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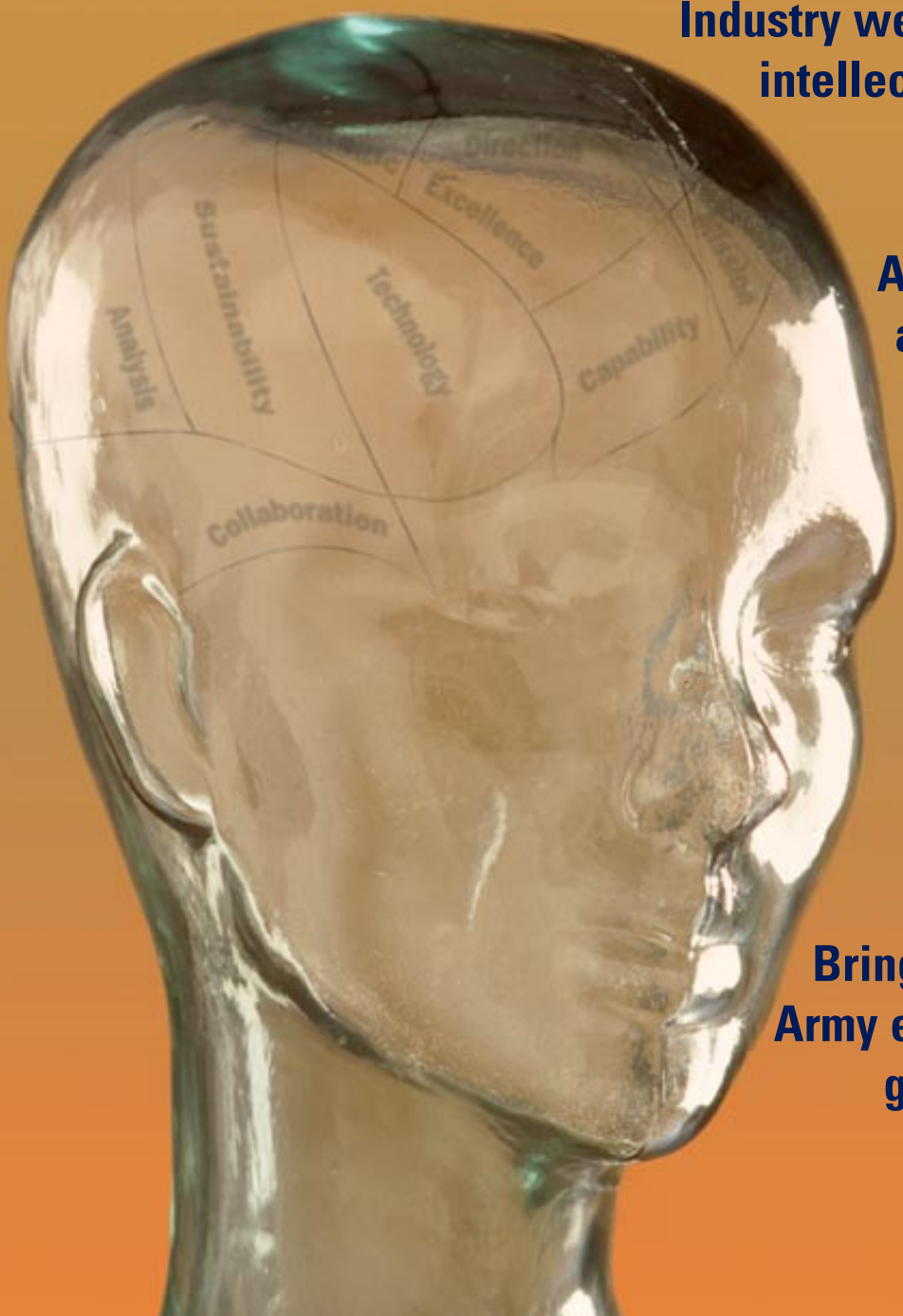

Industry wealth in DSTO intellectual property

A sound idea - art & defence science

Experimental access to explosive results

Bringing rigour to Army experiment in getting it right

Australian **DEFENCE**SCIENCE

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The Defence Science and Technology Organisation (DSTO) is part of the Department of Defence and provides scientific advice and support to the Australian Defence Organisation. DSTO is headed by the Australian Chief Defence Scientist, Dr Ian Chessell, and employs about 2100 staff, including some 1300 researchers and engineers. It is one of the two largest research and development organisations in Australia.

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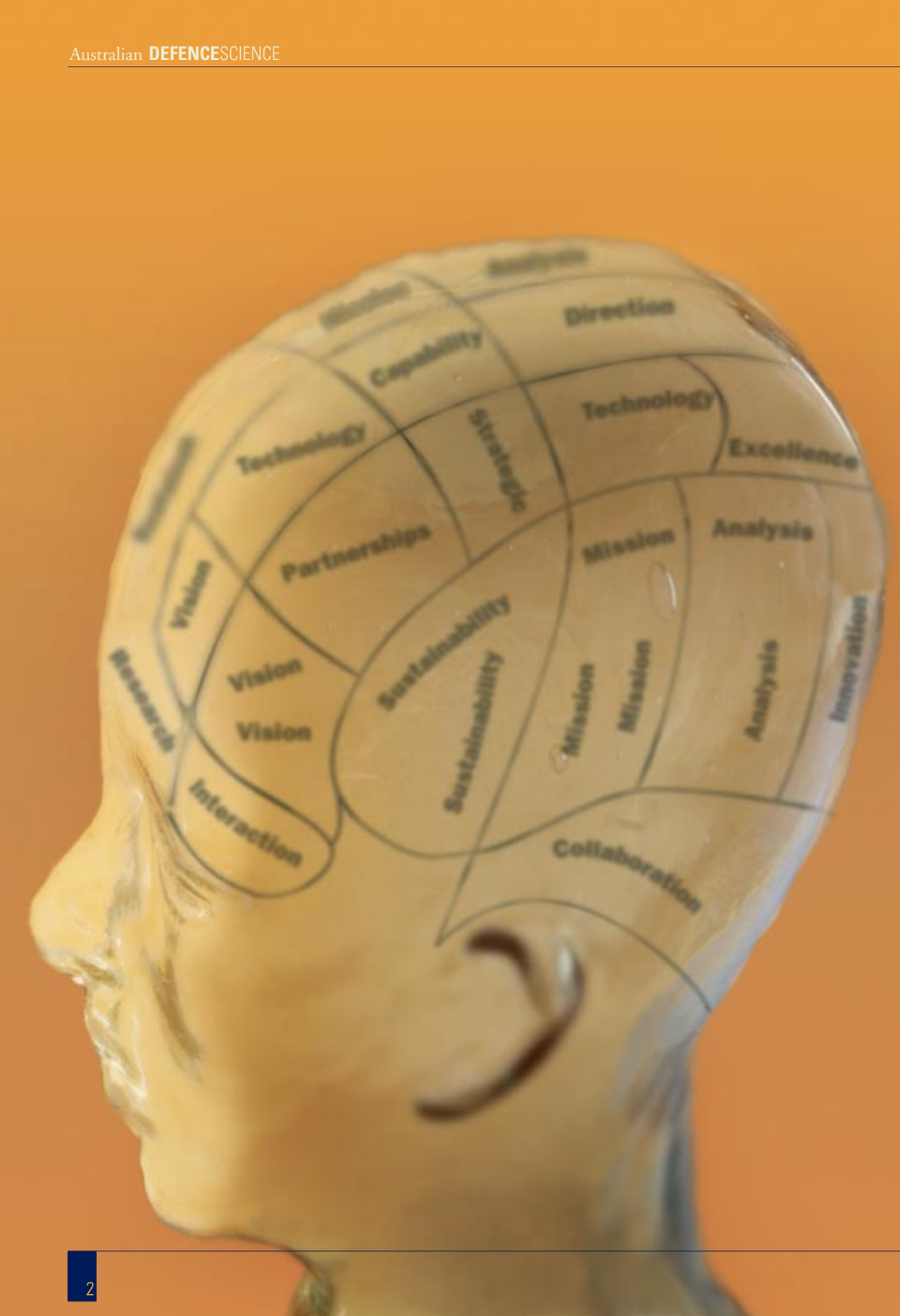


DSTO intellectual property **a valuable asset to Australian industry**

One of Australia's largest science organisations, DSTO creates intellectual property that can assist industry development in new and existing fields to add to the national wealth.

The Defence Science & Technology Organisation (DSTO) is one of Australia's two largest Commonwealth research agencies. DSTO conducts a program of applied research and development, creating intellectual property for Defence that may frequently have wider commercial application if suitably transferred to Australian firms.

Strong linkages with industry are important in transferring knowledge and fostering innovation, particularly in small-to-medium enterprises. Mechanisms for the exchange and exploitation of DSTO intellectual property include licensing agreements; providing access to DSTO's specialist facilities and research expertise; active engagement in research collaboration (through Cooperative Research Centres, the Defence Capability and Technology Demonstrator program, and industry alliances); and material assistance in product marketing overseas.

As part of its commitment to promoting innovation in Australia, DSTO recently participated in a working group to advise the Prime Minister's Science, Engineering and Innovation Council (PMSEIC) on the commercialisation of publicly funded research.

Chaired by Australian Academy of Technological Sciences and Engineering President, Tim Besley AO, the working group was asked to examine Australia's current performance in commercialising public sector research, barriers to commercialisation, and ways to overcome these barriers. It was also asked to present case studies demonstrating best practice in commercialisation.

The group included representatives from lead science agencies, science and industry groups and universities. DSTO was represented by Chief Defence Scientist, Ian Chessell and Assistant Secretary Science Industry and External Relations, Maurice Hermann.

The group's report makes recommendations on four key issues: information exchange, improving skills and confidence to commercialise, cultural and financial incentives for success, and international development for Australia's benefit. It concludes that real effort is needed to improve Australia's performance in the early stages of the commercialisation process, and notes that incentives for collaboration between clusters of research organisations under the Government's Competitive Pre-Seed Fund for Universities and Public Sector Research Agencies will assist in this area.

The working group's findings were presented to the PMSEIC in June 2001 at Parliament House Canberra. A small display erected as part of the presentation featured a solid towed array – a commercial success resulting from interaction between DSTO and Thomson Marconi Sonar Pty Limited (now called Thales Underwater Systems).

This edition of Australian Defence Science looks at two further examples of the successful transfer of DSTO intellectual property to the private sector: Mackay Industries licensing of elastomer/polymer research which has led their expansion into the defence supply market, and the DSTO-patented technology that is now setting an industry benchmark in affordable real-time infrared imaging devices.

We hope that these and other examples to be found in future editions of this publication will encourage more organisations to look at ways in which they can work with DSTO to strengthen their commercial prospects and to contribute to Australia's security.

DSTO technology protects
Army 'bottom line'

Technology developed by DSTO in the areas of elastomer research and appliqué armour design has been licensed to an Australian company with the immediate outcomes being substantial cost savings for the Army and a big boost to the defence manufacturing capability and export potential of the company involved.

STO and Mackay Consolidated Industries recently announced a licensing agreement that has positioned the Victorian manufacturer as the preferred supplier of anti-ballistic track shrouds for the Australian Army's Leopard tanks. The company has since received an order for 100 of the shrouds from the Defence Materiel Organisation on behalf of the Army.

Track shrouds are made of steel and rubber and enclose a tank's lower regions like an armoured skirt. They are a necessary part of ballistic protection for both tank crews and running gear and help to control the dust plume generated by a vehicle, a signal that can give away its approach from a considerable distance. DSTO technology not only enabled Mackay Industries to develop lighter and more ballistically effective track shrouds but also allowed them to achieve some 20 per cent cost advantage over those supplied by original manufacturers.

Chief Defence Scientist, Dr Ian Chessell says the order demonstrates that real cost savings can be achieved for the Australian Defence Force (ADF) if local industry is given appropriate technological support.

'The commercialisation of DSTO technology has very tangible benefits for the ADF, making it one of our key priorities,' Dr Chessell said. 'By transferring our intellectual property to local industry we enhance Australia's defence capabilities while at the same time contributing to the national wealth.'

Applauded as an import replacement, the Mackay track shroud also has considerable export potential. The German-designed Leopard tank is currently used by the armed forces of twelve countries, including NATO forces. Mackay's improved and cheaper products are hoped to make ready inroads into this market.

Left: Damian Johnstone, DSTO and Rohan James, Mackay Consolidated Industries, discussing armoured vehicle track link assemblies developed by Mackay Consolidated Industries under licence from DSTO.

Moreover, the Mackay track shrouds can be adapted for other vehicles, providing additional export opportunities. The company is currently developing a shroud suitable for use on the Army's M113 Armoured Personnel Carrier.

The Leopard track shrouds are only the most recent of several highly successful outcomes to intellectual property exchanges between Mackay Industries and DSTO.

Back in 1992, a DSTO licence agreement allowed Mackay to begin manufacturing and marketing track links (the entire rubber/steel track) for the M113 APC and other tracked vehicles. Recently in use with the ADF in East Timor, these track links have proved to last twice to four times as long as those of the original suppliers.

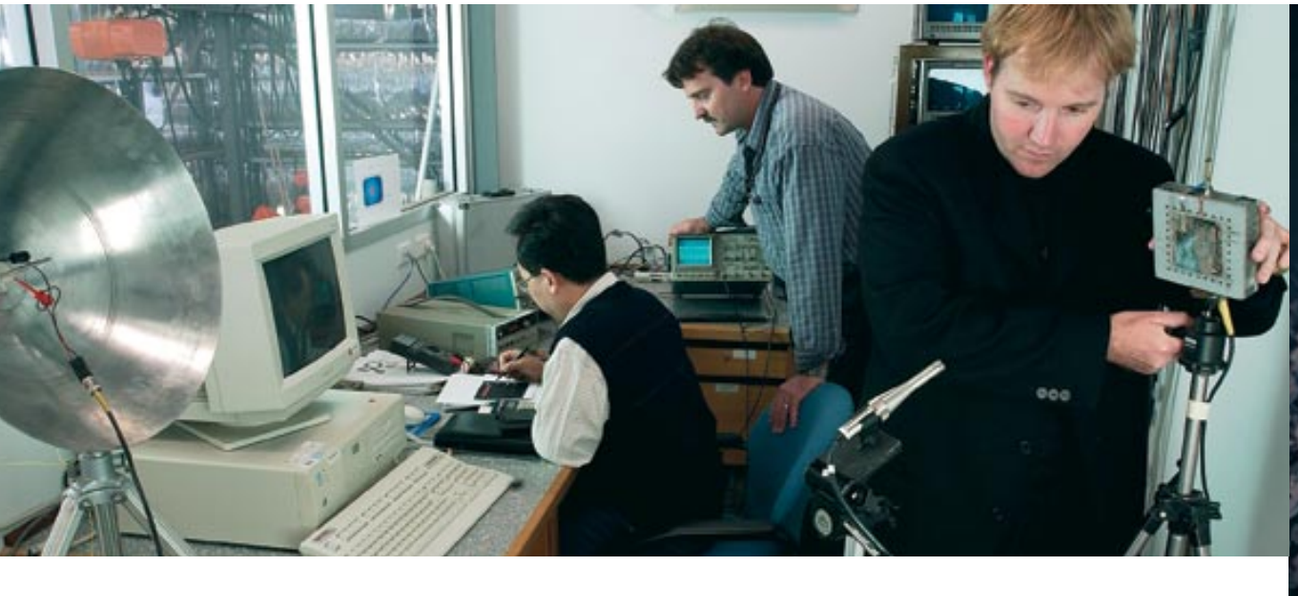
According to Mackay Consolidated Industries chairman, Mr Ross Paton, the defence industry now represents some 30 per cent of his company's business, largely due to their productive association with DSTO.

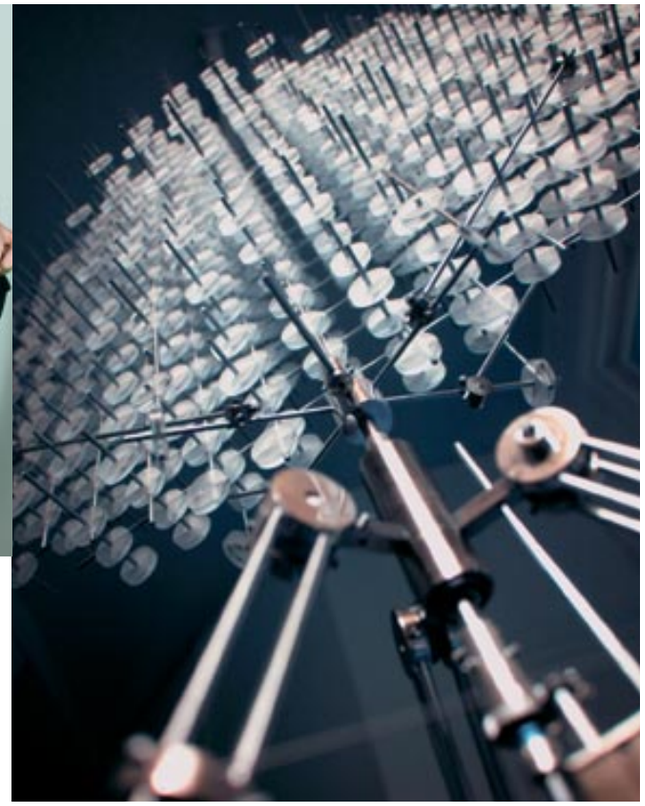
'Mackay's significant expansion into the defence industry of the last 10 years has been the direct result of its close involvement with DSTO in material development programs,' said Mr Paton. The company's defence products now include silo closures for the vertical launch missile canisters of Evolved Sparrow Missiles, anechoic tiles and noise/vibration control materials for Collins Class submarines, as well as tracked vehicle running gear and shrouds. Mackay now also supplies track links and road wheels to an Asian manufacturer of armoured vehicles.

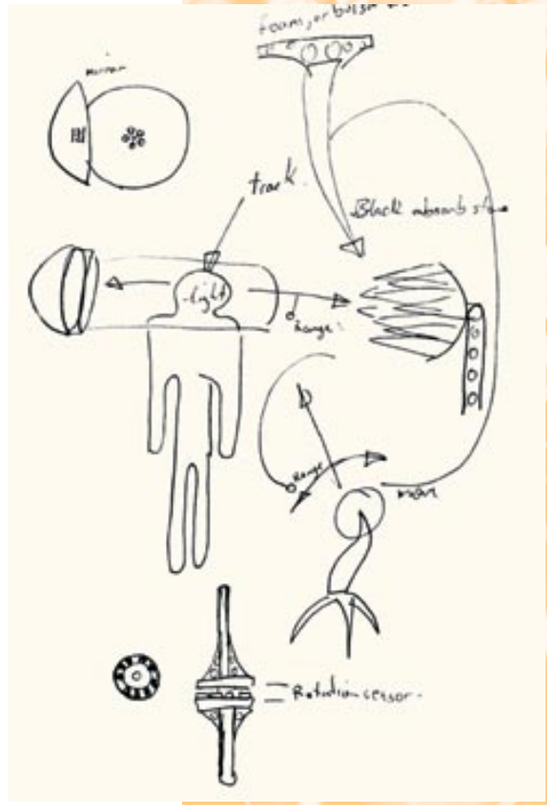
Mackay Industries' association with DSTO was formalised in its response to the organisation's calls for 'expression of interest in manufacturing opportunities' in 1992 and 1995. However, Mackay personnel were alert to the research that DSTO does in their field through the organisation's publications and its participation in peak industrial bodies and international conferences.

DSTO elastomer technologist Ted Symes is one who has played a very active role in informing the industry of the work of DSTO in polymer and elastomer research. Mr Symes is a long-time member and past chairman of the Victorian Branch of the Australasian Plastics and Rubber Institute. He recently received the APRI 'George Milne Memorial Medal' for 2001 in recognition of his contribution both to the Institute and to the plastics and rubber industry as a whole.

Sound likes a good idea...
art and defence science







Left: *Researchers Binh Nguyen and Joe Cashel with artist-in-residence Adam Donovan in his lab at DSTO, Edinburgh SA.*

Centre: Synthetic Dialectic, *Adam Donovan (May 2000). A previous science/artwork by the DSTO artist-in-residence, exhibited at the Metro Arts Centre, Brisbane. The device is a mounted array of audio macroscopic scatterers that focus impinging soundwaves to a field at the rear of the array.*

Right: *Working drawings for Adam's parametric acoustic array installation.*

Adam Donovan is a twenty-seven year old Brisbane artist working in the area of acoustic and visual art. In September 2001 he began a ten-week residency at DSTO Edinburgh. The project was initiated by the Australian Network of Art and New Technology and is the first time the Defence Department has hosted an artist-in-residence.

Adam Donovan is at the forefront of developing new and innovative methods of incorporating applied physics into artistic work. A sculpture graduate of the Queensland College of Art, Griffith University (1994), his work has been exhibited at the Queensland Art Gallery, the Institute of Modern Art and the Pratt Institute (New York). Adam is currently developing public artworks for the new River Walk Project (commissioned by the Brisbane City Council).

Adam's artist-in-residency at DSTO Edinburgh (SA) is one of a series of science residences, hosted by various organisations, called Deep Immersion: Scientific Serendipity. The scheme facilitates the marriage of art, science and technology and has proved fertile ground for artistic and scientific collaboration. The Deep Immersion series was begun by the Australian Network of Art and New Technology (ANAT) in 1999 with funding assistance from the Department of Industry, Science & Resources.

The Maritime Operations Division (MOD) of DSTO is facilitating Adam's art/technology research by sharing its expertise and knowledge in acoustics. Here he has conducted research into the development of parametric acoustic arrays. These 'acoustic lenses' focus highly directional ultrasound, which is demodulated by its passage through air to produce audible sounds that can only be heard within a narrow 3-degree beam over a range of some 200 metres. DSTO is one of the few research organisations in Australia to work extensively with ultrasound as part of its sonar technology research.

"This is the best science lab I have worked in," says Adam. "I wish I could be a permanent artist in residence at DSTO, moving about from lab to lab."

At Edinburgh Adam has set up a small lab and has access to scientists and equipment. He pays particular tribute to the stimulation and advice he has received from MOD researchers such as Dr Henry Lew, Binh Nguyen and Joe Cashel. Adam says that thanks to these people his design has completely changed since his arrival at DSTO. "I came with a concept and about ten articles on parametric acoustic array lensing effects. Now I have a complete idea of the problem and the range of technical solutions available to me."

"Adam's concept of sound projection from multiple sources and spatial sensitivity to listeners is novel," says Dr D. (Nanda) Nandagopal, Chief, Maritime Operations Division. "This kind of artist-scientist fusion of ideas stimulates innovation and certainly has useful spin-offs for us. I favour such activities because they encourage defence scientists to think 'outside of the box'."

The artwork that has been the focus of Adam's time at DSTO is to be exhibited in 'conVerge: where art and science meet; the 2002 Biennial Exhibition of Australian Art' - part of the forthcoming Adelaide Festival program. It will include two acoustic lenses linked to a robotic tracking system to follow viewers of the exhibition and create an interactive installation of acoustic and visual projections.

Adam says that he has been using an art/science approach since around 1993. His earlier work was with optical lensing and he has now moved into acoustics. Initially his audio work used parabolics to achieve lensing effects but these were nowhere near as effective or exciting as the parametric acoustic devices he is now working with.

"This is possibly the biggest development in loudspeaker design in 75 years," says Adam. "Its history goes back to 1934 when the parametric effect was first discovered but only in the last ten years has the technology become available that makes its application possible. Acoustic lenses have tremendous potential in virtual reality environments but there is still no parametric acoustic array commercially available anywhere in the world."

At a safe distance – big bang presents scarce research opportunities

Australian **DEFENCE**SCIENCE

An international explosives trial is being conducted at Woomera next year. The series, including one 27-tonne explosion, will present rare opportunities for third parties to conduct blast-condition experiments.

An international explosives trial being conducted at Woomera in September next year is the last in a current series to test the adequacy of NATO munitions storage regulations. Conducted in collaboration with the UK Ministry of Defence, these trials also present a rare opportunity for the participation of third-party experiments on blast pressure, seismic effects and the protection of personnel and equipment.

Trial Manager, Major Keith Parker says the Directorate of Trials (DTrials) tried to alert all potentially interested groups about the availability of research access to previous explosives tests in this series. Despite these efforts, he says, DTrials was contacted after the event by a number of researchers expressing keen disappointment in having missed an all too rare experimental opportunity. Major Parker hopes that the same will not be the case this time around.

Next year's tests, Defence Trial No.840, will include the simultaneous detonation of over three hundred 500-pound Mk.82 aerial bombs. It will be the equivalent of 27,000 kilograms of TNT going up in one very big bang indeed. The explosion will be detonated in standard UK-designed storage facilities, surrounded by representative industrial and residential buildings. A second test will explode 58 Mk.82 bombs in shipping containers under simulated field storage conditions.

The trial series is designed to provide data to confirm or adjust NATO munitions storage safety regulations. There is some potential for concern that these standards may no longer match the destructive force of modern munitions. The Australian Defence Force also uses the NATO regulations as a standard for munitions storage. The tests use ammunition supplied from the USA, are under the technical oversight of a Chief Scientist from the UK Ministry of Defence (UK-MOD) and are planned and managed by the Australian Directorate of Trials (DTrials).

Trial No.840 requires a long occupancy of a remote test site to allow the construction of a typical munitions storage environment. The Woomera facilities have been selected for the trials for the quality of logistic and technical support available here, but also because of the difficulty of getting such extended access to other international test sites of comparable size. Such sites are mainly in the USA.

DTrials is responsible for the management of the trial series and will construct at least ten buildings, install some 15 kilometres of fibre optic cable and provide high-speed video capture and other data capture services. Some targets from a 1999 trial, involving a 40-tonne blast, will also be moved in for this series. One of the residential buildings used in the earlier test is wired for power and data. A duplex brick building, its data cables will be used for monitoring installation performance. However this data link could also provide experimental access to the function of electronic equipment under duress.

Although UK-MOD is responsible for the technical oversight of the trial, additional experiments that do not impinge on data capture or timing of the primary tests will be considered for inclusion. DSTO Weapons Systems Division has already expressed an interest in potential experimental access to this test series, as has the Defence Estate Organisation.

For further information about Trial No.840, contact Major Keith Parker, Directorate of Trials, Canberra: 02 6265 7974.

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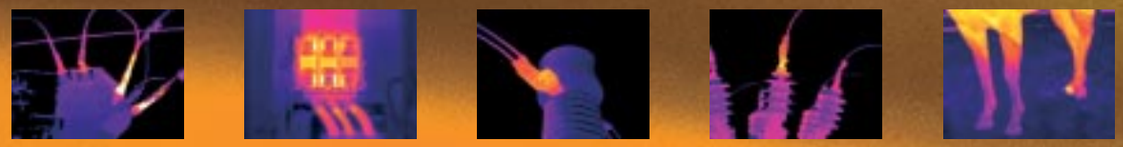
Uncooled infrared sensor arrays
are hot technology



Microbolometer FPA infrared images courtesy of Flirts(tm) {Forward looking Infra Red Thermal Systems}

A DSTO pioneered and patented invention is emerging as the worldwide industrial standard in affordable heat-imaging devices. The technology has a plethora of practical security and industrial uses and there is intense military interest in using it in lightweight night vision imagers.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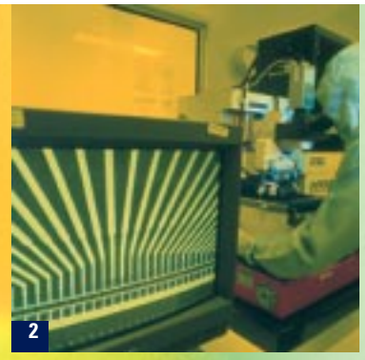
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DSTO-developed uncooled infrared (IR) detectors differ from those of the ubiquitous motion sensor in that they allow many thousands of detectors to be assembled in a single array, so that a complete heat-image of a scene can be viewed in real time. Other real time heat imaging technologies exist but use super-cooled arrays to detect the low-energy infrared photons. Such devices cost tens of thousands of dollars more to produce.

High performance, compact and affordable infrared sensor technology has many military, industrial and domestic applications. One device developed by DSTO using its patented technology is capable of high probability detection of human targets at ranges of more than 1 km. Earlier versions were used to conduct the first comprehensive measurements of the infrared signatures of military and non-military objects including all types of vehicles. Most of this data is still valid and used in performance modelling of IR devices.

Applications for this technology exist wherever it is desirable for an operator to detect invisible or hidden sources of heat. It can be extremely valuable for industrial operators to have early warning of heat build-up in machinery components or during processing. Future domestic IR security systems will give images of intruders moving in total darkness and motor vehicles are expected to be fitted with IR imaging safety sensors.

Key technologies for uncooled infrared sensors have been developed over several decades at DSTO Edinburgh (SA) in collaboration with Australian industry and universities. Research started in the 1950s with work on IR detectors called resistance bolometers. These sensitive devices are basically tiny thin-film structures that change their electrical resistance after exposure to minute quantities of heat.

During the 1970s research concentrated on micro-machining methods to achieve high efficiencies in detectors small enough to be used at the focal plane of an electro-optic camera. This pioneering research in silicon micro-machining was conducted at DSTO a decade before the acronym MEMS was coined to describe the process.

The core technology for both bulk and surface micro-machining was patented by DSTO in 1980. The first fully operational sensor arrays were constructed using this novel method during the early part of that decade. However it was nearly twenty years before the ultimate aim of developing high performance, low cost Focal Plane Arrays (FPA) integrated with readout computer chips would be achieved.

The culmination of some 40 years of research in uncooled IR sensor technology has been the development of a lightweight thermal imager (less than 2 kilograms) employing a semiconductor film bolometer array integrated on-chip with its readout integrated circuit. It has a total power consumption of 1 watt (supplied by off-the-shelf AA size batteries) with a sensor array of more than 20,000 pixels viewed via a 3cm optical display, similar to the LCD viewer of a digital camera.

Today DSTO maintains a dual defence/industry capable microbolometer processing facility at Edinburgh. In addition to in-house tasks this facility undertakes industry-funded developments based on DSTO's world patented technology. The DSTO silicon microengineering foundry also conducts small-run bolometer array fabrication for its licensees in support of technology transfer.

Commercial contracting and licensing arrangements by DSTO have enabled microbolometer development to continue in Australia, fully funded by industry investment. Developments within microbolometer design, performance and processing technology continue with DSTO's commercial licensees, Electro-Optic Sensor Design (Australia) and Infrared Components Corporation (USA).

Image 1 The Plasma Enhanced Chemical Deposition (PECVD) / Reactive Ion Etcher (RIE) unit used in the deposition and etching of the silicon and silicon based materials associated with the Bolometer project. Polymer based materials are also etched in the RIE chamber.

Image 2 The Mask aligner is used for the patterning of the various thin film layers used in the process.

Image 3 All wafers are inspected at each stage of manufacture.

Image 4 Photo resists and Polyimides are cured and baked on hot plates, in air or nitrogen, under controlled conditions in a fume cupboard.

The Headline Experiment
a concept-led team effort

"A huge team effort involving all stakeholders in deciding what defence capabilities to buy." This is the way that DSTO's Dr Alan Burgess (Research Leader, Operations Analysis and Evaluation in the Land Operations Division) describes new approaches being established for Australia's defence materiel acquisitions program.

The new procedures aim to ensure that Australian defence acquisitions accurately reflect the needs of future operations, rather than simply being an equipment replacement regime or one driven by 'next generation' arms equipment dealers.

But how can the needs of future warfare be determined - without enlisting Nostradamus or a Gypsy with a crystal ball? A significant new approach to this is demonstrated in the Australian Army Experimental Framework.

A key challenge in the Army's ongoing modernisation program lies in developing future warfighting concepts, and in investigating the validity of those concepts which exploit the combined capabilities of new and existing equipment, of new systems and the evolved logistics infrastuctures which will support them.

The Army Experimental Framework is a testing regime designed to explore this area with scientific rigour. It uses simulation based wargaming, in which military judgement is synthesised with operational analysis to explore the new concepts and to test the interactions between people and systems in operational planning roles and realistic battlefield situations.

In its focal role with the 'Headline Experiment' series (an important element in the Army Experimental Framework), Army's Combined Arms Training and Development Centre (CATDC) incorporates advanced scientific and analytical rigour to help take the ADF to new capability levels in future warfare.

As Senior DSTO Representative for the Headline Experiment, Dr Alan Burgess describes DSTO's role in the Headline Experiment as a provider of professional scientific services. "DSTO develops and implements experimental methodology and scientific design to effect more and better results, and perhaps very different results than those that might be achieved from less rigorously objective methods," he says.

DSTO's expertise in experimental modelling and simulation is employed to support wargames which enable Army to obtain vital insights into the effectiveness and risks of potential capability options (both systems and equipment) that are made possible with the introduction of new methods and technologies.

The first of the Headline Experiment series was conducted at the Army's Combined Arms Training and Development Centre at Puckapunyal in late 1999. In November 2000, over 200 Defence personnel and 70 DSTO staff engaged in phase two of the experiment to further test and refine the 'manoeuvre' concept. In October 2001, though quickly scaled down in the wake of September 11, a very productive phase three Headline Experiment was again conducted at Puckapunyal.

Recent developments in specialist experimental modelling were introduced in 2000 with the Headline Experiment being the first large scale exercise in which JANUS (a multi-station war game in which soldiers and equipment are deployed on a realistic computer generated battlefield) and the Army Battlefield Command Support System were able to work together - an achievement made possible by DSTO applying recent, innovative software and systems developments. This allows Army personnel to exercise in a simulation scenario with the tools they might use in future in the field.

The evaluation process included special reviews following each simulated battle. The battles are moderated by experienced Army commanders along with Battle Operations System observer/controllers – supported by real-time data collection and analysis by DSTO.

The Headline Experiments are seen as a milestone in the Army's journey to be concept-led. It also demonstrates how the scientific approach applied by DSTO is helping to provide the ADF with the capability to fight and win knowledge-based warfare in the 21st century.

BRIEFS

World aeronautical award for IFOSTP

The International Council of Aeronautical Sciences has awarded DSTO the prestigious Von Karman Award for its international program assessing the fatigue life of the F/A-18 Hornet aircraft. The RAAF is also named as the cooperating organisation. DSTO's International Follow-On Structural Test Project (IFOSTP) is aimed at extending the safe operating life of the Hornet fleet by up to 25 per cent, an achievement which could save the Defence Force up to $1.3 billion.

The Von Karman Award is the annual prize for the best aeronautical work judged by the Council. It was founded in 1980 to honour the memory of Dr Theodore von Karman (1881 – 1963), one of the greatest aeronautical scientists of the twentieth century. This is the first time that an Australian organisation has won the award, which recognises outstanding examples of international cooperation in the field of aeronautics. The award is shared with the Canadian Forces and the National Research Council Canada which collaborated in the fatigue test.

International representation for Women in Physics

Dr Pina Dall'Armi-Stoks from DSTO's Electronic Warfare Division has been invited by the Australian National body of the Women in Physics Group to be one of their Australian representatives at the International Union of Pure and Applied Physics Conference on Women in Physics to be held in Paris, March 2002. She will address the Conference on strategies and initiatives of the Australian National Group to support women in physics and to encourage and support girls with an interest in the physical sciences. Dr Dall'Armi-Stoks has been an active member of the Australian WiP Group which originated in Adelaide in 1992.

DSTO researcher wins Victoria Fellowship

A Research Scientist with DSTO's Airframes and Engines Division (AED), Dr Wenyi Wang has been awarded the 2001 Victoria Fellowship from the Victorian Department of State and Regional Development.

Since 1998, Dr Wenyi Wang has been involved in developing advanced techniques to diagnose gearbox failures in helicopters. These prognostic techniques allow helicopter operators to detect and diagnose mechanical faults before they occur. It is vital and exacting research that saves both money and lives and can be applied to any machine with a gearbox. Dr Wang's work, along with others, is contributing to DSTO's reputation as a world leader in gearbox fault diagnostics.Dr. Wang will use his Fellowship to attend international conferences and visit the USA, UK and France to set up collaborative research programs with leading organisations working in machine diagnostics and prognostics.

Dr Wang completed a Master of Science at Huazhong University of Science and Technology (China) and a Doctorate in Mechanical Engineering at the University of New South Wales. He has published over 35 papers.

New name for DSTO Salisbury

The Defence Science and Technology Organisation's South Australian site, known as DSTO Salisbury, has changed its name to DSTO Edinburgh following the October 19, 2001 launch of Edinburgh Parks, a new technology and industrial precinct adjacent to the existing RAAF Edinburgh base and DSTO.

"DSTO's decision to adopt the new name reflects the level of support the organisation has for the Edinburgh Parks concept," Chief Defence Scientist, Dr Ian Chessell said. "Proximity to our industry partners will greatly facilitate DSTO's efforts to increase our contribution to national wealth creation through increased commercialisation of our research outcomes."

Edinburgh Parks has been developed in response to the need in Australia and the Asia Pacific region for high quality land and infrastructure to support advanced technology based industry. It is anticipated Edinburgh Parks will provide major new opportunities for international companies to establish advanced research or manufacturing bases in the Asia Pacific region.

The new contact details for DSTO in South Australia are:

Street address:
DSTO Edinburgh,
West Avenue, Edinburgh, SA

Postal address:
DSTO Edinburgh,
P O Box 1500, Edinburgh, SA 5111.

CALENDAR

December 2001 – May 2002	To Mars and Beyond: the search for the origins of life – space exhibition at the new National Museum of Australia, Canberra. Supported by Defence.
29 – 31 January 2002	RAN Pacific 2002 Sea Power Conference, Sydney Exhibition & Convention Centre, Darling Harbour, Sydney. Phone: (+61 2) 6287 6247. E-mail: peter.leschen@defence.gov.au
29 January – 1 February 2002	Pacific 2002 International Maritime Exposition, Sydney Exhibition & Convention Centre, Darling Harbour, Sydney. Phone: (+61 3) 5282 4400 E-mail: expo@maritime.net.au
31 January 2002	Australian/French Seminar on High Technology: From Inovation to Operation, Sydney Exhibition & Convention Centre, Darling Harbour, Sydney. Contact: Joel Branchut, (+61 2) 6216 0163 E-mail: joel.branchut@netspeed.com.au
2 – 6 February 2002	ANZIAM 2002: 38th Applied Mathematics Conference, Canberra. Contact: Rodney Weber, E-mail: row@ma.adfa.edu.au or visit; www.ma.adfa.edu.au/anziam2002.html
27 February – 1 March 2002	World Congress on IT, Adelaide Convention Centre, Adelaide SA. Presented by the World Information Technology and Services Alliance, the global peak body for the information industry. Keynote speakers include Bill Clinton and Michael Capellas.