Analysis Tool for Force Planning Scenarios

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User's Guide

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Abstract

This contractor report provides information to end users with respect to the process by which scenarios are identified, characterized and evaluated in the Force Planning Scenario analysis tool. In an effort to apply a framework for characterizing the Force Planning Scenarios, a desktop application using existing commercial-off-the-shelf software was developed. This document serves as a user's guide to this 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 that more thoroughly describes the framework and methodology, "Development of a Framework for Force Planning Scenarios."

Résumé

Le présent rapport de l'entrepreneur contient des renseignements destinés aux utilisateurs finaux relativement au processus permettant d'identifier, de caractériser et d'évaluer les scénarios dans l'outil d'analyse des scénarios de la planification des forces. Dans un effort visant à appliquer un cadre permettant de caractériser les scénarios de planification des forces, une application de bureau basée sur un logiciel commercial grand public déjà existant a été mise au point. Le présent document est une guide de l'utilisateur pour cette application. Ce guide donne une description détaillée des principales fonctions de l'outil ainsi que des instructions sur son utilisation. Ce document doit être lu en conjonction avec le rapport de l'entrepreneur qui décrit plus en détail le cadre et la méthodologie, ainsi que la « Mise au point d'un cadre pour les scénarios de planification des forces ».

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Executive Summary

Analysis Tool for Force Planning Scenarios: User's Guide

Larry Cochran; Doug Hales; Peter Race; Shaye K. Friesen; DRDC CORA CR 2010-018; Defence R&D Canada – CORA; February 2010.

Background: This contractor report provides information to end users with respect to the process by which scenarios are identified, characterized and evaluated in the Force Planning Scenario analysis tool. In an effort to apply a framework for characterizing the Force Planning Scenarios, a desktop application using existing commercial-off-the-shelf software was developed. This document serves as a user's guide to this application. It provides a detailed description of the tool's main functions and instructions on its use.

Results: This document provides a step-by-step guide for applying the Force Planning 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 FPS to effectively cover these dimensions.

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 Canadian Forces 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 hoped that this tool will evolve based on such research and be adopted to serve a larger audience.

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Analysis Tool for Force Planning Scenarios: User's Guide

Larry Cochran; Doug Hales; Peter Race; Shaye K. Friesen; DRDC CORA CR 2010-018; R & D pour la défense Canada – CORA; Février 2010.

Introduction ou contexte: Le présent rapport de l'entrepreneur contient des renseignements à l'usage des utilisateurs finaux relativement au processus permettant d'identifier, de caractériser et d'évaluer les scénarios dans l'outil de planification des forces. Dans un effort visant à appliquer un cadre permettant de caractériser les scénarios de planification des forces, une application de bureau basé sur un logiciel commercial grand public déjà existant a été mise au point. Le présent document est une guide de l'utilisateur pour cette application. Ce guide donne une description détaillée des principales fonctions de l'outil ainsi que des instructions sur son utilisation.

Résultats: Ce document contient un guide de type « étape par étape » pour l'utilisation du cadre de création de scénarios de planification des forces utilisant un processus FAR (Field Anomaly Relaxation) modifié, qui est une forme d'analyse morphologique. En permettant un examen de toutes les dimensions motrices, l'ensemble du domaine des scénarios possibles peut être documenté et analysé. Le résultat final est un ensemble de combinaisons de scénarios établi par priorités qui peut guider la mise au point d'un ensemble représentatif de scénarios de planification des forces qui couvre efficacement ces dimensions.

Importance: La rigueur utilisée dans l'analyse des scénarios permet d'établir une méthode de sélection et de justification de mise au point et d'évolution de scénario qui répond aux besoins de la planification basée sur les capacités. En visualisant la couverture des dimensions motrices des scénarios, un ensemble de scénarios équilibré peut être élaboré et maintenu à jour, 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, le cadre est conçu pour évoluer en fonction des nouvelles recherches et des utilisateurs. On espère que cet outil va évoluer en fonction de telles recherches et qu'il sera adopté afin de servir un plus vaste auditoire.

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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 Chief of Force Development's (CFD) Capability-Based Planning (CBP) process. A systematic process was developed to enhance the capability based planning process by ensuring a defensible, transparent 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 tool applies the FPS framework to support the identification, evaluation and development of a scenario set for CBP. Based on the research conducted by Defence Research & Development Canada's (DRDC) Centre for Operational Research & Analysis (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.[1] 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.

1.1 Aim

The aim of this report is to provide information to end users with respect to the process by which scenarios are identified, characterized and evaluated in the analysis tool for FPS.

1.2 Report Organization

This guide is broken into two sections. The first section covers the process of conducting FAR, while the second section outlines how to characterize a scenario using the framework.

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[1] See N. Chuka, L. Cochran, S.K. Friesen, D. Hales, LCdr Harnett, C. Morrisey, P. Race, Development of a Force Planning Scenarios Framework: Inputs for the Scenario Analysis Tool (Winter 2009 Draft) (Ottawa: DRDC CORA, 2009).

2   Analyzing Scenarios using the FPS Framework

The 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 in the development process 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 relationships as the FPS framework outlined in the project report. The highest level is the dimensions, which decompose into factors and variables. The factors are also grouped as drivers (red), descriptors (green) and derivatives (yellow) within the framework.
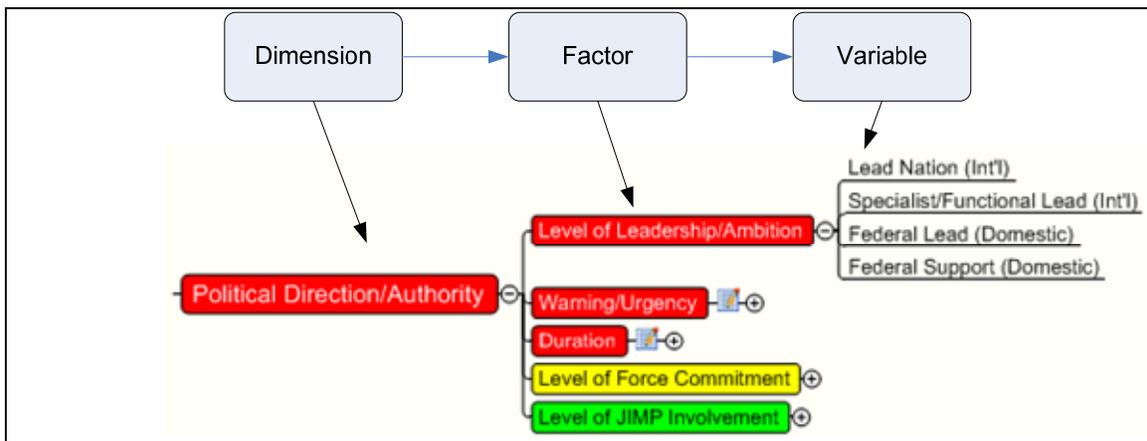
Figure 1: Framework Decomposition

To identify the range of plausible scenarios for developing the FPS set, this tool was designed to support FAR. A form of Morphological Analysis, FAR involves a mixture 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 has four steps, as shown in Figure 2:

Figure 2: FAR Process

The tool uses this process, in a modified form, for the development 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 drivers, factors and variables from the FPS framework.
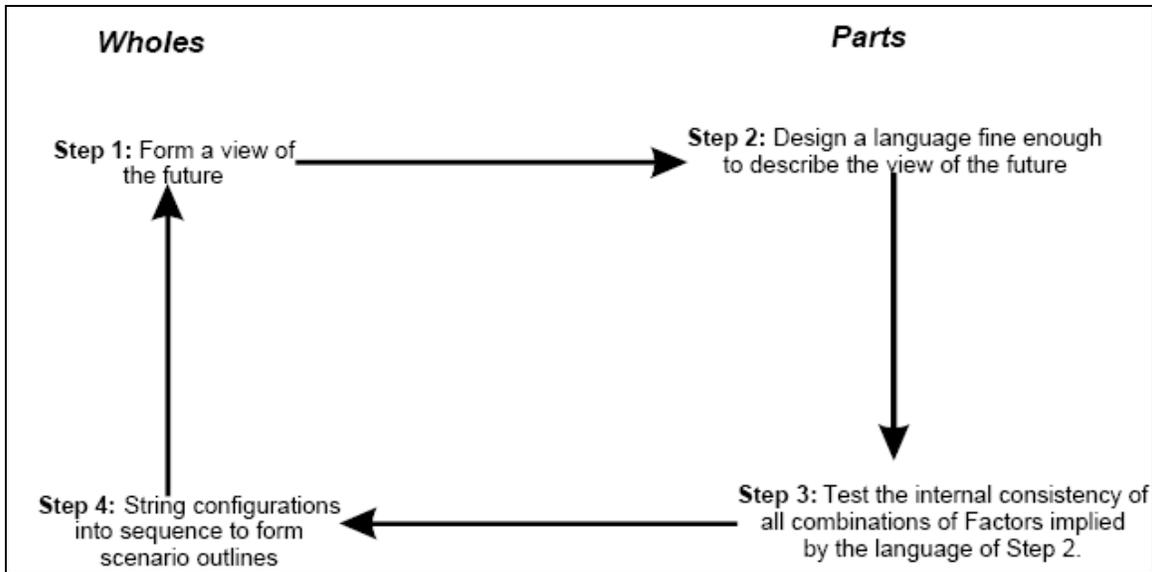
The typical FAR taxonomy is not used within this study; however, this has no impact on the analytical process. A mapping of terms is included in Figure 3 below:
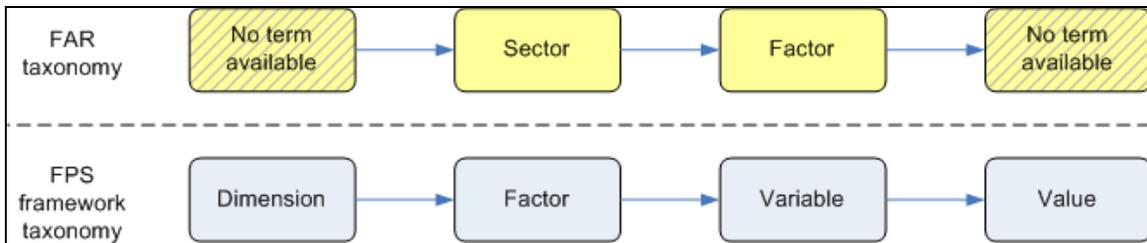
Figure 3: Comparison of FAR and FPS Taxonomy

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 counterinsurgency (COIN) campaign in the desert may receive a value of 3 or 4.

The fourth and final step of the FAR process involves 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.

2.1   Identifying Plausible Scenario Combinations

1. Once the tool opens, the first display is the main switchboard (Figure 4 below). It is the interface for navigating through all of the tool's main functions. Should you need to return to a closed form, the switchboard will allow you to return to the necessary in interface.
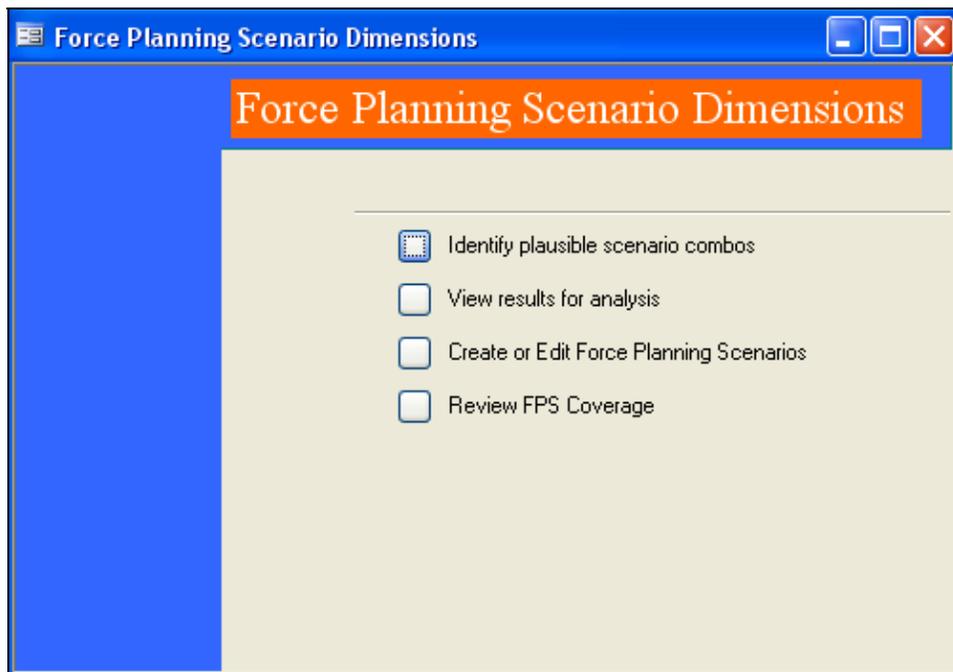
Figure 4: FPS Main Switchboard

2. To initiate FAR, select "Identify plausible scenario combos" from the main dashboard. This will place you within the FAR switchboard.

Figure 5: FAR Main Switchboard

3. Within the FAR main dashboard, the user has access to evaluate each of the driver factors. The dashboard groups the pair-wise comparison sessions by factor. The exception is the "Leadership" factor, as it is evaluated through the other factors. While the factors do not have to be conducted in the numbered order, it is advisable as it ensures completeness. The sessions within each group become progressively shorter, as each comparison only occurs once. Select "Evaluate Campaign Themes" from the switchboard to open the Campaign Theme-specific interface.
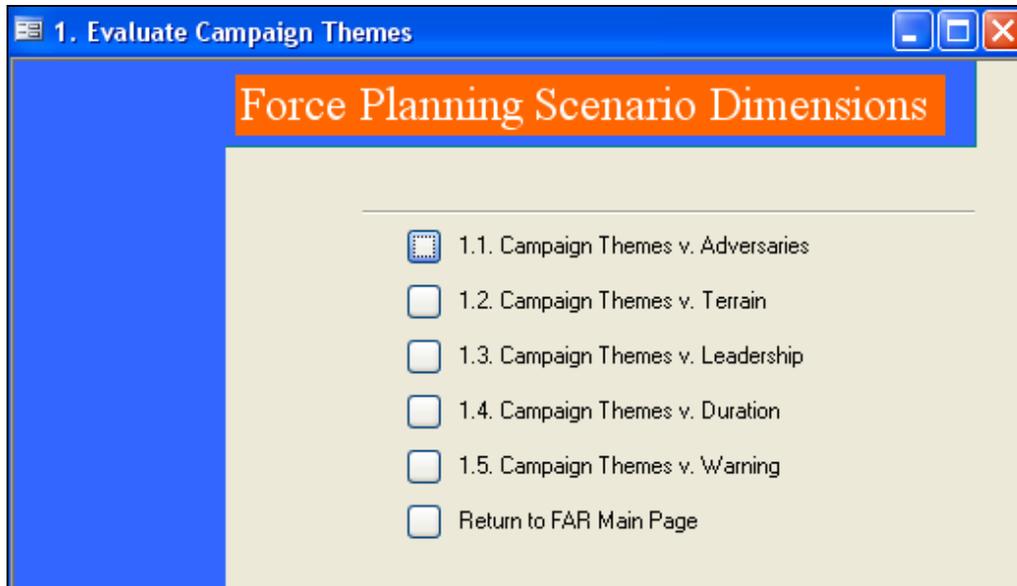
Figure 6: Session-specific Switchboard for Evaluate Campaign Theme

4. The session-specific interfaces, as shown in Figure 6, 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 plausibility values, similar to the Batelle Approach.[2] For each campaign theme, different variables are assigned a plausibility value from 0-4:

- 0 – Highly Implausible/Impossible;

- 1 – Implausible;

- 2 – Somewhat Plausible;

- 3 – Plausible; and

- 4 – Highly Plausible.

5. The pair-wise comparisons are conducted within a series of interfaces, where each comparison is assigned a value. Of greatest relevance are the insignificant variables (i.e., are not relevant to a campaign theme), which are given a value of zero. By assigning this value, the variable is not included in the matrix for further comparison. Each variable must be given a value. A systematic approach is recommended to avoid error (e.g., providing a value for all variables associated with the first factor of the first dimension, followed by the second factor of the first dimension, etc.). To begin, select the first form, "1.1. Campaign Themes v. Adversaries".

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[2] M.–T. Nguyen and M. Dunn, *Some Methods for Scenario Analysis in Defence Strategic Planning* DSTO-TR-2242 (Canberra: Australian Defence Science and Technology Organisation, February 2009).

Figure 7 Campaign Theme Pair-wise comparison

6. Within the form, select each box and enter a value between 0 and 4. Once complete, select "Save entries" and then move to the next form by using the button in the bottom-left corner. For example, in Figure 7, select "Military v. Peace Spt" to evaluate the adversary variables that may be encountered during a peace support campaign. Once complete and all entries are saved, select" Exit without saving" on each form and return to the session switchboard.

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 Theme; Terrain; Military - Red Force; 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 $C_1 M_1 T_1 L_1 D_1 W_1$:

$$= [(C_1 M_1) + (C_1 T_1) + (C_1 L_1) + (C_1 D_1) + (C_1 W_1) + (M_1 T_1) + (M_1 L_1) + (M_1 D_1) + (M_1 W_1) + (T_1 L_1) + (T_1 D_1) + (T_1 W_1) + (L_1 D_1) + (L_1 W_1) + (D_1 W_1)] * [2/(5 * 6)]$$

7. After selecting "View results for analysis" from the main switchboard, there is the option to view results by total number or by percentage of plausible scenarios. Also available is the option to view the matrix of pairs. Selecting either of the first two interfaces will bring up an interactive graph.
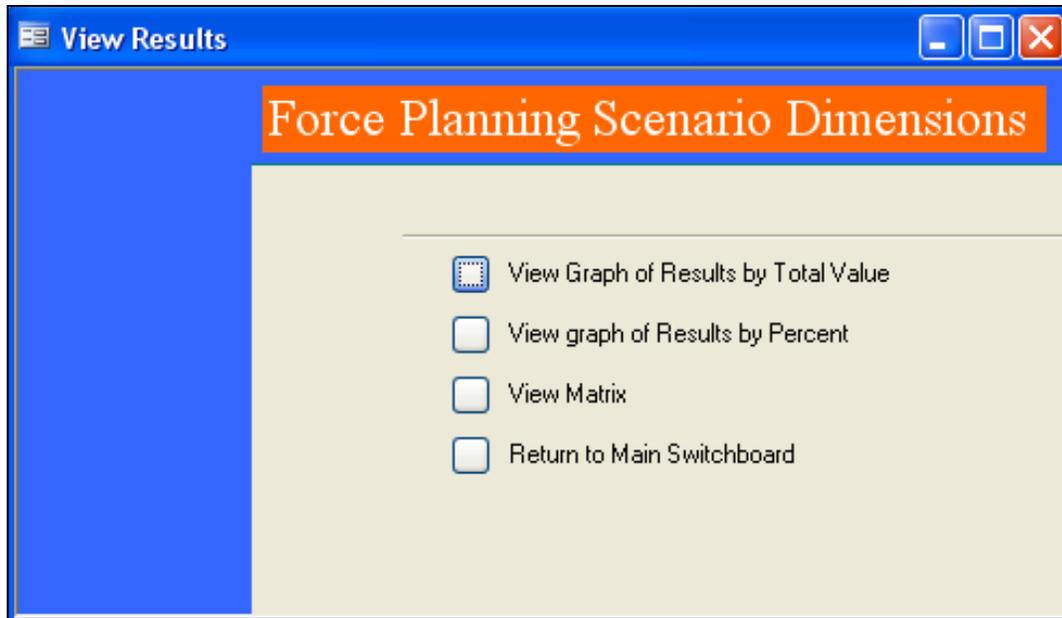
Figure 8: View results for analysis sub-menu

8.   The graph by total value 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.

9.   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.

10. To generate data based on the most recent comparisons, click "Calculate FAR Results" before generating a graph. A message will be displayed indicating the results are complete, and the number of plausible scenarios. Click "Generate Results" to view the graph. The result is a histogram similar to the one shown in Figure 9.
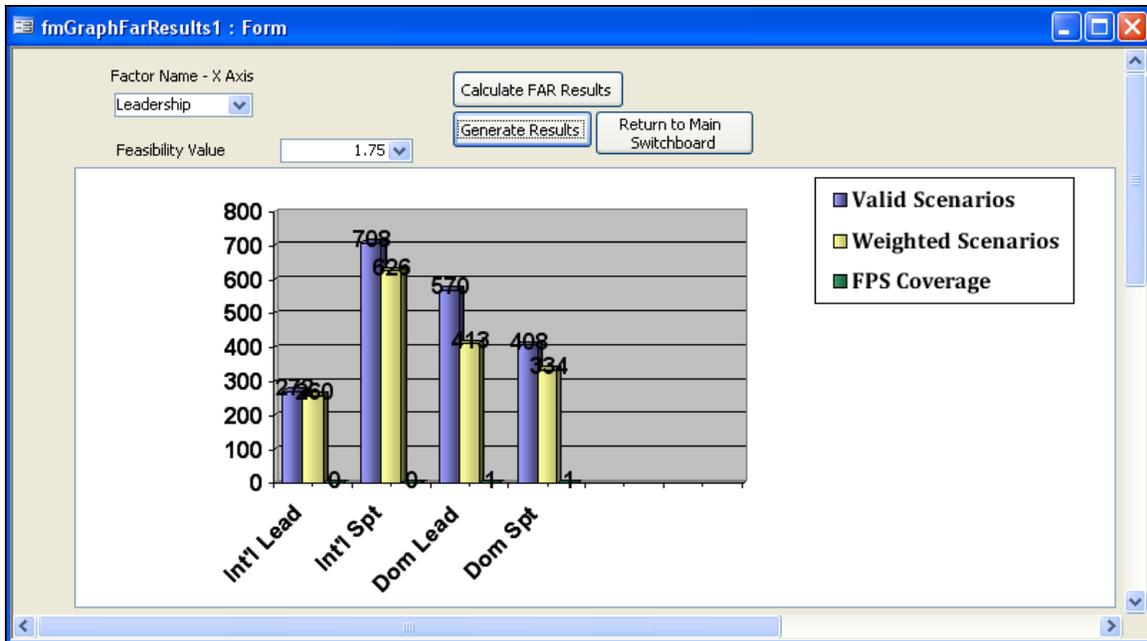
Figure 9: View FAR Results by total number of scenarios

The data shown in the histogram includes three values for each variable. The first, "valid scenarios", includes all plausible scenarios based on the calculations. That is, any scenario with no zeros in its feasibility value is distributed across the variables. The resulting data gives the user an understanding of which scenario combinations were most common. In the sample data in Figure 9, international support leadership roles had the largest number of scenarios, and international lead has the fewest.

The other data, "Weighted Scenarios", 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.

The third data will only display data if there is a set of FPS already within the application. The data will display the coverage of the variables by the current set. In the sample data in Figure 9, the coverage indicates the current FPS set has not addressed one of the most prevalent variables (that being international support leadership role), making it a prime candidate for use in an additional FPS.

11. The data in total number of scenarios is of value, but can often be difficult to interpret across all three data types. As a result, the graph can be viewed by percentage. To view this graph, return to the analysis sub-menu and select "View graph of Results by Percent".

12. Follow the same steps 8 through 10 as before. The functions are the same as the previous graph. An example of the graph is shown in Figure 10.
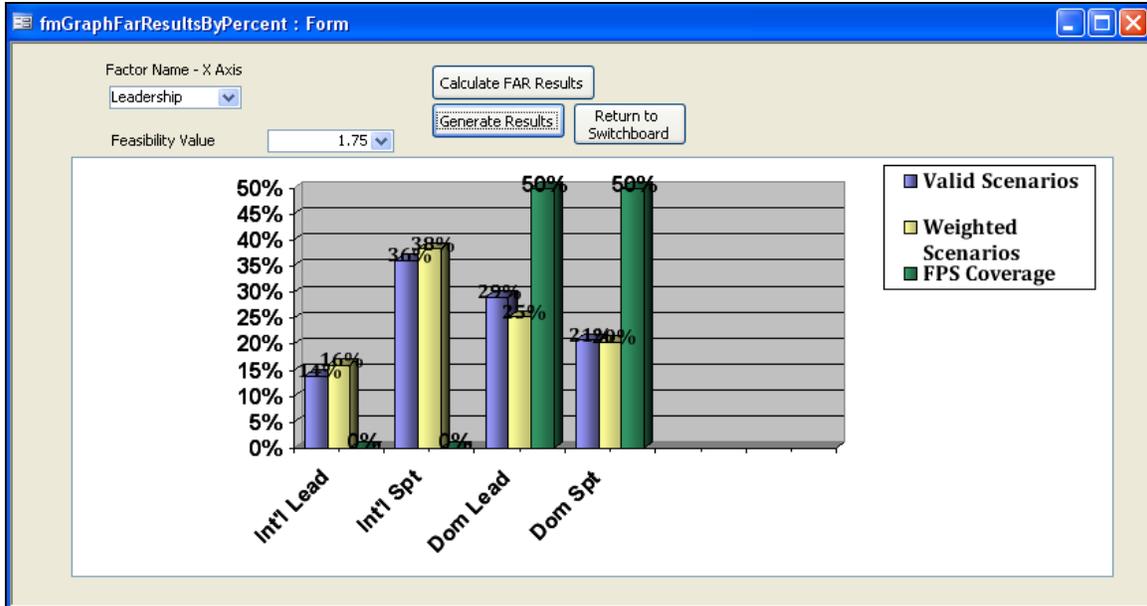
Figure 10: FPS Results by Percent

The difference in data representation provides information on relative importance. All three data sources are represented in the graph. Comparing three data sets of varying sizes is more easily understood in this graph. The third data source, "FPS Coverage", is more readily interpreted from this graph, as coverage is intended to include the most pertinent variables using a small, balanced set of FPS.

The Pair-Wise Comparison matrix provides a mechanism to review all original data. All 25 variables are included along the matrix. It provides a means to ensure all pair-wise comparisons are complete, and allows the user to manipulate all data at once. Only the data in the bottom half of the matrix (not grey) can be manipulated. Data within a given factor (i.e., terrain) will automatically have a zero associated with it (i.e., Arctic and Desert terrains).

13. To make changes to the matrix, select the relevant box, enter a new value (0-4) and click "Save Matrix". To identify how this changes the total number of plausible scenarios, click "Run Comparisons". Finally, to return to the analysis sub-menu, click "View FAR Results".

Figure 11: Pair-Wise Comparison Matrix

Pair-Wise Comparison Matrix

	L1	L2	L3	L4	W1	W2	D1	D2	D3	T1	T2	T3	T4	T5	T6	M1	M2	M3	M4	M5	M6	C1	C2	C3	C4
L1:International Lead	0	0	0	0	1	2	3	4	0	1	1	2	1	2	0	3	4	2	1	2	4	1	4	3	0
L2:Int'l Spec/Func Lead	0	0	0	0	1	1	2	3	4	1	1	1	1	1	1	1	1	1	1	1	2	1	4	1	4
L3:Domestic Lead	0	0	0	0	1	1	1	1	1	4	1	1	1	3	0	1	1	1	1	3	1	1	4	1	2
L4:Domestic Support	0	0	0	0	1	1	1	2	1	4	1	3	2	1	0	1	1	1	1	2	1	1	4	0	3
W1:Immediate (Hours)	1	1	1	1	0	0	1	1	2	2	2	3	2	1	2	4	2	3	4	1	2	2	1	3	4
W2:Extended (Days)	2	1	1	1	0	0	3	3	4	3	2	2	2	2	1	1	1	1	1	1	1	1	4	4	4
D1:Short	3	2	1	1	1	3	0	0	0	2	3	3	3	4	4	4	4	4	3	2	2	2	3	4	4
D2:Long	4	3	1	2	1	3	0	0	0	2	1	1	4	3	2	1	1	1	1	1	4	2	2	2	2
D3:Enduring	0	4	1	1	2	4	0	0	0	1	1	1	1	2	1	3	1	1	4	4	4	3	3	1	1
T1:Arctic	1	1	4	4	2	3	0	2	1	0	0	0	0	0	0	3	2	3	2	1	1	1	0	2	1
T2:Desert	1	1	1	1	2	2	3	1	1	0	0	0	0	0	0	2	4	4	2	0	0	4	4	3	2
T3:Mountain	2	1	1	3	3	2	1	1	1	0	0	0	0	0	0	3	2	3	3	4	3	1	3	2	1
T4:Urban	1	1	1	2	2	2	1	4	1	0	0	0	0	0	0	2	3	2	3	2	2	4	1	2	1
T5:Littoral	2	1	2	1	1	2	4	3	1	0	0	0	0	0	0	1	2	2	2	2	2	1	4	2	1
T6:Ocean	0	1	3	0	2	1	4	2	2	0	0	0	0	0	0	2	3	1	2	1	1	4	3	4	4
M1:Small/Low-Tech	3	1	0	1	4	1	4	1	3	3	2	3	2	1	2	0	0	0	0	0	0	0	2	3	4
M2:Medium/Low-Tech	4	1	1	1	2	1	4	1	1	2	4	2	3	2	3	0	0	0	0	0	0	2	3	3	4
M3:Large/Low-Tech	2	1	1	1	3	1	4	1	1	3	4	3	2	2	1	0	0	0	0	0	0	3	2	1	1
M4:Small/Hi-Tech	1	1	1	1	4	1	3	1	4	2	2	3	3	2	2	0	0	0	0	0	0	3	2	4	1
M5:Medium/Hi-Tech	2	1	3	1	1	1	2	1	4	1	0	4	2	2	1	0	0	0	0	0	0	4	1	3	1
M6:Large/Hi-Tech	4	2	1	1	2	1	2	4	4	1	0	3	2	2	1	0	0	0	0	0	0	3	4	3	1
C1:Routine Ops	1	1	1	1	2	1	2	2	3	1	4	1	4	1	4	0	2	3	3	4	3	0	0	0	0
C2:Peace Support	4	4	4	4	1	4	3	2	3	0	4	3	1	4	3	2	3	2	2	1	4	0	0	0	0
C3:COIN	3	1	1	0	3	4	4	2	1	2	3	2	2	2	4	3	3	1	4	3	3	0	0	0	0
C4:Major Combat	0	4	2	3	4	4	4	2	1	1	2	1	1	1	4	4	4	1	1	1	1	0	0	0	0

Figure 11: Pair-Wise Comparison Matrix

3 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 2. This process should be completed prior to defining a particular scenario.

The process of characterizing a FPS is similar to the FAR. Each FPS is characterized through a selection of variables, except that instead of using a scaled 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. FPS 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 scenario 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 FPS main interface will be displayed, as seen in Figure 12. This includes the tombstone data (i.e,. name, date added, description) of the scenario. Scroll through the scenarios using the blue arrows. To add a new scenario, scroll to the end and enter a name and description. The current date will be automatically entered in the "Date Added" field. Once complete, click "Characterize FPS".
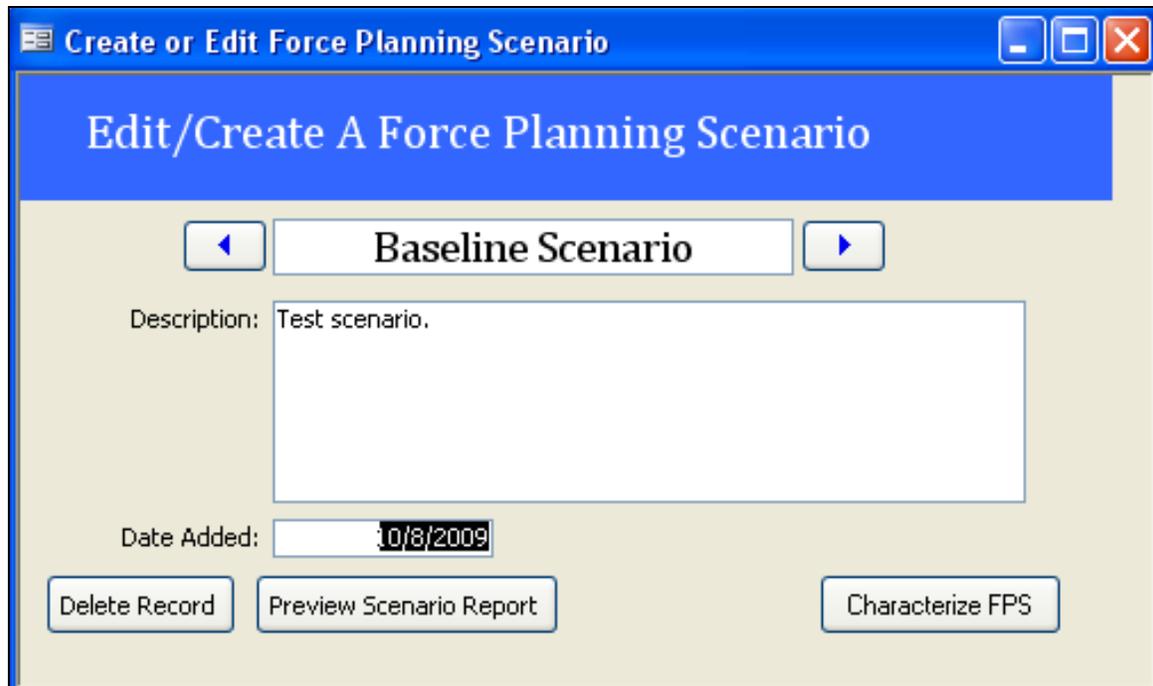

Figure 12: FPS Tombstone Data

2. The scenario data is entered using a series of check boxes. One or more check boxes can be activated for a given FPS. The first form includes all factors related to the nature of the campaign, as seen in Figure 13: Characterize FPS - Campaign Variables. Once all relevant check boxes are complete, click on the button in the bottom-right corner. This will bring up the next form. There are five forms in total.

Figure 13: Characterize FPS - Campaign Variables

3. Once all forms have been populated, the results can be printed as a report. To view the report, go to the final form, "Political Variables", and click "Preview Scenario Report".

4. To view how the updated FPS affects coverage, the same analytical process applies as in Section 2. Return to the main switchboard and select "Review FPS Coverage". This provides access to the same interactive graphs.

4   Conclusion

The development of an analysis tool for testing and evaluating the FPS is a difficult challenge, especially considering the number of plausible scenarios is virtually endless and bound only by the limits of imagination. There is a requirement for a tool that can be used by analysts as a "test mechanism" to filter the FPS and concentrate on scenarios that are plausible, relevant and challenging while eliminating low priority or probability alternatives. The analysis tool for the FPS described in this user's guide represents a technical solution to the requirement and has been developed in close collaboration with Defence Scientists. 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 Canadian Forces capabilities across the spectrum of roles and environments. 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.

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List of Acronyms

CBP	Capability Based Planning
CF	Canadian Forces
CFD	Chief of Force Development
CFDS	*Canada First* Defence Strategy
COIN	Counterinsurgency
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 Scenario
MA	Morphological Analysis
MS	Microsoft
R&D	Research & Development

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This contractor report provides information to end users with respect to the process by which scenarios are identified, characterized and evaluated in the Force Planning Scenario analysis tool. In an effort to apply a framework for characterizing the Force Planning Scenarios, a desktop application using existing commercial-off-the-shelf software was developed. This document serves as a user's guide to this 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 that more thoroughly describes the framework and methodology, "Development of a Framework for Force Planning Scenarios."

Le présent rapport de l'entrepreneur contient des renseignements destinés aux utilisateurs finaux relativement au processus permettant d'identifier, de caractériser et d'évaluer les scénarios dans l'outil d'analyse des scénarios de la planification des forces. Dans un effort visant à appliquer un cadre permettant de caractériser les scénarios de planification des forces, une application de bureau basée sur un logiciel commercial grand public déjà existant a été mise au point. Le présent document est une guide de l'utilisateur pour cette application. Ce guide donne une description détaillée des principales fonctions de l'outil ainsi que des instructions sur son utilisation. Ce document doit être lu en conjonction avec le rapport de l'entrepreneur qui décrit plus en détail le cadre et la méthodologie, ainsi que la « Mise au point d'un cadre pour les scénarios de planification des forces ».

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

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