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# Facilitating the use of decision matrices for operational planning

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## **Abstract**

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This report describes a custom macro-enhanced Excel workbook designed to aid Course of Action comparative analysis during the Royal Canadian Navy's Operational Planning Process.

## Résumé

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Le présent rapport contient la description d'un classeur Excel amélioré et personnalisé destiné à faciliter l'analyse comparative des plans d'action au cours du processus de planification des opérations de la Marine royale canadienne.

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# 1 Introduction

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The Canadian Forces Operational Planning Process describes five planning phases [1]:

- **Initiation:** Commander's initial assessment, activation of planning staff, commander's direction to staff;
- **Orientation:** Mission analysis (intent analysis, task analysis, assumptions and limitations), evaluation of friendly forces, initial operational design, initial risk assessment, mission analysis briefing;
- **Course of Action (COA) development:** COA development, information brief, COA war game, COA evaluation, decision briefing;
- **Plan Development:** Plan preparation, plan war game; and
- **Plan review:** war game and/or exercise.

This report focusses on a decision aid for COA evaluation within the COA development phase. At this point in the planning process:

- Enemy COAs (ECOAs) have been developed, if relevant;
- Viable ownship COAs have been developed; the development of three COAs is recommended, but in practice there may be more or less COAs depending on the complexity of the situation;
- Evaluation criteria have been selected for evaluating the COAs; and
- The planning team is ready to use a decision matrix to aid in COA evaluation.

## 2 OPP decision matrix examples

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The examples in this document were created by the authors, following the instructions identified in the Joint Operational Planning Process (OPP) document [2].

Suppose for a particular mission, three ECOAs and three COAs have been developed and the chosen evaluation criteria are: Operational Risk, Logistic Sustainability, Vessel Coverage, and Least Time. The decision matrix would be set up as in Figure 1. Typically this is completed within a Microsoft Word template document referred to as The Estimate [3], which guides planners through the requirements of the planning process.

	<b>ECO1</b>	<b>ECO2</b>	<b>ECO3</b>
<b>COA1</b>	Operational risk Logistics sustainability Vessel coverage Least time	Operational risk Logistics sustainability Vessel coverage Least time	Operational risk Logistics sustainability Vessel coverage Least time
<b>COA2</b>	Operational risk Logistics sustainability Vessel coverage Least time	Operational risk Logistics sustainability Vessel coverage Least time	Operational risk Logistics sustainability Vessel coverage Least time
<b>COA3</b>	Operational risk Logistics sustainability Vessel coverage Least time	Operational risk Logistics sustainability Vessel coverage Least time	Operational risk Logistics sustainability Vessel coverage Least time

*Figure 1: Decision matrix – 3 COAs x 3 ECOAS – prior to assessment.*

The team then mentally ‘wargames’ each COA and assigns a value (indicated by red = worst, yellow = moderate or green = best in Figure 2) to each evaluation criteria for each COA-ECO combination. It is important that the meaning of the colours is identified prior to conducting the assessment, to ensure that the scale is applied consistently throughout the evaluation process (e.g., what does ‘red’ mean in terms of Operational Risk?). Figure 2 shows a decision matrix example, complete with assessments.

In order to select the best COA, values are applied to the colors (e.g., red = 1, yellow = 2, green = 3) and the governing factors are weighted according to importance (e.g., Operational Risk = 2, Logistic Sustainability = 1, Vessel Coverage = 2, Least Time = 1).



	Evaluation Criteria	ECO1	ECO2	ECO3
<b>COA1</b>	Operational risk	Red	Yellow	Yellow
	Logistic sustainability	Yellow	Yellow	Red
	Vessel coverage	Yellow	Green	Green
	Least time	Green	Red	Yellow
<b>COA2</b>	Operational risk	Red	Green	Green
	Logistic sustainability	Green	Yellow	Red
	Vessel coverage	Yellow	Yellow	Green
	Least time	Yellow	Green	Red
<b>COA3</b>	Operational risk	Green	Red	Green
	Logistic sustainability	Red	Yellow	Yellow
	Vessel coverage	Green	Yellow	Red
	Least time	Yellow	Green	Green

**Figure 2:** Decision matrix – 3 COAs x 3 ECOAS – with assessment.

Figure 3 shows the calculations that would need to be completed to determine the value of each COA:

- In each coloured cell, assessed value (indicated by color, where green = 3, yellow = 2, red = 1) x weight of criterion is calculated; and
- To calculate the value of each COA, cell values are summed across all criteria and ECOAs for each COA (e.g., for COA1: Value of COA1 = (2+2+4+3) + (4+2+6+1) + (4+1+6+2) = 37.

	Evaluation Criteria	Crit. Weight	ECO1	ECO2	ECO3	Value of COA
<b>COA1</b>	Operational risk	2	1x2=2	2x2=4	2x2=4	37
	Logistic sustainability	1	2x1=2	2x1=2	1x1=1	
	Vessel coverage	2	2x2=4	3x2=6	3x2=6	
	Least time	1	3x1=3	1x1=1	2x1=2	
<b>COA2</b>	Operational risk	2	1x2=2	3x2=6	3x2=6	40
	Logistic sustainability	1	3x1=3	2x1=2	1x1=1	
	Vessel coverage	2	2x2=4	2x2=4	3x2=6	
	Least time	1	2x1=2	3x1=3	1x1=1	
<b>COA3</b>	Operational risk	2	3x2=6	1x2=2	3x2=6	39
	Logistic sustainability	1	1x1=1	2x1=2	2x1=2	
	Vessel coverage	2	3x2=6	2x2=4	1x2=2	
	Least time	1	2x1=2	3x1=3	3x1=3	

**Figure 3:** Decision matrix – 3 COAs x 3 ECOAS – with assessment and calculations.

In this case, COA2 appears most desirable. If this result is not consistent with the team's or commander's expectation, the team should re-check that the most important evaluation criteria have been considered and that the relative weightings and assessments are appropriate.

The final table is copied from Word into an information brief (also a part of the COA Development phase of the OPP), typically in the form of a PowerPoint presentation.

## **2.1 Concerns with manual creation of decision matrices**

While this process is relatively straightforward, unnecessary time can be spent:

- Developing the initial table (Figure 1);
- Using Microsoft Word font colouring options to colour cells according to the selected assessment (Figure 2); and
- Mentally calculating the total values for each COA (Figure 3).

In addition to this, manual processes such as these introduce opportunities for error, particularly in a time-pressured and stressful environment.

### 3 EXCEL workbook to aid decision matrix usage

A macro-enhanced EXCEL workbook was developed to remove some of the manual burden of this process. It was designed to support existing workflows, and produce a decision matrix that matches that from their current process, as shown in Figure 4.

Criteria	Relevant	Weight	ECO A1	ECO A2	ECO A3	Totals
Operational risk	x	2	Operational risk	Operational risk	Operational risk	37
Speed/distance			Logistics sustain.	Logistics sustain.	Logistics sustain.	
Logistics sustainability	x	1	Vessel coverage	Vessel coverage	Vessel coverage	
Vessel coverage	x	2	Least time	Least time	Least time	
Least time	x	1	Operational risk	Operational risk	Operational risk	40
Asset employment			Logistics sustain.	Logistics sustain.	Logistics sustain.	
Security			Vessel coverage	Vessel coverage	Vessel coverage	
Safety			Least time	Least time	Least time	39
Covertness			Operational risk	Operational risk	Operational risk	
			Logistics sustain.	Logistics sustain.	Logistics sustain.	
			Vessel coverage	Vessel coverage	Vessel coverage	
			Least time	Least time	Least time	

Figure 4: Decision matrix EXCEL template.

On the left, the white cells are used to indicate which criteria should be used in the decision matrix and the weighting to associate with each criterion. Both the criteria to use and the weightings must be indicated by the user. On the right is the decision matrix table, which is automatically generated based on the selected criteria. When the matrix is initially built, all cells are white to indicate that assessments have not been made yet by the user (e.g., Figure 5, ‘Security’ cells). In Figure 4, the criteria and weightings have been set to duplicate the example in Figure 3, as have the assessments. The totals on the far right are automatically calculated.

#### 3.1 Building the matrix

To add a new criterion to the matrix, the user can:

- Edit the text of an existing criterion, or
- Add a new criterion to the bottom of the list.

In both cases, in order to see the criterion added to the table, an ‘x’ must be placed in the ‘Relevant’ column. In Figure 5 an ‘x’ has just been added next to the ‘Security’ criterion, which resulted in this criterion being added to the matrix. Since assessments for this criterion have not been completed yet, the cells appear white. Prior to assessments being made, this criterion does not have any impact on the ‘Totals’ column. Once an ‘x’ is entered in the ‘Relevant’ column, the ‘Weight’ column requires a corresponding integer value. The user is alerted to this by the red outline of the cell, also shown in Figure 5.

Criteria	Relevant	Weight	ECO A1	ECO A2	ECO A3	Totals
Operational risk	x	2	Operational risk	Operational risk	Operational risk	37
Speed/distance			Logistics sustain	Logistics sustain	Logistics sustain	
Logistics sustainability	x	1	Vessel coverage	Vessel coverage	Vessel coverage	
Vessel coverage	x	2	Least time	Least time	Least time	
Least time	x	1	Security	Security	Security	
Asset employment			Operational risk	Operational risk	Operational risk	40
Security	x		Logistics sustain	Logistics sustain	Logistics sustain	
Safety			Vessel coverage	Vessel coverage	Vessel coverage	
Covertness			Least time	Least time	Least time	
			Security	Security	Security	
			Operational risk	Operational risk	Operational risk	39
			Logistics sustain	Logistics sustain	Logistics sustain	
			Vessel coverage	Vessel coverage	Vessel coverage	
			Least time	Least time	Least time	
			Security	Security	Security	

Figure 5: Building the matrix.

### 3.2 Entering assessments in the matrix

After the matrix has been built by entering or selecting the appropriate criteria, assessments must be completed for each criterion with respect to each COA-ECO A combination. In Figure 6, a selection is being made by the user to indicate their perceived assessment of ‘Security’ if COA1 is chosen and the enemy were to follow ECOA3. Notice that for COA1, the value in the ‘Totals’ column has changed from Figure 4, to account for the addition and assessment of the ‘Security’ criterion.

The text options in the drop-down menu currently include “High” (green), “Medium” (yellow), “Low” (red), and “Nil” (white, no assessment completed). This text could be easily modified within the macro code to show other suitable words or values.

Criteria	Relevant	Weight	ECO A1	ECO A2	ECO A3	Totals
Operational risk	x	2	Operational risk	Operational risk	Operational risk	43
Speed/distance			Logistics sustain	Logistics sustain	Logistics sustain	
Logistics sustainability	x	1	Vessel coverage	Vessel coverage	Vessel coverage	
Vessel coverage	x	2	Least time	Least time	Least time	
Least time	x	1	Security	Security	Security	
Asset employment			Operational risk	Operational risk	High	40
Security	x	2	Logistics sustain	Logistics sustain	Medium	
Safety			Vessel coverage	Vessel coverage	Low	
Covertness			Least time	Least time	Nil	
			Security	Security	Security	
			Operational risk	Operational risk	Operational risk	39
			Logistics sustain	Logistics sustain	Logistics sustain	
			Vessel coverage	Vessel coverage	Vessel coverage	
			Least time	Least time	Least time	
			Security	Security	Security	

Figure 6: Entering criterion assessments.

### 3.3 Limitations of the EXCEL workbook

The EXCEL worksheet tool described in this report was put together as a quick demonstration of the utility of automating the COA decision matrix construction and its corresponding calculations. It is recognized that additional features could be added to increase the general applicability of the template. These additions could be completed if there was interest from the RCN to do so.

Two notable limitations are:

- In the current template, assessing a COA-ECO combination against a particular criterion must be evaluated as green (a value of 3), yellow (a value of 2), or red (a value of 1). The value assigned to each color is currently not modifiable by the user. It is worth noting, however, that unless there would ever be a case where the incremental difference between red and yellow and yellow and green are not the same (e.g., red = 1, yellow = 2, green = 4), which seems unlikely, the relative results would not change.
- The template assumes that 3 COAs and 3 ECOAs are being considered. However, there may be times when there are only 2 COAs, or even where there are no ECOAs at all. Such situations can be handled by the template by simply not performing the criteria assessments in the cells that do not apply (e.g., Figure 7 (left) shows 2 COAs and 2 ECOAs). To capture a ‘cleaner’ image for inclusion in an information brief, the ECOA3 column could be hidden (by right-clicking on the column header), and then the appropriate table cells can be selected and copied (e.g., Figure 7 (right)). This work-around creates a bit of extra work for the user, and could be eliminated in future template versions that allow specification of the number of COAs and ECOAs.

	ECO1	ECO2	ECO3	Totals
COA1	Operational risk	Operational risk	Operational risk	24
	Logistics sustain.	Logistics sustain.	Logistics sustain.	
	Vessel coverage	Vessel coverage	Vessel coverage	
	Least time	Least time	Least time	
COA2	Operational risk	Operational risk	Operational risk	26
	Logistics sustain.	Logistics sustain.	Logistics sustain.	
	Vessel coverage	Vessel coverage	Vessel coverage	
	Least time	Least time	Least time	
COA3	Operational risk	Operational risk	Operational risk	0
	Logistics sustain.	Logistics sustain.	Logistics sustain.	
	Vessel coverage	Vessel coverage	Vessel coverage	
	Least time	Least time	Least time	

  

	ECO1	ECO2	Totals
COA1	Operational risk	Operational risk	24
	Logistics sustain.	Logistics sustain.	
	Vessel coverage	Vessel coverage	
	Least time	Least time	
COA2	Operational risk	Operational risk	26
	Logistics sustain.	Logistics sustain.	
	Vessel coverage	Vessel coverage	
	Least time	Least time	

Figure 7: Decision matrix with 2 COAs and 2 ECOAs.

## 4 Concluding remarks

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This report introduced a custom Excel-based tool to aid in the construction and application of COA decision matrices used during the OPP. The motivation, overall design, and usage were described, along with possible future enhancements. For a copy of the template, please contact Don Coady ([don.coady@drdc-rddc.gc.ca](mailto:don.coady@drdc-rddc.gc.ca)) or Tania Randall ([tania.randall@drdc-rddc.gc.ca](mailto:tania.randall@drdc-rddc.gc.ca)).

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- [1] Department of National Defence, The Canadian Forces Operations Planning Process (OPP), Canadian Forces Joint Publication 5.0 (CFJP 5.0), 2008.
- [2] Department of Defense, Joint Publication (JP) 5-0: Joint Operational Planning (JOP), 2011.
- [3] Bélanger, M. (2003). The Estimate Process: Observations. DRDC Valcartier, DRDC Valcartier TM 2003-357.

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