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Robotics and Autonomous Systems: Smart Machines


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Good afternoon Ladies and Gentlemen.

Slide 1 - Title Slide

I want to start by thanking you for the invitation to present today on an international perspective on the military application of robotics and autonomous systems.

DSEI is an excellent forum to share ideas and importantly develop the partnerships we need for future collaboration.

Looking around the room I see many robotics and autonomous systems experts from academia and industry from across the world. I know what you look like! Alas, I am not one of you.

I am Head Land Capability for the Australian Army, meaning, on behalf of the Chief of Army, I have ‘end to end’ responsibility for land capability – including future concepts, requirements setting and sustainment. Land capability in this regard ranges from helicopters, tanks, rifles through to cyber and logistics systems.
I am here today to learn from your collective wisdom and perhaps educate you on what we are thinking and doing ‘down under’ with respect to robotics and autonomous systems.

The Australian Army recognises that robotics and autonomous systems can afford us significant combat advantage in the future.

For some time we have understood that robotics and autonomous systems can replace humans for some dirty, dangerous and repetitive tasks. However, we are now coming to appreciate they have the potential to do a lot more.

**Slide 2 - Scope**

I am going to address this topic in four parts. First, I will provide our philosophical view of robotics and autonomous systems for military application, second outline the current and planned use of these systems in the Australian Army, third outline some of our current research, and I will conclude with thoughts about future challenges.

**Slide 3 – Use of RAS**

This sums up the nature of robotics and autonomous systems:

“The winner of the robotics revolution will not be who develops this technology first or even who has the best technology, but who figures out how best to use it” – Paul Scharre Author of Robotics on the Battlefield Part 1: Range Persistence and Daring, Centre for New American Security, May 2014
We agree with this assertion - this issue is not just about the technology. The true opportunity afforded by robotics and autonomous systems is how we partner or team the technology with our soldiers, develop new warfighting concepts and design new organisational structures.

Soldiers are actually accustomed to operating or controlling machines: robotics and autonomous systems provides the opportunity for soldiers to team with “smart machines” that increase their combat effectiveness.

You may be familiar with the chess matches Kasparov played with IBM’s ‘Deep Blue’ computer in the 80s and 90s. In later ‘experiments’, students were partnered with laptop computers to play chess against super computers more sophisticated than ‘Deep Blue’. The results were interesting. It found that the combination of a strong student, laptop and an inferior process of partnering would beat a supercomputer. Perhaps more remarkably, it found a weaker student, laptop and better partnering process also beat the supercomputer. The results of these experiments and the further advancements in artificial intelligence and robotics and autonomous systems provides foundational evidence for the design of soldier- machine teaming for the land force.

**Slide 4 – War remains a Human Endeavor**

It is our assessment that war will remain a fundamentally human endeavour, especially for Land Forces that must be able to interact with the human population.

Soldiers and smart machines will come together to create new types of teams but the technology will not replicate human judgment, intuition, morality or understanding.
In the words of a colleague of mine: Brigadier Mick Ryan: “More than ever - the wisdom, imagination and creativity of human beings is required on the battlefield, and for those who design, procure and support the deployed force at home”.

Although war will remain a fundamentally human endeavor, we do believe that the character of war will change; future conflicts will be about soldiers teaming with smart machines to defeat other machines.

The challenge will be designing the right soldier-machine balance to maximise the relative advantages of both soldier and machine in a future fighting system.

By getting the correct balance between the soldier and machine, the right blend of the ‘art’ with the ‘science’, we will be able to set the conditions for fully realising the benefit of robotics and autonomous systems.

**Slide 5 – Young are Robot & Tech Savvy**

As an aside, last week I attended the Chief of Army’s senior Leadership Recall. We had a number of eminent thought leaders speak to us about a range of topics. The last presenter was a Futurist.

Disappointingly he had no crystal ball or obvious superpowers, at least that I could tell! He has been the CIO of a number of large companies and now trades in predicting how technology will shape the future.

The central theme of his presentation was the rapid development of technology and different ways in which millennials interact with it.
Interestingly, due in part to the Uber phenomena and the advent of driverless cars, today only 66% of 18-25 year old young Australians get their driving licenses. His prediction is that in 10 years time none will.

By way of further illustration - this video shows a young girl seeing a broken water heater in the street and mistakes it for a robot. For me this is a very simple illustration that teaming with robots will not be a challenge for the future generation of soldiers.

I noted the keynote speakers comment this morning that “Artificial Intelligence is the new electricity”. The Futurist had a related point that: “Data is the new oil. We should Find It, Mix It and Refine It.”

Slide 6 – Australian Army – Past 10 years

Over the last ten years, in Afghanistan and Iraq, the Australian Army has employed ground robots for a variety of security roles including reconnaissance, vehicle inspection and the detection and identification of enemy IEDs.

Electronic Counter Measures were rapidly fielded to provide force protection from remote controlled IEDs. These systems responded autonomously to create jamming effects.

Following the success of the US Predator drones, Australia initially deployed relatively cheap and light, rapidly acquired systems, which we eventually replaced with a high end,
military grade tactical UAS. This system was used for tactical recon and surveillance missions.

Our Air Force operated a leased Heron UAS. Again it provided a great surveillance effect, but the lack of weapons constrained its utility.

The Iraq and Afghanistan experience provided the foundation of an evolution towards integrating smart machines into land operating concepts. Of course, these conflicts also represented an evolution in their use by our adversaries. In recent Mosul operations, ISIS deployed a range of unmanned ground and air vehicles – both armed and unarmed. As a result, we and many coalition partners are now fielding counter UAS systems.

**Slide 7 – Australian Army – Next 10 years**

In the next 10 years, the significant combat advantage smart machines will bring is from the automated sensors, protective and lethal systems they will carry.

As many of you appreciate seconds and centimeters is often the difference between life and death in combat. So smart machines that provide early warning and decision options that enable soldiers to assess and react faster is a capability worth pursuing.

Importantly, the use of soldier-machine teams may also offer a solution to one of the Australian Army’s most enduring challenges – the building of mass. We see ourselves as a capable but small Army responsible to defend, in concert with our Navy and Air Force sister services, the largest island continent in the world.
Smart machines provide a potential combat multiplier, whereby each soldier is able to control a fleet of ground and air systems for an exponential increase in the capability and reach of the force. As such, smart machines have the potential to be a true game changer.

So what investments is the Australian Army making?

Currently, on the training front, Australia is introducing into service autonomous small arms target systems. These systems provide moving and reactive “human” targets that add realism to combat shooting training.

Over the next two years we will add to our existing Brigade level UAS by introducing into service military grade UASs to every combat platoon and combat team in Army. Black Hornet down to platoon, and Wasp to combat team.

We are also providing a Commercial-off-the-Shelf Multi-Rotor UAS to every unit in the Army – Regular, Reserve and Cadets – for training and experimentation. I am particularly excited about this effort as it is only once we put these systems in soldiers’ hands that we will truly discover the breadth of missions we could use them for.

Further, we intend to integrate Autonomous Active Protection systems that can detect and neutralise in-coming munitions on our new armoured vehicles.

In the future, we anticipate further investment particularly in the area of autonomous ground vehicles for reconnaissance, logistics and casevac, and manned and unmanned teaming between helicopters and future UASs.

But, in order to ensure investment is directed in the right areas, we are embarking on a period of experimentation and research with an eye to better understand the optimal application and balance of smart machines for future use.

Slide 8 – Current Research
The Defence Science and Technology Group (DST Group) is conducting various research tasks to help us operate effectively in the congested, contested and complex operating environment of the future. I will explain four distinct examples that highlight some novel approaches to address how we know our environment, share information, protect our soldiers and act with certainty.

Slide 9: Know/Protect (Athena) – Chappie and UGV

Project “Athena” seeks to enhance the protection of the soldier through not being there. Or, in other words, ‘projecting the presence’ of the soldier by sending a ‘robot’ into an area instead of the soldier.

This serves to provide updated situational understanding to the soldier but it also means the soldier is not unnecessarily placed in an area of high threat.

A focus of this work is in the area of human-machine teaming, with the intent to better enable bi-directional communication between the robot and the human, or robot and robot. Our Counter IED Robots are an early example of this.

A future example is explored in the 2015 movie “Chappie”, where armed Assault-Bots are used by Police as the high risk “door kickers” and ballistic shield in front of a human team moving into an urban assault mission. It would appear that this type of Sci-Fi technology is not that far from becoming reality.
Slide 10: Share (OPAL and SCADS)

DST Group has two research projects to develop tools to improve the survivability of tactical communication networks when challenged by extensive distances, high tempo operations, adversarial actions (such as enemy jamming) and network failures.

The projects: OPAL and SCADS, seek to enhance network survivability through the use of distributed UAS.

OPAL employs a cooperative swarm of UASs to dynamically maximise network connectivity. The UASs putting themselves where they are needed to close communication links.

Where this cannot be achieved (e.g. when RF communications are contested) SCADS employs distributed UASs to ferry data between users. Basically robotic “runners” to distribute critical information when all other communications are being jammed.

Slide 11: Act (TORVICE)

A key challenge for the military operation of autonomous vehicles in the future will be operating in a contested electro-magnetic environment where an adversary is seeking to detect, geo-locate and attack our platforms. We need to be able to understand this threat and harden mission systems against it.

To this end, DST Group is working closely with US Army TARDEC on a collaborative program called TORVICE - Trusted Operation of Remote Vehicles in Contested
Environments. In this collaboration, TARDEC is providing vehicles which are fitted with autonomy systems and are serving as a basis for their upcoming Autonomous Ground Vehicle Reference Architecture.

The vehicles are driven from the US. DST Group provides the test range – Woomera in Australia - as well as various sensors and effectors. The key focus in this work is not so much the development of Autonomous Vehicle technologies but more on understanding how the vulnerabilities might be exploited and, in turn, what we can do to counter these threats.

Slide 12 – CRC – Trusted Autonomous Systems

In addition to these individual research projects, the 2016 Defence White Paper directed the establishment of the Defence Cooperative Research Centre (CRC) in Trusted Autonomous Systems.

This Trusted Autonomous Systems CRC links industry with academic researchers through funded initiatives to develop war-fighting technologies for the Australian Defence Force over the next ten years.

Slide 13 – Challenges
In addition to the much discussed legal and ethical issues, which I will leave to others to comment on, the application of robotics and autonomous systems has several other challenges.

As Head of Land Capability, one particular challenge I face is integrating emerging technology into Army in a timely fashion. The integration of robotics and autonomous systems is unlikely to follow a linear path. The reality is that our capability life cycle is optimised for big platform and infrastructure projects, many of which extend over multiple years, some even decades. This is a challenge that I’m sure all of you from government, military, industry or academia would appreciate.

The good news is that robotic and autonomous system need not be expensive, multi-role systems but rather can be purpose built for specific missions at lower cost. As someone who has to balance the capability budget for the Army, that is an attractive concept.

Another challenge we collectively face is aligning our respective military concepts of employment. The types of technology and the method of employment will differ from one nation to the next, potentially adding further complexity for coalition operations, like spectrum management.

It will likely remain unacceptable for most nations to remove the human from the loop in lethal autonomous systems at least in the medium term. However if this policy changed in the future, it would provide significant challenges for interoperability, in particular for Identification of Friend or Foe and our Rules of Engagement policies.
Understanding the processes, procedures and overarching policies guiding coalition nations will require regular training, experimentation and collaboration.

Perhaps the most significant challenges we need to address in order to fully leverage the potential of smart-machines is identifying innovative and creative ways of employing and structuring around the technology.

There is no shortage of good ideas from within our Army, particularly from the smart, young, tech savvy private soldiers and junior officers who are able to look at problems differently, unencumbered by the understanding of the way things have always been done. Our bigger challenge is to be able to operationalise and scale those ideas.

**Slide 14 – Innovation Days**

To address this the Australian Army has several initiatives to encourage and implement bottom-up innovation and partnering with industry.

Indeed, if I wasn’t here today I would be supporting the 3 Brigade innovation day which is run along the lines of ‘The Lions Den” or “The Shark Tank”. Soldiers get the opportunity to pitch their ideas to a panel of judges in order to be awarded seed funding to further develop their development.

We also conduct an annual Army innovation day where we invite Industry to showcase their technologies and research. The theme of the Army innovation day in 2016 Robotics and Autonomous Systems. Several capability initiatives identified through this process have been funded for further review and experimentation.
Slide 15 – Drone Racing

Another example of innovation is the recent launch of the Army Drone Racing Team. This is an informal initiative where young soldiers solder and 'code together' the latest off-the-shelf UAS technologies. They then race their drones in competitions with obvious application on the battlefield.

I know that the British Army has done something similar and we may bring our teams together with other ABCA teams next year to compete.

One of the other exciting aspects of this is the internet collaboration of racer development and ideas.

Interestingly, in my twitter feed this morning there was a story about Drone Racing being trialed as a Higher School Certificate (Year 12) subject in one state in Australia. Drones are everywhere!

I think the Australian Army is doing a lot of good bottom up innovation for robotics and autonomous systems – and this is important. The challenge with bottom up innovation is to scale and institutionalise the learnings. The next step is to now pair that bottom up innovation with some top down organisational innovation looking at concepts and organisational structures. We are looking very closely at the US RAS Concept and new UK doctrine to inform this.

Slide 16 - Conclusion

In conclusion, I would like to reiterate an earlier point: that seconds and centimetres is often the difference between success and failure, and life and death in combat. So smart
machines that provide early warning and decision options, that enable soldiers to assess and react faster or can be physically removed from the highest risk areas are capabilities worth pursuing.

I would like to finish with a quote taken from a blog on the Australian Defence Entrepreneurs Forum. The blog by Major Jamie Martin a young officer who works for me was in part a book review of the book Ghost Fleet by Peter Singer and August Cole. Major Martin wrote:

**Ghost Fleet demonstrated to me that success is the interplay between innovation and leadership. It is understanding what aspects of technology are going to be effectively wielded against the enemy by commanders to create advantage, and what parts of the force are better served without it. It is the ability to learn and to adapt faster than the enemy, harnessed by effective leadership to create a military advantage. It is out-thinking the enemy that achieves victory.**

This simply and succinctly captures the three key enablers to the effective application of robotics and autonomous systems: innovation, leadership and intellect. If I could add a fourth it would be partnerships. That is, our ability to truly make smart machines a game changer will be underpinned by expanded partnerships between allies, industry and academia.

Once again, thank you for the opportunity to provide an Australian perspective on robotics and autonomous systems. I look forward to hearing more from the experts in the room and continuing our collaboration.