



Australian Government

Department of Defence
Science and Technology

Australian Defence Force capability driven by science and technology partnerships with industry.



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Foreword



For DST, working with our partners in industry and universities is critical to our ability to realise the government's goals set out in the Defence White Paper and in the national innovation and science agenda.

Australia's defence and national security challenges demand the brightest minds and the biggest innovations. No single nation, let alone single institution, has all the answers. It is now widely accepted that collaboration is no longer an optional extra; it is a must.

Partnering brings new thinking and ideas through the meeting of different minds, perspectives and specialties. Done properly, it leads to innovation and productivity.

By harnessing the brilliance and ingenuity of scientists, engineers and innovators across the country, we can provide our Defence force with a capability edge that ensures warfighting success.

It's gratifying to know that by working with and transferring our technologies to Australian businesses, we are not only creating a more capable Defence force, but helping to create a sustainable Defence industry in Australia.

I have enormous pride in the contributions our partnerships with industry and academia have made, not just to Defence capability but to the country more broadly. This booklet serves to showcase those contributions – the clever innovations, expert analyses and smart inventions – which have such important benefits for Defence and national security.

A large, stylized handwritten signature in black ink, which appears to read 'A. Zelinsky'.

Dr Alex Zelinsky
Chief Defence Scientist

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Partnering for Defence and security

DST recognises that innovation and ingenuity do not reside in a single agency, but exist throughout Australia – in start-ups, small businesses, multi-national enterprises, university faculties and other publicly-funded laboratories.

Only by drawing on the depth and breadth of expertise and innovation across the country can we be assured of delivering the best technology outcomes to Defence.

The cross-fertilisation of ideas, knowledge and experience that comes from long-standing collaboration not only provides vital Defence capability, it cultivates a sustainable, competitive and enduring Australian defence industry which benefits the country more broadly.

DST technologies transferred to Australian industry

When DST develops new technologies, it is always with a view to transitioning those technologies into capability. Australian industry is integral to that process.



GIVING WINGS TO MUNITIONS

A wing kit developed by DST scientists to convert Boeing's standard Joint Direct Attack Munition (JDAM) into a long-range glide bomb has proven to be an unrivalled success story, not just for the RAAF which now has a long-range precision weapon, but for the 30 or more Australian and international companies involved in the product's supply chain.

The innovative wing kit extends the range of the smart bomb to more than three times the standard distance, providing delivery aircraft far greater protection against air defence systems, while maintaining accuracy to within 3 to 7 metres. The benefits for Defence are clear.

"With the range that the JDAM-ER wing kit brings, the pilots are going to be able to get JDAM levels of performance and JDAM accuracy from three times further away," RAAF Armaments Engineer, Squadron Leader Brent Thoroughgood explains.

"That allows them to have significantly more stand off from the target when they're releasing the weapons."

Brisbane firm Ferra Engineering was awarded the exclusive contract to develop and fabricate the kits and delivered the first set of wing kits to the Australian Air Force in 2015.

Twenty-seven countries around the world use the standard JDAM, demonstrating the product's export potential. Ferra Engineering expects to sell over 10,000 of the kits internationally.



PROTECTION AGAINST HARDWARE TROJANS

With the ever-increasing prevalence of cyber attacks, cyber security is a priority for governments and businesses around the world.

DST cyber security experts are continuously working on new technologies and techniques to protect against cyber attack. Recent efforts have produced the Digital Video Guard, developed to provide protection from malicious hardware and software. The device is inserted between a host computer and its display and allows the contents of a known video signal to be trusted.

The Digital Video Guard can be used wherever secure content delivery is important, for example remote network access, internet banking and the management of sensitive information such as taxation data, welfare data and medical data.

The technology won an iAward in 2014 and was licensed to the global security company, Northrop Grumman to develop a prototype.



BLACK CANARY DETECTS TOXIC VAPOURS

In a conflict zone, military personnel can be exposed to highly toxic chemicals, many of which are invisible and have no smell, making them undetectable to humans until it is too late.

DST has developed a technology to immediately warn users of the presence of toxic vapours, allowing them to either move away or don protective equipment.

Known as the Black Canary, the device constantly samples the air and alerts the user to the presence of toxins using automated tactile and optical alarms.

In addition to its military application, the device is perfectly suited to first responders, mine or refinery workers or those who work with industrial chemicals.

DST has partnered with Ideation Design to further develop the technology into a commercial product.



PIPE REPAIRS UNDER PRESSURE

Technology solutions don't need to be high-tech to be commercially successful. The Rapid Response Clamp, developed by DST to assist in the repair of high pressure pipes on board naval vessels, is a prime example.

Licensed to South Australian company Valley Precise Global in 2010, the unassuming device can stem flow from a damaged pipe up to six times faster than previous systems. Rigorous testing by Australian, US, Canadian and Malaysian navies showed that in many cases repairs took less than 60 seconds.

Beyond speed, the clamp's other distinct advantage is that it can be used by one person and requires no additional tools or consumables, with one size clamp accommodating a wide diameter range.

The performance of the clamps has been independently verified, earning them "Type Approval" from the American Bureau of Shipping.

While originally developed for naval use, the technology has a range of applications in the energy, mining, merchant marine, chemical and food industries. Exports of the clamp have been impressive, with sales to both the US and Canadian navies.





SPINNING-OFF SILENT RADAR TECHNOLOGIES

DST technology gives rise to a new company, the Australian start-up, Silentium Defence.

The company, which emerged through CSIRO's ON innovation accelerator program, was established to commercialise DST passive radar technology and further develop it for defence and civilian customers.

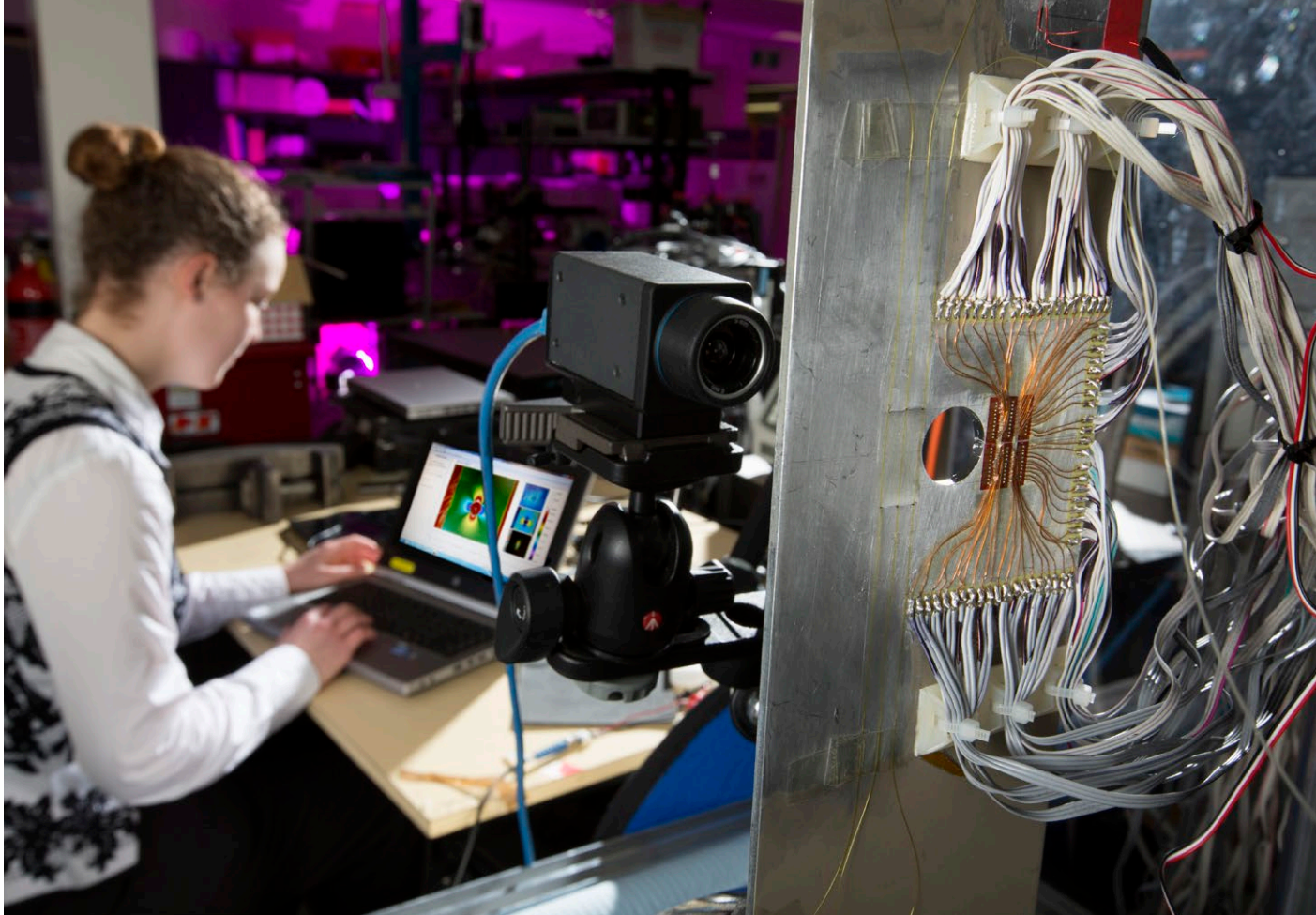
Passive radar is an emerging capability for Defence and, through the work accomplished by the Silentium Defence founders James Palmer and Simon Palumbo, DST is continuing to perform world-leading research in this area through close collaboration.

"DST is heavily focused on innovation and providing better outcomes for its partners in Defence," Chief Executive Officer of Silentium Defence, James Palmer explains.

"The establishment of a start-up to build industry capability was seen as another avenue for DST to achieve these objectives."

While initially developed as a military capability, DST's passive radar technology has broader potential applications such as the management of commercial transportation traffic at airfields and seaports.

Silentium Defence aims to have its products on the global market within the next two years, with international market potential.



TECHNOLOGY TO VISUALISE STRUCTURAL STRESS

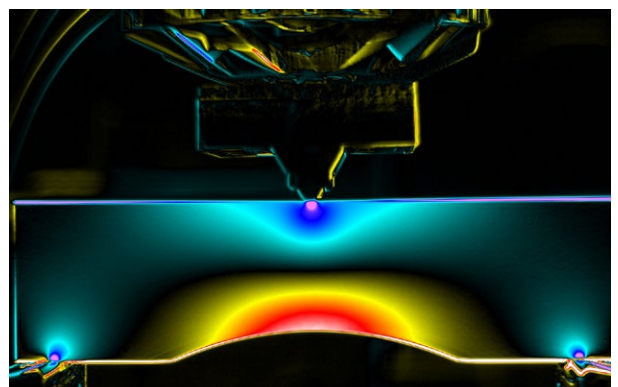
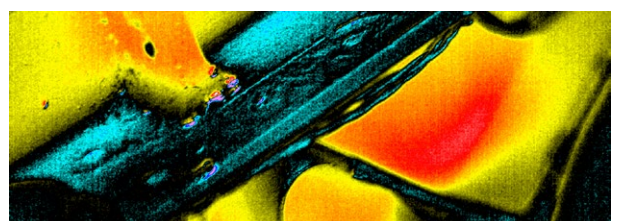
The ability to evaluate the structural health of airframes non-destructively is the holy grail for many aircraft maintainers, and Defence is no exception.

A number of technologies and techniques have been developed to measure structural strength. However, none offers the simple and precise functionality of the DST microbolometer thermoelastic technology. This technology makes it possible to image the stress in aircraft structures with little more than an off-the-shelf infra-red camera.

When Marcus McDonald and his colleagues demonstrated the technology to their US counterparts, one is said to have commented, “So we can build infra-red cameras, but it takes an Australian to show us how to use them!”

In addition to assessing the structural health of airframes, the technology can be used for detecting defects and monitoring fatigue cracks in civil and maritime vehicles and infrastructure.

The technology was licensed to Victorian company LRM Technologies in 2017.





PRECISION DRILLING RIG

Aircraft repairs often require the ability to drill holes with absolute precision. Failure to do so can be expensive and even dangerous.

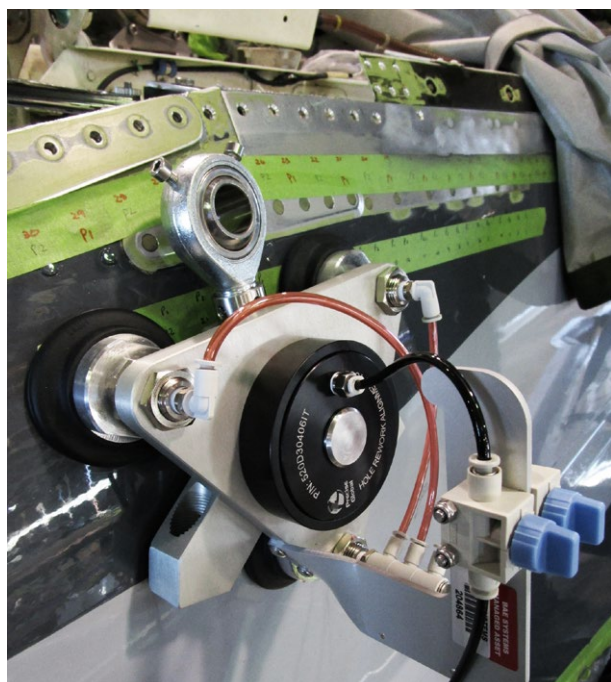
To ensure consistency and accuracy, DST scientists developed the Hole Rework Alignment Tool.

This cleverly designed tool locks into place and is used to guide hand-held drills or reamers, allowing holes to be reliably drilled or reworked in small increments and to precise tolerances.

The tool was used by Defence to complete modifications on the Hawk Lead-in Fighter. So successful was its use that the aircraft manufacturer, BAE Systems, subsequently recommended the tool to other international operators.

In addition to the aircraft industry, the tool has potential applications in the space, power and nuclear sectors.

South Australian company Precise Global secured the licence to commercialise and sell the tool to global markets in 2017.





HMAS *Huon*, a Huon class minehunter

KEEPING SHIPS SAFE FROM SEA MINES

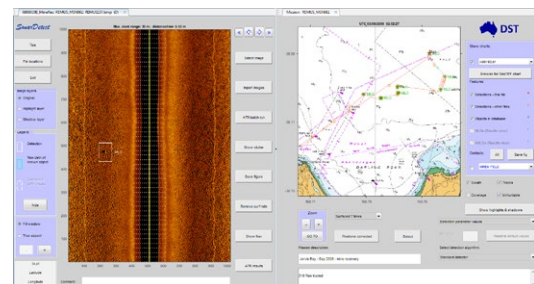
Combine the drive, ingenuity and passion of small business with any innovative, high-impact technology and you have the makings of a highly successful commercial venture.

This is the case with Sydney-based software engineering company, Solutions from Silicon.

The company specialises in naval command support systems and has a strong track record in developing mine countermeasures for Navy. In 2017, Solutions from Silicon bolstered its mine countermeasures product range, licensing DST SonarDetect technology, software that provides significantly enhanced automatic target recognition capabilities, ensuring better protection for ships operating in contested waters.

The SonarDetect software is designed to locate mines lying on the seabed. Extensive international testing has shown that it performs competitively with other automatic target recognition software.

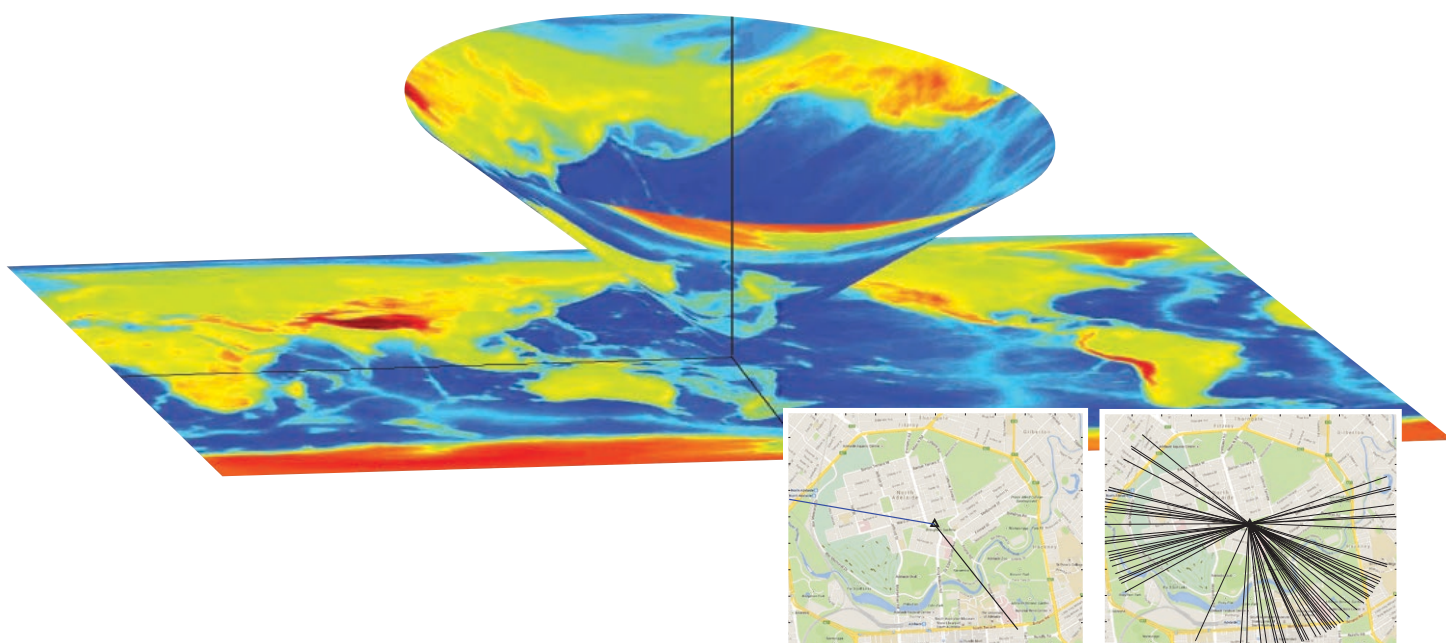
The software is being incorporated into updated versions of the Navy's Mine Warfare Tactical Command Software, MINTACS, developed by Solutions from Silicon. MINTACS software arose from DST research from the 1990s for predicting the performance of mine hunting and clearance operations.



The background image shows two men in a laboratory or office environment. One man is standing and looking through a microscope, while the other is seated at a desk, looking at a laptop. The image is overlaid with a dark blue tint.

Technologies developed collaboratively with Australian industry, universities and international partners

DST collaborates strategically with select industry, academic and overseas partners to develop the best technology outcomes for Defence. These partnerships strengthen the capability of Defence industry in Australia through the sharing of important expertise, experience and know-how. The following case studies provide examples of technologies developed collaboratively with industry, universities and international partners.



APPLYING THE THEORY OF RELATIVITY TO ELECTRONIC SURVEILLANCE

Direction finding systems are used by the military to detect, identify and locate electromagnetic signals such as light or radio waves to help identify any immediate threats, such as a GPS jammer or an improvised explosive device.

Traditionally, many direction finding systems have used interferometric techniques to determine the direction from which a received signal was transmitted. However, in situations where two or more overlapping signals with similar characteristics are intercepted, this particular direction finding algorithm is unable to accurately determine the direction of the sources.

Enter the DST 'light-cone' direction finding technology. By transforming phase differences to time differences and using relativity theory, DST's approach significantly improves the ability of direction finding systems to estimate the direction of arrival from multiple overlapping emitters.

Australian company Jenkins Engineering Defence Systems (JEDS) is integrating the DST solution into its electronic support measures systems (ESM) with a view to providing an electronic surveillance direction finding capability superior to any currently employed.

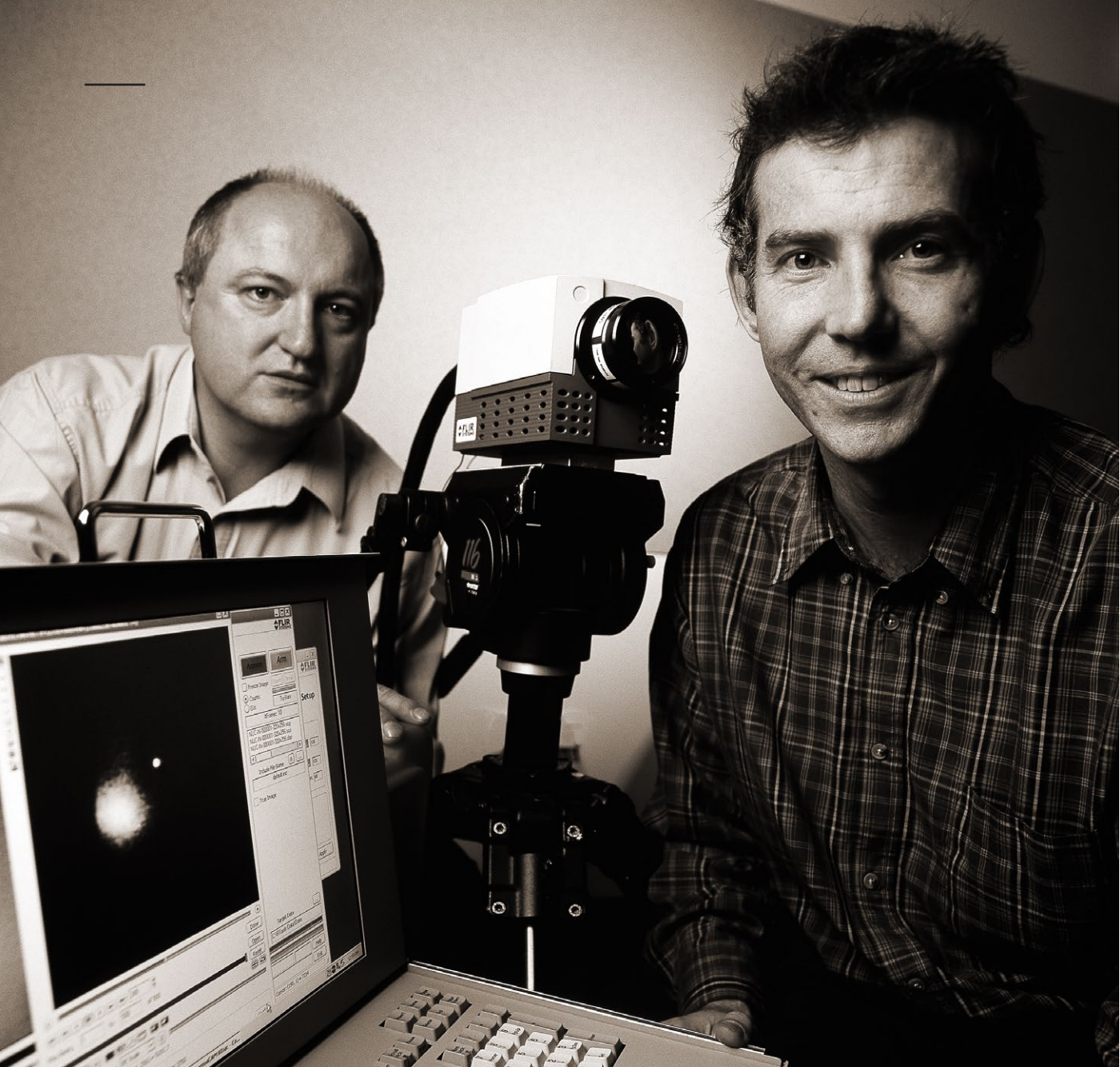
JEDS Managing Director Peter Jenkins stresses the benefits of close collaboration with DST.

"JEDS as an SME views this collaboration as an opportunity to develop an innovative product based on the ground-breaking research of DST."

He says it's critical for industry to engage.

"As an SME, it is difficult to replicate or do the things that DST does.

"The mentoring provided through close engagement with DST is valuable to SMEs. Having this engagement with DST at a formative stage is very useful."



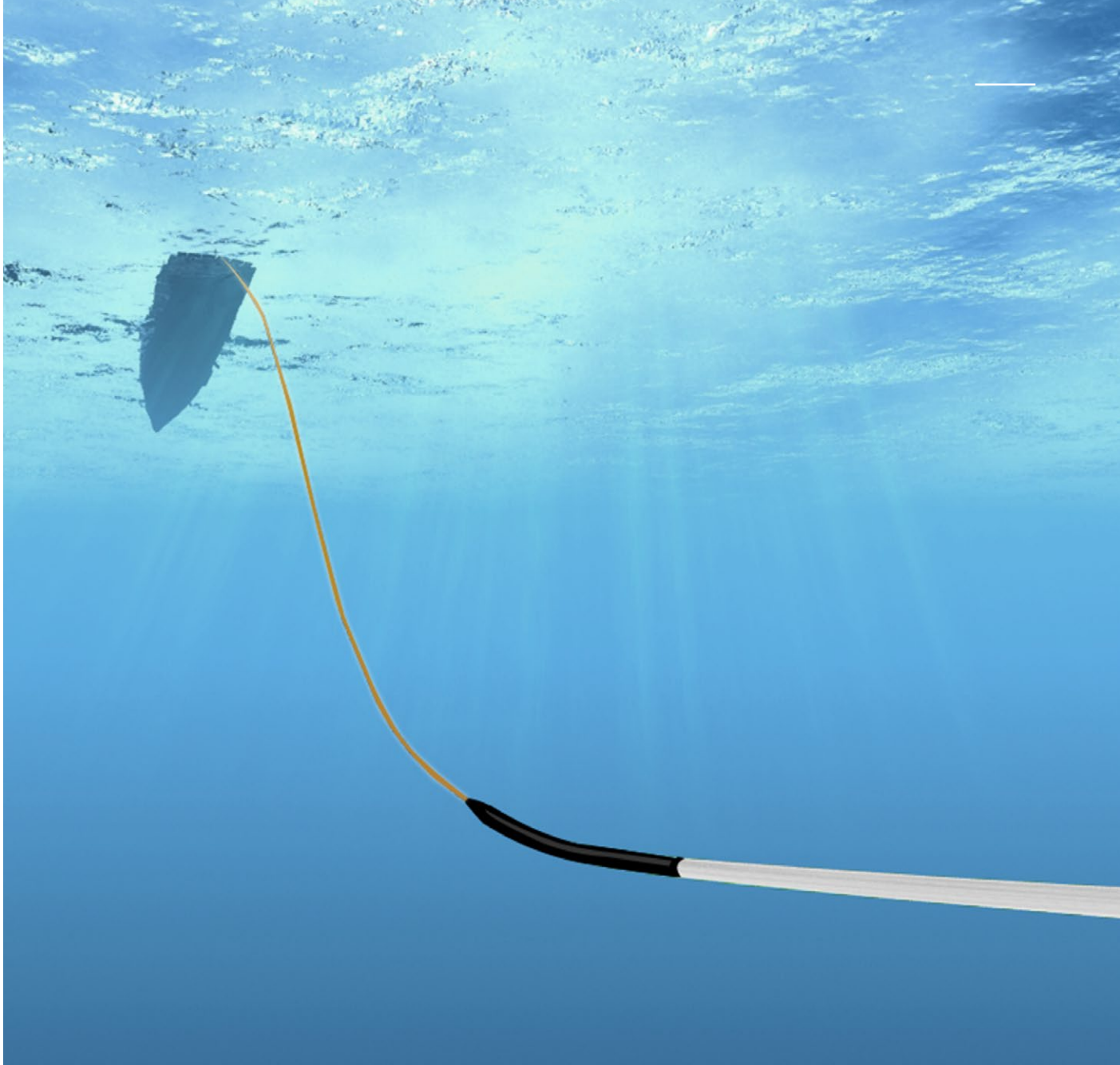
DEFEATING INFRA-RED MISSILES

Over many years, scientists from DST and BAE Systems Australia have worked collaboratively to develop an advanced laser technology to protect aircraft from heat-seeking missiles.

The technology is a key component of DST research into Directed Infra-Red Counter Measures (or DIRCM) systems which use sensors on an aircraft to detect ultraviolet emissions given off by the exhaust plume of an incoming missile. A laser is automatically aimed at the missile and emits modulated pulses of infra-red light. These pulses overwhelm the missile's guidance system through the large and rapid changes in infra-red signal information that the missile receives, causing it to lose its lock-on target.

DST has successfully developed and transitioned this laser technology to industry and continues its research into new generation fibre laser technology which will provide significant improvements in performance.

The technology has been licensed to BAE Systems for global export.



SEA-BED SURVEILLANCE

Maritime surveillance is a critical capability for Defence. With more than 90% of the world's traded goods transported by sea, maritime security has never been more important.

To address this growing requirement, DST, together with Thales Australia, has developed a rapidly deployable sea-bed surveillance capability that is able to detect sound with extreme sensitivity using micro-sized lasers embedded in the core of optic fibres.

The fibre laser sensor array combines Thales' technical know-how with DST's defence experience to produce a robust, lightweight, ultra-thin system with minimal

power requirements compared to previous electronics-based systems. It can be rapidly deployed from a rigid hull inflatable boat and brought into operation almost immediately.

In trials, the sensor array successfully detected the sound emissions of vessels of different sizes and sonar signature types, and could identify the presence of divers.



TARGET PRACTICE

Defence forces around the world have an ongoing requirement for a cost effective means of evaluating the performance of their air defence systems.

With the support of DST, Melbourne-based company, Grollo Aerospace is developing a supersonic aerial target that will provide a re-useable and affordable solution.

In 2017, DST signed a collaboration agreement with Grollo Aerospace to support the development of 'Evader', a fully autonomous aerial vehicle designed to replicate the flight characteristics of some of the world's most advanced airborne threats.

DST is providing access to its facilities and specialist subject matter expertise to assist in maximising the utility of the Evader system for Defence applications.





The Spherion hull mounted sonar

STEP CHANGE IN SONAR

For over 20 years, DST and Thales Australia have collaborated on the research and development of sonar-related technologies, and the Royal Australian Navy has benefited from much of that work.

The Spherion sonar system and associated display software, Panorama, began with DST research into the viability of integrating commercial off-the-shelf computing hardware with custom software to provide an advanced sonar capability. Thales Australia worked collaboratively with DST to develop the technology and was subsequently awarded the licence for the software which has since been integrated into the Spherion system on the Navy's frigates.

The Panorama upgrade was followed by further enhancements to the system's surveillance and data processing capabilities, in the form of BSAPS, or the Broadband Sonar Advanced Processing System.

According to Thales Australia's Submarine Product Manager, BSAPS gives sonar operators 'unprecedented levels of underwater warfare situational awareness.'

Feedback on BSAPS from the Australian Navy and allied forces has been overwhelmingly positive. The technology has already been adopted by the Royal New Zealand Navy.



A Combat Support Unit dismantles tented working accommodation at the Air Task Groups main operating base in the Middle East Region

BEATING THE HEAT

Defence technology and smart design have come together to produce an award-winning heat-stress monitor for Defence personnel working in extreme heat and humidity.

Developed by DST and designed by Melbourne-based design consultancy, Ideation Product Solutions, the handheld sensor allows Australian Defence Force personnel to monitor temperature, humidity and solar radiation, and reduce their exposure to heat stress.

Awarded a Defence Safety Award in 2008 and a finalist in the Australian Good Design Awards in 2015, the heat monitor is characterised by its ergonomic package, good user grip, ruggedized housing and easy-to-read liquid crystal display with LED backlighting for daylight conditions.

The monitor is currently used by Australian Defence Force personnel and has significant potential in other markets such as emergency services.





Inspecting the sea chest test article in the sea off Melbourne

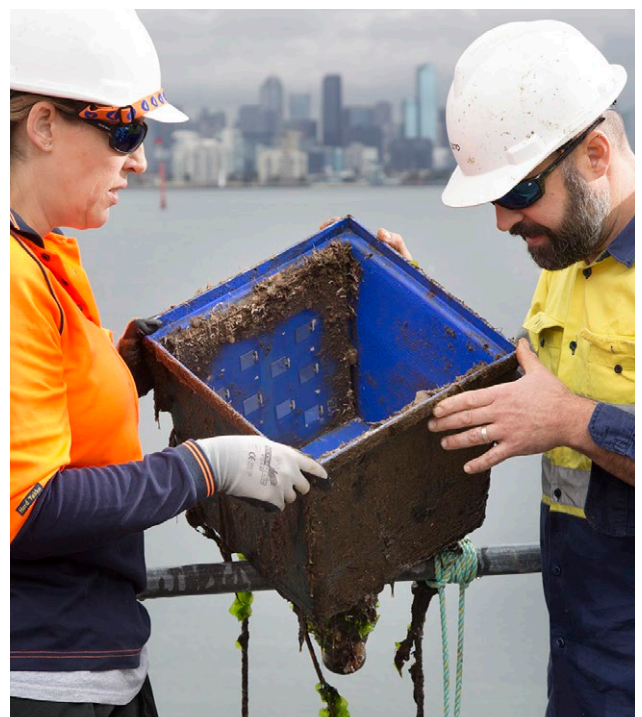
USING LIGHT TO COMBAT BIOFOULING

DST is collaborating with Dutch company Royal Philips to combat biofouling using ultraviolet (UV) light.

Biofouling is the accumulation of biomass on submerged surfaces. On the hull of ships, it increases drag and can increase fuel consumption by up to 50%. Finding an effective way to combat biofouling would have ongoing benefits for the operation of all maritime vessels.

The concept of using UV light to control water-borne organisms is not a new one. The difference in this latest approach is the use of light-emitting coatings, as opposed to traditional methods of UV antifouling that direct an external light onto a surface.

The trials of the technology have exceeded expectations. Philips has partnered with AkzoNobel which creates paints and performance coatings, to commercialise the technology.





FOOD BARS FOR LONG LASTING ENERGY

A tasty treat could be the secret to long lasting energy on the battlefield.

DST food and nutritional scientists are collaborating with CSIRO and the University of Tasmania's Centre for Food Innovation to produce a chocolate-flavoured high energy bar designed to improve the endurance of soldiers on the battlefield. The key ingredient of the bars is green banana flour, which is a good source of resistant starch and therefore a perfect candidate for providing slow-release energy.

The bar is an example of the innovative research being undertaken into so-called "functional foods", designed to deliver not just nutrition, but enhanced performance. And it's not only our troops who stand to benefit – there is a potential market for functional foods wherever high-performance physical activity is required.



EXOSKELETON EASES THE BURDEN

Soldiers can carry up to an additional 73% of their body weight into combat. Not only does this hamper performance, it can also cause fatigue, pain and injury.

Many countries are investigating the use of electro-mechanical exoskeletons to reduce the burden on personnel. However, most of these solutions are complex, require power and can increase the energy cost to the user.

DST has developed a passive, unpowered non-rigid exoskeleton known as an OX (Operational eXoskeleton) which reduces the soldier's burden by transferring the load to the ground.

Test results have been encouraging, indicating that OX could be a simple and pragmatic solution to the problem of heavy backpacks. A working prototype has been developed with industrial design company Cobalt Design.

The potential market includes infantry, firefighting services and the civilian trekking industry. The technology has promising commercial dual-use prospects.



DST technologies with global reach

DST technologies are often of interest to Australia's allies around the world.

The following case studies provide further examples of DST technologies which have found an international market.



FORCE PROTECTION AGAINST IEDS

Improvised Explosive Devices, or IEDs, pose a lethal threat in combat zones like Afghanistan and Iraq. They are cheap, easily-made and deadly. One of the most common types of IEDs is triggered remotely, typically using radio signals.

To help protect against these deadly devices, DST, together with industry partners L3 Micreo, Ultra Electronics, Associated Electronics Services, AXIOM Precision Manufacturing and Lintek, developed the Redwing suite of counter-IED devices which have been supplied to Afghanistan.

These products block the signals used to detonate the IED, effectively creating a protective force field around an individual or vehicle. Since their introduction into Afghanistan, there have been no reported casualties from this class of IEDs where Redwing systems have been employed.

“This technology saves lives and helps us build on our strong relationship with the Australian Department of Defence. We continue to focus on delivering technology enhancements to our market-leading force protection systems,” L3 Micreo Chairman and CEO, Michael T. Strianese says.

“The Redwing project is an example of Australian industry and defence collaboration, entrepreneurship and innovation to deliver a unique solution that is able to help address a persistent threat in Afghanistan, protecting the country’s soldiers and police from IED attacks.”

The Redwing systems have been commercialised with an estimated benefit to Australian industry of \$89 million. More than 190,000 units of the Redwing equipment have been supplied to the Afghanistan National Security Forces. Second generation Redwing systems have been collaboratively developed with Australian industry partners L3-Micreo, Axiom Precision Engineering and Lintek, and are now in production.



A MODERN-TAKE ON PERISCOPES



Sometimes modern innovations have their roots in age-old technologies. The Off-Axis Viewing Device (OAVD) is a case in point.

Developed by DST, the OAVD is a high-tech periscope for rifles, enabling the soldier to scan for and engage targets from a position of cover. This un-powered sighting attachment integrates with a red dot reflex sight. The image from the weapon's scope is transmitted through the OAVD's periscopic mirror system to the soldier. Mounted directly behind the sight, the OAVD can also be swivelled to a redundant position on the side of the weapon, or removed and stored in the soldier's webbing, when not required.

Some 130 units were manufactured by BAE Systems Australia for use by troops in Iraq and Afghanistan. The technology has been licensed to Swedish optics company Aimpoint AB and further refined as part of its 'systems of systems' range for global markets.



HMAS Parramatta with original Storm Grey paint above, and new Haze Grey below

NEW PAINT KEEPS NAVY COOL AND STEALTHY

The Royal Australian Navy is benefiting from a new paint developed by DST in collaboration with industry. It not only provides improved camouflage in the Australian environment, but also has better thermal properties.

The paint is the result of a decision to change Australia's naval fleet colour from Storm Grey to Haze Grey, a colour more suited to the waters surrounding Northern Australia.

The new paint, formulated using a colour-stable, low solar-absorbing pigment package developed by DST, has been shown to reduce the exterior shipboard temperatures of patrol boats by 15-20 degrees Celsius when compared with conventional coatings. This has the dual benefit of minimising the power required to run cooling systems while also reducing the ship's thermal signature.

Environmentally, the paint is also an improvement. It is free of hazardous isocyanate compounds, which makes

it safer to apply and, producing approximately 50 per cent less solvent emissions, more environmentally friendly.

DST has licensed its colour-stable technology to paint manufacturer International Paint (Akzo Nobel Pty Ltd).

The Australian fleet is expected to be fully repainted by the end of 2019. The new coating has also been sold to New Zealand for use on its own Navy ships. More recently, a decision was made to paint the replacement Pacific Patrol Boats in the new RAN Haze Grey.



Two of DST's 20kW High Frequency Power Amplification Systems deployed for HF radar experiments on the Woomera Test Range

HIGH FIDELITY CAPABILITY FOR RADAR

The Naval Research Laboratory (NRL) in the United States knows a good thing when it sees it. After witnessing the performance of DST's High Frequency Power Amplification System during a major defence trial, NRL wanted to buy it!

The system, developed by DST to support its high frequency radar research program, attracted attention for good reason. It is flexible, robust, easily deployed and scalable and is designed from the ground up to deliver the very high levels of signal fidelity that are crucial for high frequency radar applications.

BAE Systems was granted a supply licence to further develop the system and on-sell it to NRL.



Inside one of DST's 20kW High Frequency Power Amplification Systems

Contact DST

For more information about technology transfer or collaboration opportunities, please contact our Technology Partnerships Office.

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