Australian Government

Department of Defence

# Diggerworks

## Driving innovation and effectiveness in the defence sector

A study of success factors

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Danny Samson

# Foreword

Our nation has an obligation to provide our defence personnel, and the combat soldier in particular, with the equipment and systems that best meet the demands of their challenging and often dangerous roles.

Their courage and professionalism in the face of extreme threats is a source of national pride and gratitude. We are committed to equipping them with the tools they need to do what they do best.

The various groups that maintain and modernise the capabilities of the Australian Defence Force are continually striving to provide its personnel with a capability edge. The increasing complexity of modern systems, coupled with the evolving nature of the threats faced, makes capability modernisation a difficult and demanding task. Introducing new technologies to help soldiers to better perform their role, without adding to their burden, is an ongoing challenge.

The establishment of Diggerworks and its subsequent achievements illustrates the value of partnership in pursuit of the shared objective of maintaining the soldier's edge.

This report brings out many insights gained in the process that have underpinned the accelerated delivery and integration of a soldier system that is being continually adapted to the evolving needs of the soldier.

The challenge does not stop here. Defence personnel continue to face shifting demands and emerging threats. It is important that we build on the lessons gained through the formation and function of Diggerworks and apply them to other relevant areas of Defence.

**Warren Snowdon**
Minister for Defence Science and Personnel

**Mike Kelly**
Minister for Defence Materiel



# Joint statement

Diggerworks has revolutionised the way Defence equips its soldiers for combat.

The establishment of Diggerworks has allowed Army, the Defence Materiel Organisation and the Defence Science and Technology Organisation to work collaboratively to provide today's front line soldiers with outstanding equipment. It has coordinated the application of an adaptive approach to modernising capability, based on harnessing user feedback, developing innovative solutions and delivering highly functional equipment. This equipment provides protection whilst allowing soldiers to do their job and it is amongst the best equipment issued to soldiers in any Army anywhere in the world.

Diggerworks represents a true partnership between the participating organisations: Army, the Capability Development Group, the Defence Materiel Organisation and the Defence Science and Technology Organisation.

We believe that there are significant lessons from the Diggerworks experience that can be applied more broadly to other relevant areas of Defence. This report provides an independent expert review of the factors that contributed to Diggerworks' success and we welcome the opportunity that this affords to share its insights. We commend it to you.

**LTGEN David Morrison AO**
Chief of Army

**Warren King**
Chief Executive Officer
Defence Materiel Organisation

**Alex Zelinsky**
Chief Defence Scientist

# Table of Contents





# Executive summary

After a series of events that culminated in difficult Senate Estimates Committee hearings in 2010, senior executives in Army, the Defence Materiel Organisation (DMO) and the Defence Science and Technology Organisation (DSTO) decided to substantially overhaul the procurement and supply chain arrangements for the equipment and clothing used by Australian soldiers. This constituted a critical shift in organisational arrangements from the previous transactional relationships between various organisations and agencies to a coordinated and highly integrated approach built on strong relationships, facilitated by a new organisation called Diggerworks. Through the achievements resulting from this new set of organisational arrangements, the Army could provide significantly improved equipment and clothing to soldiers, leading to improved soldier effectiveness. Faster cycles of innovation and deployment of new technologies were designed into the new agile arrangements.

Diggerworks involved implementing, at a high level, some important organisational principles that are common to excellent innovators, namely:

**1.** an organisational architecture (structure and processes) and capabilities to create the desired technical outcomes

**2.** a governance system that could set the agenda, manage the delivery team's context, and create an environment for creative problem-solving with an appropriate level of risk, and

**3.** the leadership necessary to put, and keep, the governance and execution organisations in place.

In the case of Diggerworks, notable aspects included strong and united leadership, clear and commonly-held organisational objectives built around the needs of the soldier, systems for effective data gathering, data integration and problem-solving that could deliver effective technical solutions, a procurement methodology that could implement those solutions and an organisational climate that emphasised trust, collaboration and action.

Having put this organisational infrastructure in place, Diggerworks delivered improvements in the soldiers' combat systems in three specific ways:

**1.** Adopting new components developed elsewhere much more quickly and effectively than had previously been the case.

**2.** Enhancing existing components and improving their system-level configuration.

**3.** Driving innovation in new components when a need became apparent.

These improvements addressed many, if not all, the concerns previously expressed by key stakeholders, including soldiers, politicians, and Australian manufacturers.

Diggerworks established an innovative new procurement model in the Australian defence sector, which created significant value to a number of key stakeholders, most notably the front-line soldier in the field. It can and should be used as a 'best practice' example for other defence applications and contexts.

# Introduction

## The symptoms

Diggerworks was born of necessity, in that there was a strong and urgent need to dramatically increase the fitness for purpose of Australian soldiers' combat ensembles. Some key precursors to the restructuring of supply and technology development, which became Diggerworks, were:

- There was a lot of frustration among the troops that the gear they were issued was not fit for the task.
- Soldiers in the field found themselves asked to carry up to 80 kg of gear when going out for a day on foot.
- Australian manufacturers of clothing and equipment were lobbying the government, complaining that DMO was buying imported materiel when locally-produced alternatives were feasible.
- The troops placed very little trust in DMO or its acquisition process.
- Whenever the Chief of the Army went to visit the troops, he would be inundated with complaints about equipment.
- Equipment was bought on a large scale, yielding some obsolescence and lack of flexibility as soldiers' needs evolved and technology progressed. For instance, in 2010, the Army found itself with 17000 units of body armour unsuited to its key operational roles in Afghanistan.

These symptoms came into sharp focus at a difficult Senate Estimates hearing in May/June 2010 when Major General Cavenagh (Head of Land Systems at DMO) spent 9.5 hours giving testimony to explain DMO's performance. The Senate Estimates Committee challenged and questioned matters ranging from supply coming from foreign countries including China and Vietnam, to quality problems in soldiers' boots and helmets, and many other problematic items, from budgetary overruns, to supply arrangements, to quality and effectiveness of equipment.

## The underlying problem

Underlying all these issues was a fundamental problem. The system for procuring the soldier's combat ensemble was designed to maximise the static efficiency of procurement while minimising the risk of impropriety. That is, it was set up to buy large quantities of identical equipment at the lowest possible price. Underlying this was the assumption that the needs for the soldiers' combat ensemble would be static between government allocations of capital to buy equipment (approximately every seven years). However, the needs were far from static. With rapidly changing theatres of engagement (from Timor to the Solomon Islands to Iraq to Afghanistan), modes of operation in those theatres (vehicle versus foot-based), and underlying technology, there was a need for rapid innovation in the soldiers' combat ensembles. In order to respond to this dynamic environment, the procurement organisation needed to develop a capacity to learn (from soldiers, suppliers and other stakeholders), and to translate that learning into new capabilities on the ground. The capability development and acquisition system was very poorly matched to the job it needed to do.

The problem was not just that DMO was buying too much equipment at once: it was much more fundamental. The entire set of procurement processes, and the relationships between the relevant agencies, was predicated on the assumptions of static efficiency. In particular:

- Upgrades to soldiers' personal equipment, despite these items being of a commodity nature, were managed as new capital items through the normal Defence Capability Plan processes. Consequently, gear was procured on a timescale that was often much greater than the rate of change of technology in the items being bought and the rate of change of theatres of engagement.
- A set of agencies – particularly the Army, DMO and DSTO – were driven by their individual imperatives. Their measures of success were consistent with their 'stovepipes'. The effect of this was that relationships between the agencies were highly transactional, and people within the different organisations were rewarded in a way that kept those transactional relationships in place. To quite a large extent, the Army set the requirements, DMO did acquisition and sustainment, and DSTO did science. Communication between the agencies was formal and at arm's length.
- The system for configuring soldiers' equipment was completely uncoordinated. Different actors in the system could specify new or changed components within the ensemble without consideration of the other components.

Consequently, despite all the people in the procurement chain outfitting the soldiers having the very best of intentions, the soldiers in Afghanistan were going into the field ready to fight in Iraq, just as those in Iraq had essentially gone into the field well equipped for East Timor.

Also, while the individual components making up their kit were the best the procurement system could offer (though often several years out of date and designed for a different theatre) the overall configuration was not optimally managed. It was possible for soldiers to be heavily overloaded (carrying up to 80 kg) with different components interacting in dysfunctional ways.

The troops on the ground, the political establishment and local industry all had low confidence in the system for designing, procuring and issuing equipment to soldiers.

## Towards a solution

Brigadier Nagy Sorial (then a Colonel and the Head of the Soldier Modernisation System Procurement Office at DMO) made the first major step towards a learning-driven approach to soldier system acquisition. He changed the way DMO used Army Sustainment funding to replace old equipment (particularly pouches and body armour) that was no longer fit for service. Improvements to equipment were not normally considered as part the sustainment process, as 'requirements creep' was seen as a risk to the management of costs. Brigadier Sorial recognised, however, that the sustainment route could be used to incrementally improve equipment fitness in response to concerns raised in the field. He put in place processes to do so.

Brigadier Mike Phelps made the next major step by reorganising part of the Land Systems Division of DMO. He created a new Integrated Soldier Systems Branch and brought into it all System Program Officers (SPOs) within DMO who managed aspects of the soldier systems. Within that branch, Brigadier Phelps and Mr Grant Medbury (Director General Land Engineering Agency) created a centralised soldier system development and modernisation cell called the Integrated Soldier Systems Development Directorate (ISSDD). While this eventually became the core of the Diggerworks organisation, it involved only DMO staff.

Major General John Caligari (Head of Modernisation and Strategic Plans - Army) started having conversations with Major General Grant Cavenagh about how to more broadly address ongoing soldier system development. At this early stage the relationship between Army's proposed Diggerworks and the ISSDD was unclear. They soon invited Dr Simon Oldfield (Chief of Human Protection and Performance Division at DSTO), Mr Michael Aylward (Head Electronics Systems Division at DMO) and Brigadier Mal Rerden (Director General Land Development) to join the conversation to create a broad way forward.

This senior group saw that the symptoms could not be alleviated without technical innovation – substitution of the components that made up the soldiers' combat ensemble, changes in the way those components were configured, and potentially the development of new components. However, they also saw that technical innovation would not be possible without organisational innovation. They had to change the way soldiers' equipment was purchased and the relationships between the agencies that participated in that purchasing process. They, along with senior staff members working with them, set about designing a new approach to outfitting soldiers.

They also recognised that there was value lost in the lack of integration of objectives, capabilities and processes between these organisations, with their varying goals and processes.

This senior stakeholder group started to explore how other organisations were approaching the problem. General Caligari was particularly interested in the 'Gruntworks' program of the US Marine Corps'[1]. General Caligari, Brigadier Phelps and Mr Medbury visited 'Gruntworks', followed by Dr Oldfield in a later visit. Brigadier Phelps and Mr Medbury also visited the UK's Integrated Soldier Systems Executive, which had a similar remit to the ISSDD and Gruntworks. At the end of these visits (November 2010), it became clear that the desired capability could be built using the ISSDD as a platform. That is, they could achieve their objectives by extending changes that were underway and crystalising them in a new (virtual) organisation. After some further analysis and six months of discussions about how best to proceed, Diggerworks was formalised in a Memorandum of Understanding in June 2011 (see Figure 1).

[1] 'Gruntworks' is the colloquial name for the US Marine Corps' Marine Expeditionary Rifle Squad Program.

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Australian Government
Department of Defence
Defence Materiel Organisation

MEMORANDUM OF UNDERSTANDING

*for the*

COLLABORATION OF ALL PARTIES

*involved in*

THE ROLE AND FUNCTION

*of*

DIGGERWORKS

J. CALIGARI
MAJGEN
HMSP-A
AHQ
23 June 2011

G. CAVENAGH
MAJGEN
HLS
DMO
22 June 2011

S. OLDFIELD
Chief HPPD
DSTO
27 June 2011

P. JONES
RADM
HCS
CDG
23 June 2011

M. AYLWARD
HES
DMO
23 June 2011

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Figure 1: Memorandum of Understanding

Strong leadership was brought to bear across the top of the organisations to unify goals, focus attention and drive better integrated processes around the high-level goal of achieving the best equipped soldiers in the world. This achievement of strong 'unity of purpose' led people and organisations to 'lift their heads' beyond their own immediate organisational goals in the pursuit of higher goals[2].

Diggerworks was established as a virtual organisation, with a small team of core staff based in Melbourne's Victoria Barracks. It operated under a governance structure designed to maximise its chances of success (see Figure 2). Key senior decision makers were part of the framework and the Diggerworks Stakeholder Group provided day-to-day oversight, ensuring that the various parties were working well together. It was comprised of representatives from each of the stakeholder organisations who worked actively on Diggerworks (essentially people at the Colonel level). Strategic oversight would be provided by the Army Capability Integration Board, which was comprised of Generals Caligari and Cavenagh, Dr Oldfield, and Brigadier Mal Rerdon from CDG.

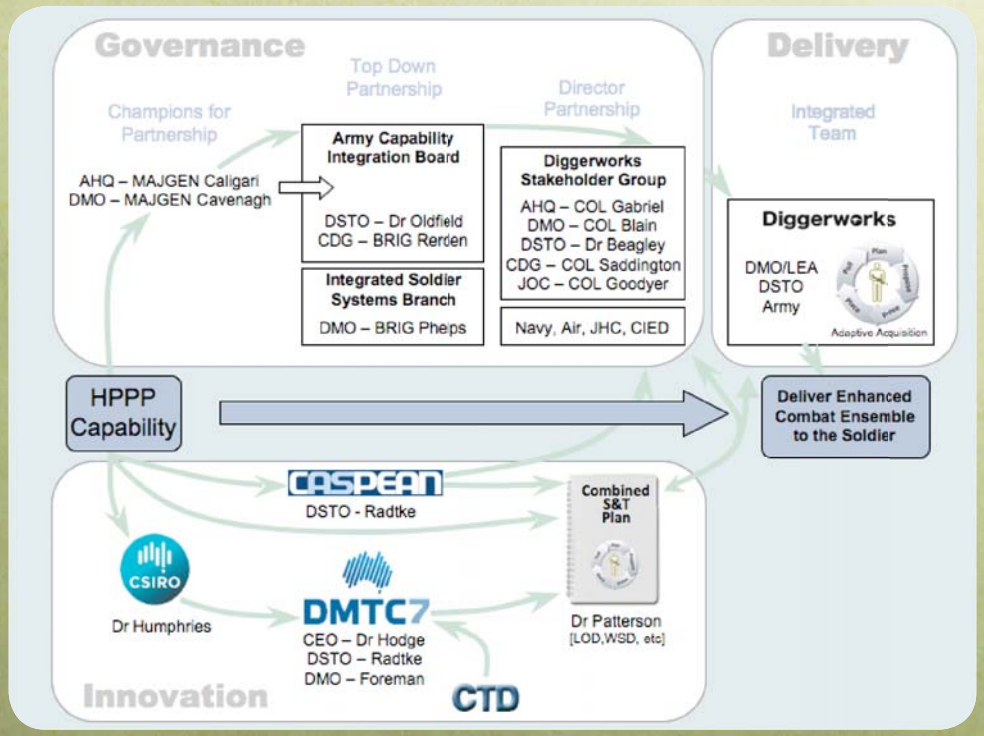



Figure 2: Diggerworks governance and delivery organisations

[2] This is reminiscent of the achievement of the Sydney Olympic games when many parties such as building contractors and building industry unions, which traditionally did not work well together and had highly problematic relationships, suspended these conflicts and worked effectively together to deliver the higher goal of delivering the Olympics assets on time and budget.



# The core of Diggerworks

At the core of Diggerworks was a team, the Integrated Soldier System Development Directorate, headed by Colonel Jason Blain. It included embedded staff from Land Systems Division of the Army[3], DSTO and direct links into Army Headquarters, Capability Development Group (CDG), Electronic Systems Division (ESD) and Joint Operations Command (JOC). It had three primary responsibilities:

1. Ensuring that the individual components of the soldier combat system were most appropriate given current knowledge, current technology, the soldiers' mission, and budgetary trade-offs.

2. Ensuring that the components were configured into the best possible system for the soldier, given variations between soldiers and the soldier's need for the ability to apply lethal or non-lethal effects, communicate and gain situational awareness, be protected from environmental threats, be sustained (fed, hydrated, not overloaded), and move and operate as part of a team within a close combat environment.

3. Driving the innovation of components, as needs were identified.

To drive these three responsibilities, the team needed to manage four fundamental objectives:

- **Manage cost pressures:** Diggerworks needed to operate in a way that would provide front-line troops with more up-to-date equipment designed to work in the theatres in which they were operating without dramatically increasing the associated costs.

- **Rapid innovation:** New components and configurations of gear had to go from conception to deployment rapidly, without exposing soldiers to uncontrolled risk as a consequence.

- **Break down the stovepipes:** Rather than each agency focusing on its own objectives, everyone had to make their central objective the needs of the soldier in the field.

- **Accommodate external stakeholders:** The Diggerworks process had to be mindful of the needs of external stakeholders such as the politicians, Australian industry, and casualty care providers.

[3] This included several Army personnel with operational experience and engineering and technical staff outposted from LSD's Land Engineering Agency.

## Creating the context

In order for Diggerworks to fulfil these obligations, the Army Capability Integration Board pushed DMO to make two fundamental changes to its purchasing approach. The categorisation of soldiers needed to change, and with that, the way their equipment was acquired.

## Reclassifying soldiers

Soldiers were issued equipment in accordance with the way they were classified. All soldiers within a given classification received functionally equivalent gear. Prior to Diggerworks, soldiers were classified into three tiers:

1. Specialists. Soldiers such as divers and pilots who have specific needs as a function of their jobs.

2. Special forces.

3. All other soldiers, whether or not they were at risk of engaging in close combat.

With the advent of Diggerworks, the soldiers were reclassified:

**Tier 1 -** Specialist. Those soldiers who have a specialised role or task. For example, combat divers, aircrew or petroleum operators.

**Tier 2 –** Close Combatant. Those soldiers whose primary role is to engage in close combat.

**Tier 3 -** General Combatant: Those soldiers whose primary role is to support close combatants but may be required to engage in combat during the course of their duties.

These changes had three effects on the equipment provided to soldiers. Primarily, it meant that Diggerworks could achieve the stakeholders' main objective of significantly upgrading the fitness for purpose of equipment provided to those who engage in close combat 'outside the wire'. In fact, by focusing more on addressing the needs of the close combatant, Diggerworks was able to increase considerably the investment in equipment for that group.



Secondly, the majority of service people would be issued with significantly less expensive equipment (though this could be upgraded if their duties changed). In addition to creating a pool of resources that could be used to pay for the equipment of close combatants, it meant that a large number of soldiers were not issued with gear they would never use. It also meant that those soldiers could be issued with gear that was more comfortable to wear and use, because it did not have to meet performance standards that were as high. Thirdly, it saved many soldiers from spending their own money on equipment to meet their needs.

## Adaptive acquisition

In addition to reclassifying the soldiers, DMO shifted its approach to the acquisition of the equipment that makes up the soldier system. Previously, DMO generally established standard offers for equipment, and then purchased against that standard offer for a period of several years (often seven years, being the period between capital authorisations). This would create little opportunity for change because the specification was locked in. Under the new system, adaptive acquisition, it would re-specify the equipment every year (for equipment that could be expected to change rapidly) or every two years (for equipment that was not expected to change).

The annual purchasing cycle meshed well with the Army's force generation cycle. Each brigade goes through a three-year cycle. At the start of the first – readying – year, each soldier would be issued with new equipment. They would train with that equipment and become highly proficient in its use. At the same time, their usage would be monitored, and so at the start of the second – ready – year, the group behind them could receive the next iteration of equipment, modified on the basis of what had been learned during the training year. During the deployment period, the equipment would be monitored further and modifications fed into the design for the third year's group (along with modifications coming from the training of the second group). Finally, on return to Australia for the third – reset - year, the gear would be checked, the soldiers would be interviewed, and further modifications would be designed (along with those from the groups one and two years ahead). This time, the new gear would be issued to that brigade as it readied for the next cycle. Their used gear would then be scrapped or transferred to lower-priority uses.

According to one of the interviewees, one advantage of adaptive acquisition was that it enabled the army to change the way equipment was allocated such that soldiers felt more ownership and treated it with more respect. This newly adopted approach of adaptive acquisition reflects practices applied by many leading organisations in other sectors, including mass customisation of supply of products and services that recognise and respond to different needs of consumers, (e.g. fashion clothing in different sizes). It is also similar to that used by automotive manufacturers which design and build a model, e.g. Holden Commodore, planning for a number of minor upgrades and changes during the life of a model, and for regular changes of the model as new features are required and new technology becomes feasible.

Re-specifying equipment more frequently would appear at first to be significantly more expensive than placing one large standardised order every seven years. DMO lost economies of scale in pricing, maintenance and support, and had significantly larger contract administration

costs. However, these cost increases were compensated for in two ways. First, DMO did not buy thousands of units of gear that rapidly became redundant with changes in technology or changes in task and environment and hence need (such as moving focus from Iraq to Afghanistan). Second, they did not buy thousands of units of gear that was rendered useless by poor configuration management. On average, in addition to providing more appropriate equipment, interviewees claimed that the unit cost was lower under adaptive acquisition than the old system. However the cost of the staff who managed the purchasing process came from a different budget allocation than the equipment itself; the increased cost of administration could not be offset from the savings in the equipment itself. Similar to companies that invest in flexible processes and product designs, the adaptability capability brings advantages that often more than make up for economies of scale in bulk purchasing of standard items.

Most important, the flexibility that the new system of adaptive acquisition provided led to significant increases in the effectiveness of the equipment ensemble, through better integration of components of equipment, and hence a more effective and safer soldier outcome. This allowed Diggerworks to become a leading facilitator of the delivery of the Army's mission, as determined by the leaders (signatories to the MOU, see Figure 1) who drove the Diggerworks initiative.

## Gathering insights about needs and possibilities

The data gathering described in the section above was just part of the information collection undertaken by Diggerworks. The overarching aim was to engage in user-centred design (see Figure 3). In order to do that, the team needed to both understand the problems the soldiers faced with their equipment, and give assurance to the soldiers that they were understood.

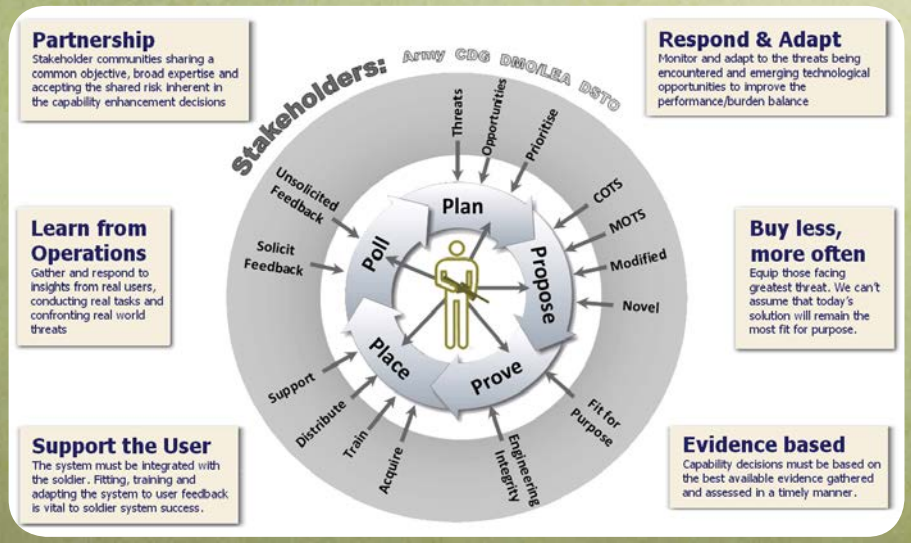



Figure 3: User-centred design

The Diggerworks team put a strong emphasis on having high quality data that enabled it to capture, as precisely as possible, the soldiers' needs. Sources included:

- **CASPEAN (CASualty and Protective Equipment ANalysis).** Before Diggerworks, the armour of soldiers killed in action would have been returned to DMO, and someone may have looked at it, but not necessarily deeply and systematically. With the advent of Diggerworks, DSTO took the lead and started to systematically analyse the armour using an array of techniques from x-ray through to microscopy. This was then combined with detailed casualty accounts provided by nursing staff in the field to develop a 'story board' account of how the armour had (or had not) performed. This account was then shared with relevant stakeholders in Australia, such as those interested in armour design, casualty care and treatment. It also led to the establishment of links to international counterparts in battlefield threat mitigation, including the Joint Trauma Analysis and Prevention of Injury in Combat group in the USA, who reciprocally shared their findings with the Australians.

Similar to other successful organisations such as General Electric (GE), Diggerworks sought to 'bring the voice of the consumer centrally and pervasively into the organisation's heart'. GE CEO Jack Welch brought this idea centrally into GE and required processes to be organised around maximising the consumer outcome effectiveness, which unified parts of the organisation that were previously not aligned to this 'higher goal'.

Colonel Blain's counterpart in DSTO, Dr Nick Beagley, headed a research branch in DSTO's Human Protection and Performance Division with particular expertise in applying a soldier–centred approach to the application of science and technology to achieving soldier system outcomes.

Part of this problem was solved through the selection of Colonel Jason Blain to head the team. Blain brought direct operational knowledge to the Diggerworks team. He had led a battlegroup in Afghanistan (~800 soldiers), where he had raised concerns regarding the gear his troops had had to wear and use. He had argued strongly that it had made their work significantly more difficult and had increased the risk they faced. His appointment provided a strong assurance to the troops that their interests were being put first.

Helmet Analysis

- **Deployed teams.** Diggerworks initiated the use of teams comprising a soldier, a DSTO scientist and an engineer who would go, embedded, into the field (in the Solomon Islands, East Timor, Afghanistan) or Australian training environments for up to four weeks to learn first-hand from the soldiers about how their combat systems worked. They would visit both the main base and outposts, and would observe the systems in use and talk with the soldiers in the evenings after they came in from the field. These missions required significant pre-deployment risk analysis and training. Once in the field, it would generally take a couple of weeks for the soldiers to build enough trust to talk honestly, at which point they became extremely astute and forthright observers of, and commenters on, their equipment. The time taken to build trust was expected to decrease markedly in the future as soldiers became used to, and trusting of, the process. Embedded teams are similar in some ways to the use of 'a mystery shopper' and other approaches that observe and measure the reality of what is going on in the 'market place' of implementation and bring this data back centrally and accurately to drive improvement processes.

- **Returned soldiers.** When soldiers returned from the field after a tour of duty they were interviewed extensively about the performance of their equipment. This mirrors the market research and exit interviews that business organisations use as a way of learning and driving improvement.

- **International cooperation.** Diggerworks engaged in extensive data and insight sharing with other coalition forces in Afghanistan, such as the Norwegians, the Dutch and the Germans. They had even closer cooperation and data sharing with the UK, Canada and the USA through a number of cooperation agreements. This is a knowledge management approach as used extensively by global companies to learn and spread best practices.

- **Market surveying.** Diggerworks team members selectively attended military trade shows to develop an understanding of available equipment and new equipment coming over the horizon.

- **Trials.** Diggerworks conducted small field trials (in Australia and in theatre) of proposed equipment to see if it worked as expected, and how it could be improved.

- **DSTO bench research.** The other data gathering activities tended to dramatically accentuate the practical relevance of DSTO research and expertise to both the Diggerworks team and the DSTO scientists. Army interviewees claimed that they had previously struggled to see the relevance of a lot of the DSTO research. However, because of focused data gathering and better communications, the Diggerworks team was able to bring its expertise to bear on problems it was trying to address.

This collection, assimilation and integration of these information sources represents a form of 'organisational intelligence' gathering and information processing that is admirable, and similar to that of best practice commercial firms.

## Innovating the soldiers' combat ensemble

Diggerworks aimed to ensure that soldiers exposed to risk had the best possible combat ensemble. Its task could be reduced to three basic innovation activities: (i) adding or substituting components that already existed elsewhere in the world, (ii) incrementally improving components and the way they were configured, and (iii) facilitating the development and bringing-to -market of truly novel components.

## Adding components

The data collection brought to the fore deficiencies in the combat systems that had been identified in other countries and could easily be remedied by importing those solutions. An example of these was the Pelvic Protection System (see Appendix 2). British researchers had identified sand and debris from explosions penetrating soldiers' trousers as a major source of infection and subsequent genital loss. This, in turn, was a key driver of post-traumatic depression and suicide. The solution was a configuration of underwear that trapped the dust, restricting the damage to this area.

While DMO would have eventually procured such a solution for the Australian soldiers under the old system, Diggerworks made it happen much more quickly. For example, through collaboration with DSTO, CSIRO developed some promising lightweight ballistic fabrics, some of which were also cut and sewed into the form of shorts for illustration purpose. These protection concepts had a low technical readiness level (TRL) of 2 to 3. In the meantime, the UK ballistic shorts came on the market as a matured commercial-off-the-shelf product (TRL–9) and therefore a decision was made to rapidly acquire the protection equipment for deployment. Because Diggerworks' primary focus was on delivering outcomes to soldiers, and because a British supplier had a solution on the market, Diggerworks was able to fast track the acquisition of this solution through the responsible Systems Program Office.

## Incremental enhancement and changing configurations

Equally important as adding or subtracting individual components to the soldiers' gear was the problem of managing the overall configuration. Because the soldier's work had a large social component, and hence high variability, and because soldiers came in all shapes and sizes, the problem of configuring a soldier's combat system was about as complex as that of configuring a ship or a fighter jet. This required moving to more of a mass customisation approach (like Dell produces computers configured to order), rather than a mass production approach.

Prior to Diggerworks, the configuration problem was essentially unmanaged, leading to the problems described above. The Memorandum of Understanding made it clear that configuration management of the combat ensemble was the role of the Diggerworks team. The team spent significant time and resources attempting to optimise the ensemble for the current theatres of operation across its five performance dimensions: applying lethal and non-lethal effects, communication and gaining situational awareness, surviving, sustaining, and moving. The principle here was to ensure that synergies were achieved across subsystems of the soldier's ensemble, rather than allowing for individually designed components to be locally optimised (which previously really meant *sub*-optimised when the whole ensemble was considered).

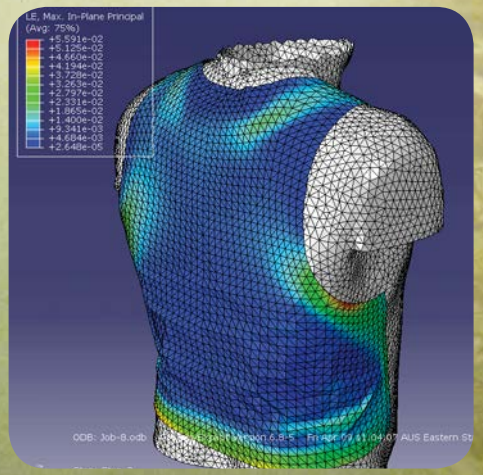
Unlike some other countries, and Australia prior to Diggerworks, which sought to design the optimal equipment for the optimal soldier, the Diggerworks team sought to develop a configuration of gear that was satisfactory for a wide range of soldiers. Some equipment was standardised, but other equipment was varied according to soldiers' size, work requirements, and preferences.

The configuration requirements varied in subtle but important ways between theatres. For instance, if soldiers were working in the jungle, it was critically important that their equipment did not make any noise. So, for example, the ammunition pouches required a securing system such as a clip or elastic material which could be removed with minimal noise so as not to identify their position. In the desert, however, where soldiers were potentially more exposed, noise was less of an issue, but speed of access was critically important. This called for quite a different design and, the use of Velcro, for example, was possible. The principle working here is similar to how commercial firms adapt quickly to changes in external/market circumstances.

Some of these changes were dramatic. For instance, the body armour system was reduced in weight significantly, based on the understanding that the changed threat environment could justify reduced ballistic protection. This, in turn, increased soldiers' performance in all other dimensions - they were more mobile and sustainable, and they could use their weapons and communications equipment much more easily. This change was to apply the core principles of quality management, namely to ensure the specification is 'fit for purpose' and 'meets the consumer's requirements', being neither over- nor under-specified for the need.



As the different agencies started to work together to gather and analyse data and focus on the configuration issues, they started to work better together. They started trying to maximise the benefits for the soldier in the field instead of focusing on the local measures used by their agency. This common goal created a basis for trust, which grew rapidly – aided no doubt by the co-location of the different members of the core team at Victoria Barracks, Melbourne. As a consequence, DSTO subject matter experts became an integral part of the daily dialogue and problem solving within the Diggerworks team. This was a continuing evolution of a trend, begun three years earlier when DSTO started to locate staff at Victoria Barracks. Prior to that, those experts would have continued with their work, oblivious of the need faced by the staff in DMO. Alignment across the core participating organisations went from weak to strong, and welded a synergistic organisation together, which in turn led to better integration and synergy between the components of the soldier's ensemble.



Protection Modelling

## Innovating components

The data gathering, along with work on the system configuration, revealed gaps and opportunities for technological improvement. At the same time, Australian manufacturers were developing new technologies that they wanted considered for inclusion in the soldiers' ensemble. However, a number of issues made innovation in these systems more problematic than in the general market. Although encouraged to engage with industry, DMO staff members were cautious in their interactions, having received criticism on a number of fronts regarding perceptions of fairness and probity.

Probity was not the only problem. In civilian markets, it is often possible to find early users who will help drive the transformation of novel technologies into market-ready products (see Moore (2002) for a discussion of the difficulties of achieving this). In military markets, however, it was quite conceivable that a laboratory or manufacturer would develop a new technology, but would not be able to finance its commercialisation without an assured customer. DMO would not normally purchase, however, unless the product was proven. This was known colloquially as the 'Technology-Readiness-Level Valley of Death' and can be problematic with Technology Demonstrator programs without effective Industry/ Defence interactions to drive the product through to market. Australia's in-country capability to produce body armour hard plates was limited, which is strategically undesirable and did not readily enable Australian design changes or requirements to be accommodated through adapting manufacture processes. Novel techniques initially conceived under programs such as the Capability and Technology Demonstrator Program are now being developed with Diggerworks support.

Similarly, in civilian markets, it was relatively easy for innovative manufacturers to obtain data about users and their needs. In military markets, however, data about needs were often classified, as were some of the technologies developed by DSTO. This information needed to be presented to companies that could use it.

To encourage collaboration and innovation for the ADF, the Defence Materials Technology Centre (DMTC) was created in 2008. The Centre was partly modelled on a Collaborative Research Centre (CRC) and administered by the CRC Program in the Department of Industry, Innovation, Science, Research and Tertiary Education. Its members comprised DSTO, several universities and Australian manufacturers and industry groups. The DMTC's mission was to leverage the contributions of its members to develop technologies and processes that would be of significantly greater direct benefit to the Australian Defence Force than could be achieved by the parties acting alone. The DMTC was created and funded with a grant, and was intended to have six programs. It did not originally have a program focusing on troops in the field.

When the need for a program in Personnel Survivability was recognised, almost simultaneously, by the DMTC and DSTO staff associated with Diggerworks, the members of the Army Capability Integration Board (particularly Oldfield, Cavenagh and Caligari) brokered its creation. Being the DMTC's seventh program, it was known as 'Program 7'. Because it was not anticipated when the DMTC was created, and so was not created within its originating documents, a novel funding mechanism needed to be adopted. It was constituted as a project. Similarly, there was a key role for CSIRO in the program, especially in materials science and 'manufacturability' support. However, CSIRO's late entry to Program 7 required careful negotiation. So, the members of the Integration Board facilitated CSIRO's joining, by, for instance, ensuring the Minister for Defence Science and Personnel visited the CSIRO Geelong facility to meet senior CSIRO staff. Eventually, DSTO, DMO, Defence, and the Army provided $9m, and the Universities, CSIRO, and Industry provided $13m over five years. The DMTC provided significant financial leverage as well as project management and sound governance of technical developments for the defence sector.

Program 7's mode of operation was that it identified needs through programs like Diggerworks, priorities set by the Diggerworks Stakeholder Group, and its understanding of equivalent projects in other countries. It identified and funded projects that called on local technical and industry capabilities. Industry participants worked with Government partners (CSIRO, DSTO) on the project. Any intellectual property developed would reside with the DMTC, but Defence and the industry partners would receive a free licence to it. The DMTC brought an enlightened and 'best practice' approach to open innovation and collaboration across the supply chain to Diggerworks.

The DMTC was ideally positioned to draw together a range of academic and industry partners such as Australian Defence Apparel, Victorian Centre for Advanced Materials Manufacturing, CSIRO, Swinburne University of Technology and the University of Melbourne, which each brought significant capabilities to the table, including skills in textiles and manufacturing technologies. By bringing together these potential contributors to technology fields of relevance to the innovation of personal protection systems, the DMTC provided a mechanism for new and existing concepts to be matured in those specific areas deemed relevant by the Diggerworks stakeholders. The principle in play in this aspect of Diggerworks delivering a high performance soldier ensemble was to get the balance right between what commercial organisations refer to as 'market pull' and 'technology push'. It also played a brokering and connecting role in tightly connecting the consumer requirement to the technology capabilities.

## Changing relationships

Underlying all these processes – the creation of the governance structure, the creation and co-location of the Diggerworks team, the creation of Program 7 at the DMTC, the movement of objectives from 'siloed' agency objectives to a focus on the soldier, and so forth – was a transformation in the relationships between the protagonists. People moved from formal low-trust relationships to strong and trusting interdependence. As people started to understand the constraints under which others worked, and the resources they could bring to bear to the tasks at hand, they were able to harmoniously coordinate their activities to create better outcomes all around. The trust was led and role modelled from the top, especially the signatories to the MOU, and it was trickled down throughout the participating organisations, from the science– based DSTO and CSIRO, to the supply chain partners in the manufacturing sector.

## Diggerworks outcomes

Even those who were originally sceptical about Diggerworks came to realise that it had moved a number of dimensions of performance forward. First and most important, it improved the effectiveness and safety of soldiers in the field. This was through the purchase of components developed elsewhere, the improved integration of the various elements of the ensemble, and the development of novel components. This in turn was based on the improved set of innovation management practices and supply chain organisation. Everything from silk shorts, improved body armour and pouches, helmets and glasses have led to improved outcomes. A significant funnel of further innovations and improvements is in train. Diggerworks has delivered a broad range of enhancements in the short time it has been established, raising soldiers' confidence in their equipment to new levels. See Appendix 2 for examples of specific Diggerworks outcomes for soldiers in the Afghanistan theatre.



ADF Combatant 1999

ADF Combatant 2010

# Analysis

Since the simultaneous rise of the Japanese automobile and consumer electronics industries, and small innovative manufacturers in Central Europe (Northern Italy, Southern Germany, etc.) in the 1970s, managers have increasingly recognised that it is not sufficient for their organisations to be efficient in the short term. Rather, organisations create long-run efficiency and effectiveness by innovating as well as operating. Consequently, organisations have moved progressively from a focus on efficient production of large lots (mass production) to more agile and flexible small-lot production (flexible specialisation, lean production, etc.) (Liker, 2004; Piore & Sabel, 1984).

Changes in the nature of military engagement have driven similar changes in military operations (with protracted trench warfare marking the mass production end of the spectrum and locally-empowered teams operating closely within the community for short periods marking the flexible-specialisation end).

As military practice has changed, there has been a simultaneous need for innovation in procurement. Not surprisingly, this innovation has required organisational forms similar to those needed for innovation elsewhere in the economy. That is, the form of the procurement organisation has needed to change. Given this, our interviewees saw Diggerworks in two distinct ways. Some saw it as the radical breaking down of stovepipes between agencies whose origins were predicated on a mass-production mentality. Others saw it as the crystallisation of ongoing changes within Australian military procurement and a catalyst for further change.

Diggerworks innovated the soldiers' combat ensemble by three routes:

**1.** adoption of new components from elsewhere,

**2**. iterative enhancement and improved configuration of components, and

**3.** development of novel components.

In much the same way, in order to make Diggerworks work, its creators needed to drive three types of management innovations:

**1.** the adoption of management practices from elsewhere,

**2.** the reconfiguration of existing practices into an effective management system, and

**3.** the development of novel management approaches.

It is relatively easy to see the management practices adopted from elsewhere (such as borrowing from 'Gruntworks'), the practices that were similar to those used by leading innovative organisations (such as those described in the next section), or the truly novel aspects of Diggerworks, (such as Adaptive Acquisition or the reclassification of soldiers). However, much of the success of Diggerworks arises because of the development of a configuration of management practices that was extraordinarily well matched to the technical problem it intended to solve. By understanding how that match occurs, we can see the extent to which Diggerworks can be extended to other aspects of military procurement.

Broadly speaking, the Diggerworks management system comprised three components:

1. **The delivery component.** This comprised the Diggerworks core team, DMTC Program 7, and all the associated people within DSTO, DMO and the Army that supported them (see Figure 2). These groups were responsible for actually delivering the soldier combat system.
2. **The governance component.** Principally, the Army Capability Integration Board and the Diggerworks Stakeholder Group delivered this. These two groups essentially managed the context within which the core teams operated. In addition to ensuring the flow of resources (such as facilitating the hiring of appropriate staff) and removing barriers to effectiveness (such as by putting the adaptive acquisition system in place) they balanced two contradictory roles, namely facilitating creative problem-solving by the teams on one hand, while ensuring they did not take unnecessary risks or waste resources on the other.

The design of these governance and delivery components was significantly more complicated than might appear on the surface. There were six months of discussions between the various parties before the structures were finalised and put in place.

3. **Leadership.** Leadership was needed in two distinct ways. First, leaders needed to see the need for a transformation, design it and put it in place. Second, because no structure will deliver perfectly in every situation, leaders needed to ensure that people were motivated to deliver the best outcomes despite the structures and systems they had to work with.

Within the broad system constructed from these three components were five elements that deserve special consideration: objectives and approach, knowledge management, procurement methodology, organisational climate, and leadership.

## Objectives and approach

Prior to Diggerworks, the soldier system stakeholder organisations each focused on different aspects of capability enhancement. In the case of 'capability development' (equipment funded as part of the capital funding process), Army attempted to comprehensively define everything they envisaged the user might want from a future system. CDG transformed this vision into a range of mandated or desirable functions and DMO would translate this into a technical specification and pursue product options. In parallel, DSTO would undertake studies for these various organisations to investigate different aspects of the proposed system. Despite this apparently sensible progression of increasingly refined specifications, the time taken to complete this process and the inherent barriers to effective communication across these stakeholders led to unsatisfactory acquisition outcomes for the soldier combat system. This separation of responsibilities led each organisation to concentrate their efforts on ensuring they maintain a reputation for irreproachable achievement of their part of the larger process. In the meantime, the needs of the user and the candidate technologies had evolved beyond what could reasonably have been envisaged at the start. In addition, the separation between these stakeholder organisations allowed each to attribute blame for the failures of acquisition to the other groups. Similarly, in the case of 'sustainment' (replacement of equipment that was no longer fit for service), DMO had the opportunity to remedy defects that had arisen through the capability development changes, or changes in purpose that had arisen as events had unfolded. However, the fear of 'requirements creep' meant that equipment was re-purchased with unchanged specifications.

Diggerworks built on changes made by Brigadier Sorial, Brigadier Phelps and others to change the frame of reference from the technical needs of the host organisations to an aligned concern for the needs of the soldier in the field (what innovation researchers call a market-focused orientation). This is not to say that it focused on near-term solutions, but rather that it used the needs of the soldier as the central lens to frame future capability options and risk trade-offs. Such a transformation had a profound effect on the organisations' abilities to innovate. In addition to directing peoples' thinking towards the desired objective, it directed conversation and action so that people focused on a collective goal instead of their sectional interests (Dougherty, 1996). When goals are not shared, people obstruct changes because those changes violate organisational imperatives. (Dougherty, 1992; Dougherty & Heller, 1994). When goals are shared, people find ways to render those concerns irrelevant.

## Knowledge management

Innovation is fundamentally a knowledge creation task (Nonaka & Takeuchi, 1995; Popadiuk & Choo, 2006). Effective knowledge creation involves data gathering, data integration, and problem-solving. One of the key strengths of Diggerworks was the way in which it was set up to ensure that all the relevant data were included in the problem-solving process. These data had to be drawn from diverse sources: detailed tacit information from soldiers in the field about how they used equipment in practice, highly technical information from the CASPEAN program or from the scientific community, information about the cutting edge of product development through the DMTC and trade fairs, and so forth. After gathering all these data, the information had to be integrated. This was achieved by having all the relevant people from different disciplines and organisations working in close proximity, principally at Victoria Barracks. If people work in close proximity, then it maximises the chances of key information being transferred between them either deliberately or serendipitously (Allen, 2007). An example of serendipitous information transfer might involve someone from DSTO overhearing a conversation and realising that a colleague at another location could provide very useful technical input to the discussion. Effective problem-solving was achieved by creating an effective working environment in which all the relevant information was created and available to the team, and in which the team had the skills to use it.

## Procurement methodology

In the commercial world, producing a product or service that clearly meets the needs of a customer is one of the major barriers to commercial success. Another is successfully marketing and distributing the product or service (Abernathy & Clark, 1985). Similarly, in the case of Diggerworks it was not sufficient to identify what should be in the soldiers' combat systems. That configuration of gear had to be enforced, and the various components needed to be procured. Diggerworks put a number of pivotal elements in place to ensure that happened, exploiting, crystallising, and then further catalysing an ongoing stream of changes in procurement methodologies. In particular, reclassifying the soldiers freed up funds and created a much better match between the soldiers and their equipment needs. Similarly, the adaptive acquisition system allowed DMO to buy up-to-date equipment based on the latest data. Forcing all configuration decisions through Diggerworks, and making sure that everyone understood that the Chief of the Army was the ultimate customer, ensured that soldiers' equipment was configured as designed.

## Organisational climate

Despite the best of intentions, it is never possible to design an organisational system that will produce innovation if people just respond to extrinsic incentives. Effective innovation requires the synthesis of diffuse information. However, because the information must cross organisational boundaries, that synthesis task is often a source of anxiety for the people involved. Participants may not feel safe revealing what they know (Edmondson, 1999), especially when that information runs against static performance measures. Similarly, because innovation is risky, those involved may well fail, despite their best endeavours. Furthermore, most organisations punish failure (Sutton, 2002).

As a result, innovation rarely happens unless management creates an environment in which participants cooperate and trust each other. Consequently, the organisational climate – the set of properties of the work environment, perceived directly or indirectly by organisational participants, which influences participant behaviour – is critically important. By force of their leadership styles, relationships, and personalities, the key players in Diggerworks and its governance managed to create a climate that was open and trusting, fostered collaboration among the various players, and biased them towards action rather than surrendering to inertial bureaucratic processes. For example, Diggerworks participants saw it as more important to overcome the risk of delayed delivery to the soldier than to minimise risk to themselves and their organisation by taking extra time to make and review their contributions to the capability development process (Beagley & Blain, 2012).

## Leadership

In addition to creating the organisational climate, leadership was necessary for two reasons. First, at the outset, the wrong systems were in place. That was why the procurement system did not work effectively. The stakeholders needed to identify, frame, and design a solution to the problem, and negotiate that solution into existence. Within the life of Diggerworks, this happened three times. The first time, the imperative for change came from the bottom of the organisation, the front-line troops. They used the Senate Estimates process to help put the inadequacy of Soldier Combat Ensemble on DMO's agenda. The second time involved the creation of the Diggerworks organisation and, along with that, the reclassification of the soldiers and the implementation of adaptive acquisition. The third time involved the creation of Project 7 within the DMTC, bringing CSIRO in as a participant, and finding a way to fund it. Second, beyond these big changes, there was ongoing leadership, both to refine and redesign the systems as improvements were identified, and to compensate for the slippage when the systems were not sufficient to produce results on their own.

# Beyond Diggerworks

What can Diggerworks tell us about military procurement more generally? At a broad level, any innovation-based procurement system needs to satisfy the same criteria:

**1.** a delivery organisation that is focused on the end-user and has the ability to gather, synthesise, and use the relevant information for its mission,

**2.** a procurement system that is capable of getting innovations into the field,

**3.** a governance system that keeps the other parts of the system focused on core objectives and manages conflicts between innovation and risk, and

**4.** strong and sensible leadership.

How those elements are put together tends to be contingent on the technical task at hand. Diggerworks was tuned to particular attributes of the Soldier Combat System, which differed from other pieces of military hardware in important ways. First, the platform was not stable. Rather, every soldier was a different shape and size, and often performed a different job from his or her colleagues. Consequently, the complexity of the Soldier Combat System was driven by the huge variations in uses for the components, rather than the need for technical integration between them, as is the case with a fighter jet or a submarine. Second, the different components of the Soldier Combat System were essentially independent. They could be developed separately, substituted if necessary, and integrated on the soldier. This is quite different from, say, a weapons system, where the different parts need to work together much more closely. Third, the components all had a very short life. It was perfectly appropriate, and in fact necessary, to replace entire systems every three years as part of routine troop sustainment processes. Other pieces of hardware are expected to remain in use for years, if not decades. Finally, the components are all small, relatively inexpensive, and purchased in reasonable quantities. Consequently, it is quite appropriate to redesign them annually if necessary. Diggerworks was built around many of these idiosyncrasies. As each of these elements changes, the appropriate organisational design should change accordingly.

However, a number of other military systems have very similar characteristics to the soldier's combat ensemble on these dimensions. Interviewees identified the following as a preliminary list:

**1.** Chemical, Biological, Radiological and Nuclear (CBRN) defence systems.

**2.** The Land 400 project which is focused on providing an integrated suite of Land Combat Vehicle Systems for the mounted close combat capability of the Land force. While not having all the attributes of Diggerworks, it is similar in many respects.

**3.** Electronic warfare / counter improvised explosive device work.

**4.** Configuration of helicopters for soldier–helicopter interaction.

**5.** Integration of a wide range of technologies into land systems.



## Conclusion

The Weberian bureaucratic ideal, on which Australian government agencies have been premised since before Federation, places a premium on flawless execution of known tasks and clear accountability for that execution. However, as the technological and execution landscapes in which agencies operate become more dynamic, long-term effectiveness, driven by innovation (defining and solving problems), increases in importance relative to operational effectiveness (implementing the solutions to problems). A focus on long-term effectiveness requires an organisation focused on learning and change. This can rarely be achieved without trust, cooperation, and a shared willingness to succeed.

The Army, DSTO, DMO and other agencies involved in Diggerworks have successfully created a set of organisational arrangements, designed around the idiosyncrasies of the Soldier Combat System, premised on, and reinforcing, trust and cooperation, that can reliably and consistently deliver the changes that are needed.

# Appendix 1: Acronyms and Glossary

| | | |
|---|---|---|
| DMO | Defence Materiel Organisation | Responsible for all defence procurement (see www.defence.gov.au/dmo/). |
| DSTO | Defence Science and Technology Organisation | Core role is to provide all relevant technical advice to the services and the Ministry. This includes research as well as monitoring technological developments (see www.dsto.defence.gov.au/). |
| LEA | Land Engineering Agency | LEA is a group within the Land Systems Division of DMO. It is responsible for ensuring the technical integrity of land systems - essentially all materiel used on the ground by the Army (see www.defence.gov.au/dmo/about/domains/land.cfm). |
| CDG | Capability Development Group | CDG is a group within the Department of Defence. It is responsible for shaping Defence's future war fighting capability by developing and gaining government approval for future Defence capabilities (see www.defence.gov.au/capability/_home/Default.asp). |
| SCS | Soldier Combat System | The equipment used by a soldier to apply lethal or non-lethal effects, communicate and gain situational awareness, survive (be protected from environmental threats), sustain (have adequate food, hydration, and not be overloaded) and move and operate as part of a team within a close combat environment. |
| ISSDD | Integrated Soldier System Development Directorate | Core team responsible for delivering the Soldier Combat System (Diggerworks core team). |
| DMTC | Defence Materials Technology Centre | A collaborative research centre, funded by the government and industry, with the military, DSTO, CSIRO and various companies as members. It develops novel military materials and products. |
| DSG | Diggerworks Stakeholder Group | A group of Colonel-level officers from the Army, DMO, DSTO, CDG and Joint Operations Command charged with tactical oversight of Diggerworks. |
| ACIB | Army Capability Integration Board | A group of General-level officers from the Army, DMO, CDG and DSTO with responsibility, among other things, for strategic oversight of Diggerworks. |
| | Sustainment items | Items that are purchased to replace other items that are removed from service, rather than to provide fundamentally new capabilities. |



# Appendix 2: Diggerworks Emerging and Future Combat Soldier Equipment

Diggerworks' focus is on Combat Soldier Equipment to identify ways to 'reduce the burden' for the close combatant while increasing his or her survivability through enhancing the areas of protection, mobility, lethality, sustainability and command, control, situational awareness. Diggerworks is actively developing/introducing a range of capability enhancements. Some of the specific areas of work are detailed below;

- **Soldier Combat Ensemble**
  Diggerworks continues to progress equipment design of new Soldier Combat Ensemble versions for Mentoring / Advisor Task Force and Special Operations Task Groups. The design enhancements are based on user feedback, Diggerworks analysis and future requirements (e.g. specialised near region environments). This development is closely linked with work programmes under DMTC-7, in particular looking at High Curvature Semi Rigid Armour systems. It is also considering the potential for different armour designs for females.

- **Blast Gauge System**
  Diggerworks has commenced Project CEREBRO, the procurement of a blast gauge system (including software and data retrieval systems). Diggerworks commenced fielding blast gauges to personnel deployed in Afghanistan in late September 2012. The purpose of the sensor is to provide a monitoring capability of individual exposure to blast overpressure resulting from an improvised explosive device or other explosive blast. The information is intended to inform a database on blast exposure in correlation to mild Traumatic Brain Injury (mTBI) suffered by troops.

- **Pelvic Protection System (silk boxer shorts)**
  Tier 1 and 2 pelvic and groin protection equipment has been introduced into service, to reduce the mortality and morbidity rates amongst soldiers injured by improvised explosive devices, by providing protection from dirt and fine debris accelerated by means of an explosive blast. A further layer, Tier 3 (an advanced layer for those most at risk such as search engineers and explosive ordnance disposal personnel) is also to be trialled in Australia to confirm the performance of the system against the manufacturer's claims and assess integration with the soldier combat ensemble.

- **Ballistic Helmets**
  Since the introduction of Diggerworks a progressive upgrade has been occurring to improve integration of the in–service helmets with head borne equipment, as well as improving the protection against blunt force trauma. The improvements have included a new suspension and retention system, a permanently attached night vision goggle bracket and trial of two exemplar lightweight helmets by Special Operations Task Group (SOTG). An interim Tier 2 helmet is also being procured in support of Assistance Task Force 1. In support of these activities DSTO is conducting research into the effects of Helmet Behind Armour Blunt Trauma (BABT) and its link to injury.

- **Individual Water Purification Systems**
  In order to reduce the burden of water carriage on dismounted soldiers when conducting missions in areas of operations, Diggerworks is continuing investigations of water purification products in order to allow dismounted soldiers to obtain water from local water sources and safely remove waterborne pathogens. Trials have already taken place in Australia and Afghanistan and two systems have been procured – one team based and one individual system. These trials will continue as more items are released onto the market.

- **Gunshot Detection Systems**
  Based on information from US and UK Armies (who have widely distributed these capabilities to their soldiers on operations), Diggerworks has facilitated the trial of gunshot detection systems in Afghanistan. Three systems have been procured for trial; one is attached to the weapon whilst the other two can be worn on the soldier. These are lightweight items designed to detect and localise the source of incoming high velocity rounds.

- **Lightweight Ballistic Plate**
  Diggerworks, through the Defence Materials Technology Centre, has been engaging with industry in order to develop a lighter and more ergonomic ballistic insert (plate) for the Tiered Body Armour System (TBAS). Prototypes have been developed and testing is on-going. Ongoing feedback from soldiers and technical investigations has highlighted the need for a lighter and more ergonomic ballistic plate. Defence Materials Technology Centre Program 7 has also endorsed hard and soft armour systems as areas for project development within Australian Industry.

- **Pistol Holster**
  An improved pistol holster capability is being developed for use with the in-service 9mm Browning Mk3 pistol as current pistol holsters are not compatible with the soldier combat ensemble in addition to being too bulky and difficult to operate with speed and accuracy when operating in body armour. A number of options have been put forward for trial in Afghanistan and user feedback will be used to inform the development of an appropriate holster for close combatants.

- **Weapon Sling**
  The current F88 sling is not compatible with the soldier combat ensemble and does not allow soldiers to drop the weapon and let it hang down whilst attached to body armour. This has resulted in Diggerworks designing and procuring a number of single point slings for trial in Afghanistan. Design of a three-point sling is also in progress. User feedback will be used to inform the development of appropriate sling specifications for future procurements.



- **Cold Weather Ensemble**
  Due to the requirement to operate in extreme temperatures in Afghanistan, Diggerworks has been conducting a trial of cold weather ensembles in both Afghanistan and Australia. User feedback will be used to inform the development of appropriate specifications for future procurements.

- **Medic Packs**
  Diggerworks is currently undertaking a trial of packs that are specific to the requirements of medical personnel. These are being trialled in Afghanistan, and the outcome of the user feedback will inform the future requirements specification for medical equipment.

- **Lumbar Support**
  Prolonged travel in protected mobility vehicles is a requirement for personnel on operations in Afghanistan. Personnel have raised the issue of pain in the lumbar region when moving in these vehicles whilst wearing their soldier combat ensemble. As a result Diggerworks is trialling a range of lumbar support systems in order to identify potential solutions for Army. This trial includes both Mentoring and Assistance Task Force personnel and Special Operations Task Group personnel.

- **Night Vision Goggle**
  Counterweight pouches: Night vision goggles place weight on the front of the helmet which requires offset using a counterweight. In order to improve the integration of counterweights into the combat helmet, Diggerworks has provided a range of counterweight pouches for trial in Afghanistan. The pouches have been designed to use the existing in-service counterweight, or alternative counterweights such as a radio spare battery or lead shot bags. Recommendations will be made to Army on the most appropriate solution at the end of the trial.

## Appendix 3: List of interviewees

- ***Dr Simon Oldfield, DSTO***
- ***Dr Bill Humphries, CSIRO***
- ***Dr Nick Beagley, DSTO***
- ***Dr Mark Patterson, DSTO***
- ***Col Jason Blain, Army, ISSDD Leader***
- ***Mr Greg Foreman, DMO-LEA, ISSDD technical director***
- ***Dr Alex Zelinsky, Chief Defence Scientist***
- ***Brig Mike Phelps, Head of Integrated Soldier Systems Branch, DMO***
- ***Dr Tom Radtke, DSTO***
- ***Dr Michael Ling, DSTO***
- ***Brig Mal Rerdon, CDG***
- ***Dr Mark Hodge, CEO of DMTC***
- ***Maj Gen Jeff Sengelman, Army***
- ***Maj Gen John Caligari, Army***
- ***Maj Gen Grant Cavenagh, DMO***



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# Danny Samson

Danny Samson is Professor of Management at the University of Melbourne (since 1988), was Head of the Department of Management in the Faculty of Economics and Commerce for three years and is Director of the Foundation for Sustainable Economic Development there.

He has an honours degree in chemical engineering (UNSW) and a PhD in management from the Australian Graduate School of Management. His work history includes three years as an engineer at ICI Australia, appointment as a lecturer at AGSM, five years as an Assistant Professor of Business Administration at the University of Illinois and ten years as the Professor of Manufacturing Management at the Melbourne Business School, University of Melbourne. He was Associate Dean (Development) in the Faculty of Economics and Commerce.

During his academic career he has been a consultant to senior executives in most manufacturing industries and in numerous service sector organisations. These include major companies in the food, building products, paper and printing, chemicals, processing, banking, engineering/ construction and other industries, in Australia and elsewhere. He regularly provides industry and executive seminars and has participated in a number of committees and industry bodies including appointment as a member of the Australian Manufacturing Council and the Commonwealth Government Industry Task Force on Leadership and Management (Karpin committee).

Danny has published ten books and over 100 research articles on various aspects of operations strategy and business management.



# Peter Cebon

Peter Cebon's current research focuses on the relationship between corporate governance and firms' management of innovation-like problems – new product and service development, I.T. implementation, mergers and acquisitions, organisational change, etc. He taught innovation management and organisational behavior at the Melbourne Business School for sixteen years until 2012, and was a Senior Research Fellow at the Faculty of Business and Economics at the University of Melbourne from 2010-2012. Prior to joining MBS, he worked at an institute of the ETH in Zurich, and before that at the Kennedy School of Government at Harvard University. He holds a master's and PhD at MIT and a bachelor's degree from the University of Melbourne.

Peter has consulted to a number of government agencies and corporations in the areas of organisational design and innovation management. He has published over 30 articles, teaching cases, and book chapters, and has edited two books. One of the books was a multi-disciplinary analysis of climate change with the analysis carried out at the regional, rather than the global, level. The other was an analysis of ten Australian high-technology start-ups about 20 years after founding. Prior the governance research, he focused on meaning and categorisation within neo-institutional theory.

He is a founder of Transport Informatics Pty Ltd - a start-up which aims to revolutionise the transportation of people and goods through the acquisition, management, and application of real-time data about people, objects, and vehicles.

Prior to commencing his academic training, Peter worked for three years for the Victorian government and as an engineering consultant.

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