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# The Definition and Prioritization of Challenges for Innovation

## *Facilitating Stakeholder Engagement*

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## **Scientific Letter**

# **The Definition and Prioritization of Challenges for Innovation**

## **Background**

The Innovation for Defence Excellence and Security (IDEaS) program is a new DND/CAF program that was launched April 9, 2018 to help solve some of the toughest defence and security challenges through innovation.<sup>1</sup> This Scientific Letter describes recent work on two interrelated activities that are instrumental in the way the program has evolved: 1) the process of engaging with stakeholders to identify innovation challenges; and 2) the process for defining and prioritizing the challenges.

The L1 organisations within DND/CAF are the stakeholders of the program and also its main beneficiaries. Involving them in a process of consultation and decision-making that is open and inclusive by design is thought to ensure their support for the IDEaS program. By identifying and maintaining clearly defined links between the submissions and the published innovation challenges, this will also ensure ongoing stakeholder support for achieving the program's outcomes.

## **Statement of Results**

For the latest round of the IDEaS program, Chief of Force Development (CFD) was responsible for the elicitation of challenges for innovation; consequently, CFD required a process that would facilitate stakeholder engagement from the initial call for challenges to the final set of well-crafted challenges. A working group, comprised of authoritative representatives from each L1 organization, was created to facilitate communication, cooperation, and consultation between organizations, and to permit a transparent and participatory approach to decision-making. Working group participants were involved in collating challenges for innovation from their respective organizations, and were then engaged in prioritizing the full list of challenges. The L1 representatives were tasked with reworking their challenges into standardized problem statements, and were then engaged in a collective endeavor to assess what had become a list of 99 challenges against two criteria (i.e., urgency and impact) in order to create a bank of challenges for IDEaS with varying levels of priority for innovation (Annex A).

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<sup>1</sup> IDEaS have its origins in Canada's new Defence Policy, entitled "Strong, Secure, Engaged" (SSE) [1].

## Discussion of Results

In preparation for the first Call for Proposals (CFP) for competitive projects in April, 2018, the IDEaS program chose to leverage the role and function of the ADM(S&T) Directors General Science and Technology Programs (DGSTPs) to elicit challenges from their respective DND/CAF counterparts. For the second call, CFD assumed responsibility for this task and chose instead to canvas the L1 organizations directly. Part of the rationale was to establish and maintain a clear connection between the program's inputs and outputs by: 1) directly involving L1 stakeholders in a process of identifying and prioritizing challenges for innovation; and 2) sustaining their participation throughout the innovation cycle.

Chief of Force Development created a submission form that was sent to each L1 organization (Annex B). They were asked to propose between 10 and 20 challenges for innovation (depending on the L1) which could include challenges that were submitted, but not selected, in the first CFP (see Annex A and B). Although CFD did not consult directly with ADM(S&T) during the second round, each of the L1 organizations were asked to liaise with their S&T advisors when identifying challenges.

This second round produced a total of 176 challenges initially. While the intent was to obtain a list of challenges that could be addressed by IDEaS, not all of the 176 challenges were suitable. Some were more akin to a procurement request; others identified solutions (not problems); not all of the challenges had a definite scope; and others were not believed to be solvable by IDEaS.

A core working group, which included the authors, members of CFD and Director General Capability and Structures Integration (DGCSI), undertook a review of the initial list of challenges based on a set of criteria they developed. Each challenge was assessed based on whether it:

- Represents a clear and concise problem—not a solution;
- Aligns with strategic priorities and/or guidance;
- Has a definite technical scope;
- Represents a solvable problem by IDEaS within a discernable timeframe;
- Identifies a real “pain point” and not just a “nice to have”; and
- Does not require access to classified knowledge or materials.

The list of challenges was reduced to 90 following the assessment. However, the ability to move forward with an exercise to prioritize the list was hindered by the fact that many of the problems were not straightforward or specific. A revised problem template was proposed and adopted (Figure 1) and CFD gave stakeholders the option to rewrite their challenge statements [2]. Ninety-nine challenges were resubmitted using the problem template, and having a succinct and standardized list of problem statements turned out to be a key prerequisite for the next step.

Here is a template for creating a problem statement:

Here is a template for creating a problem statement:  
**How might we \_\_\_\_\_ for \_\_\_\_\_ in order to \_\_\_\_\_ .**  
Ex: How might we provide real time location for Navy Divers in order to increase their situational awareness and increase mission capabilities?

Source: Hacking for Defence, Stanford University

*Figure 1: Problem statement template.*

The CFD intended all of the L1 stakeholders on the Working Group be jointly involved in prioritizing all of the challenge statements, not just their own contributions. While each of the challenges were already considered to have some priority by their L1 contributors, a prioritization exercise was believed necessary for shedding light on the most pressing issues based on the collective views of all of the L1 representatives. In order to create a scientifically robust method for decision-making, the authors settled on two criteria that would help to distinguish between those problem areas that were thought to be more or less urgent and to have greater or lesser impact on operations or departmental processes (see Annex C):

**Urgency.** How urgent would you say the problem is?

Urgency measures the time sensitivity of the problem based on the length of time that is needed to obtain solutions, and when answers are needed to prevent or limit impacts on operations or processes.

**Impact.** What is the level of impact should the problem not be addressed?

Impact measures the effect a problem has on operations or processes. Impact is based on the extent to which DND/CAF is likely to be affected should a solution to the problem not be found.

The use of urgency and impact is a variation of the Eisenhower Decision Principle [3], which made a distinction between urgency and importance based on the view that tasks can be important but not urgent and vice versa. With the current focus on problem areas, not tasks, the “importance” criterion was not deemed to be as relevant or useful. The Eisenhower framework is also thought to contain logical incongruities when it is applied to problem areas. For instance, it is hard to envision DND/CAF problems that are collectively viewed as unimportant but still need to be urgently addressed. Since IDEaS does not have the resources to focus on all of the problems that were identified, a priority framework was needed that would rate the *urgency* of problems in relation to their *impact* on operations and processes should a solution not be found.

The definition of “urgency” also needed to be revised so that stakeholders did not show undue preference for short-term problems. The IDEaS program seeks to have a balanced portfolio across three time horizons. The program does not intend to focus, solely, on Horizon One problems that might lead to “incremental innovations” or only small, gradual improvements in the way things are done. To be truly innovative, the program must also focus on problem areas that could lead to disruptive or transformative changes. The core working group was concerned that by focusing on urgency, stakeholders would not lend as high a priority to future challenges, including emerging disruptive technologies, e.g., quantum computing, advanced materials, artificial intelligence, etc., thus, the definition for urgency was written to account for the length of time that is needed to obtain solutions. The authors wanted problems to still be viewed as “urgent” if they require many years to decades of effort before solutions can be obtained.

The challenge statements were randomly numbered from 1 to 99 and reference to the L1 was removed. All of the L1 stakeholders assessed the urgency and impact of every problem as either “low”, “medium”, or “high”. The goal was not to rank order the challenges from 1 to 99, but rather to organize them into discrete sets (i.e., a priority matrix) of varying urgency and impact (Figure 2), which serves to alert decision-makers to sets of problems that warrant more or less immediate attention.

		Urgency			
		L	M-	M+	H
Impact	L-	44	21		
	L+	22 25 87	12 13 14 28	98	
	M-		8 18 27 39 61 67 75 94	16 19 26 30 43 56 57 64 68	34 65 99
	M+	31	17 32 35 42 46 52 54 60 85 86 88	1 58 77 78 83 91	2 9 29 49 62 63 73 81
	H		5 23 33 84 95	10 11 15 36 45 51 55 59 70 71 72 74 76 89 92	3 4 6 7 20 24 37 38 40 41 47 48 50 53 66 69 79 80 82 90 93 96 97

**Figure 2:** The urgency-impact matrix of all 99 challenges.

Seventeen L1 contributors provided an ordinal valuation (i.e., “low”, “medium”, or “high”) of the relative urgency and impact of each challenge statement. These valuations allowed for the application of non-dominated sorting,<sup>2</sup> which is a method for sorting many options, each of which has multiple ordinal valuations. In this analysis, sorting the challenges by urgency corresponded to identifying the set of challenges that every assessment indicated to be at least as urgent as the remainder of the challenges; therefore, in this case “at least as urgent” is the practical meaning of “non-dominated”. The initial set of options sorted in this manner is called the first Pareto front, or Pareto frontier. After removing the first Pareto front (column “H” in Figure 2), the at-least-as-urgent sorting was repeated on the remaining challenges, thereby sorting out the second Pareto front (column “M+” in Figure 2). Two more iterations of at-least-as-urgent sorting yielded two more distinct Pareto fronts (columns “L”, and “M-” in Figure 2).

Similarly, at-least-as-impactful sorting resulted in the partition of all challenges into five distinct Pareto fronts (impact rows “L-”, “L+”, “M-”, “M+”, and “H” in Figure 2). There are more Pareto fronts than the three levels of urgency or impact because the seventeen assessments had valuations that were similar, but not identical. In other words, variations in relative valuations yielded intermediate Pareto fronts. The matrix in Figure 2 is a rectangular Venn diagram, in which the cells of the matrix correspond to the intersection of the indicated Pareto fronts of impact (row) and urgency (column).

Based on the results, the red set, comprising 23 challenges, were seen to warrant immediate attention. The working group collectively agreed that significant impacts are likely if solutions to these problems are delayed. The orange set (23 challenges) were considered to be high priority areas with clear impacts that

<sup>2</sup> Non-dominated sorting is based upon the notion of Pareto efficiency, which was developed by Vilfredo Pareto (1848–1923).

must be addressed. Work on the 14 challenges in the yellow set should begin as soon as possible; whereas, there was still believed to be time to address the challenges in green (30 challenges) before they become urgent. By contrast, there was a collective view that the challenges in blue could be set aside for now and considered again later.

## Recommendations

The involvement of CFD has marked an important evolution of the IDEaS program; nevertheless, there are improvements to the process that are recommended based upon the authors' observations:

- A workshop should be created to inform the L1 organizations about the IDEaS program, its five elements, how to construct effective problem statements, and the resource requirements when problems are selected for innovation by the program;
- ADM(S&T) should be included in future requests for submissions or there should be a process for ensuring that the DGSTPs are consulted by their L1 counterparts;
- Challenges should be submitted with an identified point of contact (POC). An ADM(S&T) POC or subject matter expert should also be identified, if different than the POC;
- A standard problem statement template should be used for all future submissions;
- The prioritization process is robust and sound and should continue to be used;
- Ideally, the L1 organizations should be familiar enough with the IDEaS program to recommend which element is best suited to providing the answers they are wanting. Thus, a preferred IDEaS element should be identified for each challenge; and
- There should be a process for securing L1 commitments to deliver against the selected challenges.

## Conclusion

The second call for challenges has shed light on the importance of the *process* as much as the *outcome* of identifying, selecting and prioritizing problems for innovation. Identifying problems for innovation can appear to be a straightforward technical and scientific endeavour. However, agreement needs to be reached by a process that is regarded as fair, transparent, and inclusive. Without effective stakeholder engagement, then even the best outcomes are not likely to be supported. The IDEaS program is an ambitious undertaking that requires a significant commitment by the DND/CAF stakeholders who are also the program's main beneficiaries. An effective process of engagement is what will ensure buy-in for the program's outcomes.

Having the L1 organizations directly involved –during the latest call– in the identification, review, revision, and assessment of challenges for innovation produced important intangible benefits. The process was seen to be open, inclusive and transparent by the L1 stakeholders. The L1 stakeholders shared control over the process and decision-making was participatory. The process produced a bank of challenges for IDEaS that have been endorsed by the L1s.

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## References

- [1] Department of National Defence, Strong, Secure, Engaged. Canada's Defence Policy, June 2017.
- [2] Hacking for Defense, Publisher: Stanford University, <http://hacking4defense.stanford.edu/>, accessed 18 July 2018.
- [3] Eisenhower, D.W. (1954) "Address at the Second Assembly of the World Council of Churches, Evanston, Illinois," August 19, 1954. Online by Gerhard Peters and John T. Woolley, The American Presidency Project: <http://www.presidency.ucsb.edu/ws/?pid=9991>, accessed 01 September 2018.



## Annex A    CFD Stakeholder Engagement Process

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This Annex provides a brief overview of the process that was used by the CFD organization to elicit and amalgamate the L1 problem submissions for use by the IDEaS innovation program.

Two staff members of DG CSI were tasked to lead this activity, brief the L1s on the process; receive and consolidate the inputs and coordinate the overall effort to generate a prioritized list of challenges that IDEaS could use.

First, CFD directed that each L1 organisation (except ADM(S&T)) provide a point of contact (PoC) who could serve as an authoritative liaison between their L1 organization and CFD. The request was for representatives involved in strategic planning within the L1. The DG CSI leads, the authors and the designated representatives formed a working group to accomplish the task.

Next, the representatives of each L1 organisation were asked to consult with their organization on a list of problems or “challenges” for innovation that were of high importance using the template in Annex B. The IDEaS program intends to work with external innovators to seek answers to these problems. Although the L1s were not specifically requested to prioritize their list of challenges, many chose to provide lists of problems that they had already prioritized.

A total of 176 challenges were received from the representatives of these organisations:

- |                                       |  |
|---------------------------------------|--|
| 1. Royal Canadian Air Force           | 8. Canadian Joint Operations Command (CJOC)                                      |
| 2. Royal Canadian Navy                | 9. North American Aerospace Defense Command (NORAD)                              |
| 3. Canadian Army                      | 10. Strategic Joint Staff (SJS)  |
| 4. Special Operations Forces          | 11. Chief Military Personnel (CMP)   |
| 5. ADM Information Management (IM)    | 12. Vice Chief of the Defence Staff (VCDS) Chief of Force Development VCDS (CFD) |
| 6. ADM Material (Mat)                 |  |
| 7. CF Intelligence Command (CFINTCOM) |  |

Upon consolidating the 176 inputs, the core Working Group noticed that the inputs came in a range of forms and levels of detail that did or did not meet the needs of IDEaS. Therefore, it was decided to both do an initial filtering of the list of 176 and also allow the stakeholders to revise their inputs according to additional guidance from the authors as described in the body of this Scientific Letter. Those revised challenge statements and the filtered list of 176 comprised the data that was used for further prioritization as described elsewhere in this Scientific Letter and Annex C.

During the second round, it was apparent that not all of the L1 contributors appeared to be overly familiar with the IDEaS program, its elements, and innovation, broadly. The CFD request for challenges was believed to be a “fire and forget” exercise by some. Not every L1 organization was aware of the need to assign resources to problems that are selected for innovation by IDEaS. Rather than identify 10 or 20 challenges, as directed, it seems likely had the L1 organizations known what was required, they would have identified only as many challenges as they were willing to assign effort towards addressing. The other recurring issue involved the need to identify and keep track of the originator of every challenge. Even though the submission form in Annex B asked for an OPI for each challenge, some L1 organizations still had difficulty when asked to quickly identify who proposed the challenges that were put forward.

## **Annex B    CFD Request for Challenges Inputs Template**

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### **CAF IDEaS Program—L1 Contributions**

#### **L1/Organization:**

*Table B.1: L1 challenge template.*

<b>Serial</b>	<b>Challenge Description</b>	<b>Addressed Capability Gap</b>	<b>Alignment with Policy/Strategic Guidance</b>	<b>OPI</b>
Example				
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

## Annex C CFD Stakeholder Engagement Process

### Developing a Challenge Prioritization Process

The authors were asked to develop a scientifically robust and transparent process for organizing and then prioritizing the IDEaS challenges. At the behest of CFD, a set of themes were identified from Strong, Secure and Engaged, that could be used to organize the initial 176 challenges that were received from the L1 organizations (Figure C.1). Having thematic groupings that are aligned with departmental priorities allows decision-makers to identify and focus on particular themes, e.g., the Arctic, Cyber, etc. when deciding where to invest innovation funds. It can be difficult to define priorities for investment when dealing with a hundred or more challenges; whereas, organizing challenges by theme permits decision-makers to prioritize among what is likely to be a much smaller subset of challenges within each theme. Focusing on themes also provides a way to communicate how funds are being expended. While there was not a decision to focus on a particular theme during the latest round, the set of 12 overarching themes in Figure C.1 can be used when eliciting or prioritizing future challenges.



*Figure C.1: Challenges themes framework.*

In addition to the themes, other criteria were proposed that could be used to prioritize challenges for innovation in the future. The IDEaS program seeks to develop a balanced investment portfolio across the three time horizons. Associating each challenge with the time horizon in which a solution is needed provides yet another way to prioritize the challenges.

For the latest round, it was decided that the challenges would only be assessed and scored against two criteria that were proposed by the authors that were considered the most important. The section below describes the definitions of those two criteria. L1 stakeholders were asked to independently assess each of

the challenge statements and assign a high, medium or low score for each of urgency and impact, defined as follows:

## 1. Urgency

### How urgent would you say the problem is?

Urgency measures the time sensitivity of the problem based on the length of time that is needed to obtain solutions, and when answers are needed to prevent or limit impacts on operations or processes.

*Table C.1: Urgency response options and criteria.*

Urgency	Action Needed
High	Work to address the problem should begin immediately to prevent impacts
Medium	Work to address the problem should be scheduled as soon as possible.
Low	There is time to address the problem. Work can be scheduled or deferred.

## 2. Impact

### What is the level of impact should the problem not be addressed?

Impact measures the effect a problem has on operations or processes. Impact is based on the extent to which DND/CAF is likely to be affected should a solution to the problem not be found.

*Table C.2: Impact response options and criteria.*

Impact	Criteria
High	Significant impacts on operations or processes are likely.
Medium	Moderate impacts can be identified.
Low	Impacts on operations or processes are considered low or negligible

## Priority Matrix

By cross-tabulating the results, a matrix can be constructed with cells that are associated with varying priority levels, which supports decision-making. For instance, if it turns out that 20 out of 100 problem statements are seen as warranting immediate attention (i.e., are located in the red quadrant), then leaders can more easily review them vis-à-vis the IDEaS implementation schedule to decide which ones to address and when. Further processing of the urgency and impact inputs from the L1s using multi-criteria

decision analysis showed that there were logically distinct groupings within the data which resulted in the 9 cells being revised to 20 as shown earlier in Figure 2.

**Table C.3: Priority mix.**

<b>Impact</b>	<b>Low</b>	<b>Medium</b>	<b>High</b>
<b>Low</b>	There is time to address the problem. Work can be scheduled or deferred. Impacts on operations or processes are considered low or negligible	Work to address the problem should be scheduled as soon as possible. Impacts on operations or processes are considered low or negligible	Work to address the problem should begin immediately to prevent impacts Impacts on operations or processes are considered low or negligible
<b>Medium</b>	There is time to address the problem. Work can be scheduled or deferred. Moderate impacts can be identified	Work to address the problem should be scheduled as soon as possible. Moderate impacts can be identified	Work to address the problem should begin immediately to prevent impacts Moderate impacts can be identified
<b>High</b>	There is time to address the problem. Work can be scheduled or deferred. Significant impacts on operations or processes are likely.	Work to address the problem should be scheduled as soon as possible. Significant impacts on operations or processes are likely.	Work to address the problem should begin immediately to prevent impacts Significant impacts on operations or processes are likely.

<b>Colour</b>		<b>Risk</b>	<b>Remediation Required</b>
	Red	Extreme Risk	Immediate
	Amber	High Risk	High Priority
	Yellow	Manageable Risk	As soon as possible
	Green	Minor Risk	Continuous Improvement
	Blue	Low Risk	Revisit later

## **Scoring the Challenges and Final Prioritization**

The input from each L1 was provided to the authors, amalgamated and ultimately expressed as Figure 2 shown earlier. The priority matrix can now be utilized by IDEaS when selecting challenges for innovation using any one or more of the program's five elements.

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