine operation in desert terrain may be seen as incompatible, receiving a value of 0, whereas a counter-insurgency (COIN) campaign in the desert may receive a value of 3 or 4.

The fourth and final step of the FAR process is the analysis of combinations to form scenario outlines. This step is not adhered to along strict FAR guidelines, as scenarios are not grouped

using Faustian trees or other mechanisms. Rather, those variables deemed of greatest significance are displayed to then be adopted into the FPS framework.

3.1 Identifying Plausible Scenario Combinations

1. To initiate FAR, select "Identify plausible scenario combos" from the main dashboard. This will open the FAR switchboard, (Figure 10). This page displays all of the factors specified as "drivers" in the framework. In the Baseline framework, six of the eleven factors are designated as drivers.
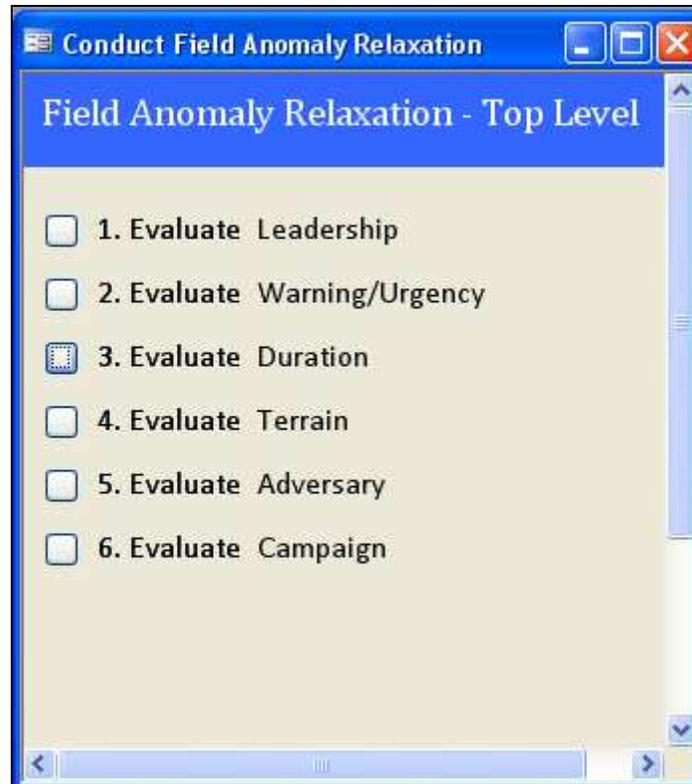
Figure 10: FAR Main Switchboard

2. Within the FAR main switchboard, the user has access to evaluate each of the drivers. The switchboard groups the pair-wise comparison sessions by factor. Figure 11 illustrates the selection of the Leadership factor for comparison against the other five driver factors. The last factor will not allow any further comparison, as it will have been evaluated against all others. While the driver factor comparisons do not have to be conducted in the order of appearance, it is advisable as it ensures completeness. The sessions within each group become progressively shorter, as each comparison only occurs once. Select "Evaluate Leadership" from the switchboard to open the Leadership-specific interface. This second-level display allows access to all the pair-wise comparisons for the FAR process.
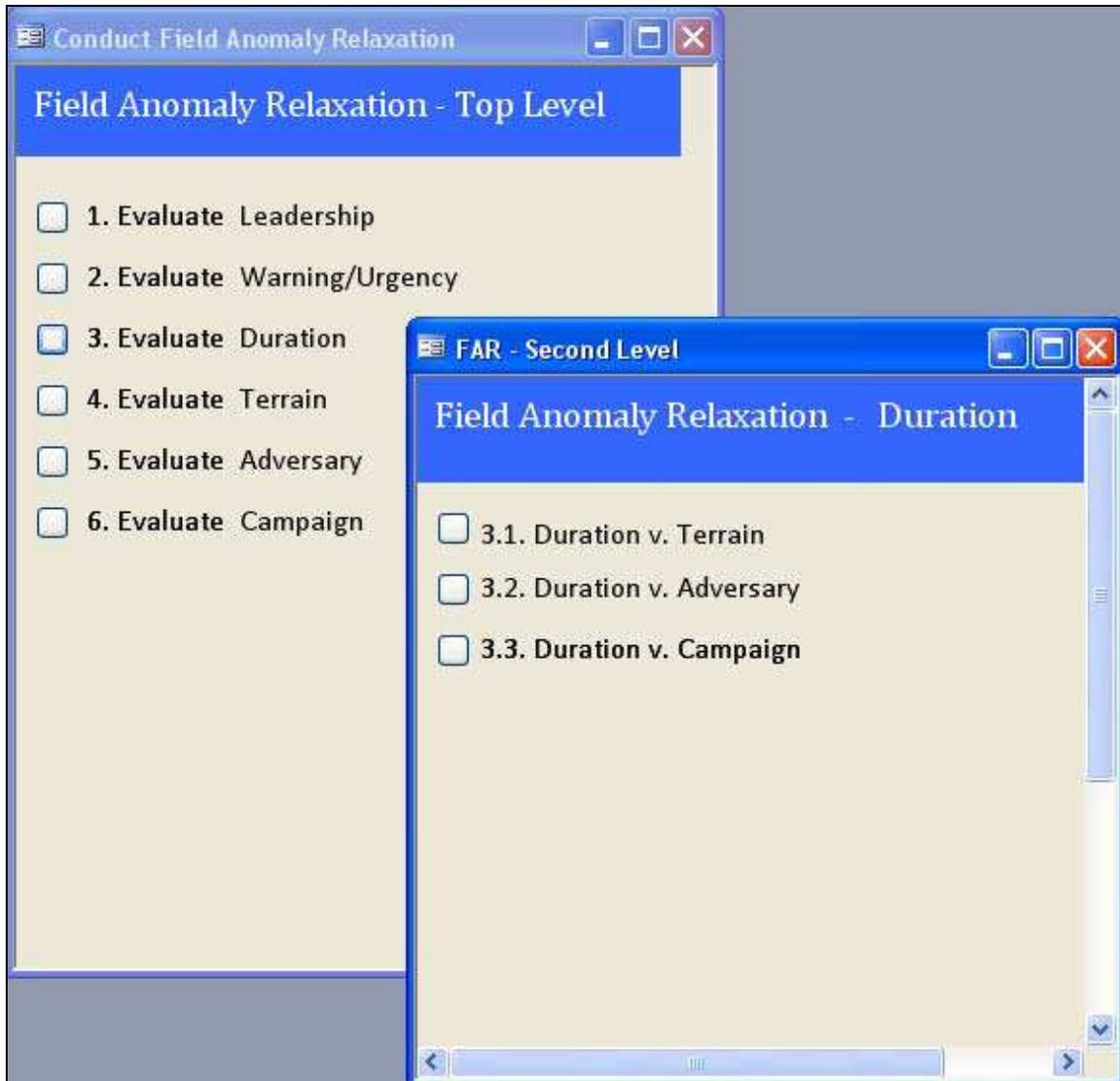
Figure 11: Session-specific Switchboard for Evaluate Leadership

3. The session-specific interfaces, as shown in Figure 12: Conduct Pair-wise Comparisons – Leadership and Terrain, are used to conduct pair-wise comparison. Traditional MA involves a binary selection (Yes/No, True/False, Compatible/Incompatible). As mentioned above, this FAR process uses relative plausibility values, similar to the Batelle Approach.[2] Each variable associated with a given factor, is assigned by the user a plausibility value from 0-4:

> 0 – Highly Implausible/Impossible;
>
> 1 – Implausible;
>
> 2 – Somewhat Plausible;

---

[2] Nguyen, M. –T. and M. Dunn. "Some Methods for Scenario Analysis in Defence Strategic Planning". Australian Defence Science and Technology Organisation, February 2009.

3 – Plausible; and

4 – Highly Plausible.

4. The pair-wise comparisons are conducted within a series of selections, where each comparison is assigned a plausibility value. In the example below in Figure 12, the two factors being compared are highlighted in blue (Leadership and Terrain). All of the variables for the Terrain factor are displayed against a single variable (Int'l Lead") from the Leadership factor. The combination of variables considered to have no possibility would be assigned a plausibility value of zero by the user. By assigning this zero value, the variable is not included in the matrix for further comparison. For instance, if it is considered that the CF would not possibly take on the role of "international lead" in an "ocean" environment, the plausibility value of 0 would be selected instead of the value 2 as indicated. Each variable must be given a value. A systematic approach is recommended to avoid error. Update each value and click "Next" until a message alerts the user they have reached the last variable for the first factor.
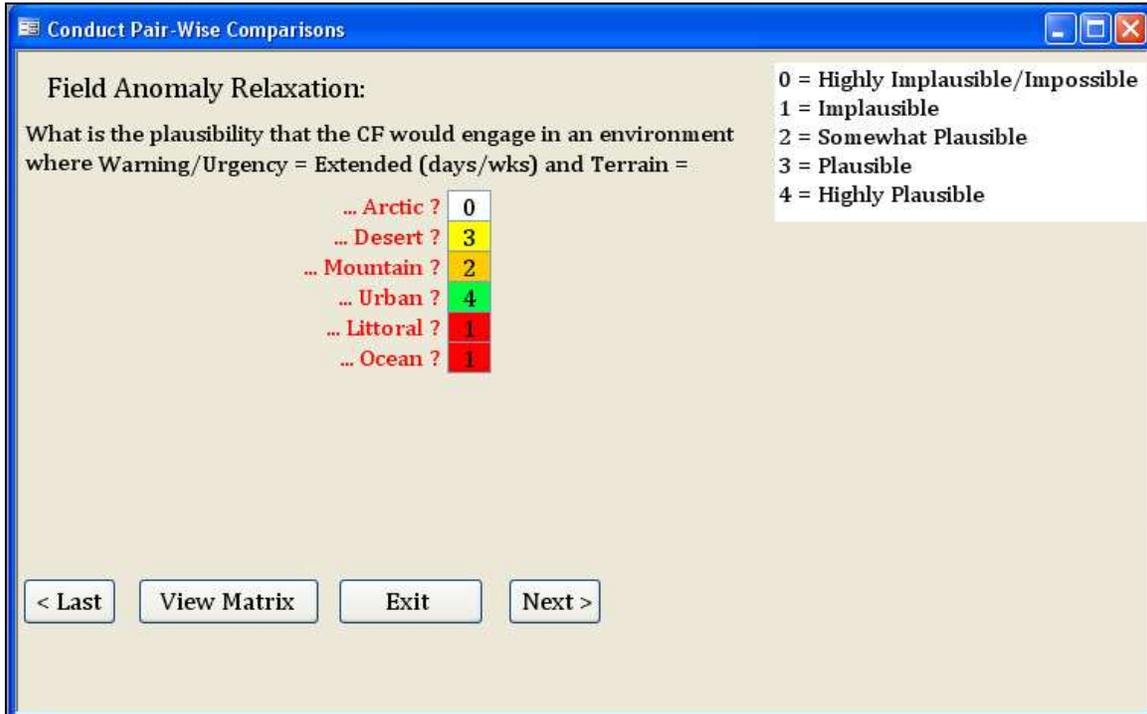
Figure 12: Conduct Pair-wise Comparisons - Leadership and Terrain

5. Evaluate wholeness of comparisons. After populating the matrix with plausibility values, the whole set of plausible scenarios can be displayed and filtered. A plausible scenario is made up of one variable from each factor, and includes no plausibility values of zero. Within the FPS Framework, there are six driver factors: Campaign Themes; Terrain; Military - Red Force (a.k.a. "Adversary"); Political Leadership/Authority; Duration and Warning. Each scenario is a combination of these variables, such as $C_1 M_1 T_1 L_1 D_1 W_1$. As a result, there

are 15 plausibility values that are assessed and averaged for each scenario combination. For example, the feasibility value for scenario $C_1 M_1 T_1 L_1 D_1 W_1$:

$$= [(C_1M_1) + (C_1T_1) + (C_1L_1) + (C_1D_1) + (C_1W_1) + (M_1 T_1) + (M_1L_1) + (M_1 D_1) + (M_1 W_1) + (T_1 L_1) + (T_1 D_1) + (T_1 W_1) + (L_1 D_1) + (L_1 W_1) + (D_1 W_1)] * [2/(5 * 6)]$$

6. The matrix of all pair-wise comparisons can be displayed at any time during the FAR process. This allows users who wish to see all pair-wise comparisons to do so. The matrix is the over-arching interface for reviewing modifying comparisons, allowing a final completeness and logic check. The matrix is displayed below in Figure 13. Unlike previous iterations of the tool, the data is only displayed on the bottom left hand side of the matrix, i.e. anything below where x = y.

7. Plausibility values can be edited in the Pairs Matrix. To make changes to the matrix, select the relevant box, enter a new plausibility value (0-4) and click "Save Matrix". The values will change colour, indicating that the table has been updated.
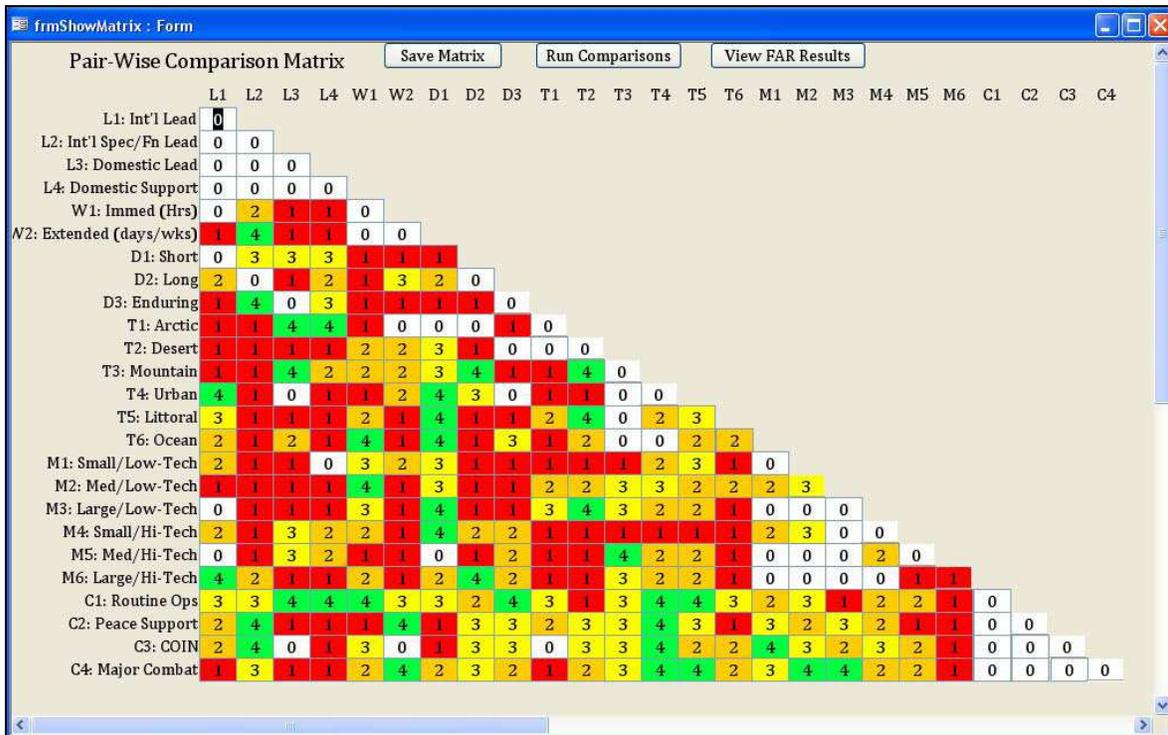

Figure 13: Pair-wise Comparison Matrix

8. From the matrix view, the user can run the comparisons to calculate the number of plausible scenarios. After clicking "Run Comparisons", the program will run calculations that will take anywhere from five seconds to a minute. A pop-up window will display the number of plausible scenarios.

9. Selecting "View FAR Results" from the pair-wise comparison page will open a window to an interactive graph. This graph allows the user to evaluate the relative plausibility of the different variables by percentage.

10. The graph represents the number of scenarios distributed along all variables of a selected factor. A drop-down menu, "Factor Name – X axis", is available to select any of the driver factors. Select the desired driver from the list.

11. This representation can then be filtered based on feasibility value (i.e. all scenario combinations with a feasibility value above "x"). The "Feasibility Value" drop-down menu includes a set range of potential threshold values. Select the appropriate feasibility value from the menu.

12. Click "Generate Results" to view the graph. If there has been no data based on the most recent comparisons, the graph will take a short time to load data based on the selection. A message will be displayed indicating the results are complete, and the number of plausible scenarios. The result is a histogram similar to the one shown in Figure 14.

13. Should the user wish to compare FAR results against case studies or Force Planning Scenarios, select the relevant check boxes on the upper-left area of the window and click "Generate Results".
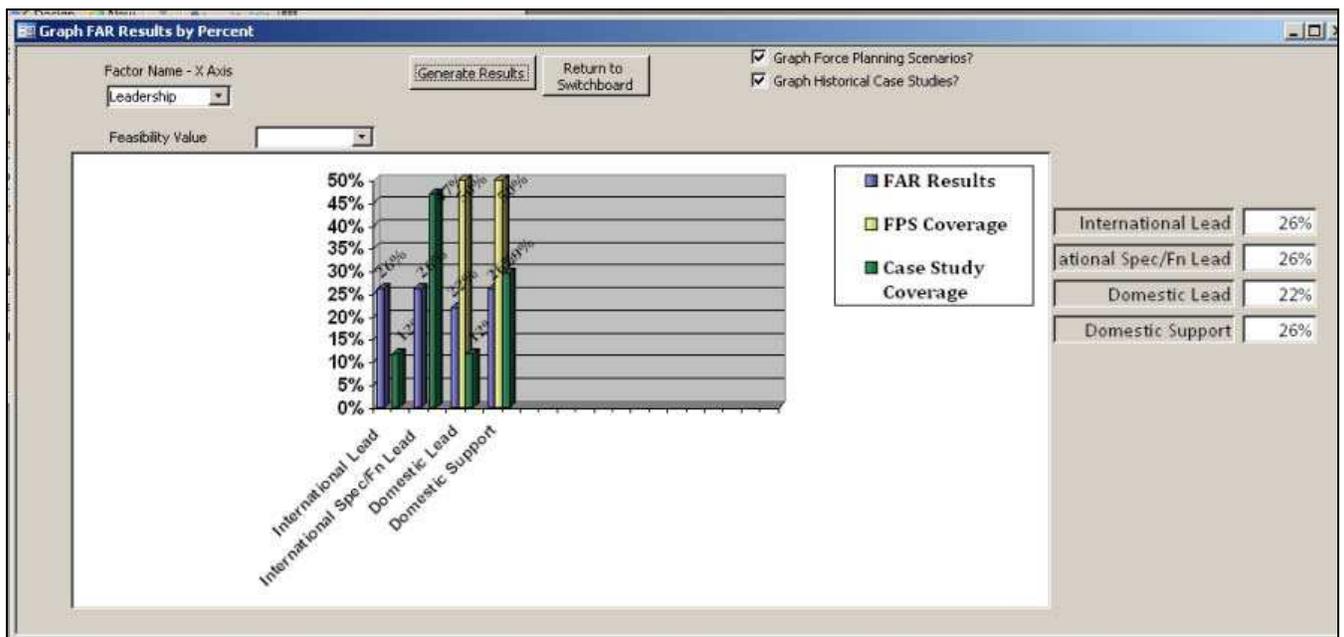

Figure 14: View FAR Results by percent coverage

The two check boxes provide the ability to compare FAR results against two other data sets: Force Planning Scenario Coverage and Case Study Coverage. FPS coverage will display all FPS within the database that is associated with the displayed variables. The advantage of this data is the user's ability to understand if the current FPS set is balanced when compared with FAR results. For example, if the FAR results place a higher relative weight on all leadership roles except "Domestic Lead", the FPS set should ensure that scenarios involving the other three leadership roles are used more often.

The case study coverage has a similar value to the FPS coverage, except the data is based on historical instances rather than future security considerations. Any case study within the database is displayed against its associated variables. These case studies are useful for understanding how analysis of the future security environment (FAR results) compares against past operations. If the results are significantly different, they can force to re-evaluate their pair-wise comparisons, or justify why the future security environment will differ from past trends. It is important that the user carefully evaluate the case studies within the database prior to drawing any conclusions to ensure historical assumptions are explicit and to avoid using a biased or incomplete sample set.

The data displayed will alter based on the feasibility value. The values include any feasible scenarios falling above the threshold set by the user. The most relevant variable by total scenarios is not necessarily the same as by weighted scenarios.

Framework analysis can also be reached from the main switchboard by selecting the "View results for analysis" button. This button opens a separate switchboard (Figure 15) that provides access to the matrix, as well as the graphical results by percent and total values. The former graph is the same as in Figure 14. The results by total value are the same, except the values are absolute (i.e., the total number of scenarios above a particular threshold value, broken down by variable). This data is valuable for conducting sensitivity analysis, as the user can see the variance in total number of scenarios at different threshold values. However, the numbers can be difficult to interpret, particularly when comparing FAR results against FPS or case studies, which typically have a much smaller sample size.
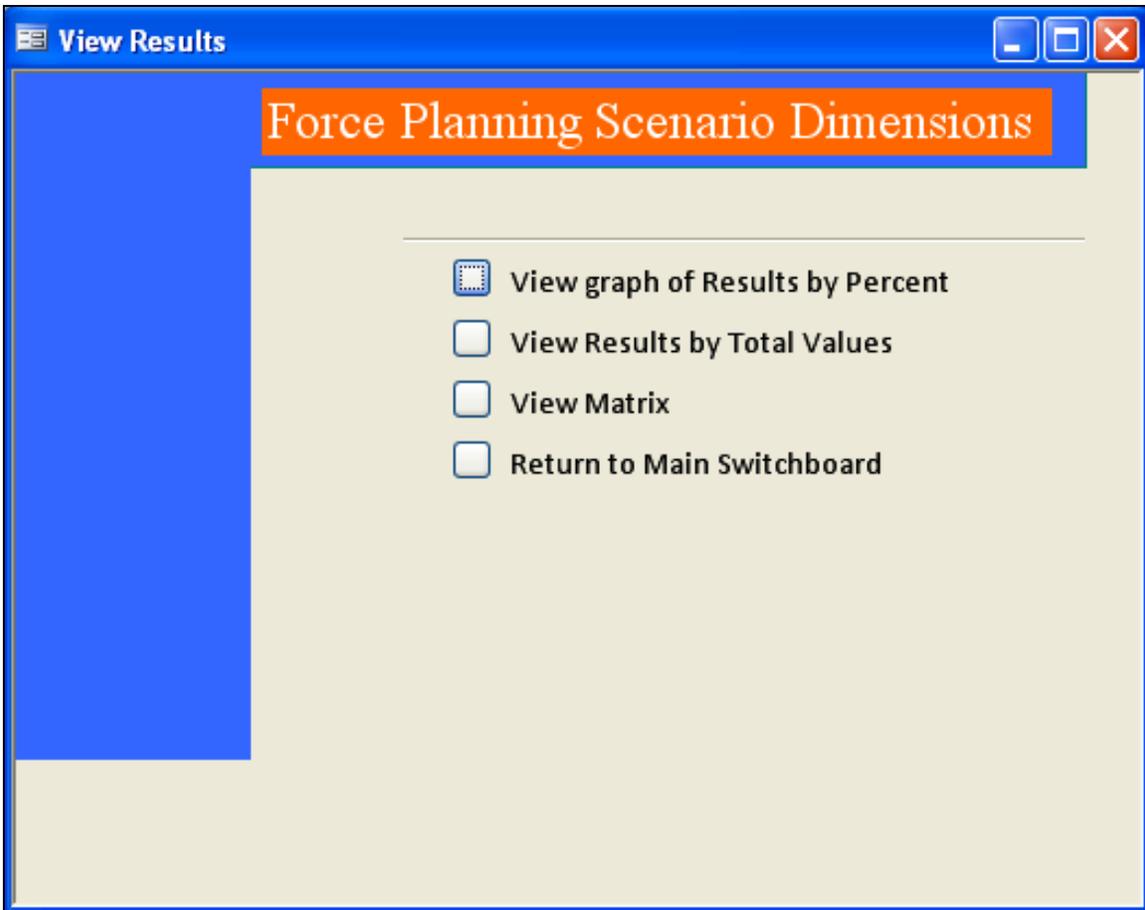
Figure 15: View Results for Analysis

4   Creating or Modifying a FPS Set

As mentioned earlier, this tool serves two key functions. The first function, identifying the range of plausible scenarios, was outlined in Section 3. This process should be completed prior to defining a particular scenario. The second function involves characterizing the FPS against all other dimensions, factors and variables.

The process of characterizing a FPS is similar to the FAR. Each FPS is characterized against all variables within a framework. However, instead of using a scalar value for each variable, a binary selection from all driver and descriptor factors is selected. Within the FAR process, scenario combinations were developed using one variable from each factor. The resulting scenario combinations were very narrow representations of reality. The Force Planning Scenario development involves the creation of scenario clusters, where each FPS is composed of several variables. For example, the FPS may describe a COIN campaign that involves desert, mountain and urban terrains, as well as multiple unique red force adversaries. This cluster thus involves several campaign combinations within the clustered FPS.

1. To create a FPS, select "Create or Edit Force Planning Scenarios" from the main switchboard. The tool then provides the ability to create a scenario, associate a scenario with a framework, and finally to characterize a scenario based on a framework's variables, as shown in Figure 16.

Figure 16: Scenario Development Switchboard

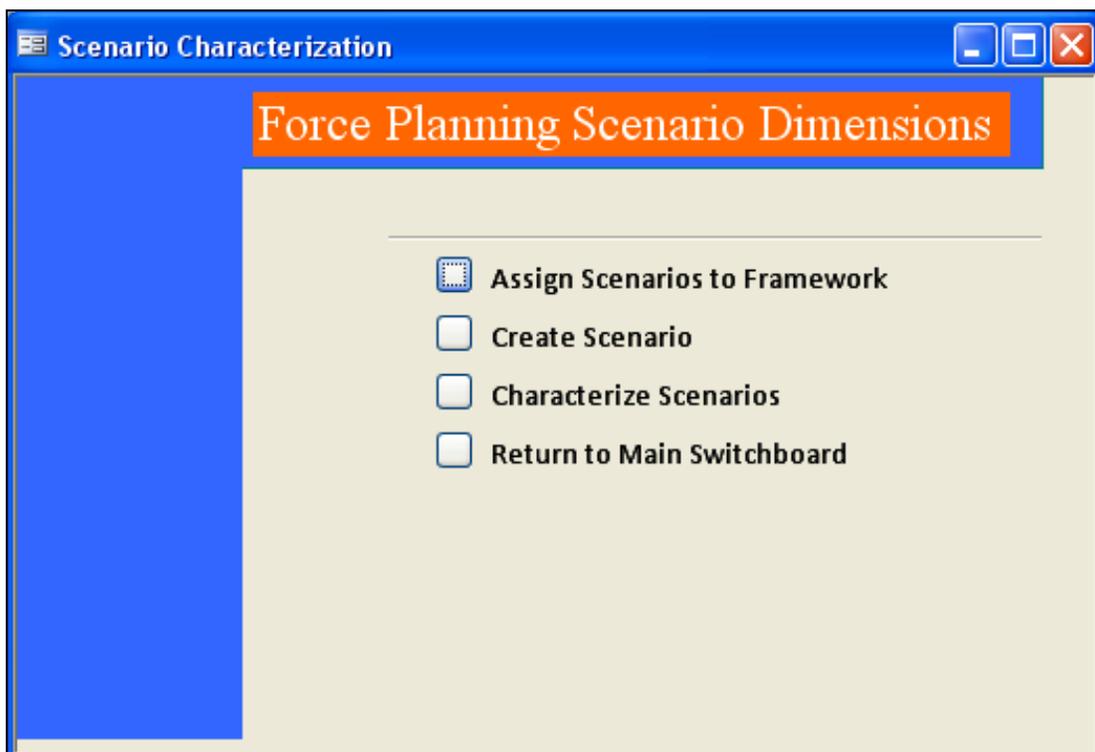2. To add a new scenario, click "Add Scenario". A separate window will open, where the user can enter a name and description (Figure 17). The current date will be automatically entered in the "Date Added" field. If the scenario is a case study and not a Force Planning Scenario, check "Case Study" and enter the year the historical operation took place. A description is optional, but advisable, as it will provide guidance when characterizing the scenario. Once complete, the scenario is automatically associated with the active framework, and can be characterized by clicking "Characterize FPS". Alternatively, clicking "Close" allows the user to return to the scenario switchboard.
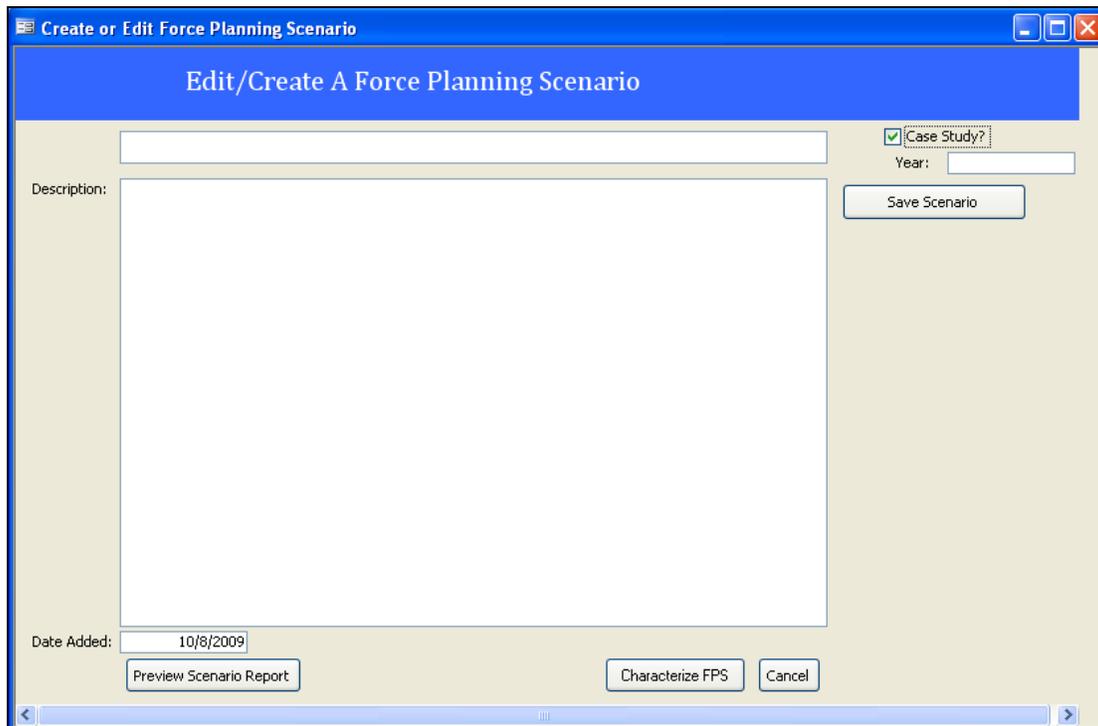
Figure 17: Create a Scenario

Each scenario exists independent of a particular framework. It can be characterized against any or all frameworks, depending upon user requirements. In order to facilitate the characterization process, an additional step has been added to allow the user to associate scenarios already in the database with a new framework. For example, if there is a desire to characterize a pre-existing FPS with the NATO expeditionary operations framework, the user can then associate have the same FPS with both frameworks. Only those scenarios associated with a particular framework will be used to calculate FPS coverage.

3. From the scenario interface, select "Assign Scenarios to Framework". A new window will appear, displaying all scenarios currently in the database (Figure 18). The left-hand side of the screen will display all scenarios not associated with the active framework. The right-hand side of the screen will display all scenarios associated with the active framework. For a new framework, the right-hand side will be empty.
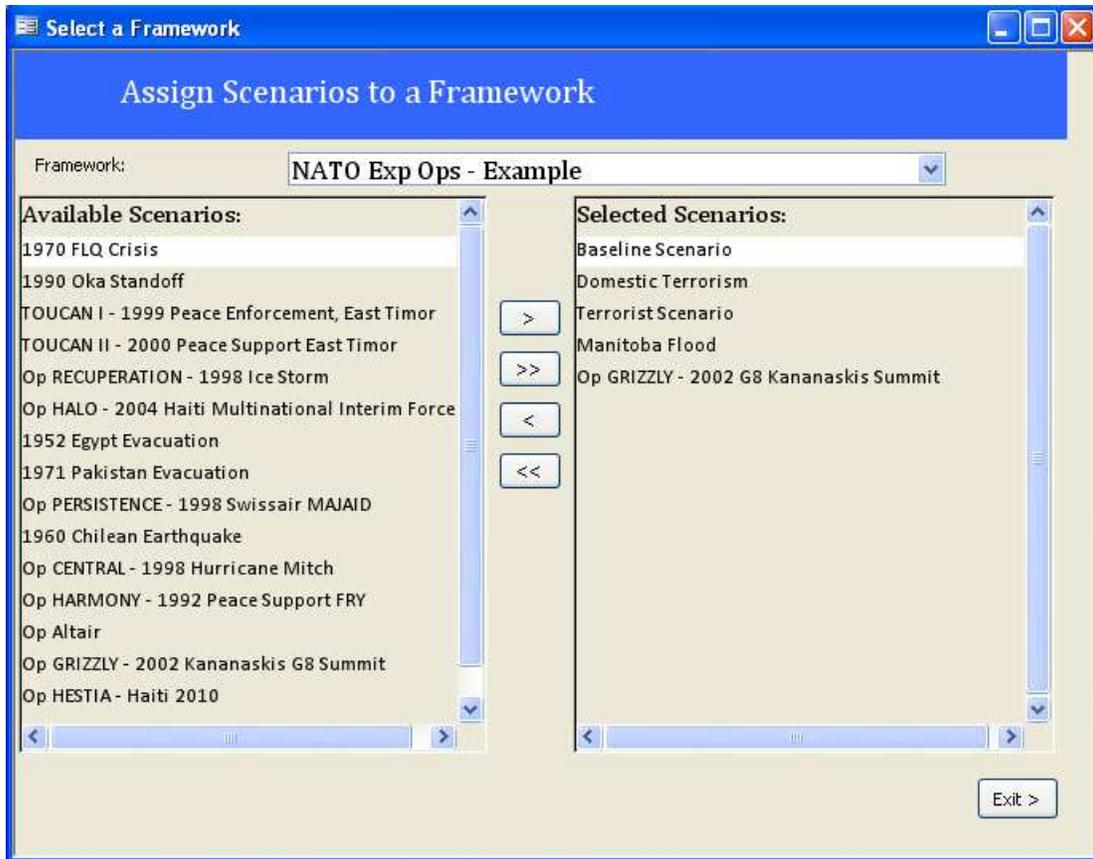
Figure 18: Assign Scenarios to Framework

4. To associate a particular scenario with the active framework, ensure it is selected from the drop-down at the top of the page (the active framework is automatically displayed, but any framework can be manually selected). For a given scenario, select it from the left-hand side (it will highlight) and click ">" to move it to the right-hand side. Once a scenario has been displayed on the right-hand side, it has been successfully associated with the selected framework. To disassociate a scenario from a framework, highlight the scenario on the right-hand side and click "<".

5. To associate all scenarios with a selected framework, select ">>". All scenarios will then be displayed on the right-hand side of the page. Again, to reverse the process and disassociate all scenarios, select "<<".

6. Once complete, click "Exit" to return to the scenario switchboard.

7. The FPS main interface will be displayed, as seen in Figure 16.

Figure 19: Scenario Builder

The scenario design page is similar to the "Edit Framework" interface (see Figure 19). The dimensions, factors and variables all change depending on user selection. Along the far right hand side of the page are a series of check boxes. These check boxes allow the user to characterize a particular scenario.

8. The top of the page allows the user to select any existing scenario from the repository. This includes the tombstone data (i.e., name, description) of the scenario. Select from the set of scenarios using the drop-down. To view the description, click the yellow description box, which will expand the description. To minimize, click the up arrow above the yellow box.

9. Once all forms have been populated, the results can be printed as a report. To view the report, click "Preview Scenario Report". The report for the current scenario will display. In addition, a separate window will open with a drop-down for every scenario. Any scenario can be selected for viewing. Click "View All Characteristics", and a report is generated automatically, including all relevant variables for the given scenario. An example report is included in Figure 20**.**

The Baseline Scenario reflects the ongoing domestic operations and activities that represent a major portion of the CF peacetime routine.

The CFDS specifies benchmark activities that must be accomplished to achieve the strategic goals. For 'excellence at home' the CF must be able to: provide surveillance of Canadian territory and air and maritime approaches; maintain search and rescue response capabilities that are able to reach those in distress anywhere in Canada on a 24/7 basis; and, assist civil authorities in responding to a wide range of threats—from natural disasters to terrorist attacks. For the goal of being a 'strong and reliable defence partner' the benchmarks are: conduct daily continental operations (including through the North American Aerospace Defense Command (NORAD)); carry out bilateral training and exercises with the United States; respond to crises; and, remain interoperable with the US military. For the final goal of 'projecting leadership abroad' the benchmark capabilities set by the GoC are: maintain combat-capable units at the right level of readiness; provide deployed personnel with the right mix of equipment so they can take part, on their own or with allies, in the full spectrum of operations; and, work closely and develop a coherent overarching strategy with departmental partners. [Quotations from Canada First Defence Strategy]

The baseline scenario includes elements from the full range of CFDS tasks, as it is assumed that the CF will maintain its capability to engage in all of the CFDS missions. Baseline activities will all be routine in nature, though they will contribute to all of the CF roles. As lead government department for Search and Rescue (SAR), the CF will be responsible for operating in all Canadian terrain and climates. There are no adversaries identified.

The basline activities would include:

Routine and targeted surveillance and control of Atlantic, Pacific and Arctic maritime areas of jurisdiction and approaches (surface and subsurface) in concert with Other Government Departments
Routine and targeted surveillance and control of Canadian territory and airspace in concert with Other Government Departments
Fusion of integrated CF intelligence with the Government of Canada Integrated Threat Assessment Centre
Strategic, operational and tactical mobility within the Canadian operational theatre
Secure operating bases across the country
Reliable, robust and efficient communications nation-wide
Interoperability with OGDs including the Government Operations Centre
Readily deployable general and specialist forces for domestic contingencies including natural and man-made disasters, counter-terrorism, WMD response, critical infrastructure protection, and Aid of the Civil Power.

Scenario Title: Baseline Scenario

Political
Leadership
☐ Int'l Lead
☐ Int'l Spec/Fn Lead
☑ Domestic Lead
☑ Domestic Support

Political
Warning/Urgency
☐ Immed (Hrs)
☐ Extended (days/wks)

Political
Duration
☐ Short
☐ Long
☑ Enduring

Natural Environment
Weather
☐ High Visibility   ☐ Wind - Low
☐ Low Visibility   ☐ Clouds - Dense
☐ Precipitation - Rain ☐ Clouds - Sparse/Nil
☐ Precipitation - Fog
☐ Precipitation - Snow
☐ Temperature - Hot
☐ Temperature - Temperate
☐ Temperature - Cold
☐ Wind - High

Scenario Title: Baseline Scenario

Natural Environment
Climate
- ☐ Arid
- ☑ Arctic
- ☐ Temperate
- ☐ Tropical

Natural Environment
Terrain
- ☑ Arctic
- ☑ Desert
- ☐ Mountain
- ☐ Urban
- ☐ Littoral
- ☑ Ocean

Operational Environment
Political
- ☐ Collapsed Governance
- ☐ Failing Governance
- ☑ Stable Governance
- ☑ Permissive Public Support
- ☐ Non-permissive Public Support

Operational Environment
Military - Brown
- ☐ Brown Small/Low-Tech
- ☐ Brown Small/Hi-Tech
- ☐ Brown Medium/Low-Tech
- ☐ Brown Medium/Hi-Tech
- ☐ Brown Large/Low-Tech
- ☐ Brown Large/Hi-Tech

Scenario Title: Baseline Scenario

Operational Environment
Economic
- ☐ Impoverished
- ☑ Developing
- ☐ Affluent

Operational Environment
Social
- ☑ Dense Population Density
- ☑ Sparse Population Density
- ☐ Homogeneous Population fragmentation
- ☑ Heterogeneous Population fragmentation
- ☐ High Normative violence
- ☑ Low Normative Violence

Operational Environment
Infrastructure
- ☑ Mature
- ☐ Immature

Operational Environment
Information
- ☑ Developed Infostructure
- ☑ Poor/Developing Infostructure

Scenario Title: Baseline Scenario

Operational Environment
Military - Green
- ☐ Green Small/Low-Tech
- ☑ Green Small/Hi-Tech
- ☑ Green Medium/Low-Tech
- ☑ Green Medium/Hi-Tech
- ☑ Green Large/Low-Tech
- ☑ Green Large/Hi-Tech

Operational Environment
Adversary
- ☐ Small/Low-Tech
- ☐ Med/Low-Tech
- ☐ Large/Low-Tech
- ☐ Small/Hi-Tech
- ☐ Med/Hi-Tech
- ☐ Large/Hi-Tech

Campaign Theme
Campaign
- ☑ Routine Ops
- ☐ Peace Support
- ☐ COIN
- ☐ Major Combat

CF Role
CF Role
- ☑ Defend Canada
- ☑ Defend North America
- ☐ Contribute to Int'l Peace and Security

Scenario Title: Baseline Scenario

Range of Operations
Range of Operatio
- [ ] Collective Defence
- [ ] Counter-terror
- [x] Enforcement Operations
- [ ] Defence Lines of Communication
- [ ] Consequence Management
- [ ] Peace Enforcement
- [ ] Peacekeeping
- [x] Surveillance and Monitoring
- [ ] Non-combatant Evacuation Operations
- [ ] Conflict Prevention
- [ ] Humanitarian Assistance
- [ ] Search and Rescue
- [ ] Support to Major Events

Impact
Psychosocial
- [ ] Displaced persons - significant
- [ ] Displaced persons - low/insignificant
- [ ] Casualties and Fatalities (pre-mission) - Hi
- [ ] Casualties and Fatalities (pre-mission) - Lo

Impact
Physical
- [ ] Infrastructural impact - Negligible/None
- [ ] Infrastructural impact - Significant/Devast
- [ ] Economic impact - Negligible/None
- [ ] Economic impact - Significant/Devastating
- [ ] Environmental Impact - Negligible/None
- [ ] Environmental Impact - Significant/Devast

Triggers
Natural Hazards
- [ ] Geophysical - Earthquakes and landslides
- [ ] Geophysical - Tsunamis and tidal waves
- [ ] Meteorological - Wildfires
- [ ] Meteorological - Hurricanes/cyclones
- [ ] Meteorological - Ice Storms and Blizzards

Scenario Title: Baseline Scenario

Triggers
Man-Made Disaste
- [ ] Inter-state violence
- [ ] Intra-state violence
- [ ] CBRN Incident
- [ ] Mass population movement

Geographic Region
Western Hemisphe
- [x] Canada
- [x] North America
- [ ] South America
- [ ] Africa
- [ ] Europe

Geographic Region
Eastern Hemispher
- [ ] E Asia
- [ ] W Asia
- [ ] Pacific

Figure 20: Excerpts from Scenario Report - Baseline Scenario

10. The report can also be generated from the switchboard. After selecting "Create or Edit Force Planning Scenarios" from the main switchboard, select "Generate Scenario Report". An additional switchboard opens with two main options. The first, "Create Generic Scenario Report", allows access to the scenario drop-down in Figure 21. The second, "Custom Report – Baseline Scenario", builds the customized report developed for the original baseline scenario framework, as indicated in Figure 22.
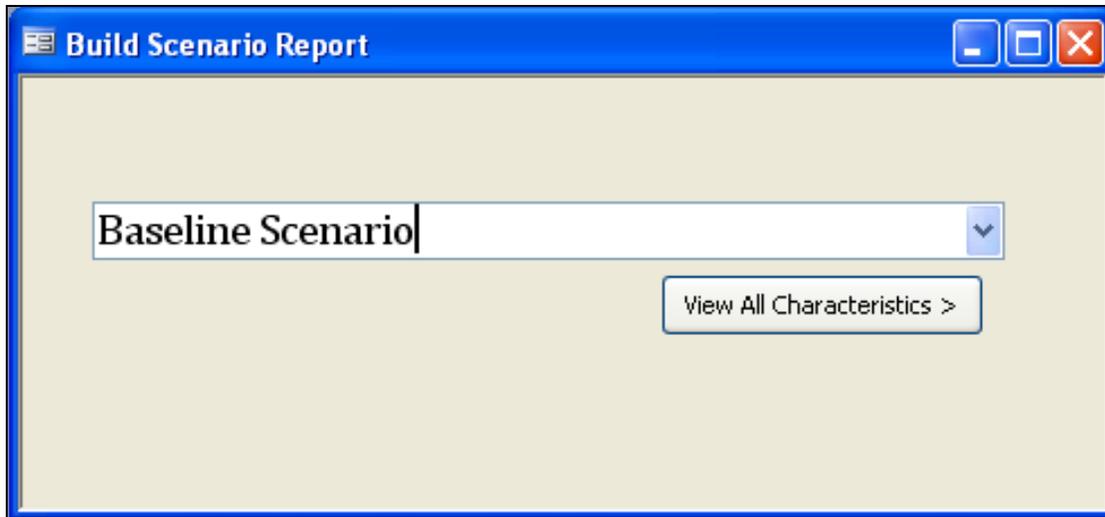
Figure 21: Scenario Report Builder
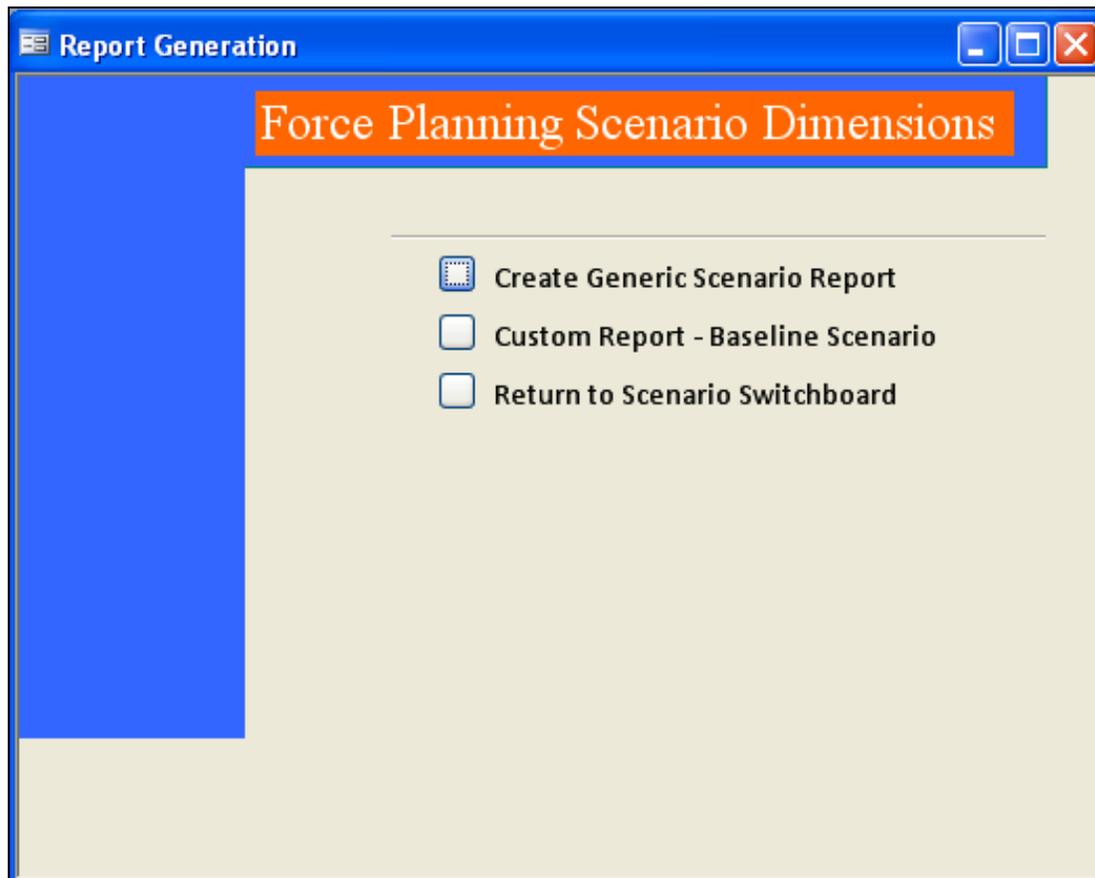
Figure 22: Report Generation Switchboard

11. To view how the updated FPS affects coverage, the same analytical process applies as in Section 2. Return to the main switchboard and select "View Results for Analysis" to access the same interactive graphs.

5   Compare Frameworks

An added feature of the FPS tool is the ability to evaluate the results of two separate frameworks. The process is similar to evaluating a single framework, with a few additional steps to pull relevant data on a separate framework.

1. From the main switchboard, select "Compare Frameworks".   A window with two blank graphs will open.

2. As with the previous graph, select the relevant factor and feasibility value for the active framework on the left graph. Click "Generate Results" to populate the graph. The graph will display the data, and below the graph will appear the percentage and total values for the related variables.

3. To compare the information against a second framework, select a framework from the drop-down menu. This will populate the factor drop-down with all driver factors for that particular framework. Select the relevant factor and click "Compare Frameworks".

As with the other graph, the variable data is visible both in the graph and in the fields below. An example has been generated using NATO's Expeditionary Operations framework as a template.[3] The data is representative data used for illustration purposes. The graph and results can be seen in Figure 23.
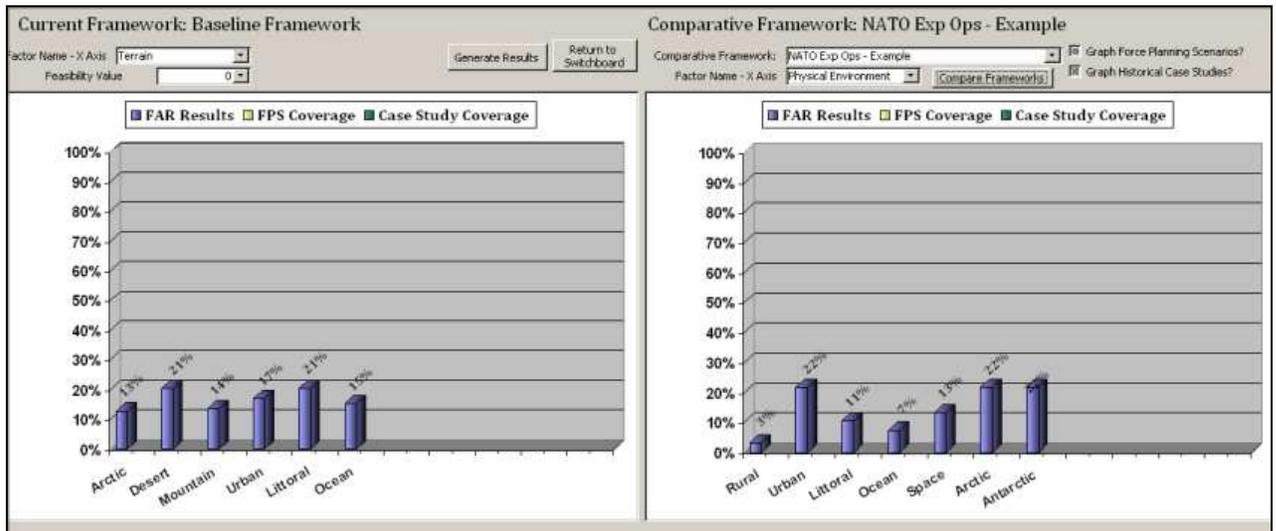
Figure 23: Compare Frameworks

---

[3] Sue Collins and Simon Purton, *Characteristics of Expeditionary Operations* (NATO RTO-TR-SAS-075), December 2009.

6   Conclusion and Future Development

This document has described the capabilities and functionalities of the analytical tool for the defence force planning scenarios. The analytical rigour of analyzing scenarios provides a method for selecting and justifying scenario development and evolution to meet Capability Based Planning. This application is designed to apply the FPS framework in its current form. However, the framework is designed to evolve based on new research and users. This guidebook will need to be updated as changes are made to the tool, for instance to reflect the evolution of defence policy, government priorities and targeting of military capability gaps, technology and response. It is hoped that this tool will evolve based on such research and be adopted to serve a larger audience. The Concept Development and Operational Research and Analysis Team continues to refine and evolve the analytical tool as a web-based platform. The tool has been validated with end users in a series of workshops, and populated with historical case studies to facilitate analysis. The framework and analytical tool is "fitted for but not with" a capability to support mission analysis and relate capabilities to scenarios. This capability might be added at a later time.

This page intentionally left blank.

Annex A Programmer's Guide

This guide is designed to provide a means to understand the core algorithms of the FPS tool. Not all code is included in this guide – only those core elements necessary to understand the architecture. The annotations are included in the tool itself. To best understand these algorithms, the reader should be familiar with both Structured Query Language (SQL) and Visual Basic for Applications (VBA).

The guide includes three sections. The first section discusses the development of a framework and shows the relationships between dimensions, factors and variables within the framework. The second section describes the process for conducting pair-wise comparisons. The third section includes the process by which the variable matrix is populated, giving the reader insight into both how the data is stored and displayed as well as how the FAR calculations are performed. For ease of use, different fonts were used throughout the guide:

All introductory text is displayed in normal format, Times New Roman.

```
All code is displayed in Courier New
```

A.1   Framework Design

This allows the ability to scroll through the active framework's dimensions, factors and variables. It relies on three subforms, each of which are displayed in the document. As one subform is selected, the others are updated to show the related dimension, factors and variables.

```
Private Sub txtDimension_Click()
'Activates any time the user selects a new dimension

Dim txtSQL As String
Dim sqlDimension As String
Dim sqlFactors As String
Dim sqlVariables As String
Dim Conn As ADODB.Connection
Dim RS As ADODB.Recordset
Dim RS2 As ADODB.Recordset
Dim RS3 As ADODB.Recordset

Set Conn = CurrentProject.Connection
Set RS = New ADODB.Recordset
Set RS2 = New ADODB.Recordset
Set RS3 = New ADODB.Recordset

'This section hides the checkboxes on the scenario design form, and does
not apply Framework Design
x = 1
While x < 15
    'Each time a new dimension is selected,the scenario checkboxes are
    all hidden, to be revealed based on
```

```vba
    'the new factor's variables
    Form_fmScenarioDesign.Controls("label" & x).Visible = False
    Form_fmScenarioDesign.Controls("check" & x).Visible = False
    x = x + 1
Wend

'The recordsource for this form is set on the opening of the parent form
'The recordsource includes all dimensions for the active framework

ActiveDim = Form("DimensionID")
'This grabs the first Dimension in this subform
ActiveDimensionID = Form("DimensionID")

sqlFactors = "Select * from tblFactors where DimensionID = " & ActiveDim
'Each factor for the top dimension is selected and is added to the
form's recordsource
RS2.ActiveConnection = Conn
RS2.Source = sqlFactors
RS2.Open

If RS2.EOF = True Then
    stDocName = "fmAddFactor"
    DoCmd.OpenForm stDocName, , , stLinkCriteria
      'If no factors exist for a given dimension (e.g. it is a   newly-
      added dimension),
     'a form opens to allow the user to add a factor to the dimension
    Else
        RS2.MoveFirst
        ActiveFac = RS2("FactorID")
        Form_sfrmFactors.Form.RecordSource = sqlFactors
        Form_sfrmFactors.Form.OrderByOn = True
        Form_sfrmFactors.Form.OrderBy = "FactorID"
        RS2.Close

        sqlVariables = "Select * from tblVariables where FactorID = " &
ActiveFac

        RS3.ActiveConnection = Conn
        RS3.Source = sqlVariables
        RS3.Open
        'RS3 opens all variables for a given factor

        If RS3.EOF = True Then
        stDocName = "fmAddVariable"
        DoCmd.OpenForm stDocName, , , stLinkCriteria
            'If no variable exists for the selected factor, a window
            opens to prompt the user to add one
        GoTo Exit_txtDimension_Click
        End If

        If RS3("VariableID") <> "" Then
        ActiveVar = RS3("VariableID")
        End If
```

```vba
        Form_sfrmVariables.Form.RecordSource = sqlVariables
        Form_sfrmVariables.Form.OrderByOn = True
        Form_sfrmVariables.Form.OrderBy = "VariableID"

        RS3.MoveFirst

    x = 1
     'This section applies only to scenario design
     'All variables that are visible are given a label and checkbox for
     scenario characterization
    While Not RS3.EOF
        Form_fmScenarioDesign.Controls("label" & x).Caption =
RS3("Variable")
        Form_fmScenarioDesign.Controls("label" & x).Visible = True
        Form_fmScenarioDesign.Controls("check" & x).Visible = True
        x = x + 1
        RS3.MoveNext
    Wend

    RS3.Close
End If

If Form_fmScenarioDesign.cboScenarios.Value <> "" Then
    RS.ActiveConnection = Conn
    sqlDescription = "Select * from tblFPS where FPS_ID = " &
Form_fmScenarioDesign.cboScenarios.Value
    RS.Source = sqlDescription
    RS.Open
    Form_fmScenarioDesign.Controls("txtScenarioDesc").Value =
RS("Description")
    x = 1

    While x < 15

        If Form_fmScenarioDesign.Controls("label" & x).Visible = True
Then
            'For all variables, the checkbox is assigned a value based
            on the checkbox value in the scenario table
            CurrentVar = "'" & Form_fmScenarioDesign.Controls("label" &
x).Caption & "'"
            Form_fmScenarioDesign.Controls("Check" & x).Value =
RS(CurrentVar)
        End If

    x = x + 1

    Wend

    RS.Close

End If

Exit_txtDimension_Click:
```

```
End Sub
```

A.2   Conduct Field Anomaly Relaxation (FAR)

The FAR process is initiated by selecting the first and second driver factors for comparison, and
then evaluating them in a sequence of pair-wise comparisons. The code below describes the
process of populating the form with existing pair-wise values for evaluating and updating the
pair-wise comparison matrix.

```vba
Private Sub Form_Open(Cancel As Integer)

Dim txtSQL As String
Dim sqlDimension As String
Dim sqlFactors As String
Dim sqlVariables As String
Dim sqlvarcount As String
Dim stDocName As String
Dim stLinkCriteria As String
Dim Conn As ADODB.Connection
Dim RS1 As ADODB.Recordset
Dim RS2 As ADODB.Recordset
Dim RS3 As ADODB.Recordset


Set Conn = CurrentProject.Connection
Set RS1 = New ADODB.Recordset
Set RS2 = New ADODB.Recordset
Set RS3 = New ADODB.Recordset

If ActiveFrameworkID = 0 Then
ActiveFrameworkID = 1
End If

DriverCount = 0

txtSQL = "select * from tblDimensions where FrameworkID = " &
ActiveFrameworkID

RS1.Source = txtSQL
RS1.ActiveConnection = Conn
RS1.Open

RS1.MoveFirst

ActiveDim = RS1("DimensionID")
sqlFactors = "Select * from tblFactors where driver = 'driver' and
DimensionID = " & ActiveDim
'Recordset captures all driver factors for FAR within sqlFactors
    RS1.MoveNext
    While Not RS1.EOF
    ActiveDim = RS1("DimensionID")
```

```vba
    sqlFactors = sqlFactors & " OR driver = 'driver' and DimensionID = "
& ActiveDim
    RS1.MoveNext
    Wend
RS1.Close


sqlvarcount = "select * from tblVariables where"

RS2.ActiveConnection = Conn
RS2.Source = sqlFactors
RS2.Open
If RS2.EOF = True Then
counter = MsgBox("No Factors exist for this framework.", vbOKOnly,
"Error: No Driver Factors")
    Else
    RS2.MoveFirst
End If

        While Not RS2.EOF
            DriverCount = DriverCount + 1
            'DriverCount counts total number of drivers in the active
            framework
            ActiveFac = RS2("FactorID")
            Form.Controls("txtDriver" & DriverCount) = RS2("Factor")
            Form.Controls("txtDriver" & DriverCount).Visible = True
            Form.Controls("lbl" & DriverCount).Visible = True
            Form.Controls("cmdDriver" & DriverCount).Visible = True
            'For each factor, the button and label are made visible
            sqlvarcount = sqlvarcount & " FactorID = " & ActiveFac
            'sqlvarcount captures all variables from the active
            framework
            RS2.MoveNext
                If Not RS2.EOF Then
                    sqlvarcount = sqlvarcount & " or "
                End If

    Wend
    RS2.Close

RS3.ActiveConnection = Conn
RS3.Source = sqlvarcount
RS3.Open
'RS3.MoveFirst
While Not RS3.EOF
VarCount = VarCount + 1
'VarCount totals all of the variables in the framework
ReDim Preserve intVariableID(2, VarCount)
'Array "intVariableID() includes data on the factors and variables
within the framework
'intVariableID(0, 0) includes the first factor's ID number
'intVariableID(1, 0) includes the first variable's ID number
intVariableID(0, VarCount - 1) = RS3("FactorID")
intVariableID(1, VarCount - 1) = RS3("VariableID")
```

```
RS3.MoveNext
Wend
'Once complete, the array "intVariableID()" can be used to collect the
FactorID and VariableID for any driver variable
RS3.Close

End Sub

Private Sub cmdDriver1_Click()
On Error GoTo Err_cmdDriver1_Click

    Dim stDocName As String
    Dim stLinkCriteria As String

    ActiveDriver = Form.Controls("txtDriver1")
    FarLevel = 1
    'The variable "FarLevel" identifies which Driver is being evaluated
    'When FarLevel = 1, the first driver is compared against drivers
     from 2 to "n" (n being the last driver factor)
    stDocName = "fmFAR_PairWiseGuide"

    DoCmd.OpenForm stDocName, , , stLinkCriteria

Exit_cmdDriver1_Click:
    Exit Sub

Err_cmdDriver1_Click:
    MsgBox Err.Description
    Resume Exit_cmdDriver1_Click

End Sub

Private Sub Form_Open(Cancel As Integer)

.
.
.
'sqlFactors includes all factors for the active framework

RS2.ActiveConnection = Conn
RS2.Source = sqlFactors
RS2.Open
If RS2.EOF = True Then
counter = MsgBox("No Factors exist for this framework.", vbOKOnly,
"Error: No Driver Factors")
    Else
    RS2.MoveFirst
End If
    ActiveFac = RS2("FactorID")
    While ActiveDriver <> RS2("Factor")
    'Filter through the recordset to find the previously selected driver
        RS2.MoveNext
    Wend
    While Not RS2.EOF
```

```vb
        If RS2("Driver") = "Driver" Then
        'Every driver after the selected driver is selected and
         displayed
            DriverCount = DriverCount + 1
            Form.Controls("txtDriver" & DriverCount) = RS2("Factor")
            Form.Controls("txtDriver" & DriverCount).Visible = True
            Form.Controls("lbl" & DriverCount).Visible = True
            Form.Controls("lbl" & DriverCount).Caption = FarLevel & "."
& (DriverCount - 1) & ". " & ActiveDriver & " v. " & RS2("Factor")
            Form.Controls("cmdDriver" & DriverCount).Visible = True
            RS2.MoveNext
        Else
            RS2.MoveNext
        End If


    Wend

    RS2.Close

Form.Controls("cmdDriver1").Visible = False

End Sub
```

A.3 Populate FAR Matrix and Calculate Results

The code to select the driver factors and variables is the same as for the pair-wise entry forms. Once this information is gathered, the matrix uses the variable IDs as its guide for populating the matrix.

```
        x = 1
        y = 1
        z = 1

        a = 1
        b = 1
RS4.ActiveConnection = Conn
While x <= VarCount

            While y <= x
            'x and y align with the x and y axes of the matrix
            'only the lower-left half of the matrix need to be displayed
and populated
            txtSQL = "SELECT * FROM tblVariableMatrix where VariableID =
" & intVariableID(1, x - 1)
            'tblVariableMatrix has columns listed "y1" to "y33"
            'the rows of tblVariableMatrix are all of the VariableID
numbers
            RS4.Source = txtSQL
            RS4.Open
            txtdest = "txt" & x & "_" & y
            Form.Controls(txtdest) = RS4.Fields("y" & y)
            Form.Controls(txtdest).Visible = True
                    If Form.Controls(txtdest) = 4 Then
                        Form.Controls(txtdest).BackColor = 4259584
                        'depending on the value (0-4), the backcolour is
changed (e.g. green, red, etc)
                        Else
                        If Form.Controls(txtdest) = 3 Then
                            Form.Controls(txtdest).BackColor = 65535
                            Else
                            If Form.Controls(txtdest) = 2 Then
                                Form.Controls(txtdest).BackColor = 52479
                                Else
                                If Form.Controls(txtdest) = 1 Then
                                    Form.Controls(txtdest).BackColor =
255
                                    Else
                                    Form.Controls(txtdest).BackColor =
16777215
                                End If
                            End If
                        End If
                End If
```

```
            y = y + 1
            RS4.Close
            Wend
            y = 1
            x = x + 1
            Wend


sqlVarTitles = "Select * from tblVariables"
RS5.ActiveConnection = Conn
RS5.Source = sqlVarTitles
RS5.Open
x = 1
RS5.MoveFirst
While x <= VarCount
While Not RS5.EOF
If RS5("VariableID") = intVariableID(1, x - 1) Then
Form.Controls("lblVar_" & x) = RS5("VarSymbol") & ": " & RS5("Variable")
Form.Controls("lblVar_" & x).Visible = True
'The Variable symbol and title are displayed along the left-hand side of
the matrix
RS5.MoveNext
Else
RS5.MoveNext
End If
Wend
RS5.MoveFirst
x = x + 1
Wend

y = 1

x = 1
While x <= VarCount
While Not RS5.EOF
        If RS5("VariableID") = intVariableID(1, y - 1) Then
        Form.Controls("lblVarSym_" & x) = RS5("VarSymbol")
        Form.Controls("lblVarSym_" & x).Visible = True
        'Only the Variable symbols are displayed aloong the top of the
matrix
        RS5.MoveNext
        Else
        RS5.MoveNext
        End If
    Wend
    RS5.MoveFirst
    y = y + 1
    x = x + 1
Wend

RS5.Close
```

The matrix is saved in much the same way it is populated. The code maps the fields corresponding to tblVariableMatrix and updates the table using a SQL statement.

```
txtSQL = "UPDATE tblVariableMatrix SET "

    While x <= VarCount

        While y <= x

            txtSQL = txtSQL & "y" & x & " = " & Form.Controls("txt" & x
            & "_" & y)
            txtSQL = txtSQL & " WHERE VariableID = " & intVariableID(1,
            y - 1)

            If Form.Controls("txt" & x & "_" & y).Value > 4 Or
                Form.Controls("txt" & x & "_" & y).Value < 0 Then
                'The matrix only allows values between 0 and 4.
                Outside these values, the update process is stopped.
                counter = MsgBox("Pair-wise value must be between 0 and
                4", vbOKOnly, "Error: Feasibility Value")
                GoTo exit_cmdSave_Click
            End If

        Conn.Execute (txtSQL)

        txtSQL = "UPDATE tblVariableMatrix SET "
            y = y + 1

        Wend

        y = 1

        x = x + 1

    Wend

exit_cmdSave_Click:

End Sub
```

To execute the FAR calculation, all entries from the tblVariableMatrix are evaluated to determine which combinations are valid. Below is a sample of this calculation for a framework with eight driver factors.

```
Private Sub cmdRun_Click()

Dim Conn As ADODB.Connection

Dim RS As ADODB.Recordset
Dim RS2 As ADODB.Recordset

Dim txtSQL, sqltxt As String
Dim FarTotal As Integer
```

```vba
Dim b, c, d, e, f, g, h, i, j, k, l, m, n, o, p, q, r, s, t, u, v, w, x,
y, z, possScenarios, FacGroup As Integer
Dim txtSQLScenarioValue As String
Dim a As Double
Dim Score As Double

Set Conn = CurrentProject.Connection
Set RS = New ADODB.Recordset
Set RS2 = New ADODB.Recordset

If ActiveFrameworkID = 0 Then
Call Calc_Vars
'In case of an error, the baseline framework is recalculated and the
matrix is repopulated.
End If

txtSQLInfo = "SELECT * FROM tblVariableMatrix where FrameworkID = " &
ActiveFrameworkID

RS.Source = txtSQLInfo
RS.ActiveConnection = Conn
RS.Open

RS2.ActiveConnection = Conn

FarTotal = 0

m = 0
ActiveFac = intVariableID(0, m)
FacGroup = 1
While m < VarCount - 1
If intVariableID(0, m) = ActiveFac Then
m = m + 1
Else
FacGroup = FacGroup + 1
ActiveFac = intVariableID(0, m)
End If
Wend
FacGroup = intVariableID(2, m - 1)
'Facgroup is the number of driver factors within the framework

m = 1
While m < FacGroup
FarTotal = FarTotal + m
'FarTotal is the permutation calculation value for the number of driver
factors.  For example, FarTotal for the six-driver baseline framework is
n*(n-1)*0.5, or 5*6*0.5 or 15.
m = m + 1
Wend
Dim tempVars() As Integer
ReDim Preserve tempVars(FarTotal)
Dim counter As Integer
Dim tally As Double
```

```
b = 1
x = 1

While x <= VarCount
    If intVariableID(2, x - 1) = 1 Then
        c = x
        'c is the number of variables for the first driver factor
        Else
        x = x + 1
    End If
x = x + 1
Wend

x = 1
b = b + 1

While x <= VarCount
If b <= FacGroup Then
    If intVariableID(2, x - 1) = 2 Then
        d = x
        'd is the number of factors for the second variable
        'the process continues for up to eight driver factors
                Else
        x = x + 1
    End If
End If
x = x + 1
Wend

x = 1
b = b + 1

While x <= VarCount
If b <= FacGroup Then
    If intVariableID(2, x - 1) = 3 Then
        e = x

        Else
        x = x + 1
    End If
End If
x = x + 1
Wend

x = 1
b = b + 1

While x <= VarCount
If b <= FacGroup Then
    If intVariableID(2, x - 1) = 4 Then
        f = x
                Else
        x = x + 1
```

```
        End If
End If
x = x + 1
Wend


x = 1
b = b + 1

While x <= VarCount
If b <= FacGroup Then
    If intVariableID(2, x - 1) = 5 Then
        g = x
        Else
        x = x + 1
    End If
End If
x = x + 1

Wend

x = 1
b = b + 1

While x <= VarCount
If b <= FacGroup Then
    If intVariableID(2, x - 1) = 6 Then
        h = x
        Else
        x = x + 1
    End If
End If
x = x + 1
Wend

x = 1
b = b + 1

While x <= VarCount
If b <= FacGroup Then
    If intVariableID(2, x - 1) = 7 Then
        i = x
        Else
        x = x + 1
    End If
End If
x = x + 1
Wend

x = 1
b = b + 1

While x <= VarCount
If b <= FacGroup Then
    If intVariableID(2, x - 1) = 8 Then
```

```
        j = x
        Else
        x = x + 1
    End If
End If
x = x + 1
Wend

z = 1

possScenarios = c
FarTotal = 0

If FacGroup >= 2 Then
y = c + 1
'y = the first variable from the second driver factor
'For example, if there are four variables associated with the first
driver, y = 5
possScenarios = possScenarios * (d - c)
FarTotal = FarTotal + 1
End If

If FacGroup >= 3 Then
x = d + 1
'x = the first variable from the third factor
possScenarios = possScenarios * (e - d)
FarTotal = FarTotal + 2
End If

If FacGroup >= 4 Then
w = e + 1
possScenarios = possScenarios * (f - e)
FarTotal = FarTotal + 3
End If

If FacGroup >= 5 Then
v = f + 1
possScenarios = possScenarios * (g - f)
FarTotal = FarTotal + 4
End If

If FacGroup >= 6 Then
u = g + 1
possScenarios = possScenarios * (h - g)
FarTotal = FarTotal + 5
End If

If FacGroup >= 7 Then
t = h + 1
possScenarios = possScenarios * (i - h)
FarTotal = FarTotal + 6
End If

If FacGroup >= 8 Then
```

```vba
s = i + 1
possScenarios = possScenarios * (j - i)
FarTotal = FarTotal + 7
End If

intValidScenarios = 0
'intValidScenarios is an integer value of the number of scenarios whose
feasability value >0
p = 0
ReDim intFarScenarios(FacGroup, 1)
'intFarScenarios() is an array that captures the values of all valid FAR
scenario combinations
'It holds, for each combination, the variable ID for each variable, as
well as the combination's feasibility value
While p <= possScenarios

If FacGroup = 8 Then
        While s <= j
            While t <= i
                While u <= h
                    While v <= g
                        While w <= f
                            While x <= e
                                While y <= d
                                    While z <= c
                                    'the looping process allows for all
permutations to be evaluated
                                        sqltxt = "SELECT * FROM
tblVariableMatrix WHERE VariableID = " & intVariableID(1, y - 1) & " OR
VariableID = " & intVariableID(1, x - 1) & " OR VariableID = " &
intVariableID(1, w - 1) & " OR VariableID = " & intVariableID(1, v - 1)
& " OR VariableID = " & intVariableID(1, u - 1) & " OR VariableID = " &
intVariableID(1, t - 1) & " OR VariableID = " & intVariableID(1, s - 1)

                                        RS2.Source = sqltxt
                                        RS2.Open

                                    farcounter = 0

                                    While Not RS2.EOF
                                    'each pair-wise entry for the selected
                                     variables is collected in succession from
                                     the recordset
                                    If RS2.Fields("Variableid") =
intVariableID(1, y - 1) Then
                                        tempVars(farcounter) = RS2.Fields("y" & z)
                                        farcounter = farcounter + 1
                                        RS2.MoveNext
                                    Else
                                        RS2.MoveNext
                                    End If
                                    Wend
                                    RS2.MoveFirst
```

```
                        While Not RS2.EOF
                        If RS2.Fields("Variableid") =
intVariableID(1, x - 1) Then
                        tempVars(farcounter) = RS2.Fields("y" & z)
                        farcounter = farcounter + 1
                        tempVars(farcounter) = RS2.Fields("y" & y)
                        farcounter = farcounter + 1
                        RS2.MoveNext
                        Else

                        RS2.MoveNext
                        End If
                        Wend
                        RS2.MoveFirst

                        While Not RS2.EOF
                        If RS2.Fields("Variableid") =
intVariableID(1, w - 1) Then
                        tempVars(farcounter) = RS2.Fields("y" & z)
                        farcounter = farcounter + 1
                        tempVars(farcounter) = RS2.Fields("y" & y)
                        farcounter = farcounter + 1
                        tempVars(farcounter) = RS2.Fields("y" & x)
                        farcounter = farcounter + 1
                        RS2.MoveNext
                        Else
                        RS2.MoveNext
                        End If
                        Wend
                        RS2.MoveFirst

                        While Not RS2.EOF
                        If RS2.Fields("Variableid") =
intVariableID(1, v - 1) Then
                        tempVars(farcounter) = RS2.Fields("y" & z)
                        farcounter = farcounter + 1
                        tempVars(farcounter) = RS2.Fields("y" & y)
                        farcounter = farcounter + 1
                        tempVars(farcounter) = RS2.Fields("y" & x)
                        farcounter = farcounter + 1
                        tempVars(farcounter) = RS2.Fields("y" & w)
                        farcounter = farcounter + 1
                        RS2.MoveNext
                        Else
                        RS2.MoveNext
                        End If
                        Wend
                        RS2.MoveFirst

                        While Not RS2.EOF
                        If RS2.Fields("Variableid") =
intVariableID(1, u - 1) Then
                        tempVars(farcounter) = RS2.Fields("y" & z)
                        farcounter = farcounter + 1
```

```vb
                            tempVars(farcounter) = RS2.Fields("y" & y)
                            farcounter = farcounter + 1
                            tempVars(farcounter) = RS2.Fields("y" & x)
                            farcounter = farcounter + 1
                            tempVars(farcounter) = RS2.Fields("y" & w)
                            farcounter = farcounter + 1
                            tempVars(farcounter) = RS2.Fields("y" & v)
                            farcounter = farcounter + 1
                            RS2.MoveNext
                            Else
                            RS2.MoveNext
                            End If
                            Wend
                            RS2.MoveFirst

                            While Not RS2.EOF
                            If RS2.Fields("Variableid") =
intVariableID(1, t - 1) Then
                            tempVars(farcounter) = RS2.Fields("y" & z)
                            farcounter = farcounter + 1
                            tempVars(farcounter) = RS2.Fields("y" & y)
                            farcounter = farcounter + 1
                            tempVars(farcounter) = RS2.Fields("y" & x)
                            farcounter = farcounter + 1
                            tempVars(farcounter) = RS2.Fields("y" & w)
                            farcounter = farcounter + 1
                            tempVars(farcounter) = RS2.Fields("y" & v)
                            farcounter = farcounter + 1
                            tempVars(farcounter) = RS2.Fields("y" & u)
                            farcounter = farcounter + 1
                            RS2.MoveNext
                            Else
                            RS2.MoveNext
                            End If
                            Wend
                            RS2.MoveFirst

                            While Not RS2.EOF
                            If RS2.Fields("Variableid") =
intVariableID(1, s - 1) Then
                            tempVars(farcounter) = RS2.Fields("y" & z)
                            farcounter = farcounter + 1
                            tempVars(farcounter) = RS2.Fields("y" & y)
                            farcounter = farcounter + 1
                            tempVars(farcounter) = RS2.Fields("y" & x)
                            farcounter = farcounter + 1
                            tempVars(farcounter) = RS2.Fields("y" & w)
                            farcounter = farcounter + 1
                            tempVars(farcounter) = RS2.Fields("y" & v)
                            farcounter = farcounter + 1
                            tempVars(farcounter) = RS2.Fields("y" & u)
                            farcounter = farcounter + 1
                            tempVars(farcounter) = RS2.Fields("y" & t)
                            farcounter = farcounter + 1
```

```
                              RS2.MoveNext
                              Else
                              RS2.MoveNext
                              End If
                              Wend
                              RS2.Close


counter = 0
'The counter goes from 0 to n(n-1)*0.5, where n = the number of driver
factors
tally = 1
'Tally is the means to determine if the scenario is valid.  If tally >
0, none of the pair-wise entries are 0.
Score = 0
'Score is the averaged value of the pair-wise entries for a given
scenario combination, i.e. the feasibility value.
While counter < farcounter - 1
    tally = tally * tempVars(counter)
    counter = counter + 1
    Score = Score + (tempVars(counter) / farcounter)
Wend

If tally > 0 Then

    intValidScenarios = intValidScenarios + 1

    intFarScenarios(0, intValidScenarios - 1) = z
    intFarScenarios(1, intValidScenarios - 1) = y
    intFarScenarios(2, intValidScenarios - 1) = x
    intFarScenarios(3, intValidScenarios - 1) = w
    intFarScenarios(4, intValidScenarios - 1) = v
    intFarScenarios(5, intValidScenarios - 1) = u
    intFarScenarios(6, intValidScenarios - 1) = t
    intFarScenarios(7, intValidScenarios - 1) = s
    intFarScenarios(8, intValidScenarios - 1) = Score
        'If the scenario combination is valid, each variableID is
     stored in the intFarScenarios array.
End If


                              z = z + 1
                              p = p + 1
                              Wend

                          y = y + 1
                          z = 1
                          p = p + 1
                          Wend

                      x = x + 1
                      y = c + 1
                      p = p + 1
                      Wend
```

```
                    w = w + 1
                    x = d + 1
                    p = p + 1

                Wend

            v = v + 1
            w = e + 1
            p = p + 1

            Wend

        u = u + 1
        v = f + 1
        p = p + 1

        Wend

    t = t + 1
    u = g + 1
    p = p + 1

    Wend

s = s + 1
t = h + 1
p = p + 1

Wend

End If
```

This page intentionally left blank.

List of Abbreviations

CBP	Capability-Based Planning
CF	Canadian Forces
CFD	Chief of Force Development
CFDS	Canada First Defence Strategy
COIN	Counter-insurgency
COTS	Commercial off the shelf
DND	Department of National Defence
DRDC	Defence Research & Development Canada
DRDKIM	Director Research and Development Knowledge and Information Management
FAR	Field Anomaly Relaxation
FPS	Force Planning Scenarios
IT	Information Technology
MA	Morphological Analysis
MS	Microsoft
R&D	Research & Development
SQL	Structured Query Language
VBA	Visual Basic Applications

This page intentionally left blank

Distribution list

Document No.: DRDC CORA CR 2010-113

Information

Internal

1 DDG [PDF]
1 SH Strategic Analysis [PDF]
1 Library [print + PDF]
1 Authors [PDF]

External

1 DFSA [PDF]
1 DST IC [PDF]
1 CAE [PDF]
1 DRDKIM [PDF]

This page intentionally left blank.

DOCUMENT CONTROL DATA

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

1. ORIGINATOR (The name and address of the organization preparing the document. Organizations for whom the document was prepared, e.g. Centre sponsoring a contractor's report, or tasking agency, are entered in section 8.) CAE Professional Services (Canada) Inc. 1135 Innovation Drive Ottawa, Ontario K2K 3G7	2. SECURITY CLASSIFICATION (Overall security classification of the document including special warning terms if applicable.) UNCLASSIFIED

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

Analytical Tool for Force Planning Scenarios User Guide Version 2.0:

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

Cochran, L.; Hales, D.; Race, P.; Friesen, S.K.

5. DATE OF PUBLICATION (Month and year of publication of document.) June 2010	6a. NO. OF PAGES (Total containing information, including Annexes, Appendices, etc.) 63	6b. NO. OF REFS (Total cited in document.) 3

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

Contract Report

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

Defence R&D Canada
305 Rideau Street
Ottawa, Ontario K1A 0K2

9a. PROJECT OR GRANT NO. (If appropriate, the applicable research and development project or grant number under which the document was written. Please specify whether project or grant.) PG0 10ab	9b. CONTRACT NO. (If appropriate, the applicable number under which the document was written.)
10a. ORIGINATOR'S DOCUMENT NUMBER (The official document number by which the document is identified by the originating activity. This number must be unique to this document.) [i.e. 12345 - as shown above]	10b. OTHER DOCUMENT NO(s). (Any other numbers which may be assigned this document either by the originator or by the sponsor.) DRDC CORA CR 2010-113

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

Unlimited

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

Unlimited

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

Force Planning Scenarios serve as the key input to conducting capability-based planning and force development efforts. As such, the characterization and selection of these scenarios warrants the application of available analytical tools and techniques to ensure an objective and defensible scenario set. To meet these needs, a force planning scenario framework and methodology was developed, identifying the most relevant dimensions of force planning scenarios to support analysis and development. In an effort to apply this framework for characterizing force planning scenarios, a desktop software application was developed. This contractor report serves as a user's guide to this desktop software application. It provides a detailed description of the tool's main functions and instructions on its use. It is anticipated that this document be read in conjunction with the contractor report (DRDC CORA CR 2010-17) that more thoroughly describes the framework and methodology, "Development of a Framework for Force Planning Scenarios." This document covers the second iteration of the Force Planning Scenario analytical tool, and covers the additional functions of extending and comparing frameworks. This document is covered in two volumes. The first volume provides guidance to standard tool users. The second volume covers the programming background of the Force Planning Scenario analytical tool.

Les scénarios de planification des forces sont les principales données que les chercheurs utilisent dans leurs efforts de planification fondée sur les capacités et de développement des forces. À l'étape de la caractérisation et de la sélection de ces scénarios, ils doivent utiliser les outils et les techniques d'analyse disponibles pour produire une série de scénarios objectifs et défendables. À cette fin, un cadre et une méthodologie de création de scénarios de planification des forces ont été développés, et les dimensions les plus pertinentes des scénarios de planification des forces ont été identifiées pour appuyer l'analyse et le développement des scénarios. Pour appliquer ce cadre à la caractérisation des scénarios de planification des forces, un outil logiciel a été mis au point. Le présent rapport de l'entrepreneur sert de guide de l'utilisateur pour cet outil logiciel. Il donne une description détaillée des fonctions principales de cet outil logiciel, ainsi que des instructions sur son utilisation. Ce document doit être lu en conjonction avec un autre rapport de l'entrepreneur (RDDC CARO CR 2010-17) qui décrit plus en détail le cadre et la méthodologie, et qui s'intitule « Mise au point d'un cadre pour les scénarios de planification des forces ». Ce document porte sur la deuxième version de l'outil analytique des scénarios de planification des forces, et il décrit deux fonctions additionnelles : l'élargissement et la comparaison des cadres. Ce document comporte deux volumes. Le premier volume donne des directives aux utilisateurs de l'outil logiciel standard. Le deuxième volume porte sur la programmation de l'outil analytique des scénarios de planification des forces.

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

Force Planning Scenario; Framework; Capability Based Planning; Field Amonaly Relaxation; Morphological Analysis

Defence R&D Canada

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

R & D pour la défense Canada

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

DEFENCE **R&D** DÉFENSE

www.drdc-rddc.gc.ca