



**Australian Army
Research Centre**



Benchmarking Bottom-up Innovation in the Australian Defence Force: An International Comparative Analysis

Stefan Meisiek

Australian Army Occasional Paper No. 26



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¹ The author acknowledges the contribution of Scott Coleman to this report. Mr Coleman worked as a Research Assistant at the University of Sydney Business School, collected data, and compiled the research database.

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Cover image: Australian Army soldier Private Robert Leighton from the School of Military Engineering operates a 3D printer at the Makerspace facility at Holsworthy Barracks, Sydney. (Source: Defence image gallery).

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Executive Summary

This paper reports the findings from a study of bottom-up innovation in defence organisations. It presents a comparative study of bottom-up innovation activities in the Australian Defence Force (ADF), New Zealand Defence Force (NZDF), United States Armed Forces (US military), and British Armed Forces (BAF). The NZDF, US military and BAF are benchmarked against the ADF with the purpose to identify best practices in bottom-up innovation and to identify gaps in best practice in the ADF.

To fulfil this purpose, the study traces the relationships between levels of authority, funding opportunities, innovation practices, open innovation, and measurement. It further describes how bottom-up innovation builds upon an innovation system grounded in people, structures and culture. The benchmarks thus derived are intended to help the ADF to develop a sustainable innovation capability that adds to its ability to deter potential adversaries.

The study is primarily grounded in the qualitative analysis of 29 interviews with personnel working on bottom-up innovation in the ADF, NZDF, US military and BAF at various levels of authority across various branches. Additionally, the researchers created a database of over 500 documents on bottom-up innovation in the defence organisations of 18 other countries. Of these documents, 397 came from the four militaries under comparison. The remaining 100-plus documents were used in a later stage of the analysis to corroborate the findings. We identified nine benchmarks. The benchmarks inform the governance (three), innovation processes (three) and organisation (three) of bottom-up innovation in the defence sector.

The three benchmarks for governance are senior leadership support, strategic alignment, and funding. The ADF performs strongly against these benchmarks, but there are gaps in senior leadership involvement and longer term strategic alignment, and an overreliance on ad hoc and competitive funding. It is also noteworthy that the coordination of joint bottom-up innovation initiatives lies with the branches, while elsewhere it is coordinated at a ministerial level. This situation might explain difficulties in sustaining joint activities and cross-branch learning.

The three benchmarks for innovation processes are methods, open innovation, and measuring impact. The ADF is bringing many methods to bear. An oversight, however, is the relative absence of stage gate approaches. 'Stage gate' is a project management term that refers to a methodology that improves project outcomes and prevents risk by adding gates, or areas for review, throughout your project plan. While it might suit the ADF's operational and technological demands for advancing innovation, the downside is that opportunities are missed for design thinking, agile, and lean startup. It leads to difficulties in transitioning solutions into continued application. The ADF is strong in open innovation, but there are still opportunities for it to learn from the US military and the BAF, which have both doubled down on open innovation and have larger national innovation systems to draw on. Measurements of innovation performance are in place at the ADF, but need reviewing as regards the specific demands and processes of bottom-up innovation. The present measures are too static.

The three benchmarks for organisation are people, structure, and culture. The ADF has invested in the people benchmark but could improve embedding bottom-up innovation in its organisational structures. Without this, bottom-up innovation could fade. Culture remains a benchmark under development, not only in the ADF but more broadly in each of the studied militaries.

Introduction

Articles in journals, newspapers, and websites from around the world describe bottom-up innovation in defence organisations. Australia, Canada, China, Denmark, India, Ireland, Israel, Italy, Japan, Korea, the Netherlands, New Zealand, Poland, Russia, Singapore, Thailand, the UK and the USA are represented. Bottom-up innovation is defined as involving staff members across organisations in the continuous improvement and adaptation of capabilities. The documents describe activities that encourage and enable staff from all ranks to innovate and improve force posture and design from bottom up. Examples of bottom-up innovation initiatives are makerspaces, hackathons, idea-pitching events, incubators, and agile sprints. With the introduction of these initiatives come new roles, such as innovation coach, innovation ambassador and innovation mentor. There exists, so far, limited research on the bottom-up innovation within militaries. Best practices, benchmarks and suitable management approaches to help sustain these efforts remain to be identified.

This report addresses a gap in research by presenting the results of a study of bottom-up innovation within defence organisations. The purpose of the study was to identify and compare bottom-up innovation in the militaries of selected countries and to benchmark them against the ADF. Identifying areas of excellence, gaps and opportunities shows a trajectory towards the achievement of greater capability across all services and arms. The report informs ADF personnel working in bottom-up innovation on how to improve their efforts, provides senior officers with information on how to assess the performance of bottom-up innovation, and promises to strengthen the development of a stronger sovereign capability.

The four countries selected for this study are Australia, the United States of America, the United Kingdom and New Zealand. The modes of data collection were interviews and the accumulation of publicly available information from online and offline sources. An ethics approval from the Defence People Research—Low Risk Ethics Panel covered the data collection and analysis. The analysis process involved searching for strengths and weaknesses in bottom-up innovation initiatives within the defence sectors of the four countries studied.

The bottom-up innovation initiatives identified within defence organisations, and the language used to describe them, had parallels within private sector companies and non-profit and government organisations. This fact indicates that defence bottom-up innovation is at least in part inspired by the wider discourse and non-military practices. Uniquely however, the defence context sets specific boundaries for innovation work in terms of safety, security, strategic alignment, and transfer of solutions into the system of existing capabilities.

On the following pages we first provide details on our methods. We describe the type of data collected, identify the kind of benchmarking analysis undertaken, and explain how benchmarking can provide actionable information. The methods are followed by a brief overview of the four studied militaries. This overview is meant to put the four militaries into perspective, noticing that there are large differences between them, although they are allies in the Five Eyes network. Then we turn to the topic of benchmarks. The benchmarks are closely related within three identified groups: governance, innovation process and organisation. We conclude the description of each benchmark with notes on gaps and opportunities. A brief discussion of future work on benchmarking in bottom-up innovation concludes this report.

Methods

We applied a constructivist research lens to benchmark the ADF against the NZDF, the US military and the BAF (Charmaz, 2006). The goal was to better understand bottom-up innovation initiatives and measures of success based on empirical data and the current literature. Constructivism is an interpretive method that is a suitable lens through which to study ongoing developments, because it enables systems to be seen through the written and spoken language of immediate participants and stakeholders. This means looking at how practical understandings emerge around bottom-up innovation and identifying what works and what doesn't work, how innovation might become sustainable, and what possible objections and challenges persist.

Benchmarking Approach

Benchmarking allows organisations to adapt. It involves a process of examining key metrics and practices and comparing them to understand how and where the organisation needs to change to improve performance. Benchmarking includes several stages: planning, data collection, analysis, action, and review. Of these stages, this report covers the first three. It also includes a list of recommendations for action. It is for the audience for this report to decide which actions to take and to review their implementation.

Of the various forms of benchmarking, this report presents an external approach to practice. Practice benchmarking involves gathering and comparing qualitative information about how an activity is conducted through people, processes and technology. It results in insights into where and how performance gaps occur, and what best practices the organisation is already applying. Benchmarking is external, because it compares the practices of one organisation to several others, all of which need to agree to participate in the exercise. The authors of this report act as a third party to facilitate data collection and analysis, thus avoiding conflicts of interest.

The objective of the benchmarking study is to gain insights into the current state of bottom-up innovation in the four selected militaries, which allows us to set baselines and determine goals for improvement. Practice

benchmarking is recommended where an activity is relatively new to all comparable organisations and key performance indicators are not yet identified. A quantitative benchmarking study might follow up on the results, operationalising the discovered concepts and developing valid and reliable measurement instruments.

Data Collection

To capture bottom-up innovation, an initial list of key concepts was compiled through an exploratory search in international defence journals, newspapers and websites. Based on the publicly available information, we expanded our search to non-classified strategic documents, reports, conference presentations and similar. Our search produced 544 documents from 18 countries. The collected documents indicate the existence of diverse bottom-up innovation initiatives in militaries around the world.

For benchmarking purposes, we then selected countries that are commensurable to Australia in terms of technological development and military organisation. The chosen countries are New Zealand, the United Kingdom and the United States. Our research database consists of (a) 397 publicly available and non-classified documents (Australia 127; New Zealand 13; United States 211; United Kingdom 46) and (b) 29 semi-structured interviews with key personnel involved in military innovation in the selected countries (Australia 16; New Zealand 4; United States 5; United Kingdom 4).

The interviews were each about one hour long and aimed to generate insights into existing operations and activities in bottom-up innovation. The target participants were past and present members of defence forces and associated private organisations managing bottom-up innovation. In terms of demographics, all participants were over 18 years of age. We concentrated on experienced (10-plus years of service) people who work or worked with defence innovation in a managerial position. We assessed this group as being the most knowledgeable about the organisational aspects of how to create and maintain bottom-up innovation. An anonymised list of participants is attached to this report (Attachment A). It provides a notion of the kinds of organisations, titles and entities of interest.

Within Australia, Army participants were from Australian Special Operations Command's Innovation and Experimental Groups (SOCOM IXG), the 8th

and 9th Brigade of the Royal Australian Regiment (8/9 RAR IXG), Army's Makerspace Pilot Program, and the Robotic and Autonomous Systems Implementation & Coordination Office (RICO) within Army's Future Land Warfare Branch. Participants from the Royal Australian Air Force (RAAF) were from Jericho Disruptive Innovation and Edgy Air Force. We also interviewed members of the Royal Australian Navy (RAN) Centre for Innovation within the Warfare Innovation Navy Branch. Further, we worked closely with the Australian Army Research Centre which supported and oversaw the sampling approach.

For the NZDF, the participants were members of the Defence Excellence—Innovation organisation and Defence Industry Engagement. We also interviewed two former NZDF officers who were recognised innovators in humanitarian assistance, logistics, army and air force.

For the United Kingdom, the participants came from the British Field Army, Future Capability Group, Army Innovation Hub, and Army Rapid Innovation and Experimentation Laboratory (ARIEL), which works closely with Defence BattleLab. We also included participants from Defence Equipment and Support, a Ministry of Defence collaboration with the UK military.

For the United States, participants were from Naval X, Air Force Werx (AFWERX), Special Operations Force Werx (SOFWERX), and Kessel Run. Werx is a slang word for 'works', used by the military to indicate informality relative to standard operations. One participant was a former senior manager in charge of acquisition and technology development with the US military.

To avoid interviewing too widely and losing focus, Australian military participants were drawn from within target organisations and focal activities that we assessed to be most likely to practise bottom-up innovation. In this way, the source, number, expertise and age of the potential participants was tailored to achieve the aims of the project—the development of benchmarks for defence innovation.

Data Analysis

We transcribed the interviews and, together with the text from the documents we gathered, uploaded them to the qualitative research software NVivo. The analysis followed three steps.

First, we coded the interviews and documents. This process produced a wide roster of codes indicating managerial, strategic, resourcing, methods, behavioural, structural and cultural issues. Sorting the codes resulted in a rough first identification of possible benchmarks. Going back to the raw data, we corroborated the emerging benchmarks, firming up the boundaries and identifying additional concepts that were descriptive and definitive of the benchmarks. This analytic step provided the emerging benchmarks with depth. We arrived at nine major benchmarks, which we interpreted to belong to three groups of benchmarks as reported in this paper.

The second step of our analysis involved creating benchmark tables (provided in Appendix B), where we compared the ADF, NZDF, US military and BAF. These comparisons provided best practices. Once identified, we then benchmarked the best practices against the ADF to affirm the existing practices or to point out gaps.

Third, we drew on the innovation literature to further define our emerging benchmarks and relate them to one another. This allowed us to link our study to a wider theoretical conversation of innovation in non-military organisations and provided the basis for the recommendations in this paper.

Finally, we turned to the documents on bottom-up innovation in the countries that were not part of the main study to corroborate our findings and to check if we had missed something.

Bottom-up Innovation in the Selected Militaries

We begin reporting our findings with a brief characterisation of each studied military and the scope of their bottom-up innovation activities. According to Global Firepower’s ranking of size and strength (www.globalfirepower.com), the USA holds the first spot, the United Kingdom the eighth, Australia the 17th and New Zealand the 84th. Size notwithstanding, the ranked militaries have a common ambition to engage with bottom-up innovation. The driver for such innovation is a widely held perception of a volatile, uncertain, complex and ambiguous strategic environment, combined with accelerating technological development, which are both difficult for militaries to deal with using traditional research and development (R&D) and procurement processes.

Table 1: Bottom-up Innovation in Selected Militaries

	Australia	New Zealand	United States	United Kingdom
Army	SOCOMD IXG, 8/9 RAR IXG, RICO	Army Innovation Scheme	Army Futures Command; Army Combat Capabilities Development Command (DEVCOM)	Defence BattleLab, Army Innovation; ARIEL
Navy	Warfare Innovation Navy (WIN) Centres—East and West		Naval X	Discovery, Assessment and Rapid Exploitation DARE innovation team; Navy X
Air Force	Jericho Disruptive Innovation, Edgy Air Force (4)		ABIR, AFWERX Kessel Run	

	Australia	New Zealand	United States	United Kingdom
Joint	Information Warfare Division—Joint Capabilities Group	Defence Innovation Centre of Excellence	SOFWERX	Defence BattleLab; Joint Forces Command innovation hub (JHub)
Government (Department/ Ministry of Defence)	Defence Innovation Hub	Defence Technology Agency	Defence Innovation Unit	Future Capability Group, Defence and Security Accelerator (DASA)
Public-private	H4D (Hacking for Defense) BMNT		H4D/BMNT; National Security Innovation Network	H4D/BMNT

Australian Defence Force

The ADF consists of the Australian Army, RAN and RAAF. The Australian Army encourages and supports numerous bottom-up activities aiming at incremental innovation for extending and improving the capabilities of existing and continuing capabilities. Notable initiatives are the creation of makerspaces for ideation and prototyping, and RICO for R&D of autonomous technologies. To support bottom-up innovation, the RAN established Warfare Innovation Navy (WIN) centres in Sydney and Perth. These centres function as leverage points for a host of activities, like innovation training, ideation and prototyping workshops, and industry outreach. While most aircraft are sourced abroad, RAAF has created the Jericho Disruptive Innovation centre to explore technologies that support and complement its activities. Jericho seeks to innovate with the help of RAAF personnel and technology companies in order to create new warfare capabilities. The ADF also has several joint operations initiatives in bottom-up innovation. The aim of these joint activities is to avoid ‘reinventing the wheel’ across the three services, and to learn from each other’s innovation successes and failures.

New Zealand Defence Force

The NZDF consists of the New Zealand Army, Royal New Zealand Navy (RNZN), and Royal New Zealand Air Force. With insufficient resources to attain heavy capabilities (it operates no main battle tanks, for example), the NZDF has oriented itself towards bottom-up innovation to extend and improve the use of existing capabilities and to develop technology-driven solutions to complement these. The New Zealand Army has turned foremost to its personnel for ideas on how to improve and develop existing capabilities and to experiment with new solutions. Annual idea challenges and awards play a growing role, expected to feed into the development of a widespread innovation culture. Seeking new ideas and solutions, the RNZN hosted a hackathon together with the RAN that attracted service personnel and external inventors from both countries. Overall, we observe a debate among stakeholders about centralised and distributed innovation activities, with the Defence Innovation Centre of Excellence ostensibly coordinating NZDF innovation.

United States Military

The US military consists of six service branches: Army, Marine Corps, Navy, Air Force, Space Force and Coast Guard. For commensurability to the other defence forces in our sample, we concentrated on the Army, Navy (including Marine Corps) and Air Force, because they are organised under the Department of Defense. Based on the portfolio of tasks of the US Army, there are numerous bottom-up innovation activities going on. Several organisational entities within Army are encouraging and supporting these activities, such as Army Futures Command and Army Combat Capabilities Development Command (DEVCOM). To provide global vigilance, global reach and global power, the US Air Force is at the forefront of innovation and capability development. Small Business Innovation Research, AFWERKS and Kessel Run encourage, host and support initiatives that explore new technologies with external technology startups and that enable air men and women to be innovative bottom up. Departing from the WERKS template, the US Navy's central coordinating initiative is Naval X, which runs makerspaces and, more broadly, focuses on building tech bridges to industry. In this it diverges somewhat from the other branches. Notable also is SOFWERX, which sits at the joint level and is very active in the bottom-up innovation and outreach activity of the Special Operations Command

(SOCOM). SOFWERX is a public-private innovator of technology, bringing together academia, companies and non-traditional partners to work on SOCOM's most challenging problems.

British Armed Forces

The British Armed Forces (BAF) consist of the Royal Navy (RN), the Royal Marines, the British Army and the Royal Air Force (RAF). Building upon its traditions, the British Army has established several initiatives to drive bottom-up innovation. These include the Defence BattleLab, Army Innovation, and ARIEL, each of which aims to bring new technologies and new solutions to bear on operations and capabilities. Within the RN, the DARE innovation team and Navy X accelerator are tasked to drive bottom-up innovation, providing the groundwork for continuous incremental innovation and experimentation with new technologies. Of the three branches, the RAF seems to be the least involved with bottom-up innovation. Most initiatives run through the Defence and Security Accelerator (DASA), which sits within the Ministry of Defence. With this, the BAF has its central coordinating, funding and initiating body at the government level. Its priorities are to integrate information and physical activities across domains, to deliver agile command and control, to operate and deliver effects in contested domains, to equip defence people with skills, knowledge and experience, and to simulate future battlespace complexity.

Identified Benchmarks

We identified nine benchmarks, which cover best practice in governance, innovation processes, and organisation of bottom-up innovation. In each benchmark, we describe best practices across all militaries studied, before benchmarking against Australia to identify areas of strengths and gaps. The groupings reflect that bottom-up innovation is a multifaceted phenomenon involving not only the work of innovators on their ideas but also the dependency of innovation on the support of the larger military organisation.

Table 2: The Benchmarks

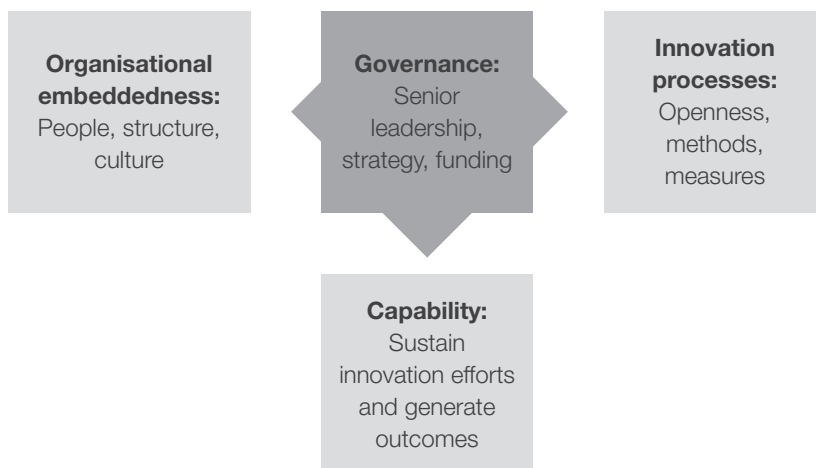
Benchmark	Definition
<i>Governance</i>	
1: Senior leadership support	Upper echelons driving, supporting and shaping innovation efforts
2: Strategic alignment	Following and fulfilling the strategic direction set
3: Funding	Budgeting for innovation initiatives and projects
<i>Innovation process</i>	
4: Methods	Competently creating or deploying appropriate innovation approaches
5: Open innovation	Tech, ideas and solutions sourced from beyond the defence sector
6: Measuring impact	Gauging the success or failure of innovation outcomes
<i>Organisation</i>	
7: Leadership and people	Leader behaviours, mentoring and training
8: Structural embeddedness	Units, rules, norms, reporting and relationships
9: Cultural change	Innovation as the new normal

The relationship between the nine benchmarks is not summative but mutually reinforcing. Best practice in one benchmark enables the achievement of better outcomes in other benchmarks as well. For example, excellent senior leadership support for bottom-up innovation usually leads to adoption of a wider variety of innovation methods, which in turn leads

to the creation of structures (such as innovation centres or hubs) where these activities are housed and showcased. As this example demonstrates, while the benchmarks in each group are closely linked, they influence the development of the other benchmark groups. Together they create a bottom-up innovation system that is sustainable.

The interdependencies within the bottom-up innovation benchmarks are, however, also what makes balancing and managing the activities difficult. Overly rigid or narrow strategic direction might hamstring the freedom and creativity needed to explore untravelled idea pathways, noticing the overlooked and reassessing the wrongly discarded. Creating innovation centres that house innovation capabilities might relegate innovation to a special task, outside the realm of the ordinary service men and women. Further, centres might get stuck in their own innovation model, increasingly unable to reinvent themselves, which can generate divergence between the priorities of senior leadership and the innovation processes they are tasked to lead. Because of these interdependencies, bottom-up innovation systems are necessarily dynamic and need continuous managerial attention. Success is measured less by the capacity to get it right once and more by the ability to continuously keep it right. This interrelationship of the benchmarks at the service of sustaining innovation efforts and generating outcomes is expressed in Figure 1.

Figure 1: Sustaining Innovation Efforts and Generating Outcomes



This observation is important when reading the benchmarks reported below. It means that any attempt to improve upon a single benchmark will have positive or negative consequences for other benchmarks.

Governance

Governance benchmarks take a view from the top. Specifically, they present best practices in how the senior leadership enables, fosters and manages bottom-up innovation. Such benchmarks counter a misconception that innovation could ‘bubble up’ from the bottom of defence fuelled by the needs and motivation of individual staff members. Without endorsement, encouragement and resourcing from the top, bottom-up innovation will inevitably be short lived. A key aspect for governance is strategic alignment. Without it, innovation efforts quickly lose their legitimacy. Further, there are several ways to fund bottom-up innovation. While the funding needs of individual projects might be small in comparison to larger procurements, such projects have distinctive needs in terms of human resources, space, equipment, test-and-learn processes, and implementation. We will describe the three benchmarks that together represent governance, identifying for each one how Australia stacks up against the other countries in our sample.

Benchmark 1: Senior Leadership Support

Although it is called bottom-up innovation, it is not sustainable unless it receives senior leadership support. Ad hoc, idiosyncratic attempts at being innovative (where novice service personnel invest their goodwill, time and resources to solve problems within their remit) might occasionally succeed. When bottom-up innovation is to become a regular, sustained and systemic element, however, senior leadership needs to lend its legitimacy and resources. By doing so, leaders motivate and enable junior personnel to apply themselves to bottom-up innovation.

We have loads of high-level support from all over the Department of Navy. I would highlight that we have lots of support from entry level as well, folks that are just coming in 22 years old up to, you know, mid-career. And then we have loads of support again from senior leadership on up, on up. So, the one-star and above, the two-star and above—totally get it. They see the strategic plans that we have

ahead of us. They know what's at stake. They know where we have capability gaps and they are thrilled to try something different. They know that the status quo will not get us there. (Bradley, US military)

Where support remains lip service, and operational concerns dominate the agenda, bottom-up innovation initiatives quickly wither, as our interviewees told us. Motivated innovators become frustrated and move on to other positions or leave the military altogether. To support bottom-up innovation, senior leadership must establish strategic direction, be involved with innovation, secure resourcing, set risk thresholds, and put the right people in charge.

In those environments, people start to leave, and your creatives will start to leave right away because they'll feel uncomfortable and they'll stop talking. Or you'll see a very specific, focused area of technology innovation, and other areas will start to really struggle. Because whatever that individual or that senior leadership team's focus is, is where everybody will turn their effort, and they'll just stay within bounds. They'll be afraid to go outside of it. (Jennifer, US military)

Establishing strategic direction means to define the aim and scope of innovation activities. The aim includes a broad target, such as defining the number of experiments, expected capability improvements, or the achievement of widespread competence. The aim also includes identifying how meeting the target will be measured. Measurement defines what success looks like and allows leaders to gauge how efforts are tracking overall. Additionally, the aim involves setting a timeframe for achieving the target. Defining the scope means to single out specific areas of activity for innovation, such as cybersecurity, maintenance, collaboration or mobility. The scope is essential to direct innovators towards what is key and will be supported, and what might be less likely to find approval, no matter the amount of effort invested. It directs attention to those opportunities that fit into the strategic direction.

I just realized I left the copy of my innovation strategy that's currently drafted that we've been working on behind, but the purpose of it really is to—what's the term?—and I'm struggling here—provide an environment for people to successfully put their ideas forward, to feel safe putting your ideas forward and know that they will be supported to try and deliver those ideas or implement those ideas, or at least, to

start the work towards designing the proof of concept, and then with the idea, towards implementing their idea. (Yogi, NZDF)

In our analysis, we noticed that strategic direction is generally set in strategy documents, which are circulated widely and explained at suitable events. The wording of these documents remains at a generalised level, with aim and scope remaining open to interpretation. Senior leadership provides impetus and legitimacy to innovation efforts and offers a wide aim, such as building 'the force of the future'. Beyond the documents, an interviewee from the BAF explained that detailed strategic direction needs to be given in multiple interactions so that personnel can develop a sense of what is expected and in which way they might invest themselves. It is in these informal interactions that a sense of the importance of bottom-up innovation and its role for the military evolves.

So, there was at work with the leadership team to create an empowered environment to my level. And then there was the reorganisation of our headquarters to move from, the Field Army Headquarters being a traditional hierarchical structure like that, to flattening out our structure and developing agile organisational protocols. So, I don't know whether you've done any work, or you have any understanding of agile reorganisation and agile organisations, but ... they have a different approach to a traditional bureaucracy, in terms of their agility, and their ability to respond and the empowering environment they create. (Ivan, BAF)

As our interviewees told us, supporting bottom-up innovation requires a delicate balance by senior officers between maintenance of the status quo and the provision of sufficient space and legitimacy for innovators to usher in novelty. For example, in Australia all service chiefs have been involved in innovation initiatives. In some cases, they give permission for military innovators to operate outside the chain of command. In other cases, such as the Army Innovation Day, they furnish their own expertise to help drive innovation and create the opportunity for personnel to submit ideas for funding support by the Chief of Army. However, developing a sense of the appropriate balance requires knowledge and skill that develops slowly among the ADF's senior leadership, because this cohort rose through the ranks in times when bottom-up innovation was not a strategic goal.

I think if you were to talk to any really Senior Leader in Defence, you know, they would give you the standard bureaucratic management leadership speak of, 'You know, we need to innovate to survive.' And, you know, there's a bunch of catch words bingo that would be used, but I don't think any of them. Sorry, not many of them truly know what that means. They know they want it, but they don't know what it is and honestly. (Lyle, ADF)

Senior leadership sets different risk thresholds for initiatives depending upon their origin. Consider, for example, initiatives involving artificial intelligence (AI) and autonomous systems. Large R&D or procurement projects involving such capabilities have high risk thresholds because they require considerable investment in radically new technologies and their adoption for military use. By contrast, where AI and autonomous systems are part of bottom-up innovation, the risk thresholds are lower due to the experimental nature of the engagement. Bottom-up innovators are attempting to find out what new technologies could do, *before* large investments are decided upon. This comparison garnered considerable attention in the documents we collected. Military journals and magazines from around the world describe the way senior leaders have approached breakthroughs in tests and adoption of new technologies.

Part of my job from a leadership perspective, is to say, 'No, but ...'. Because saying no is one of the biggest problems now it is a really easy objection to roll out to our people and in so doing, we stop them in their tracks. But if you go, 'No, but why don't you think about this?', So 'why don't you go and talk to somebody?' So, I'm trying ... I have ... I say, you know, you are not allowed to say, 'No', alone. You've got to go, 'No, but' and give them, 'You've done a great job.', 'How about looking at this?', 'Why not go and have a look at that?', 'Here is a problem I really need solving', 'You obviously have the skill set—you can go and do this.' (Debbie, NZDF)

Senior officers regularly review the risk thresholds across innovation activities. A best practice is to communicate the risk appetite widely, because it informs the focal areas of bottom-up innovation. Comparing the four defence forces in our study, risk thresholds were communicated to innovation centres and individual innovators, and the higher the military budget, and the more technologically sophisticated the defence force, the higher the risk thresholds seemed to be.

And so, we're pretty agile in terms of what we can get after and how we get after it. But with that kind of top level, I guess management from the Director General level and then the two-star level, Head of Land Capability, we invite Heads to come and see some of those demonstrations. He's obviously aware on a periodic basis of what we're doing and what I see ... probably a couple of times a week. And then higher, we provide a report to the Strategic Leadership Group, Senior Leadership Group, like everybody else does about what we're doing. (Robin, ADF)

To guarantee a low risk threshold, it becomes crucial to find, select and nurture specialised innovation personnel. Spotting potential innovators requires attending to personal and professional attributes which may be different to traditional career progression criteria. In the comparison between the defence forces, we found that all four showed care in selecting innovators and putting them in charge of bottom-up initiatives. At the same time, it was not uncommon that roles in innovation centres were filled on a rotational basis, where personnel would step in and out as part of their competence development trajectory. In these cases, there was the danger that the time spent in innovation (between six months and one year) was too short to see projects through or to become deeply familiar with all aspects of bottom-up innovation work.

Best Practice: Provide strategic direction in brief documents outlining aims and scope, and then follow it up by providing further clarity regarding strategic direction on a case-by-case basis. This can be achieved by senior leaders getting personally involved with innovation, including at events, discussions and base visits. By doing so, senior leaders help to set and communicate risk thresholds. Being involved with innovation also makes it easier for senior officers to put the right people in charge with a better understanding of what resourcing is needed.

Gaps: Based on the results of our interviews and analysis of the documents collected, we assess that there is top-level support and involvement in bottom-up innovation within the ADF. Yet maintaining an innovation capability inside an operational unit remains a challenge. We found that ADF senior leaders do provide written strategic direction encouraging innovation, but there is less evidence of their direct and active involvement with initiatives. This left risk thresholds less well defined, and there also seems to be less clarity regarding how to identify, select, challenge and support key

innovation staff outside of their volunteering to get involved or being posted to innovation centres in the course of their ordinary career progression.

Benchmark 2: Strategic Alignment

Strategic alignment is defined as a match between what a military can do (based on its strength and weaknesses) and the universe of what it might do (as presented through environmental opportunities and threats). Bottom-up innovation, however, has no clear direction in and of itself. Everything that can be identified as an opportunity might seem worth pursuing. To avoid the risk of misdirected effort, the relevant question is not so much whether an opportunity exists as whether it is an opportunity worth pursuing by the specific branch of the military. The answer to this question is guided through the strategic alignment of efforts.

So basically, our goal is to ensure that we don't get left behind in what we're doing. We want to be a Future Ready Defence Force and ensure that our efforts in innovation align with the wider NZDF strategy. (Yogi, NZDF)

Lack of strategic alignment poses many dangers. Without it, innovation becomes a grab bag of techniques. There is a lack of decision criteria for necessary trade-offs. Innovators might imitate the innovation processes and directions of another military. If a military holds the ambition to make innovation a capability, then it is crucial for bottom-up innovation to stay tightly aligned with the overarching strategy. This prevents a situation in which projects are started, succeed in development, but ultimately fail in implementation. It also prevents accusations of money wastage on pet projects, and it prevents the loss of legitimacy among peers and in the eyes of senior officers. Strategic alignment provides a communication platform upon which bottom-up innovation projects can move from development to implementation, then to sustained capability.

Yeah, I think most of them come from my team. So we just explore it and we discuss it, and we build on what it might look and then we consider whether it's worth pursuing or not. Then we look at how we might pursue it if we didn't want to pursue it and as I say, a reference is back to something like the RAS Strategy, where it talks about in there making better decisions, using Artificial Intelligence for example to firstly automate, but then inform how we might make decisions.

And you know, you could take it to the next step and actually get it to make decisions about we're all super uncomfortable about that right now, even though it's doing it for you already. (Robin, ADF)

When military personnel are working at the front line of everyday problem solving, or face difficulties in employing and maintaining capabilities, they can easily become enthused about the prospect of generating solutions which engage their individual expertise and concerns. Such efforts, however, might not align with the overarching strategic direction as envisioned by senior officers.

So, the Air Force produced its strategy last year, which is called 'AFSTRAT 2020'. And in that we have several lines of effort that we're looking for people to progress towards, and one of them is upskilling our personnel. So, we don't mind if somebody fast fails a prototype and it doesn't work, because there is value in what they might have learned from that journey. And that's what we see as the upskilling piece. They may not have had a success, but they go, they're backing the workplace, thinking about something else, and they can draw on those failures or successes that they've had working in our ... programs for the next big idea. (Nicholas, ADF)

To address the issue of strategic alignment, all four studied militaries locate bottom-up innovation efforts in purpose-created centres and hubs, such as RAN's Warfare Innovation Navy. Here it falls to the centre director to make sure that ideas picked and supported cluster within the strategic direction. The director becomes a critical link between senior officers and innovators in that she or he needs to communicate the value and alignment of innovation projects upwards, while encouraging, inviting, protecting and supporting individual projects downwards.

The attention to strategic alignment in the short term needs to serve the long-term purpose of bottom-up innovations. In the BAF there is an ambition to go from integration of new solutions and technologies to long-term adaptability as a capability. In the NZDF there is the long-term ambition of setting in motion a self-reinforcing trajectory towards capability enhancement and continuous innovation. The idea is that such a continuous effort will afford and support aligning and realigning to defence policy and strategy changes in response to a changing geopolitical context.

So, it's really about making sure that all of that type of stuff is in place in line with the senior messaging. In terms of top cover, yes, CGS will absolutely cite innovation as one of his priorities, and it's in his Army Command Plan as well. It is written in the Land Industrial Strategy that we need to be innovative. So, all of our doctrine, both internal and external facing, will cite innovation as an important part of realizing operational advantage, which then makes it important. (Glen, BAF)

Finally, alignment is thought of not only in terms of following a strategic direction but also in terms of identifying, evaluating and aligning to emerging technology for new capabilities. We heard that the ADF framed this approach in terms of 'technology vectors' (e.g., a vector might comprise technological developments in autonomous vehicles or generative AI) which would lead to solutions across several potential capabilities. To realise the potential in each technology vector, it is important to bring external and internal stakeholders together in a focused way. Once a technology vector has been established for one military capability, alignment involves mining its potential by identifying, developing and testing whether the technology can be applied to other capabilities.

But out of it came an argument and a debate about additive manufacturing at sea. And now we're writing and in the third month of an additive manufacturing strategy which will be presented to [Chief of Navy] by the end of the year, financed by Joint Logistics Command. So, this little, tiny project has led to a large Defence capability. And that's how innovations energise thinking. (Steve, ADF)

Best Practice: Strategic alignment requires a person to bridge the relationship between bottom-up innovators and senior officer strategic decision-makers. Where there are multiple initiatives, hubs or centres, each requires such an innovation director. These 'bridge personnel' assure that idea selection, development and implementation fall within the defence force strategy, and he or she communicates the actions taken and the outcomes to senior officers. It has a dual benefit: future top-level strategy making is informed by a realistic view of innovation capabilities and outcomes, and innovation activities benefit from support and uptake from the legitimacy gained through strategic alignment.

Gaps: Benchmarking the NZDF, USAF and BAF against the ADF, we noticed that Australia has suitable bridge personnel in place and strategic

alignment is continuously reviewed. However, this study indicates room for improvement in how the activities, and the results achieved, are fed back into the organisational processes that inform future strategy. At the moment, the relationship is unidirectional (from strategic leaders downwards to those engaged in innovation), which is characteristic of an operational organisation but not yet of an innovative organisation.

Benchmark 3: Funding

One of the most critical aspects of innovation is to provide adequate funding. Too much, and innovators can buy their way around difficulties that might otherwise have inspired novel approaches. Too little, and innovators feel like they are asked to make something out of nothing. Apart from the amount, it is also the practice of funding that matters. Discretionary funding provides flexibility, while competitive funding seeks to reward the greatest opportunity, pitching ideas against each other. Both forms of funding have advantages and disadvantages.

Further, funding for bottom-up innovation is different from funding allocated for capability acquisition. Innovation involves inadvertent failure. Innovators learn from failure. Yet, for militaries, failure is generally something to be avoided—albeit there are pockets of the organisation where failure is tolerated, particularly in training institutions. Lengthy documents are written to justify funding proposals, explaining how risks will be avoided or managed to give the project in question the maximum likelihood of success. Preparation of these documents is supported by capability analysts who provide advice and support so that proposals can pass the necessary quality gates before they are tabled at the decision-making level. In much bottom-up innovation work, however, there is too much ambiguity and uncertainty to meet the normal criteria for project progression. A good proportion of the funding provided will have to be written off as a necessary investment into learning what doesn't work. The advantage of bottom-up innovation is, however, that failure is cheap. Most bottom-up innovation costs only a fraction of other projects that are subject to regular procurement processes. The achievement of innovation, therefore, becomes a game of low cost, ingenuity and speed, rather than meticulous planning and documentation. But how do militaries set up a reliable funding structure for that? Several practices that we found in our study are outlined below.

Now through my funding I have that pre-approved funding to be able to deliver on that Bottom-Up innovation. And that's where that funding forum funds the ideas. If it's a fairly simple, straightforward idea, good to work with, we can do it as a Jericho Labs supported idea, or if it's quite a good idea that fits within a capability priority or has a category sponsor who has a need, then we can provide up to \$50,000 to develop out that idea. (Michael, ADF)

When asked, most personnel who seek innovation prefer discretionary funding. It means that a budget is provided to an initiative, hub or centre for a given period, usually one year. The budget comes with an expectation of outcomes being aligned with strategic direction, an agreement on principles to follow, and risk thresholds to observe. The budget can then be applied to as many or as few projects as the innovators see fit. The innovators we talked with favour frugality and tend not to overfund any specific project. An advantage of discretionary funding is that financial support is decided at a level close to competencies, technologies and innovation processes, leading to a more targeted approach. A disadvantage can be that innovators are using the funding towards projects that seem most challenging and interesting to them, which will inevitably lead, over time, to slippage in strategic alignment. Also, funding might go to more radical projects to show innovation prowess.

I'd like to highlight we have a very tiny budget inside of Naval X. We rely on all the rest of the money out there for the Department of Navy to actually do the work. We're not another funding program to go figure out a contract. And I see that as a benefit, people are not coming to us with their ideas. They're not coming to us with solutions that they want us to buy, they're coming to us with ideas that they want advice on, and I can frankly give them unsolicited advice, without giving undue favour. (Bradley, US military)

Ad hoc funding becomes available where bottom-up innovators can prove that their idea has potential. This potential might be outlined in a proposal or a plan, and is usually communicated to senior officers. Ad hoc support provides an opportunity to align funding to risk appetite and strategy, and funding levels can be more accurately weighted against the perceived potential of the innovative idea. For the innovators themselves, however, it presents a lower level of funding certainty and a greater workload to research the exact value their idea might help generate. Importantly, this

approach reduces the flexibility available to innovators to respond to knowledge gained during the innovation process by pivoting from the original idea to a more promising one.

Time or whatever, then that unlocks another tier of funding or something like that. I believe a model more agile like that is what we need to move towards if we're going to remain relevant going into the future, because the danger is we don't, and then our current capabilities just increasingly become less and less relevant as they're off the shelf technology just goes through the roof. So the disparity between, private sector then and public sector becomes quite dangerous. (Jono, NZDF)

Competitive funding is gained through idea competitions, 'shark tanks' and similar events. To obtain funding, innovators need to pitch their idea against those of other innovators. Innovators might come from inside defence, from smaller companies, or from a mix of both. A judging panel of experts listens to the pitches, reviews the reduced-length innovation proposals, and discusses which idea or prototype has the highest potential. Such competitions might happen at the back end of a hackathon, for example, or there might be a regular schedule for when shark tanks take place. The advantage of winning competitive funding is often not only the financial resource but also the attention that an idea or project gains through winning a competition. It might make it easier for innovators to obtain funding from other sources, such as ad hoc funding. Many of the documents collected presented the winner of idea competitions.

The senior leaders supported this by doing Shark Tank and Spark Tank stuff. So, we had publicity. We had internal learning. The mission itself still exists. And in fact, it continues to grow from what I've seen with the new AFWERX regime and stuff like that. So yeah, sustainable because we kept producing enough wins that made it worth the funding because it wasn't, the Air Force has cancelled more than enough programs over the years if we weren't giving back positive value and stuff. (Brian, US military)

So far, the funding sources presented are principally concerned with providing money for initiatives that are rooted in defence. With an increase in open innovation (discussed in Benchmark 5) external collaborators are also becoming involved. To position such collaborators to work on their projects

with defence, there are government funding opportunities for external collaborators. This funding is meant to put cash-strapped startups in the position to develop and test their services, products or technologies for defence applications, something which they would otherwise have difficulty achieving. Also, the funding provides the respective defence force with a tie to bind the startup to a project and to legally secure follow-through.

I'd like to highlight that the defense and government science funding model is unique in that it funds early-stage research for universities, which provides long-term investment. This is best served by government investment, not by private companies like Apple. The AFWERX is doing interesting things related to the Small Business Innovative Research Program, such as making cyber cool again. However, this is a snapshot in time approach and we should evolve over time to meet the needs of the Department of Navy as we grow. We should be starting to buy new things and depending on old things. The Impressionist approach is not a term of insult, but a way to celebrate the moment in time quickly. We need to be nimble to meet the needs of the Navy going forward. (Bradley, US military)

Finally, an important aspect of funding bottom-up innovation is to secure continuing capability funding for the solutions created and implemented. Once an idea has gone through the innovation process and has demonstrated itself to be an effective, efficient and implementable solution, resourcing needs to pass from the innovation initiative, hub or centre to the normal budget cycles. If this transition fails because senior officers assess that the solutions are unnecessary or still too risky, the solution will likely be abandoned. Therefore, the hand-off of the outcome of bottom-up innovation is a critical phase which goes far beyond the innovation process itself. In the literature examined for this study, innovation is seen as the adoption and normalisation of a new solution, not only its invention.

Best Practice: The militaries in our sample apply a mix of funding models. There are budgets for innovation for one-off projects; there is discretionary funding for innovation initiatives, hubs, and centres; there is competitive funding; and there are funds for working with external collaborators. There is, however, little evidence of continuation funding for new innovations. This is a concerning finding as it indicates a disconnect between innovation and the development of sustainable capability enhancements. Best practice is to provide central actors in the internal innovation ecosystem with

discretionary funding, coupled with senior officer oversight and an ongoing demand for the innovation work to be strategically aligned. The same approach applies to ad hoc funding, competitive funding and funding for external collaborators. Best practice sees the funding streams for capability acquisition and maintenance as an extension of the bottom-up innovation system. While several militaries attempt to achieve this outcome through their focus on strategic alignment, we couldn't find any military that had mastered it.

Gaps: Unlike Australia, the UK has a fixed pool of funds that are made available to support innovative activities across the BAF. There is a team that is dedicated to 'passing the baton' to help ideas cross the 'valley of death'. Also, the US and the UK both have programs where personnel can be posted into an innovation program and receive funding from their home unit or as part of a fellowship. These programs are called 'tech bridges', a term which refers to productive networks where stakeholders can share ideas and best practices. The US Navy has seen a proliferation of tech bridges across the country and internationally. Further, there already exists a US-UK collaborative London Tech Bridge. The ADF, which has been less coordinated in the way it applies funding for innovation, could seek to participate in this organisation in order to learn more about the management and funding of cross-sector or cross-military developments.

Innovation Process

We selected the term 'innovation process benchmarks' because innovation takes various pathways from insight to idea, experimentation, prototyping, testing and implementation. At any point in this process, learning occurs that might prompt the innovator to pivot towards more promising avenues or may pose challenges that need to be overcome. Metaphorically, this is called the innovation journey.

Within the studied militaries, a variety of innovation methods are presently being employed in bottom-up innovation efforts. Most of these methods hail from the private sector, where they have been in effect for the past 20 years or longer. Even the language that is being used to describe bottom-up innovation activities in the military derives from the private sector. This might seem odd because the goals of the two sectors are different, with private organisations innovating for profit and in the interest of their shareholders,

and the military sector building and maintaining defence capabilities. The parallels in language and approach, however, indicate the militaries' willingness to learn from the private sector, to work with it and to experiment with new approaches to innovation that have been developed elsewhere. Ultimately, what matters most for benchmarking is not the genesis of the methods but the kinds of practices in use and their effectiveness in delivering innovative solutions in a military context.

Beyond the methods, there is also a growing concern with open innovation in all studied militaries. Open innovation is an approach where an organisation doesn't just rely on its own internal knowledge, sources and resources (its own staff or R&D, for example) for innovation. Open innovation affords bottom-up innovation for the purpose of bringing new technologies to bear on defence problems. While open innovation can include a spectrum of innovation efforts, from large-scale collaborative projects to small-scale tests and experimentations, in this report we are concerned most with the latter. For example, the US military includes open innovation in its WERX model, where defence personnel seek out and collaborate with startups and smaller companies to find trends and solutions.

Finally, the studied militaries are demonstrably preoccupied with how to measure innovation. How do we know that an innovation journey fraught with uncertainty and ambiguity is on the right track? Further, what measures are relevant and important to communicate up the chain of command to show that the allocation of funding has achieved results that are aligned with strategic direction? Measuring innovation is a pervasive concern—one to which a satisfactory answer might still be missing. Several interviewees told us that measuring innovation is difficult and agreed that measures of effectiveness are often missing.

Benchmark 4: Methods

Militaries seem intent on testing any method, tool or technique that has been applied in the private sector. Hackathons, pitch events, innovation sprints, and design thinking workshops are proliferating. The trouble is that a military that engages in all possible methods, tools and techniques is most likely acting arbitrarily and in search of what works best. In reality, a gap in the use of available methods doesn't mean that an innovation practice is missing. It might rather mean that the innovators know why they engage with a

particular technique and not another. Relating to the benchmark of strategic direction, the reason for choosing a particular method is more important than trying them all out.

So in terms of innovation processes, a lot of the things you have there have ideas, submissions, organisations, design thinking, hackathons ... all those things. I think a fair number of those are used, but it wasn't in the formal sense that these things have become, you know, these are relatively new phrases. Some of them, you know, solid learning theory research, a [inaudible] environment in order to do work, a small team, very well supported at the highest levels with a bit of funding. That's really what it took to get that particular innovation off. (Thomas, ADF)

Two observations are key. The first one is that methods are not independent of context. For example, linear innovation processes (such as funnels or stage gates) work in stable environments, where influences and effects are reasonably predictable. In contrast, iterative innovation processes (such as design thinking, agile and lean startup) are made for contexts characterised by volatility, uncertainty, complexity and ambiguity. Instead of keeping innovation in a narrow bandwidth, iterative processes help to solve problems by creating search patterns through which to discover what is in between and at the fringes of existing capabilities. Secondly, another distinction exists regarding experimentation. All innovation processes use experimentation to shed light on what works and what doesn't work. However, scientific experimentation methods work only when it is possible to isolate the issue under consideration. Scientific experimentation begins with a hypothesis that will be tested to create knowledge and possibly lead to a solution. Accordingly, it finds its place in linear innovation processes. Creative experimentation, in contrast, works without hypothesis and draws more on broad events or activities that allow staff to explore bottom-up issues following their interests. The idea here is that problems and solutions are not centrally defined but are instead part of the search process itself. This is why creative experimentation is a method often used in hackathons, idea contests and other small-scale search processes for new solutions. These events are therefore particularly useful for harnessing iterative innovation.

But to their credit, that has proved certainly when I was in the seat as a success. That design thinking methodology drove itself down through to our Maker Labs and how we conceived ideas, how we

tested them, how we iterated them, developed prototypes, iterated again. And that was a journey for some of our senior uniformed leaders and senior public servants that you know, ‘a failure is a success.’ (Lyle, ADF)

The methods benchmark can be organised along two categories: ‘harvesting ideas’ and ‘developing innovation’.

Harvesting Ideas

All four militaries have online idea platforms in place. Some have different platforms to support different military branches. The purpose of idea platforms is to allow service men and women of any rank to submit a proposal for an idea that they have developed, often involving a money- or time-saving way to perform a routine involved in delivering capability. Increased safety is also a possible goal. A committee evaluates the submitted ideas, deciding which ones deserve support. Support might involve two different pathways:

- a. The person who proposed the idea might receive funding and time to work on the idea.
- b. The person will be put in touch with staff at the innovation initiative, hub or centre, who will collaborate with him or her on the project. This process is meant to introduce the innovator to the methods of innovation work, which might enable and encourage future engagement with innovation opportunities.

Related to the idea platforms, militaries regularly run idea contests where service men and women, and at times outsiders, present ideas to expert panels, who will decide if the idea warrants funding, resources and support. Many of the idea contests are modelled on the ‘shark tank’ concept that was originally introduced in an American business reality television series. The US military calls such contests ‘spark tanks’. An important characteristic of idea platforms is that they involve innovators participating in an event. Participants receive immediate feedback and a ‘go or no-go’ decision. Further, participation in the contest provides visibility and a certain level of prestige for the participants’ units. It is important to notice the competition format of ideas, suggesting a funnel process where ideas are selected based on explicit criteria. Many ideas will fall by the wayside, especially radical and unfamiliar ideas that are likely to be eliminated in this format.

I'd put up these ideas on social media and allow for that natural, robust discussion to occur across all interested parties. Then find those ideas pitches that were, I guess, the meatiest and we potentially thought had some real interesting outcomes for Army and then at a forum at the back end of the year have a physical event where those idea pitches would like Shark Tank pitch their idea to senior leadership and either get those leaders to invest in that decision, whether that be through a change in process or taking a risk and posting someone to try that job or whether it was money but a lot of the times it wasn't throwing money at the problem. (Jasmin, ADF)

A third method of harvesting ideas involves hackathons. While hackathons are similar to idea contests in that both involve an event, the difference is that ideas are being developed during the event, rather than being brought to it in a presentable format. Taking from one day to one week, hackathons tend to end with a panel judging the outcome of the hack and awarding funding and support to those ideas that merit further investigation.

So no longer was it intimidating to come in and talk and a lot of people felt comfortable, you know, coming in and having fun and making an impact. So, we would do hackathons where we'd have a specific problem that we were going to solve or that we were interested in people coming up with ideas for. Sometimes those would be a weekend, sometimes those would be a few weekends. We did both physical and digital hackathon solutions, and we also hosted, you know, things like a GitHub online with open source code and different solutions like that. (Jennifer, US military)

Developing Innovation

Makerspaces are inviting service personnel to bring their ideas into a dedicated space that provides playthings, modelling, and experimentation equipment. These spaces are often outfitted with a machine tool workshop to enable the production of minimally viable prototypes. Makerspaces are a standing offer, staffed and managed, which distinguishes them from idea contests or hackathons. And the invitation to work on ideas and to explore their potential and their viability, before presenting them to a committee or panel for further funding and support, distinguishes makerspaces from idea platforms. The methods for the spaces often build on design thinking—i.e., an iterative innovation process—to develop minimally viable solutions.

So, AFWERX had very light prototyping over at the Vegas hub, like they had a shop where you could do a little of that. But through the base innovation offices, you did end up with some different makerspaces both on the 3D printer side of the house with some really interesting like nose cone stuff for the front of aircraft there that they would do different things. (Brian, US military)

We found numerous examples of design thinking within the US military, including training in innovation methods and examples of innovative solutions generated within the Navy, Army and Air Force. While it is not entirely clear what the dominant variant of design thinking was, innovation was undoubtedly applied to problem-solving at the front end of the capability acquisition and maintenance cycle. Design thinking promises a structured approach to creativity that invites innovators to reconsider problems from a user-focused perspective. This human-centric approach makes design thinking an ideal method for bottom-up innovation.

Yeah. I would highlight that that's a real tenant of Design Thinking [and] Lean Startup methodology, [that is] getting to that test point quickly of, 'Are we headed down a path that is interesting to a customer or interesting to a user?', 'Are we confirming are we living in a space of confirmation bias where we ... just kind of think we're doing the right thing?' (Bradley, US military)

Our data suggests that 'agile' is a popular method for innovation work in militaries. Agile is a project management term that refer to a way of breaking down project elements into smaller, more manageable components called 'sprints'. Rather than forming a fixed bundle of tools and techniques, agile is driven by principles of collaboration, modularity and iteration. In the interviews, it was evident that many participants used the term 'agile' loosely, referring more to an attitude and ambition than to a set of processes. Successful bottom-up innovation was regarded as evidence for agile, whether or not the process of innovation followed agile principles. In the innovation initiative hubs and centres, however, agile principles were more closely followed. There were clear attempts to enact them in a repeatable fashion to drive bottom-up innovation projects forward.

In different parts of the organisation, agile is being used. Currently, the CIO ironically is in the midst of a transformation program called CISCTP Continuous Transformation Program, and its focus has been

very agile-driven like the methodology that's been used and that is definitely very agile. (Debbie, NZDF)

The third method to work with environmental and technological complexity is known as 'lean startup'. This approach owes its origins to a methodology that aims at shortening product development cycles and discovering if a proposed business model is viable, involving hypothesis-driven experimentation, iterative product releases, and validated learning. We found it practised in two forms. In the US military, where entrepreneurial behaviour was often referred to, and where reservists and veterans were encouraged to start businesses after their tenure, lean startup was seen as a supportive methodology to allow these service men and women to achieve bottom-up innovation. The other form of lean startup happened outside the defence forces, and it involved collaborating with external founder teams to help them develop solutions that are appropriate for a military context.

We are also teaching Lean Startup, Lean Design Thinking and the tenets of standard waterfall P3M management. Everybody can now say fast-fail, learn by doing, 'show, not tell', and zoom out and zoom in. Zoom out as in you have a vision for what you want, 'Future Commando Force.' You then zoom in and you iterate. Because as the Navy CTO, I could only see good ideas probably shaping about three months in front of our face because everything is moving so fast. So how on earth could you write a 3 billion pound program for Future Commando Force Modernisation Program over the next 10-15 years? In any actual relevant detail, what you need to do is behave like Space X, have a hopper of cash and then spend X amount a year, iterating and going after it in chunks as you can. And I'll do a worked example to the minute. (Dan, BAF)

Best Practice: It is difficult to describe one single best practice for the methods benchmark. Makerspaces, idea platforms, hackathons, idea contests, design thinking, agile, and lean startup all indicate tried and tested methods at work. However, the mere presence of all of these across the four studied militaries, with the exception of NZDF, where it is still in development, doesn't indicate best practice. The reason is that the mix of these methods is directly dependent on application of the governance benchmark. Depending on senior officers, strategic alignment and funding, some of these methods make more sense than others. Further, a more careful consideration of the environment is needed. To assume that the

environment is always turbulent is of little help, since there might be at least pockets of stability that support innovation methods that are more linear. The right practice is equal to the right mix under the circumstances with reference to the strategic goals.

Gaps: There is a gap within all arms of the ADF in terms of their demonstrated ability to support ideas that arise from the end-user community at the tactical or operational level. The Australian Army, Navy and Air Force have seen makerspaces on bases and deployable makerspaces in the field and on ships. However, the US Marines are still ahead in the coordinated application of methods. Also, the Defence BattleLab in the UK provides a more cohesive approach. Instead of trying additional processes, it may be more productive for the ADF to concentrate on a strategically aligned signature process. This approach might help foster bottom-up innovation efforts that are ultimately more sustainable.

Benchmark 5: Open Innovation

Militaries recognise that the source of valuable knowledge to help solve defence problems might reside outside of the defence sector. While the military sector has produced innovations that changed the private sector in the past (such as the internet and global positioning system), the flow of innovation seems to be turning around. This might have happened due to an accelerated and more distributed development of technological novelties in the private sector. Militaries therefore seek out open innovation activities. These activities enable them to participate in a marketplace of ideas and solutions that benefit the various stakeholders included. Open innovation stretches into national (and sometimes international) innovation systems. For example, the US military has links to Silicon Valley, the Massachusetts Institute of Technology and other centres of excellence and innovation, and is particularly active in this space. The ADF, BAF and NZDF are also involved in open innovation, usually with an eye towards technological advances and how these might improve, complement or amend existing capabilities.

Within IXG, we have established a deliberate annual, quarterly-based framework over the last four years. The last three years have been a venture of discovery into what 'right' looks like and when to do particular types of activities. We have weighted our effort in quarter one, where we run an open innovation sprint that invites others from

the IXG network, noting that we have helped three other organisations establish a like model within their units. We invite them from across the Army and the Joint community, primarily from the end-user level. We have developed a specific sprint methodology that applies the 'Think-Make-Connect' innovation methodology. We run an education package that includes non-traditional education tools that take the best from Lean Six Sigma, Lean Startup, Design Thinking, and Agile. We bookend that with a custom and end-user-oriented framework, which is called the EURECA framework. We provide them with that to enable the teams with specialist experts from industry and DSTG, give them an open challenge and a time pressure of artificial mission constraints around the 72 hour 'Maker Mission' window. We allow the teams to provide a prototype demonstrator, a pitch, and pitch that demonstrator to a leadership panel. This year, that included representatives from each of the services at the right level, hosted by one of our One Stars, to provide immediate feedback and, for us, to look at options to take their prototype through. (Benny, ADF)

To engage in open innovation, the first step is ecosystem development. Militaries need to build lasting relationships with external actors. In general, militaries position themselves at the centre of their ecosystem, maintaining independent relationships with numerous external entities—companies, universities, think tanks and so on. Alternatively, careful steps are sometimes taken to generate a more dynamic, multipolar ecosystem. For the ADF this may occur, for example, when solving an identified challenge requires multiple stakeholders to interconnect. In such circumstances, the military is but one actor, contributing to solutions that might benefit its mission, while simultaneously addressing larger societal concerns such as sustainability, environmental preservation, equality or social justice. Of the two types of ecosystem positioning, all four studied militaries profess the former, placing themselves and their mission at the centre and striving to create a diverse ecosystem that benefits their mission and strategy. To begin creating such ecosystems, defence actors invite external parties to conferences, events, meetings, competitions and the like. The US military also maintains offices off base, custom designed for defence personnel to interact with technology startups and other potential external partners.

So the focus there was now how do I scale up the SOFWERX model to work at the service level? So, we created a thing called

Naval X, which was really this learning framework that would speed connections and lessons learned. And then we developed as part of that a TechBridge network, as we called it, which I think is now up to 19 different sites, including a site in Japan, one over in England, and probably a couple of others. (Jim, US military)

Once potential ecosystem actors are identified and invited, the militaries proceed to sourcing ideas, technologies and solutions through interactions. The ADF sources from startups, mid-sized companies, private tech platforms, aircraft manufacturers, and universities through a multitude of agreements.

And we also have within Defence Excellence, we have a budget that we've used for various activities that are more tri-service across defence sort of activities. It's quite a small budget but what we're looking to do going forward is use that for a new program, which was stepping up around Open Innovation and picking projects to push forward with up to 100k, 50 to 100k level projects or maybe even as low as \$10k—anything that sort of meets the criteria that we're going to set. (Yogi, NZDF)

Competitions are a popular and safe way to source ideas and possibilities in open innovation. Defence forces issue a challenge related to a specific problem or interest—for example, unmanned vehicles in rough terrain, technology for smart sensing, quantum computing for defence purposes, or AI for situational awareness. Companies, universities and other external organisations can study the challenge, submit their proposals and—if selected—present them at defence industry events. The advantage of the competition format is that it holds the potential for surprising entries and unusual perspectives which would not have emerged if the military had relied on existing relationships.

So, for public competitions for example, you could go to AFWERXchallenge.com and you can see all our different competitions. And I think you technically have to register [and] leave your email behind. But I haven't looked in a while since I am retired from the assignment, but it used to be a sign up with an email and then you can look at anything you want. (Brian, US military)

In many cases, sourcing happens by establishing a collaboration with the partner. This might or might not happen after identifying a prospective

partner through a competition. The collaboration is based on a legally binding agreement concerning the partners' expected activities and the ownership of intellectual property (IP) created in the process. These collaborations often involve testing and co-development of solutions with specific units and defence personnel. This is the point at which open innovation becomes part of bottom-up innovation in the defence forces. Working together, especially with small and mid-sized companies (which would not ordinarily enter a government tender processes on account of the associated bureaucratic overheads), militaries have the opportunity to test ideas, and to search for the innovation potential in new technologies, before a larger procurement process might be undertaken. As part of bottom-up innovation, collaborations provide service personnel with insights and experiences with technologies and work processes that they would otherwise not encounter in their daily routine. This situation broadens their capacity to see innovation potential in the future.

So we're really leveraging industry best practices, both things coming out of other large bureaucracies or Silicon Valley that are related to human centred design or design thinking that have us quickly testing an idea or getting to ... testing a hypothesis about an idea or getting to a 'pre-totype', or a prototype or a minimum viable product. But that's different for the Department of Navy. We often have a five year spending plan and we commit to. These ideas that are golden good ideas, and then we fund them for five years, instead of just funding it for six months—to really understand, does this warrant further funding? (Bradley, US military)

Best Practice: Open innovation is a widespread phenomenon linked to bottom-up innovation in the militaries we studied. There is an appetite for engaging with emerging and new technologies and to find out how they might address defence issues and problems. Many of these technologies are still too emergent to be the subject of a traditional procurement process. In such cases, bottom-up work permits proof of concept, tests and discoveries to ease the way for a new technology to become part of, or to constitute, a new capability. The best practices in open innovation are largely based on the US military approach to open innovation. The pre-existence of a large national innovation system and traditional ties to technological universities make it easier for the WERXs to forge defence ecosystems and to engage in multiple relationships with outside partners. It is notable,

however, that their best practice is characterised by downplaying the military culture and processes, because these might confuse potential collaborators. The contact points deliberately maintain an approach of no uniform, no ranks and no defence acronyms. This ensures that the representatives from industry and universities encounter technology enthusiasts (as they would in other companies) and not individuals who embody the front end of a large defence organisation.

Gaps: The ADF is active in open innovation, but its approach is less coordinated and more fragmented than that of the US military. There is a need to establish an Australian TechBridge or a cooperative research centre to facilitate transfer and exchange of technology nationally and possibly internationally. Further, the interactions between the ADF, startups and smaller companies need to be placed on more neutral ground, similar to that achieved by the US military.

Benchmark 6: Measuring Impact

Measuring innovation is a difficult task, because the outcome of innovation results from a journey of discovery, and it is not clear at the beginning what exactly the solution will be. Further, uncertainty and ambiguity make it difficult to establish strong measures that would allow predictions around outcomes. This is a classic problem that afflicts any innovation work. Process measures, however, offer at least a partial solution. These measures are dynamic as they trace and adapt to the journey of discovery. The measures might be rules of thumb, first principles, and experimentation guidelines at the fuzzy front end of the innovation journey. As the project matures, more conventional measures might be used to establish whether the idea is developing towards a workable solution. This approach means that strategic alignment is established along the journey even if it is not necessarily evident at the outset. Another measure is concerned with the ability of personnel to repeat the innovation process. It establishes to what degree personnel have created a sustained innovation capability. Finally, outcome measures seek to capture the impact of innovation work on the organisation in terms of efficiency and effectiveness.

But I would definitely say that comparing the military to a corporate, the magnitude is in the thousands in terms of, literally, it is like turning a frigate around. You know because there are so many moving parts.

And I know [there at] big corporates they're driven by the bottom line and if they can measure and make the difference on the bottom line, it's a much easier sell. It is a magnitude harder in the military and that can be seen from the ADF and all the other militaries we deal with. We're not alone and/but what I do know is that it is definitely a 'from within' scenario that gets the best results within the military. (Debbie, NZDF)

Process measures take account of the progression of ideas, from initial proposal, through development, to prototyping, and on to testing. The number of ideas in the innovation process, at what stage, and how many might make it through, offer a ratio that informs senior officers about the bottom-up innovation throughput. Also, the number of failures is taken into account, accompanied by measures of the learning that has been generated along the way. The measures are dynamic because each stage along the process is evaluated through different criteria.

Which is essentially how much capability do you actually generate? How many projects successfully spend in year? What outcomes have they reached at the end of it? We want to ... We are doing benefits management measurement. The reason we're taking the benefits measurement approach is if we're doing innovation right, actually very many of our projects should fail because they're doing things that are leading edge or they're pushing at the boundaries of what's possible or they've never been tried before. And we just need to find out if they're going to work. (Glen, BAF)

In projects that present radical novelty, measures are developed as the project unfolds and takes shape. At first, the number of service personnel showing interest might be counted, then how many are using an online platform, then how many sign up for innovation training, then how many complete it, and then who takes on which problem statements and runs with them. At every step there is the opportunity to abandon the project, and at every step there is the opportunity to incorporate what has been learned into the developing measures.

Not really, no. We do everything based on how close to a working prototype can we get, and then where does that fit in a technical readiness level? That's the kind of measure that we look at. (Nicholas, ADF)

Measuring the innovation capability at hubs and centres, competitions, panels and so on brings the personnel into focus. As funding is provided, people are trained and prepared for innovation, and in trial-and-error learning they apply innovation methods. This creates an innovation capability in the military, which is a critical outcome according to a BAF interviewee. It signals that, whatever the circumstances, personnel will be able to react and adapt in innovative ways. The military is normalising bottom-up innovation and holds it as a capability beyond individual specialisation or the preoccupation of any particular senior officer. This innovation capability is measured in leadership behaviours, in the level of training of personnel in innovation methods, and in the repeated attempts at being innovative and seeking solutions to pernicious problems.

There are two different things to consider when talking about innovation: capabilities being developed and members being upskilled. These require very different metrics to measure success. For capability innovation, there are three key categories that are tracked: time, money, and capability capacity. The success of a project is measured by how long it took, how much it cost, and whether it increased capability capacity for the RAAF or has the potential to have an impact. (Erica, ADF)

Outcome measures relate investment to impact. They show whether efforts spent on innovation are paying off in the short, medium and longer term. Building innovation capabilities and producing the first measurable outcomes takes time. Over the medium to longer term, the level of innovation might increase or decrease, which can indicate whether things are going very well or whether something is failing. This environment inspires a search for reasons. Measuring impact is usually done in terms of time or money savings, speed, increased efficiency, and effectiveness or similar.

Measures of effectiveness can be more challenging in that it has to do with other people and some of the things that we were doing, it was difficult to measure that effect. But yeah, definitely from the metrics that you can develop, whether how quickly, how much time things take, the amount of information that you've got, the aggregation of that information, how automation can improve things, you know, both qualitative and quantitative metrics. (Patrick, ADF)

Best Practice: The best practice is to apply all the measures of process, capability and outcomes to assess bottom-up innovation. Just as important as creating the metrics—and insisting on the documentation needed to gauge innovation performance—is acceptance of the results throughout the organisation from senior leadership to middle-level officers, to junior officers. Without acceptance, it is easy to brush the results aside and to replace them with a singular observation, gut feeling or other incomplete data.

Gaps: IXG and Edgy Air Force have not yet seen bottom-up ideas transition all the way through to becoming in-service capability, so their metrics are still incomplete. There are numerous other examples of bottom-up innovations that only reach prototype or pilot stage. There therefore remains an acute need to develop more dynamic measures of bottom-up innovation so as to be able to compare approaches, outcomes and learnings.

Organisation

To make bottom-up innovation sustainable, it needs to be embedded in, and connected to, the organisation: its decision-making structures, reporting relationships, operational routines, human resource systems, and technological integration. Embedding and connecting must happen at the people, structural and cultural levels. Many interviewees we spoke to mentioned that behaviours, rules and norms, as well as expectations, had to change to keep bottom-up innovation going and to integrate its outcomes. Several interviewees expressed their enjoyment of innovation work and their frustration with the roadblocks that the organisation could place into their way.

Benchmark 7: Leadership and People

Innovation is a people-intensive activity. People need to be motivated and trained to engage in bottom-up innovation. People need to be empowered and enabled to follow up on their insights and ideas. People need to be willing to change their routines and to adopt new solutions. And people need to be led in a way that makes it possible for them to work on their ideas and to grow into teams that support and challenge them. For these reasons, good leadership at the middle and front end is essential if bottom-up innovation is to be embedded in the capability development process. At the same time, people are conscious and critical about what they experience as they propose and develop ideas. Lack of support, lack of psychological safety, forbidding feedback, and the feeling that they are working on something that is not really valued will quickly kill bottom-up innovation. The leadership and people benchmark relates directly to measuring the innovation capability benchmark. However, measuring it and making it happen are different tasks.

I think that you cannot lead a sea change, revolution, or any large movement from the top. You can make policy changes at the top. You could grant authorities and allow people to modify their current rights and abilities and tools. But you can't. You can lead from the top, and inspire from below. (Bradley, US military)

Innovation activity requires supportive leadership behaviours among mid-career and junior officers. The expected behaviours are markedly distinct from what usual good managerial work and principles look like. In respect of the strategic alignment benchmark, leadership behaviours are the task of innovation directors, champions and coaches who are selected and trained to help their fellow service men and women to engage in bottom-up innovation. These leaders need to balance the tension between explaining and legitimising innovation activities to higher levels of management and at the same time protecting and guiding innovation activities among their teams and self-selected innovators.

I think you need some leaders that are really open to unusual projects. They also should be people that are Renaissance men or women, comfortable and familiar across a wide variety of areas. For example, if you talk to Hondo, he is a massive music lover. He can tell you about Classical Music, Jazz, Blues, Reggae, Rock and Roll. He can tell you the song and do a deep dive on that. He also does a lot of wood carving and word work. He knows acquisitions in depth—35 plus years. He also knows innovation and can talk about things like cryptocurrencies, advanced robotics, additive manufacturing, and the future of the space economy. He knows all of those and can talk in depth on most of them because he's constantly reading and learning and exposing himself to those environments. (Jennifer, US military)

Experienced innovation leaders know how to identify, reward and compensate innovators. Much bottom-up innovation seems, on the face of it, to be a voluntary activity. Whoever self-selects themselves to become active in bottom-up innovation, whoever participates in hackathons or idea competitions, or visits a makerspace, is welcome to give it a try. The competitive format will then winnow out less attractive or flawed ideas.

And so, creating that empowerment at the lowest level and allowing soldiers to feel that they had a stake in their future. That was the other side of it, that once you've done that, the middle moves quite quickly. The sort of frozen middle, as many people call ... that can fall out. (Ivan, BAF)

For a sustained innovation activity, and the creation of an innovation system, self-selection provides an opportunity to identify personnel who show the right characteristics to persistently excel in innovation. Inviting and taking

these individuals to a higher level of training and application becomes a task for innovation leaders. Innovation leaders might also notice and identify people who are not self-selecting but who have a reputation as tinkerers, problem-solvers, and creatives (sometimes asking uncomfortable questions). Identifying and inviting these people to innovation activities might ensure that the right people become involved. Beyond identifying and inviting them, innovators need to be rewarded. Rewards often take the form of recognition, for example as innovator of the year. Standing out among colleagues as someone who has improved a capability or solved a persisting problem provides appreciation and status. Other rewards might include promotion to or integration into specific peer groups of innovators. Beyond such rewards, the US military in particular has developed options to compensate innovators, either through monetary rewards or through co-ownership of the IP they created. Rewards and possible compensation make engagement in bottom-up innovation more than an organisational 'citizen duty' for personnel.

Yeah. I mean, and then you train, teach other people, so these people volunteered, and I can't imagine how much it cost. The Difference in internal love, I mean genuine love, no profit, right? There's no profit on this book. I mean, 'We're going to make a publicly available book of what AFWERX was doing during its first two-years', and they did all of these additional graphics and formatting, and God knows how many internal dollars they spent, just as business partners, because they thought what we were doing was so blinking cool. And so that book is like one of the symbols of, 'Yes, we were a learning organisation, but we were also a teaching organisation while we were doing it.'

(Brian, US military)

Militaries provide potential innovators with training, coaching and mentoring. Training means providing knowledge of the innovation opportunities and systems that the military provides. Training also specialises in the methods, tools and techniques listed in Benchmark 4. Coaching is a more intensive activity, where an experienced innovation leader or innovator takes time to provide advice and to act as a sounding board to personnel presently engaged in trying to turn an idea into a solution. Coaching is supposed to help people develop the mindset needed to innovate and to persist in the face of numerous challenges. Finally, mentoring means placing new innovators into a relationship with seasoned innovators, who provide

advice and suggestions on how to overcome difficulties. Mentoring means accompanying a person in their development.

So having someone mentoring and coaching and facilitating the enablers that need to circle you to make success, especially not the C-end ... but the middle and upper ends, you need that coaching and mentoring. And because often these people are people that have in that leadership. Or the career progression program ... On something that provides them with the training around developing a business case, all of that stuff, which is why that fact that design thinking and those steps on the portal. (Debbie, NZDF)

Finally, and crucially, defence forces have investigated the possibilities of developing career pathways for innovators. Knowing that there is a possible professional pathway to innovation, beyond self-selection or being tapped on the shoulder, will make an individual's involvement seem less risky and opens career opportunities for those who enjoy working with innovation and who are good at it. Within the military, these aspects of leadership and people management still seem to be very much in their infancy. Often personnel rotate in and out of innovation roles, and there is uncertainty if the time spent in an innovation role will pay off in career prospects in the longer run.

Best Practices: Leadership and people management require militaries to carefully select whom to place into innovation-related roles. Rather than simply selecting the person available, there needs to be a broader consideration of the characteristics needed. Best practice is to develop several innovation leaders and to trust that organisational growth will occur by selecting personnel and by training, coaching and mentoring them. Providing career prospects for innovators is a best practice approach that has not yet been introduced in the ADF. But it seems crucial if bottom-up innovation is to be sustained.

Gaps: There is a lack of recognition of innovators within the ADF, and there are few formal opportunities for innovators to be tasked, or posted into innovation units, to work on their ideas. There is a need to showcase home-grown innovators and entrepreneurs with a defence background to provide inspiration to others. Similarly, there should be spotlights on grassroots innovators who have had successful journeys in bottom-up innovation. The US has no shortage of entrepreneurial role models who have assisted the

militaries. The UK also has role models to highlight, such as the founder of Gravity Industries, who is a Royal Marines reservist and inventor of the flying suit. Australia should also identify similar role models. Both the US and UK have mechanisms to remunerate personnel for their innovative ideas, albeit that this process is not well developed.

Benchmark 8: Structures

Organisational structures are the rules, norms, routines, documentation and hierarchies that make for a functioning organisation. There is a risk that bottom-up innovation will become a passing fad if it is not embedded in the existing structures. At the same time, those structures will have to adapt to accommodate innovation work alongside other routine activities. If bottom-up innovation is not embedded in structures, it inevitably becomes unwieldy, difficult to direct, and costly in that every activity needs to be managed as an exception to the rule.

But then this peacetime structure and approach, which is conformist in nature, the imperatives internally and externally aren't there. And as a consequence, it tends to be comfortable with the status quo. So those are two sort of interesting perspectives of the Army. And if you compare that to the world around us, you know, just in the past 20 years ... the impact of technologies accelerated our world beyond recognition, you know, that you and I ... [on] the other side of the world are doing most of our business today through this medium, I mean, just highlights. (Ivan, BAF)

The first and foremost sign that a defence force is creating structures for bottom-up innovation is the creation of innovation centres. While these centres quickly become hotbeds of innovation and develop hub and team structures supporting their work, there is the danger that they become islands within the larger structures of the organisation and interlink poorly with the remaining operations. Innovation centres cannot remain unchanged for long. If they repeat the same methods and approach over and over for too long, they tend towards obsolescence. So the key task of innovation centres is to continuously develop what innovation means to the organisation. Reinventing itself every three to five years is a strong sign of a centre in flux but is a situation that is to be expected.

We're always equipping workplaces and our innovation centres to identify innovative solutions which impact capability, morale, retention or finances or whatever. The scope of it is really from, it's got to be, top down. And it is you know from all the Navy commands or the admirals downwards and their commands. And we're seeing more and more of that as time goes by as culture swings. (Steve, ADF)

Another aspect of innovation structures is the degree to which, and way in which, they involve middle-ranking officers. While strategic direction might come from senior officers, as discussed in Benchmark 1, it falls to the middle ranks to create the continuous enabling structures for innovation work. To avoid the chimera of the 'frozen middle', militaries have begun to provide greater degrees of freedom and empowerment to this cohort.

So to answer your question, we have loads of high level support and loads of entry level support. We need to work on that frozen middle. And come at that with empathy, come at them with empathy ... that, 'Yeah, we appreciate what you've done so far.' We need to bring you along into this future state that works in 2050, that works in 2035, if we expect to, you know, maintain a liberal democracy that is open and transparent, [and] if we expect to maintain our style of government and, you know, allied power primacy. (Bradley, US military)

Finally, with three or more branches, defence forces engage in joint initiatives to make sure that innovation, and the solutions it provides, is not stovepiped but instead benefits overarching military objectives. Joint initiatives might include testing solutions together or testing them at the critical intersections between the branches. The ADF calls the ability to engage in innovation across the different services 'omnidexterity'—building upon the willingness and mutual benefit of stakeholders to engage. The BAF have gone a different way in that they rely on a Ministry of Defence initiative to coordinate innovation efforts as joint initiatives. This creates a higher-level coordination mechanism.

So we've got an awful lot of co-teaming, particularly Army and Navy. We are really, really joint teams. So with the 700F Squadron that flies UAVs—that heavy lift challenge—and the Office of the Chief Technology in the Royal Navy—that was an absolute dream story of collaboration between the future capability group and those

two entities in terms of ... progressing that capability against the Brigadier's goal. (James, BAF)

Best Practice: To create structures that sustain innovation efforts, it is best practice to create innovation centres but to maintain them as hotbeds for developing ever new approaches to innovation instead of seeing them as 'innovation factories'. Further, innovation should not stay confined to the centres but should instead be an activity that occurs across the services to provide the basis for establishing self-sustaining structures that support everyday operations. Middle management plays a key role in developing enabling structures. And while it might be difficult to get them deeply involved, senior leaders can empower the middle ranks to take a more wholehearted approach to their role as stewards of innovation. Finally, joint innovation activities need to be coordinated and supported, either at the branch level or at a higher level.

Gaps: While there is support for disruptive and bottom-up innovation from senior leadership, middle-ranking officers seem more wedded to the status quo. A more concerted effort is therefore needed to embed bottom-up innovation within ADF structures, with clear responsibilities, funding options, and a better pathway for the uptake of solutions. Embedding bottom-up innovation in structures would benefit the governance and process benchmarks. The UK has tried to achieve this through creating structures at the ministerial level, which then reach into the branches. This might be a suitable model for Australia to follow.

Benchmark 9: Culture

While leadership behaviours can be observed, personnel trained, innovation centres established and joint initiatives started, culture is not something that can be bought or simply created. It grows and changes slowly based on myriad interactions and interpretations among personnel. Further, it is invisible most of the time, because it lives in sense-making and assumptions. Only the symbols of culture are visible.

You can't create that culture when you're sitting in the forming up point waiting to cross a line of departure. That's too late. You've got to have that mindset, that ethos within your organisation that as you're evolving into conflict and you're in conflict, you have a culture within the organisation that is adapting quickly. And more often than not,

major conflict is more about speed of adaption and innovation from your start point than it is about where you started. (Ivan, BAF)

Culture, as such, represents the taken for granted and the basic assumptions about what is the appropriate thing to do in each situation. It is the expressed desire of all four studied militaries to foster and develop a culture of innovation. However, the militaries already have a culture which regularly gets in the way of new approaches and activities. For this benchmark, we summarise activities that signal attempts at developing an innovation culture within the militaries studied. This includes symbolic and practical measures taken.

Which is a really hard mindset for a Commanding Officer to get their head around because they're meant to be the ones that know everything, right? They know everything and everyone comes to them. But in this case, it wasn't. He literally turned the ship around in his head. And he got into this intent-based leadership style, and that's kind of the scenario we want. We want to say this, 'Is what we're trying to achieve?' You look at how we do it, and come and tell me how you're going to do it. (Debbie, NZDF)

A fundamental step towards an innovation culture is a change in attitude towards risk. This factor already shone through in Benchmark 2, where senior leadership set risk thresholds for innovation activity. Bottom-up innovation is fuelled by a change in risk appetite, interpretation of risk, and the empowerment of personnel to take calculated and acceptable risks. It would be unusual to expect personnel to take risks that are not sanctioned by their superiors. It would represent an imbalance of responsibility that would quickly smother motivations to be innovative. Instead, risk taking needs to be accepted by superiors, who also carry the responsibility to communicate risk thresholds.

Yeah, I think it's, again, it's super important. I spent a lot of my personal time at those organisations, (1) giving them the confidence that they could try some new things, (2) ensuring there was a safe culture to drive two new things and (3) being an early adopter. (Jim, US military)

On the back of accepted risk taking, innovators need to feel encouraged and included. This requirement includes giving junior soldiers a voice and providing them with sufficient psychological safety to ask difficult questions

and to give candid feedback. This benchmark relates to the innovation methods, tools and techniques and their use to address problems.

We talk a lot about it, in fact. And that's a large part of our culture changes, getting people that have not shared their ideas for maybe ten years. They keep their heads down and their hand low because they have been burned too many times in previous meetings or brainstorming sessions. And we want to teach them the skills to have new ideas, to share their ideas, to create psychological safety, within their teams and their groups so they can take that back. (Bradley, US military)

Beyond the innovation processes, new ways of working need to be welcomed. Old understandings of what is appropriate will challenge the new, and new approaches have to prove their value. Innovation awards showcase what is valued and give recognition to innovators.

In general, I think culture change is a complex and multifaceted process that can't be reduced to a simple formula or law. It involves a range of factors, including leadership, communication, employee engagement, and structural structure, among others. (Erica, ADF)

Best Practices: Building a culture of innovation takes time. It builds gradually, if the conditions for it are maintained over an extended period. Culture change can take years. Best practice is to follow culture change frameworks to gradually move the needle towards a culture of innovation. It includes presenting a vision, building guiding coalitions, communicating the desired changes continuously, and enabling personnel to achieve small wins frequently.

Gaps: Some militaries have innovation units that comprise people from diverse backgrounds, including those who have a background in startup investment or have worked for technology companies. The Royal Navy has undergone a massive organisational and cultural change, rolling out agile management processes across most of the organisation. By contrast, there were few indications that bottom-up innovation has become part of the culture of the ADF yet.

Recommendations and Questions

Based on our data, the preceding analysis has detailed the practices of bottom-up innovation in four militaries and has benchmarked three of them against the ADF. This report represents a first step toward developing benchmarks that can inform continued investment and involvement in bottom-up innovation within the ADF. Since we have chosen a practice-based approach to studying bottom-up innovation, the resulting benchmarks might seem high level, and in part quite general. It is worth remembering, however, that a practice-based approach to benchmarking is only a first step. The purpose is to identify, lay out and organise the practices involved in an activity, and from there to develop more detailed benchmark measures for each in subsequent studies.

Based on the practice benchmarking outcomes, we have formulated the following recommendations concerning how the ADF could innovate more effectively and close identified best practice gaps. The recommendations address the benchmarks (and the interrelationship between benchmarks) to form a bottom-up defence innovation system.

- The benchmarks for governance are senior leadership support, strategic alignment, and funding. The ADF performs strongly against these benchmarks, but there are possible practice gaps in the level of senior leadership involvement, longer term strategic alignment, and the propensity for ad hoc and competitive funding. Notable is that joint bottom-up innovation is coordinated among the three ADF services, while in other countries it is coordinated at the ministerial level.
- The benchmarks for innovation process are methods, tools and techniques, open innovation, and measuring process and impact. The ADF has been very active in bringing many methods to bear. An oversight might be the relative absence of stage gate approaches, which seem to suit the operational demands of the military but which are less well adapted for the achievement of design thinking, agile, and lean startup. The absence of stage gates contributes to the difficulties that the ADF evidently faces in transitioning innovative solutions into sustained capabilities. The ADF is strong in open innovation, but there are still opportunities to learn from the US military and the BAF, both of

which have doubled down and have larger national innovation systems to draw on. Measurements are in place but need reviewing.

- The benchmarks for organisation are leadership and people, structures and culture. The ADF has invested in leadership and people but could improve its efforts to embed bottom-up innovation in structures. Culture remains an area under development across the militaries studied, not only within the ADF.
- The ADF would be well advised to consider the interrelationship within each of the benchmarking groups. How could governance enable innovation more purposefully and how could funding be applied in a more enabling and effective way?
- Finally, it is recommended that the enabling and constraining relationships between the three benchmark groups are addressed. How can strategic direction provide clarity with respect to the appropriate methods, tools and techniques to employ in innovation and thereby avoid a grab-bag approach? How can structures and culture support bottom-up innovation processes and possibly relieve senior leadership from the need to dedicate too much time to it? How could leadership and people be managed in ways that make sure the right people are involved and there is a self-reinforcing development culture throughout the organisation, and not only in innovation centres?

In summary specific areas for benchmarking and decision-making are:

- Communicating the reasons, processes and impact of bottom-up innovation
- Incentivising and motivating participation in innovation activities
- Teaching innovation approaches, processes or practices employed to staff
- Permitting and safeguarding collaboration with external partners
- Funding, organising and delivering bottom-up initiatives such as makerspaces, hackathons and design challenges
- Capturing, evaluating and supporting ideas coming from any level of the ADF

- Safeguarding and sharing IP
- Building supportive structures, including innovation centres, hubs, units and teams.

In making these recommendations, we acknowledge that we bring a non-military perspective to bear and therefore invite ADF decision-makers to blend our recommendations with their own expertise and insider perspective. Acting upon the outcomes of the benchmarking study will require taking stock of the activities underway, to decide on a course of action to close the gaps, and to follow up and assure the implementation.

Conclusion

Taking stock of the benchmarking study of bottom-up defence innovation, we noticed that the ADF is well advanced in comparison to other militaries, but that there is still work ahead to build a sustainable innovation capability that might deter potential adversaries. Further, we recognise that innovation is never finished and that the approach to innovation is itself the target for continued development.

The present study has some weaknesses. We were unable to interview internal innovation teams that address current and future challenges that war fighters may face, largely because some units are more ‘closed door’ than others. For example, while we were able to look at IXG, a unit-level innovation capability inside an operational unit, comparable programs in foreign militaries mostly operate confidentially, so we could not make a real comparison. Further, due to COVID-19 we were not able to travel to visit innovation centres, conduct in-person interviews or observe frontline personnel engaging in bottom-up innovation activities. While we made efforts to interview a representative sample of leaders from a variety of bottom-up innovation initiatives from each selected country and for each domain or service, our sample group remains limited. Archival search uncovered many programs that would fit our definition of bottom-up innovation but were unable to be contacted for this study. The archival data consists largely of publicly available material (websites, social media posts, news feeds) and some other documents (strategy) that were released for this study. This did not include internal documents.

The weaknesses speak to the need for future studies. The concepts developed in this report might lend themselves to become the measures for a quantitative benchmarking study. Such follow-up work would also allow comparisons to be made over several years, potentially tracing how bottom-up defence innovation develops and matures, or fades and declines.

About the Author

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Key Terms

Agile: A work methodology involving ‘sprints’ where teams work for a set period of time with the intent of delivering an outcome. It is typically associated with ‘scrum’ techniques.

Bottom-up innovation: Where ideas originate from staff, and they identify opportunities through their day-to-day operations. Bottom-up innovation is regularly supported through establishing innovation centres and organising innovation-oriented events.

Design thinking: A non-linear, iterative process that teams use to understand users, challenge assumptions, redefine problems and create innovative solutions.

DevSecOps: Short for developer, security and operations. It refers to the practice of integrating and automating security into the entire software development cycle.

Hackathon: An intense innovation marathon where individuals and teams compete to solve challenges within a limited timeframe.

Innovation capability: An organisation’s continuous ability to identify new ideas and transform them into new/improved solutions or processes.

Innovation centre: A cross-functional place to foster a culture of innovation through the creation, sharing and testing of ideas.

Innovation process: A set of steps between an idea’s conception and its implementation, managed in a way that reflects an organisation’s structure, culture and innovation goals.

Internal innovation: Approaches that focus on the resources, ideologies, processes and people within a company, meaning potentially harnessing and exploring HR, R&D, company policy, employee engagement, management structures, legal conventions and more.

Makerspace: A place in which people with shared interests, especially in computing or technology, can gather to work on projects while sharing ideas, equipment and knowledge.

Open innovation: Purposive inflows and outflows of knowledge to accelerate internal innovation.

Strategic alignment: A process that ensures an organisation's structure, use of resources (and culture) support its strategy.

Appendix A

Participant list

Position	
Deputy Director	3
Director	6
Former Acting Director	1
Former Chief of an armed service	1
Former Chief of Operations	1
Former Chief Technologist	1
Former Director	1
Former Innovation Capability Manager	2
Former Senior Manager	1
Head of a Division or Group	2
Head of a unit level innovation program	1
Leader of a bottom-up defence innovation centre or program	3
External consultant	2
Current or former Commanding Officer	2
Total	29



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