

PROGRAM 10: SCIENCE AND TECHNOLOGY

OBJECTIVE

To give advice that is professional, impartial and informed, on the application of science and technology that is best suited to Australia's defence and security needs.

The Science and Technology Program, through the Defence Science and Technology Organisation, provides the core of Australia's skills in defence research and its applications. There are four principal supporting objectives:

- to position Australia to exploit future developments in technology which show promise for defence application;
- to ensure that Australia is an informed buyer of equipment;
- to develop new capabilities where Australia's circumstances require this; and
- to support existing capabilities by increasing operational performance and reducing the costs of ownership.

The skills required to meet these objectives enable the Defence Science and Technology Organisation to support Australia's regional and global security interests and to interact with industry.

DESCRIPTION

The Program Manager is the Chief Defence Scientist. The Program comprises three Sub-Programs: Aeronautical and Maritime Research; Electronics and Surveillance Research; and Executive and Support.

PROGRAM SUMMARY

The Program has responded to the priorities of *Australia's Strategic Policy* by appropriate evolution of its work program. It continued to give very high priority to the 'knowledge edge', and its three sub-elements (intelligence; command and supporting systems, including communications; and surveillance), building on work already commenced under the Takari initiative, which is designed to provide the ADF with the capability to fight and win knowledge-based warfare.

Issues important to Defence which were also major shaping factors for the Program's work during the year included support to the *Restructuring the Army* initiative; support to the operational-level of command; support to the force-in-being, including Australia's increasing 'parent service' role (eg Collins, Anzac and F-111); the use of imagery for surveillance purposes; weapons systems and electronic warfare issues; interaction with industry and universities; and regional engagement.

Responding to the directions set out in the Defence Reform Program and the *Defence and Industry – Strategic Policy Statement*, a program of capability and technology demonstrators is being developed within Defence. The aim is to foster the early introduction of capabilities based on advanced technologies into the ADF. The Program continued to play a significant role in developing and shaping this program and its governing policies.

The new laboratory complex at Salisbury, South Australia, was formally opened in September 1997, bringing together many of the research and support staff at the Salisbury site in a modern, more efficient laboratory. Planning continues for the consolidation of the organisation's Melbourne laboratories by the end of 2001. This will achieve cost savings and work synergies through better integration of the Aeronautical and Maritime Research Laboratory at Fishermens Bend.

PERFORMANCE MEASURES FOR 1997-98

The performance of the Defence Science and Technology Organisation was measured by the extent to which:

- a. clients' needs and priorities were met, and in particular:
 - advice provided to the Defence organisation to make informed decisions on new defence capabilities was timely and useful;
 - enhancements to existing defence capabilities provided increased operational effectiveness, including more cost effective use of personnel and materiel; and
 - the life-of-type of defence platforms was extended, with consequent cost and operational benefits;
- b. those emerging technologies relevant to Australia's future needs were identified and exploited;
- c. Science and Technology's interactions with industry led to an increased ability on industry's part to support Australia's national defence effort and to contribute to national wealth creation;
- d. Science and Technology's interactions with regional countries contributed to Australia's regional security;
- e. Science and Technology's international interactions contributed to alliance relationships and allowed access by the Defence organisation to current and future defence science and technology relevant to Australia; and
- f. the proportion of Program resources allocated to support continued to decrease, while sustaining and improving the quality and effectiveness of the organisation as a whole.

1997-98 PERFORMANCE AGAINST FORECASTS

Science and Technology's activities and outcomes for 1997-98 are grouped below in broad areas corresponding to the organisation's client groups.

Policy and Command

Developing a testbed for generation of the Recognised Air Picture for operation in exercise Pitch Black 97. This testbed will integrate data from a wide range of surveillance and intelligence sensors

Achieved: The testbed was developed, deployed and used operationally in Exercise Pitch Black 97. It will assist the ADF in exploiting technologies relevant to future command, control, communications and intelligence needs.

Demonstrating in the field a compact deployable information network, based on commercial GSM digital phone technology, developing plans for its integration with the Parakeet trunk communications system, and seeking solutions to military encryption requirements

Achieved: A compact information network was demonstrated and integration with Parakeet has been completed. Solutions to military encryption requirements continue to be sought. The demonstration assisted the ADF in identifying technologies relevant to its future communications needs.

Undertaking systematic evaluation of the key factors which impact on ground-truth accuracy of over the horizon radar. This work will also be used to evaluate the performance of the Jindalee Operational Radar Network coordinate registration process as a risk mitigation strategy

Achieved: Trials of the coordinate registration system were held. They identified the key factors affecting the ground-truth accuracy of over the horizon radar. The results have enabled Jindalee Operational Radar Network contractors to develop a risk mitigation strategy for the development of the coordinate registration system.

Providing advice on the vulnerability of personnel to munitions, in particular land mines, and the medical logistics implications of munitions injuries

Achieved: Advice was given to Army Surgeon General and Director General Land Development on the vulnerability of personnel to munitions and a closer understanding of the risk to ADF personnel was obtained.

Providing technical support for the Government's opposition to the proliferation of weapons of mass destruction through the chemical and biological weapons conventions and missile technology control regime initiative of the UN

Achieved: Timely technical support was provided to the satisfaction of the Department of Foreign Affairs and Trade.

Maritime Capabilities

Providing advice and technical assistance on the monitoring of strain at critical regions of HMAS Collins and HMAS Farncomb during shock tests and on eddy current testing methods of advanced materials that are used in the submarines.

Achieved: Preliminary activities to the shock testing of *Farncomb* have been completed, with testing expected to occur in the first half of 1999. Advice was provided to the Navy on a range of non-destructive testing techniques, including eddy current testing, for materials used in the Collins propeller.

Assisting the RAN with the acquisition, assessment and acceptance of optronic systems for the Collins class submarines

Not achieved: The Navy is modifying its requirements and timescales.

Supporting the proposed upgrading of the Seahawk helicopter capability by evaluating the operational effectiveness of the helicopter in its various roles, and by coordinating the assessment of the adequacy of support to the helicopter

Partially achieved: A draft report has been provided to the Navy which assesses the operational effectiveness in tactical situations of the current and possible future role of the Seahawk

helicopter. A Science and Technology study is currently being defined in consultation with Naval Aviation to develop options for overcoming identified deficiencies. Work on the support aspects is continuing and is expected to be completed in two years.

Developing techniques and algorithms for the implementation of onboard electronic countermeasures on guided missile frigates against surveillance and targeting radars

Partially achieved: This is a five-year research and development program, expected to be completed in mid-2002. A Science and Technology scientist is in the United Kingdom on 15 months long-term attachment to develop counter-surveillance and counter-targeting techniques.

Identifying sensor technologies which have the potential to increase a ship's detection, tracking and/or classification range against other surface vessels and low-flying aircraft/missiles, leading to improved beyond-horizon surveillance and situation awareness and improved ship self-defence

Partially achieved: A preliminary report to the Navy has identified a number of suitable sensor technologies (both on-board and off-board ship) to enhance vessels' detection, tracking and/or classification ranges. The optimum sensor mix against different scenarios remains to be evaluated. This work has been delayed because of higher priorities, with achievement now planned for FY1998-99.

Land Force Capabilities

Developing procedures to conduct analysis and optimisation of Army organisational structures, operations and logistic support and mobility, including interactions with Headquarters Australian Theatre, to inform the process of Restructuring the Army

Achieved: Procedures were developed and used to identify the critical issues investigated in the *Restructuring the Army* task force trials during 1997-98. Further development and refinement will be undertaken in 1998, which will provide Army with a clearer view of these activities.

Developing a dynamic deployed-force mobility model to improve the capability, effectiveness and efficiency of logistic support to the deployed land force

Achieved: A model was developed and used for the Army 21 Logistics Review. The model will be expanded and will be used for *Restructuring the Army* Logistics Trials in 1998-99.

Demonstrating automated target-detection cues for assisting analysts rapidly and reliably to identify the targets of military interest in radar imagery of broad tracts of land and contiguous littoral areas

Achieved: An automatic change-detection algorithm, an essential component of automated target detection, has been developed, refined and demonstrated. Development of other automated target detection cues continues and is expected to be refined and fully demonstrated during FY1998-99.

Supporting Project Bushranger by carrying out ballistic and shock trials on candidate vehicles and by modelling of the land-mine threat

Partially achieved: The Army has rescheduled the performance trials of Project Bushranger for November 1998. The Defence Science and Technology Organisation has nearly completed all detailed planning for the ballistic and shock elements of the trials and is awaiting availability of

vehicles, due in early FY1998-99, to finalise test details. A land-mine threat-modelling package has been produced but requires further development.

Air Force Capabilities

Assisting in the AP-3C upgrade by evaluating classification aids for the new radar; developing improved techniques for the prediction of detection performance against small targets in sea clutter; optimising the operational effectiveness of the updated weapons systems; and ensuring that noise at tactical crew and sensor task stations is within acceptable levels

Partially achieved: Major emphasis during the year was on advice to the acquisition project on radar acceptance and this has taken effort from the classification aids research. Work on improved techniques for the prediction of radar performance against small targets in sea clutter is expected to be achieved by the end of FY1998-99. An assessment of noise level at crew stations was carried out and a report provided to the project office. Both of these activities will enable Air Force to more effectively use the AP-3C radar.

Supporting the acquisition of an airborne early warning and control system by modelling of tactical and battle-level operations; assessing radar performance; and research into fusion of multi-sensor and multi-source data, decision support, automation and human-machine interfaces

Partially achieved: Scientific and technological advice was provided as part of the evaluation of the 'Request for Proposal' responses. Models were developed to examine tactical airborne early warning and control operations. These will be used to examine the operational effectiveness of proposed enhancements and to assist in developing tactical procedures. Expertise and models to support the evaluation of radar performance are being developed as part of a longer-term support program. These models will enable the analysis of manufacturers' data on radar performance. Research into fusion of data, decision support, automation and human-machine interfaces has commenced, and will be applied later to monitor the contractor's progress.

Supporting the F/A-18 radar upgrade by verifying the capability of the radar upgrade hardware; ensuring that the radar upgrade is capable in regional terms; and evaluating the electronic protection performance of the radar upgrade against modern jamming techniques to improve aircraft capability in hostile jamming environments

Achieved: Science and Technology support was directed towards the evaluation of the capabilities of the two contenders for the F/A-18 fighter radar, the Hughes APG-73 from the United States (an evolution of the current radar) and the GEC Marconi Blue Vixen from the United Kingdom. Laboratory and flight trials of the contenders, carried out in environments typical of those encountered in the region, were conducted to verify their strengths and weaknesses. An electronic countermeasures test bed was acquired and used to evaluate the electronic protection performance of the APG-73 radar against modern jamming techniques. The decision to select the APG-73 has been announced. Science and Technology's evaluation role was crucial in ensuring the best possible outcome for the ADF.

Providing advice on the acquisition of simulators for AP-3C; airborne early warning and control; Black Hawk; and Anzac Ship Helicopter

Partially achieved: Advice has been provided to the satisfaction of the client on acquisition of the simulators for airborne early warning and control and the Anzac ship helicopter. Advice on the AP-3C and Black Hawk simulator has been delayed due to contract slippages.

Providing the capability for detection and classification of low-probability-of-intercept radar signals

Achieved: Prototype low-probability-of-intercept receivers are now successfully in service on an airborne platform and a ship. They are providing a new capability in the detection of low probability of intercept radars and are also proving very useful in giving the platforms increased detection range against conventional radar.

Defence Science and Technology Research

Investigating the use of micro-electromechanical systems in 'smart' materials and structures to monitor the health of bonded components to reduce through-life costs

Achieved: As part of the early stages of this investigation, a prototype of the micro-electromechanical device has been successfully designed and manufactured. The device will be tested in 1998-99. A licence agreement has been finalised with Analatom Inc to develop and commercialise this device.

Continuing to collaborate with the Australian National University and the US Air Force in the development of a novel weapon-guidance concept based on fly vision and navigation

Achieved: A novel algorithm for extracting data from a simple image based on optical flow processing has been developed and validated for real-world images. Equipment for testing the algorithm in a real-time dynamic environment has been acquired and set to work. In addition to exploiting emerging technologies relevant to Defence weapons systems' needs, this work also promotes Defence's access to current and future defence science internationally.

Applying innovative uses of genetic algorithms and genetic programming to flight dynamics to identify unresolved aircraft equations and aerodynamic stability and control parameters from flight trials

Achieved: Very complex equations have been developed using genetic algorithm techniques that relate drag and mach number for the ballistic section of store release. They will lead to an improvement in the accuracy of calculations relating to the release of stores from aircraft.

Industry and External Relations

Placing research and development contracts and licensing arrangements with industry, universities and other research organisations

Achieved: The Program has 64 licence agreements currently, 10 of them signed during 1997-98. During the year, research and development and technical support was sourced from industry and other external agencies to the value of \$16.5m, representing 11.5% of the Program's research and development expenditure.

Developing existing and new industry alliances and other collaborative arrangements in a variety of areas

Achieved: The Program currently has 22 active industry alliances. Five new alliances were signed in 1997-98. Eight new collaborative agreements were signed with companies and government research agencies during the year, bringing to 17 the current number of active collaborative agreements.

Developing close affiliations with other research institutions

Achieved: During 1997-98, Defence Science and Technology Organisation participated in nine Cooperative Research Centres; as a core member of six, a non-core member of one and an affiliate with two. Negotiations are also well advanced for participation in the Cooperative Research Centre for Molecular Engineering and Technology.

International Cooperation and Regional Engagement

Increased collaboration in defence science with the United States, principally under the auspices of the 1994 Deutch-Ayers Agreement

Achieved: During 1997-98, the number of formal joint-research projects with the United States increased by six to the current total of twelve.

Revision of the 1990 Memorandum of Understanding on Defence Science and Technology with Canada

Achieved: Negotiations were completed and the Memorandum is expected to be signed by late 1998.

Signing an Administrative Arrangement with France to cater for joint research programs and staff attachments

Achieved: The Administrative Arrangement was signed on 14 October 1997, and several joint research projects are being negotiated.

Cooperation in our region in defence science and technology will continue through a range of collaborative activities conducted under existing bilateral defence and science and technology cooperation arrangements with Indonesia, Malaysia, Singapore and Thailand.

Achieved: Defence science and technology interaction with the region has provided benefits to the armed forces of each participating country and contributed to Australia's security through regional engagement. Examples during 1997-98 include collaborative work with Indonesia and Malaysia on the impact of the equatorial ionosphere on Global Positioning Satellite signals, and continuing collaboration with Indonesia and Thailand on high frequency communications under the Low Latitude Ionosphere Sounder Program.

Further preliminary work towards the establishment of a defence science and technology relationship with the Philippines could occur

Partially Achieved: Preliminary talks were held with the Philippines Armed Forces, who welcomed a proposal to collaborate on work in high frequency communications. Discussions to progress the proposal will be held in late 1998.

Defence Science and Technology Organisation Corporate Management and Support

Continued improvements in resource management to ensure maximum effectiveness of expenditure on research and development, including upgrades to corporate computer networks and better coordinated policy advice to the research and development divisions

Achieved: Staff and financial resources for most areas of support were transferred to other Programs at the start of the year and agreements relating to service provision were put in place with those Programs. The Defence Science and Technology Organisation wide area computer

network's capacity was increased between Salisbury, Canberra and Sydney and a new high-speed local area network was installed at Fishermens Bend.

Successful occupation of the new laboratory complex and scheduled progress with the rationalisation of land holdings and building usage at Salisbury, with associated support savings; further progress in planning and approvals for the rationalisation of properties in Melbourne; and progress toward completion of the new transonic wind tunnel at Fishermens Bend by the end of 1998

Achieved: The new laboratory complex at Salisbury is fully occupied. A post-occupancy review shows a high level of effectiveness and general user satisfaction with the facility. Planned rationalisation of land holdings and buildings' usage is nearing completion. The rationalisation of properties in Melbourne is to be reviewed in October 1998, with planned completion in 2001. The new transonic wind tunnel will be operational in early 1999.

Continued improvements in personnel management to ensure flexible and productive use of all skills, including through better performance management, implementation of the review of Professional Officer and Information Technology Officer career development, and further development of management and leadership courses for the Defence Science and Technology Organisation

Achieved: The Program has been developing an integrated human resource framework to meet organisational priorities through improved recruitment and career management strategies. Work is well advanced on developing a unified work structure for research and development staff, improving and extending the existing performance management and appraisal scheme and developing a pilot Executive Leadership Development Program.

RESOURCES

Table 10.1: Defence Function Outlays Summary

<i>Sub-Program</i>		<i>1997-98 Budget Estimate</i>	<i>1997-98 Revised Estimate</i>	<i>1997-98 Actual Outcome</i>	<i>Variation (97-98 Actual less Revised Estimate)</i>	
		<i>\$m</i>	<i>\$m</i>	<i>\$m</i>	<i>\$m</i>	<i>%</i>
10.1	Aeronautical & Maritime Research	87.9	91.3	92.5	1.3	1.4
10.2	Electronics & Surveillance Research	65.5	72.1	72.4	0.3	0.4
10.3	Executive & Support	76.9	56.3	47.1	-9.2	-16.4
Program Total		230.3	219.7	212.1	-7.6	-3.5

Note:

Figures may not add due to rounding.

Table 10.2: Staffing Summary

<i>Sub-Program</i>		<i>1997-98 Budget Estimate</i>	<i>1997-98 Revised Estimate</i>	<i>1997-98 Actual Outcome</i>	<i>Variation (97-98 Actual less Revised Estimate)</i>	
		<i>Personnel Numbers</i>				<i>%</i>
10.1	Aeronautical & Maritime Research	998	994	935	-59	-5.9
10.2	Electronics & Surveillance Research	710	732	693	-39	-5.3
10.3	Executive & Support	698	424	457	33	7.8
Program Total		2,406	2,150	2,085	-65	-3.0

Table 10.3: Staffing Profile

<i>Personnel</i>		<i>Sub-Program</i>			<i>Total</i>
		<i>10.1</i>	<i>10.2</i>	<i>10.3</i>	
Permanent Force	97-98 Budget	10	0	15	25
	97-98 Revised	8	0	15	23
	97-98 Actual	8	0	15	23
Civilian	97-98 Budget	988	710	683	2,381
	97-98 Revised	986	732	409	2,127
	97-98 Actual	927	693	442	2,062
Total	97-98 Budget	998	710	698	2,406
Personnel	97-98 Revised	994	732	424	2,150
	97-98 Actual	935	693	457	2,085

Table 10.4: Reconciliation of Appropriations for the Science and Technology Program

<i>Division/Appropriation Item</i>		<i>1997-98 Budget Estimate</i>	<i>1997-98 Revised Estimate</i>	<i>1997-98 Actual Outcome</i>	<i>Variation (97-98 Actual less Revised Estimate)</i>	
		<i>\$m</i>	<i>\$m</i>	<i>\$m</i>	<i>\$m</i>	<i>%</i>
180-01	RUNNING COSTS					
	Service Personnel	1.7	1.6	1.6	0.1	3.3
	Civilian Personnel	140.6	138.2	140.6	2.4	1.8
	Administrative Expenses	50.1	40.8	41.2	0.4	1.0
	Facilities Operations	9.0	9.0	0.8	-8.2	-91.2
180-02	OTHER SERVICES	0.9	0.6	0.6	-0.1	-8.1
181	EQUIPMENT AND STORES	31.1	32.6	30.3	-2.4	-7.3
Total Defence Function Appropriations (A)		233.4	222.9	215.1	-7.8	-3.5
Total Defence Function Receipts (Offset within Outlays) (B)		-3.1	-3.1	-3.0	0.2	-4.9
Total Defence Function Outlays (C) = (A+B)		230.3	219.7	212.1	-7.6	-3.5

Note:

Figures may not add due to rounding.

Table 10.5: Major Variations between 1997-98 Revised Estimate and 1997-98 Actual Outcome

<i>Appropriation</i>	<i>\$m</i>
180-01 RUNNING COSTS	
Service Personnel (\$0.1m)	
Minor miscellaneous variations	0.1
Civilian Personnel (\$2.4m)	
Higher than anticipated number of civilian voluntary redundancies	2.5
Part-year effect of ADF Workplace Bargaining Agreement	1.9
Provision for Commercial Support Program transition costs	1.1
Lower than anticipated Accrual-Based Superannuation and 3% Productivity Benefit liability	-3.1
Minor miscellaneous variations	0.1
Administrative Expenses (\$0.4m)	
Higher than anticipated Research and Development costs for electronic warfare	0.3
Net Programs transfers	-0.4
Minor miscellaneous variations	0.5

<i>Appropriation</i>	<i>\$m</i>
Facilities Operations (-\$8.2m)	
Net Programs transfers primarily associated with Facilities Operations transfer to Program 11	-7.9
Minor miscellaneous variations	-0.3
180-02 OTHER SERVICES (-\$0.1m)	
Minor miscellaneous variations	-0.1
181 EQUIPMENT & STORES (-\$2.4m)	
Increased requirement for Research and Development relating to surveillance facilities	1.1
Minor miscellaneous variations	0.2
Net Programs transfers primarily associated with Commercial Support Program Contracts to Program 11	-3.7
DEFENCE PORTFOLIO RECEIPTS (\$0.2m)	
Transfer of Utilities-generated receipts to Program 13	0.7
Minor miscellaneous variations	-0.5

Note:

Figures may not add due to rounding.