Public Communication of Science and Technology in Australia

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Foreword

This paper attempts to list the participants in the public communication of science and technology in Australia. It describes their activities, their budgets and their objectives, and where space permits, gives some sort of historical perspective to their current position.

We acknowledge that it is not a complete list. For instance, botanical gardens, zoos, education centres, and activities related to ecotourism have not been covered, and we regret that the constraints of time and space did not allow us to explore this topic more fully. We would be delighted to receive suggestions, additions and comments on this paper.

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"Largely by accident, Australians in the last quarter of the 20th century have become a nation of pioneers; some heroically, some reluctantly, some painfully. We have been plunged into a period of unprecedented social, cultural, political, economic and technological change in which the Australian way of life is being radically redefined[1]."

Australia is beginning to come to terms with itself, with its history, its location in the Pacific, and its place with other Asian countries. The global shrinking has brought it firmly into the world community, and out of the splendid isolation that it enjoyed only 40 years ago. Isolationism is no longer a feasible nor desirable state.

1. A brief description of Australia

1.1 Geography, history, political structure

Australia is the smallest continent and one of the largest countries in the world, and at nearly eight million square kilometres almost 80% of the land size of the USA. It is sparsely populated, with about 2.2 people to the square kilometre. If Australia had the population density of the USA, its population would be 200 million rather than 17.5 million. Most Australians live in the major cities around the coastline - Sydney, Melbourne, Brisbane, Perth, Adelaide and the conurbations that spread out from them.

Australia was settled by the English in 1788. They were keen to ward off French attempts to expand her empire. There was another reason: the English had recently been thrown out of America, a place which until then had served as a conveniently remote place to send the overflow from their teeming prisons. Australia was even more remote, and the English saw the chance to serve two purposes: forestall the French, and get rid of criminal undesirables from English soil.

The early settlers established six independent colonies, all reporting directly to England by sea for instructions. They clung to the coastline, and ventured only with trepidation into an interior that was, the further the early explorers moved from the coast, increasingly characterised by a harsh environment, uncertain rainfall, barren land and thin soil. The colonists brushed aside the original inhabitants of Australia, and official policy towards the Aborigines, which ranged from indifference to genocide, created scars in the community which only now are being painfully and slowly resolved.

The six States created their own laws and their own education systems, sent their own contingents off to fight in colonial wars in Sudan and South Africa, and built railway lines with tracks of different widths. When the States joined together in 1901 to form the Commonwealth of Australia, the jealousies and rivalries between them were only partially submerged, and the battle between the financially powerful Commonwealth (national) Government and the States continues. Australia has fifteen houses of parliament for a population of 17.5 million, many with responsibilities little above those of a city council. "Particularly in areas such as health and education - but even in relation to things like road rules - Australians fail to see why national policies cannot be developed[2]."

Modern Australians are keen members of the consumer society, and the three most popular domestic appliances of the 80s were the dishwasher, the VCR and the microwave oven. Since the introduction of credit cards in 1974, about 80% of Australians have come to hold at least one (compared with 1% of Germans, Italians and Dutch, 33% of the British, and 60% of Japanese). It has prided itself on being a "classless" society, or at least a largely middle-class one. Recent evidence tends to contradict this. Mackay quotes figures showing that the proportion of

households with an income of more than $72,000 rose from 15% to 30% in the 16 years from 1976, while at the same time, the proportion with an income of less that $22,000 increased from 20% to 30%.

The English heritage has created a country largely united in language, in culture and in attitudes: Australians are predominantly white and Christian. Perth and Brisbane may be 3,500 kilometres apart, but their inhabitants watch the same television (TV), read the same books, enjoy the same sports, and speak the same language.

1.4 Current challenges

In *Reinventing Australia*, Mackay refers to the last 20 years in Australia as being an Age of Redefinition. "Since the early 1970s, there is hardly an institution or convention of Australian life which has not been subject either to serious challenge or to radical change. The social, cultural, political and economic landmarks which we have traditionally used as reference points for defining the Australian way of life have either vanished, been eroded or shifted[3]."

Science is one of the landmark institutions being "redefined" - sometimes rather harshly. "Politicians are castigating scientists for indulging in self-interested activity - 'too much science for sciences' sake'; governments are calling on CSIRO to 'get its act together'; business and industry leaders are blaming scientists for failing to communicate their research results to industry as a reason for absence of commercial use of research advances; anti-science lobbyists and extreme conservation groups have blamed science and scientists for all the perceived harmful consequences of the application of scientific results and the media have made the most of all these issues by the exercise of selective emphasis. In fact,

science has been made the 'whipping boy' on which these groups have vented their frustrations[4]."

The communication of science has changed to meet the challenge. Bodies of scientific research have not only had to justify themselves to the community, but listen to the community's response. Some have found two-way communication a painful process.

2. Public support, opinion and understanding of science and technology

A recent Australian survey found that science and technology (S&T) were the subjects about which most Australians admitted being ignorant, and science was the only area where business, trade union and Government leaders were as poorly informed as workers[5]. Even the "attentive groups" of people interested in S&T have a limited understanding of scientific processes or terms.

Two recent national reports on under-achievement in S&T came to two major conclusions: that primary school children love science[6]; and that brighter university entrants avoid the subject because they do not see it offering attractive careers.

"No matter how much improvement can be made in science and technology curricula and teachers' professional experience, students will continue to avoid further science and technology studies and S&T careers unless they are perceived as attractive options[7]."

The reports found that the key missing ingredient is the linkage between education and future benefits such as financial rewards, employment prospects, and interesting careers and lifestyles.

A review of six surveys of popular attitudes to S&T in Australia concluded:

"Australians applaud technological progress, and fear it ... We generally regard S&T as a good thing, but feel threatened by their growing and seemingly

uncontrolled power ... This anxiety may be heightened by the fact that few of us feel we are very well informed about S&T[8]."

Despite the schizophrenic attitude, recent surveys indicate continuing support for scientific research in Australia. In a *New Scientist* survey, 61% of respondents agreed that scientific research could solve many of the world's problems and that the Government should spend more money on research, preferably on medical research (70%), pollution control (60%) and the environment (50%). There was little support for information technology and computers (9%), space exploration (4%) or robotics (2%), but only 9% said that less money should be spent on research generally[9]. These results were confirmed by a more recent survey commissioned by CSIRO[10].

This strong support for Government funding of scientific research may not be uniform across the population. A 1987 survey found a huge difference of over 50 percentage points between the level of support for research by male professionals and managers, and by female semi-skilled or unskilled workers[11].

Factors outside the media such as education, direct experiences with technological processes or products, and observable links with science may influence these attitudes, although Barns claims that "mass media representations are probably the most important continuing influence shaping perceptions of science and technology[12]." But positive feelings for S&T are not necessarily related to knowledge. Nearly two thirds of Australians in a 1986 survey did not consider that either their jobs or main activity would be affected by S&T[13].

Australians are certainly interested in S&T, even if they do not understand it. The portraits of seven scientists have featured on Australian banknotes; and when TV viewers from Brisbane, Sydney and Melbourne were asked to rank a list of 15

different news subjects, they put science and medicine as first in their list of interests, above politics and sport[14]. These findings were supported by a national Saulwick Age poll that showed that twice as many Australians would prefer to read stories about medical and scientific discoveries as stories about sport and politics[15].

3. The role of the Commonwealth Government

In a major statement on science policy in 1989, the then Prime Minister called for the creation of a "Clever Country": a more educated and scientifically literate population. People should "understand the role played by science and technology in all aspects of life and especially wealth generation and the creation of a more productive culture, and to encourage informed debate and a proper appreciation of the ways in which we should use the scientific and technological opportunities that arise[16]."

This was a notion the Government of the Australian Labor Party (ALP) had advanced consistently since it came to office in 1983. The Government decided that "the most effective means of lifting awareness of science and technology is by harnessing existing mechanisms in the public and private sectors[17]." It did not, however, issue explicit instructions to the organisations it funded.

The Government's total expenditure on science and technology exceeded $3.1 billion in 1993-94[18]. A wide range of institutions and programs are funded:

research at higher education

institutions

$492 million

CSIRO

$461 million

18 Research and Development

Corporations and Councils

$260

million

Defence Science and Technology

Organisation (DSTO)

$231.4 million

Commonwealth Bureau of Meteorology

$119 million

52 Cooperative Research Centres

$ 94 million

Australian Nuclear S&T Organisation (ANSTO) $ 64 million

Australian Antarctic Division

$ 64 million

Each institution has some element of public communication of S&T within its program, and several are scrutinised later in this paper.

The Commonwealth Government has its own specialist programs for PCST as well as relying on the general efforts of the institutions it funds. The National Technology Conference in 1983, involving participants from business, union,

academic and research organisations, set out "to achieve the 'shock of recognition' of where Australia was placed in the dramatic sweep of technological change. Other aims were to seek community and industrial consensus concerning technology, to promote dialogue and to draw media attention to technology issues[19]."

The Commission for the Future was formed in 1985, to "stimulate public debate by publishing discussion papers, contributing to TV and radio programs, preparing newspaper and magazine articles and making itself available for direct contact with groups in the community[20]." The Commission has not successfully established a clear role for itself and its future is doubtful. It is currently funded at $500,000 per annum, although this funding is being reduced as the body moves towards privatisation. It publishes a magazine, *21C*.

The Science and Technology Awareness Program (STAP) was created in 1989 "to increase understanding of the central role which S&T play in Australia's economic and social well being. An important concern has been to promote greater acceptance and use of modern technology in the daily life and productive activities of the workforce and the general population[21]."

It has five target groups - young people and their teachers, women, industry and business leaders, scientists, and journalists.

The STAP budget for 1993-94 is $1.7 million, and it has a staff of 7. Its role includes supervision of the $250,000 Australia Prize for science and the Michael Daley Awards for science journalism, and supporting about 40 special projects including briefing forums for the media, school curriculum resource development, and science summer schools.

4. The Commonwealth Scientific and Industrial Research Organisation (CSIRO)

4.1 Description, structure and funding

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) is Australia's largest science research organisation. It employs 7,300 people, about 45% of them scientists, and is located at 100 sites across Australia. CSIRO has a wide-ranging brief, and its research covers areas ranging from manufacturing to environment to rural products. CSIRO is funded largely by the Australian Government. In 1993-94, total funding is about $650 million with about 70% coming direct from Government. There is a strong commitment to communication within the organisation, and its very high community status reflects this commitment.

4.2 The Divisional communicators

CSIRO is divided into about 35 Divisions, which are grouped into six Institutes. Communication with the public can be initiated by any of three levels, Corporate, Institute or Divisional; and there are officers with specific communication responsibilities at each level. Most public communication is carried out at Divisional level, with communicators in the Institutes and the Corporate office mainly fulfilling a coordinating role.

Divisions range in size from about 50 to 460, and staff engaged in communication (apart from scientists) might include a communication manager, journalists, editors of scientific papers and photographers.

The Divisions interpret their responsibility to communication differently. Some emphasise media work and maintain an active public presence; while others see their core activity as working closely with industrial partners. So while some

Divisional communicators concentrate on preparing presentations, displays, newsletters and information sheets aimed at the same close band of industry users, others view general media coverage of their work as a priority.

The Divisions may also organise special events, often working with Institute or Corporate communicators. These can vary from simple displays for agricultural shows or industry conferences to elaborate exhibitions involving a number of Divisions.

Over three days BIOTA 93 drew a crowd of 35,000 to thematic science displays on themes such as Biodiversity, Waste Disposal and Genetic Engineering, and attracted heavy media coverage. The formal budget for BIOTA 93 was $85,000, but if the time of the 500 scientists and technicians who manned the displays is taken into account, then the total cost was about $400,000.

An example of an industry event is CSIRO's Manufacturing Month, which aims at an industry and manufacturing audience through breakfast seminars, media events and industry displays.

4.3 The Institute communicators

Communication managers in the six Institutes largely play a coordinating role. They assist Divisional communicators in a wide range of activities. Their emphasis tends to be on internal communication rather than with the outside world, and they do not initiate stories for the media although they may advise and approve such stories.

4.4 Corporate Public Affairs

CSIRO Corporate Public Affairs consists of the Public Affairs Unit, the Science in Education Unit, and the Information Network. It has a total budget for 1993-94 of $3.3 million (of which $1.2 million is provided by external sponsors) and a total staff of about 50, many of whom are paid for by industry-funded educational programs.

It aims to "gain widespread recognition of CSIRO ... [and] help create a scientifically literate community and to increase the interest and awareness of students about careers in science and science in careers[22]."

The Public Affairs Unit is responsible for corporate publications, and for organising formal events such as the presentation of special awards. It employs two journalists who assist Divisions with the production and distribution of media releases. The group produces an in-house bi-monthly newspaper,*CoResearch,* and writes speeches for senior CSIRO figures.

The Science in Education group aims to interest young people in science and science careers. The group operates nine science education centres around Australia, and runs the Double Helix Club, a science-activities group for school children with 23,000 members who receive six issues annually of *The Helix* magazine.

The Information Network handled 33,000 telephone inquiries in 1992, from private citizens, industry, Government, students, teachers, and the media. It also has a coordinating role, organising regional meetings of CSIRO communicators, and helping set up major touring exhibitions.

"Will Pigs Fly?" is a new activity for CSIRO. This sophisticated travelling exhibition, jointly prepared by Corporate and Divisional staff, toured shopping centres throughout Australia with its combination of computer interactives and modern display panels. Costing about $300,000 and sponsored in part by private industry, the exhibition alerted an estimated audience of three million people to issues on genetic engineering.

4.5 *ECOS* and *Rural Research* magazines and *Business Review Weekly*

CSIRO produces two magazines describing its research, *Ecos* and *Rural Research*. *Ecos* has an environmental emphasis and covers subjects such as water pollution, wildlife, and soil degradation; and *Rural Research* is aimed at local agriculture authorities and extension officers. Copy in these magazines is checked by the scientists involved. Their total circulation is about 10,000, although the influence of the magazines exceeds their circulation figures.

CSIRO also places a paid four page supplement in the *Business Review Weekly,* Australia's leading business magazine with a readership of 200,000. Articles in this magazine describe research findings and CSIRO technology with industrial applications.

4.6 From information officers to communication managers

Communication in CSIRO has changed over the last decade. It used to be characterised by a central media office generating media stories at a great rate and by Divisional information officers adopting a fairly passive role in the public sphere. Divisions tended to wait until questions were asked of them, rather than taking scientific ideas out to the community.

Anything which could be described as "public communication of S&T" was generally either absent or regarded as being of low priority in most Divisions. It was instead the responsibility of the Media Liaison Group, a Corporate body which publicised CSIRO activities through the media, produced films and publications, organised displays, and liaised with education authorities.

In 1981 the Media Liaison Group's five journalists generated a set number of stories for the media each month - seven for the 400 non-metropolitan newspapers, four for the 220 suburban papers, one longer article for 100 larger papers and magazines, and nine stories which were distributed nationally to

journalists and all media outlets. Other officers in a closely related group worked on CSIRO magazines and special projects.

The "one-way pipeline" method of transmitting stories to the public is now being replaced by a new type of communicator, one who actively attempts to keep the public informed and at the same time listens to the community. The old "information officer" has become the new "communication manager," and communication activities today are moving towards a blend of marketing and media, with a eye on industrial partners and commercial applications.

4.7 Official policy to communication

Guidelines on Public Comment by CSIRO Staff spells out official policy strongly. "CSIRO staff have an increasingly important responsibility to communicate with the public about scientific aspects of their work. CSIRO management encourages such communication, subject only to the relevant sections of Terms and Conditions of Service and the Crimes Act, concerning unauthorised disclosure of confidential Government and commercial information and documents. Effective public communication is taken into account in staff promotion processes.[23]"

The guidelines have been backed up by CSIRO's Chief Executive Officer, Dr John Stocker, who announced in launching "Project Ambassador" in 1990 that "communication is the responsibility of every CSIRO member ... I invite all staff to become involved in an all-out information campaign to demonstrate the value for money Australia derives from its premier research organisation[24]."

5. Other Government funded R&D organisations

5.1 The Research and Development Councils and Corporations

The 18 R&D Corporations are generally funded in equal proportion by levies on specific agricultural products and the Commonwealth Government. They

commission and manage research programs aimed at improving industrial practices in the primary and energy industries. Generally their communication activities are orientated towards keeping industry informed rather than lifting the knowledge base of the entire population, and this is in line with the levy-based nature of their funds.

The objective of the Fisheries R&D Corporation is typical: "To increase awareness of FRDC activities within the fishing industry, among researchers, fisheries managers and policy organisations, and in the Australian community[25]." Where the general public is mentioned in R&D Corporation objectives, it usually comes last.

Most Corporations have one full-time communicator, who may devote part of their time to PCST. Communication budgets vary widely, from $1.1 million to $15,000, and this normally amounts to 5% of the total funds of a corporation. Corporations commonly contract some communication activities out.

5.2 The Cooperative Research Centres (CRCs)

CRCs are partnerships set up to carry out research. The 52 CRCs already established bring together private companies, universities, Government-funded bodies such as CSIRO, and Government departments. The intention of the Government in establishing the CRCs was to improve the capture of benefits of research, by strengthening the links between the researchers and the users. The CRCs were expected to fulfil this role by involving the users in the work and management of the Centres.

Few employ a specialist communication manager. The communication task is either carried out by the administrator of the CRC, handled by a communicator

working with one of the partners, or devolved to the scientists. The communication activities of nine CRCs are summarised in Table 1.

5.3 Other major R&D organisations

Four other major R&D providers largely funded by Government include the Australian Nuclear Science and Technology Organisation (ANSTO), the Australian Institute of Marine Science (AIMS), the Defence Science and Technology Organisation (DSTO), and the Australian Antarctic Division. Their communication activities are summarised in Table 2.

6. The Universities

6.1 Public relations

Fifteen out of 35 universities provided us with information about the resources, activities and objectives of their science communication program. On average they devoted 1.5 staff and $80,000 each to promoting science to the public.

Much of this effort goes into publishing university newspapers, newsletters and other publications. Open days, promotional trips to schools, advertising and promoting courses, and media activities are also supported.

The objectives of the universities in publicising their work is a blend of self-interest and altruism. Deakin University lists three objectives:

"a. To create awareness of and generate demand for Deakin University Science courses.

b. To raise the profile of Deakin University's Faculty of Science and Technology, and to promote its activities in general and its specialisms in particular.

c. To promote an understanding of the relevance of Science to the everyday needs and aspirations of individuals, communities, our nation and the world[26]."

Internal communication is a first priority, and many respondents listed the largely internal university newspapers as a major activity. One of Australia's largest universities, the University of New South Wales, listed its first communication objective as "to keep the university community up-to-date with what is happening in their own and other areas of research[27]."

Given the size of the institutions, the level of Government funding they receive, and the Commonwealth Government's often-expressed interest in creating a more scientifically literate society, the universities' efforts to publicise their scientists' research is surprisingly modest.

6.2 Science Communication Courses

There has been an increasing provision of courses for people wishing to make a career in science communication, or current practitioners who wish to upgrade their communication skills.

The Australian National University (ANU) and the University of Central Queensland (UCQ) both offer graduate diplomas and masters degrees in science communication, and 27 students are currently enrolled. The courses cover a broad range of practical and theoretical activities, and are normally undertaken by science graduates.

Some other universities offer a graduate certificate or units covering either science communication or journalism within related courses.

7. The Museums.

7.1 What the museums were

"Museums used to be dusty, static, even dead emporia of esoteric mysteries. However, in the 1960's and 1970's a revolution took place. Around the world, museums began changing. They started to come alive, to involve and question

their millions of visitors; they started to explain, entertain and educate. They stopped being didactic textbooks, weighed down with the need to be comprehensive at all costs, and filled with rows of lifeless objects that became the "ultimate deterrent" for many people. Science centres sprang up, first in Toronto, then across the USA and south-east Asia. These new "museums" made understanding science fun, through a hands-on philosophy, and they broke fresh grounds by spreading awareness and confidence in new technologies ... A new era had arrived[28]."

This description of museums fitted the Australian model of the mid-20th century. The Commonwealth Government's Piggott Inquiry found that 18 of the 20 most important collections in the country were housed in institutions founded in the 19th Century. Funding, storage and preservation of collections, lack of trained staff and erratic acquisitions policies all drew criticism.

Professor Arthur Birch, then President of the Australian Academy of Science, said to a meeting of 98 museum curators and directors that "in order to make valid decisions as to the uses of science, decisions which rest on a social consensus, the community should be educated in scientific thinking and in an appreciation of what science can and cannot do ... Traditional museums have usually done quite well in exposing scientific facts and in setting out the standard historical records which are generally available. They have not done so well with the much more difficult tasks of penetrating beneath the surface, and of showing how ideas actually arise: the human elements of choice and chance in discovery. They treat science as prose rather than poetry[30]."

7.2 Ideas for a new type of museum

The success of S&T centres overseas had been noted, as they spread from the United States to Canada, Singapore, Japan, Hong Kong and France. "Science centres tease, excite, entice, provoke thought and motivate the visitor. The interactive nature of the exhibits provides the visitor with an insight into the real world of science and the scientist, and of how the latter works, thinks and explores the secrets of nature[31]."

Australian political parties began to recognise this need: science policy for the Australian Labour Party in 1982 included the intention "to initiate a continuous public information campaign in an attempt to demystify scientific processes, to raise levels of community understanding about S&T so that the Australian people and their political representatives can be directly involved in choosing between options and determining priorities[32]."

7.3 The first science centre - Questacon

The Questacon Science Centre was Australia's first. It was sparked by a visit to San Francisco's Exploratorium in 1975 by Dr Michael Gore of the Australian national University and began in 1977.

Questacon opened on a shoestring budget, and every science organisation based in Canberra helped build the displays. Based in an old inner-city infants school, it grew and began to attract private sponsorship. In 1988 Australia was to celebrate its bicentenary; and the Bicentennial Authority determined to establish a National S&T Centre in Canberra. The Japanese Government donated half the capital cost of the building as a Bicentennial gift.

The formal objective of the NSTC is "to advance the cultural and economic wealth of Australia by promoting in all Australians confidence, understanding and a positive attitude to S&T[34]." In each year since it opened in November 1988, about

500,000 visitors have visited the Centre or seen one of its travelling programs. It runs an active Outreach Program of travelling exhibitions, lectures, and the Shell Questacon Science Circus. The Circus takes 45 hands-on exhibits in a semi-trailer all over Australia. It is run by young science graduates enrolled for the ANU's one year graduate diploma in scientific communication.

The National Science and Technology Centre (NSTC) is one of about ten centres now operating in Australia, most offering a blend of interactives with some traditional museum activities. (See Table 3) "They have attracted both acclaim and criticism and become the subject of considerable debate. In spite of the debate, one thing is certain: they are extremely popular with the public and they appear to be providing a very powerful method of influencing the public's perception of S&T[33]."

7.4 The Powerhouse Museum

The Powerhouse Museum was Australia's second major innovative science museum. While Questacon arose cleanly from a new vision, the Powerhouse had to drag itself away from a 19th century background. Originally founded as the Museum of Applied Arts and Sciences in 1880, the museum struggled with inadequate premises for 80 years, until in 1979 the NSW State Government announced it was to be relocated into the old Power House.

Described as "an old hulk[35]" and "a bombed-out cathedral[36]", the building had provided electricity for Sydney's trams. Designing the museum was a challenge: it "was a vast unusual building with a vast unusual collection, everything from flying boats to baby bonnets ... [The architect] decided on a ramp, to lead visitors up past major items like The Gates of Paradise and the Strasbourg Clock, with Hargraves's kite hung joyously, dramatically, from the roof. The ramp proceeds around to view

the Mona Lisa of the museum's collection, the Boulton and Watt steam engine - in action, the engine that hastened the industrial revolution[37]."

The project took ten years and $54 million to complete, with an additional exhibition budget set at $32 million.

It aims "to be a dynamic, innovative and enjoyable museum which promotes awareness and understanding of the past, present and future of Australian society through research, scholarship and the acquisition, conservation and integrated presentation of material in the fields of science, technology, industry, design, decorative arts and social history[38]."

7.5 Scienceworks

Scienceworks in Melbourne opened in 1992, on a 3.7 ha site incorporating the city's historic sewerage pumping station. Market research showed that visitors wanted interaction and a feeling of fun along with their education.

"Doubt grew that these audience desires and the [Museum of Victoria's] educational objectives were likely to be met through the existing museum model. Objects alone were not seen as sufficiently engaging; interactives alone, insufficiently informative ... The need was for an integrated message delivery system which was both informative and enjoyable. Here, events, objects, audio-visuals, interactives, pre- (and post) visit projects, school kits, and other community resources could be combined to provide a manageable experience - a 'program' - tailored to the needs of a particular target audience. The term a 'programs approach' was coined[39]."

The new centre aimed itself squarely at two audiences - school children and families. As well as increasing the awareness of S&T in the community, it "aims to assist visitors to understand not only the principles of science but also the

relationship between technology and culture, and the issues surrounding uses of technology[40].

The Centre was constructed at a cost of $23.3 million, most of which was devoted to the building ($18.6 million) with the balance spent on exhibitions ($3.6 million) and relocation and storage of objects ($1.1 million). The Centre has been strongly supported by corporate sponsors, and over $2 million was contributed either in cash or materials prior to the opening.

7.6. Australasian Science and Technology Exhibitors Network (ASTEN)

ASTEN is a cooperative network of all the museums and science centres in Australia and New Zealand that display interactive science exhibitions. Founded in 1992, it has 19 member organisations, 12 of them Australian. It aims to "(1) enhance awareness and understanding of science and technology through hands-on interactive approaches and (2) share ideas and developments for exhibits, exhibitions and education programs. The network shares marketing and promotion ideas and can provide efficiencies in development costs and in the use of resources[40a]."

One of the main activities of the network has been to arrange the exchange of exhibitions between museums, and there are currently six in circulation around Australia.

8. Scientific societies

8.1 The Academy of Science

The Academy of science was founded by Royal Charter in 1954, and first in its nine objects and pursuits was "to promote, declare and disseminate scientific knowledge[41] ..."

Activities include fostering international connections, influencing Government policies, publishing journals, organising conferences, and recognising excellence by making awards. The Academy organises occasional lectures and comments on science policy. It supported, with limited success, proposals for a Museum of Australia and the Australian S&T Information Service, and has published a successful series of science text books.

In the financial year 1992-93, the Academy's total income was $1.857 million, with $214,000 in direct support from the Federal Government. Staffing was the equivalent of 18 full-time employees. Just under 300 distinguished academics have been elected to the Academy.

In 1991 the Academy recognised that Australian science needed greater support. "The protests of scientists and expressions of dismay by university leaders show the problems facing science in Australia. Despite modern interest in and desire for the products of modern research, S&T are in retreat[42]." Its response was to form the Australian Foundation for Science, with the prime aim of improving public awareness of S&T.

Within two years the Academy has raised over $2.5 million for the new Foundation, and identified 18 projects to fund. These include the National Primary School Project, the preparation of an environmental science text for senior secondary students, and a 75 minute TV special on Gondwanaland.

The Australian Academy of Science is one of four bodies based upon similar lines. The others are the Australian Academy of Technological Sciences and Engineering, the Academy of Social Sciences, and the Institution of Engineers, Australia.

8.2 The Institution of Engineers, Australia (IEA)

IEA is a professional association comprising over 60,000 professional engineers, engineering technologists and engineering associates. It aims to build a stronger economy through better engineering practices, and one objective is "to influence the community, private enterprise and governments in the development of appropriate practices, policies and legislation on matters which bear on engineering and engineering opportunities[43]."

The Institution lists as its communication activities the National Public Awareness Program, which works through the education system, industry and the media and costs $400,000 per year; the production of videos, brochures and displays; and participation in National Engineering Week.

8.3 The Federation of Australian Scientific and Technological Societies (FASTS)

FASTS, through its 70 member societies, represents "60,000 people working in industry, Government, research and administration, and throughout the education system in mathematics, S&T[44]." .

A primary function of FASTS is to lobby the Government "to get a better deal for S&T[45]". . It was established in 1985, following a "disastrous budget for science in 1984[46]," and has consistently represented the need for Government to take a more planned approach to R&D funding. FASTS also tries to influence opinion by working through the media.

9. The Australian and New Zealand Association for the Advancement of Science (ANZAAS)

ANZAAS has been one of the great public institutions for the communication of S&T in Australasia. It held its first meeting in 1888, when 850 people gathered in the Great Hall of the University of Sydney to listen to the Government Astronomer

of NSW. Since then ANZAAS has held nearly 60 Congresses in the major cities of Australia and New Zealand, attracting audiences of up to 4000 and wide media attention.

The object of the organisation is "to foster communication between scientists of all disciplines, and between scientists and the general public, especially in Australia, New Zealand and neighbouring countries[47]."

ANZAAS has been "the premier scientific society in the country[48]." Many leading scientists attended the conferences and contributed to its administration. But with the birth of the Australian Academy of Science in 1953 and the progressive formation of specialist societies, the influence of ANZAAS declined.

ANZAAS has tried to adapt to changing circumstances. State branches were formed in some of Australia's six States, attempting to counter criticisms that "ANZAAS dies between Congresses", and that it was not relevant to the major issues and major interests of the day[49].

Membership has dropped from 3,000 ten years ago to 600, and it has become "a marginal operation[50]". The national budget is only $60,000, and these funds are absorbed by administrative expenses and supplying *Search* magazine to all members. The operating budget is supplemented by a Commonwealth Government grant of $30,000 for the annual congresses.

Over the last decade the number of participants at ANZAAS Congresses has declined rapidly. Only 250 participants attended the 1993 Congress in Perth, compared with a regular average of 2,500 in post-war years. Media reports have blamed lack of interest by scientists and poor organisation.

Search is the authorised magazine of ANZAAS. It aims to publish "articles which deal with the social and economic consequences of advances in S&T." It covers

"public issues such as science policy, innovation, communication in science, pollution and environmental concerns[51]." Ten issues are published annually, and the circulation is 2,000.

11. The media

11.1 Demographics and cultural setting

The Australian media services a relatively small population in widely dispersed centres. New technology and economic pressures have strongly influenced rationalisation of mainstream media outlets in recent years. The number of newspapers has dropped sharply, and TV stations have formed into networks stretching across the country. The low costs of radio allow a large number of stations to operate, particularly on the FM band.

Australia does not have an established culture of science journalism. There are pockets of expertise, in TV programs such as *Quantum*, the Radio Science Unit of the Australian Broadcasting Commission (ABC), and in a handful of newspapers; but in mainstream media science is normally covered by generalist reporters. A few key specialist journalists play a crucial role in getting science news to the public, and the loss of any one of these people would mean a noticeable decline in the quantity and quality of coverage.

11.2 Newspapers

The most substantial science coverage is in newspapers. There are only two national daily newspapers, *The Australian* (which employs a full-time S&T writer) and *The Australian Financial Review* (which has just appointed one). *The Australian*'s influence is national, although its circulation is one twentieth the combined circulation of the main daily metropolitan State newspapers (see Table 4).

Of these metropolitan papers, only *The Canberra Times,* the *West Australian, The Melbourne Age* and to a lesser extent, *The Sydney Morning Herald*, could be put in the serious science issues-tackling category. Each has a specialist science writer, or at least a person on staff nominated as the science writer. Other metropolitan papers generally do not have a specialist science writer (see Table 4), although a member of staff - usually a junior member - might be temporarily assigned the title "science reporter".

Efforts have been made to measure the amount of science coverage in media. The Science and Technology Awareness Program (STAP) has counted column inches and minutes-to-air of items dealing with S&T, and by using circulation and ratings figures, this data has been converted to a measure of potential exposure - the number of people who are given the opportunity to watch a program or read an article.

STAP's results show that newspaper coverage has improved in recent years. A survey in 1989 showed a trebling of the number of newspaper articles over the past decade and indicated that 1.3% of the total space in 17 major newspapers was devoted to S&T. The most significant coverage was in *The Sydney Morning Herald* and *The Australian*. *The Canberra Times* had the second highest coverage. Coverage was particularly poor by Brisbane's *Courier-Mail* and the national daily *The Australian Financial Review*.

A similar survey in 1993 showed that the average share of science news in newspapers rose to 2.9%. These surveys do not, however, distinguish between news, features, articles in advertising supplements and opinion pieces. Nor do they show qualitative changes that have occurred over the last 15 years. Science has

moved from being seen as a source of entertainment to something more fundamental, significant in the economic future of the country.

Most newspaper articles covered by the surveys were about life sciences and medicine; mathematics and physical sciences obtained very little coverage.

Newspapers are drawing an increasing number of their S&T stories from overseas[52]. For instance, 36% of *The Australian*'s science stories in a 1991 survey came from overseas[53]. This could possibly reflect a healthy interest in world affairs, or it could reflect the globalisation of news, which makes it cheaper to use international wire services than to send a reporter out to find new stories.

10.3 Magazines

Mainstream science magazines with the largest circulations are *New Scientist* (15,000), *21C* (about 14,000), *Ecos* (8,000) and *Australasian Science* (3,500). *New Scientist* is an international magazine which is now co-published in Australia. It has an Australasian content of about 7%, and independent audits show an Australian readership exceeding 120,000.

Articles in the magazines are often more detailed, more technical, and better illustrated than newspaper stories. Stories can be picked up by mainstream media for more popular treatment, and so although magazine circulations are relatively small, they can be influential beyond their size.

STAP's 1989 survey of 13 popular women's, business and current affairs magazines showed that S&T accounted for 4.1% of published news area, over double that of newspapers. This was generally in the area of life sciences and medicine (83%), and tended to exclude other S&T topics except for environmental sciences, and technology and computers in business magazines[54].

10.4 Television

Science on TV news programs is almost invariably covered by a non-specialist reporter. Some metropolitan stations allow reporters to work in a broad science-environment-medicine area, and the national Government-funded ABC employs one specialist science reporter. TV news programs reflect the strong regional variations of the other forms of media, and over the period of a 1993 survey S&T coverage on TV fluctuated between 1% and 5% of the news broadcast. To this must be added coverage in current affairs programs such as ABC's *Lateline*, Channel 7's *Real Life* and *Eleven AM*, and Channel 9's *Nightline* and *Today* which averaged between two and three minutes of science coverage per program. Channel 9's business-orientated *Sunday*, and ABC's rural program *Lateline* averaged 10 minutes per program while ABC's *7.30 Report* covered no science during the survey period.

There are two regular weekly specialist science programs in Australia: *Quantum* on the ABC TV network, and *Beyond 2000* on a commercial network. *Quantum* runs for half an hour and *Beyond 2000* for one hour.

ABC TV's Science Unit has a staff of 29 and a budget of about $3 million to produce 22 hours of science programs a year. Screened nationally on the ABC network, the programs attract an audience of about 700,000 each. The main programs are *Quantum (*24 programs of 30 minutes) and *A Question of Survival* (10 programs of 30 minutes).

The birth of the Science Unit in 1964 was a seminal event in communication of science in Australia. Dr Peter Pockley was then given responsibility for both radio and TV broadcasting, and the event created an interest in the reporting of science which was picked up by other media.

For nearly a decade, *Quantum* has aimed at an intelligent audience with "cutting edge" science news. It presents items in a social context rather than as simple "breakthrough" stories, and the program tries to show the process of science so that people are more aware of the limitations of scientific method[55]. Its production standards are high, and reporters generally have science backgrounds.

When the program launched an appeal for funds to keep "Eric", a 110-million year old fossil in Australia, 25,000 people donated $270,000. This drew *Quantum* host Karina Kelly to comment that the appeal of science-based TV programs was often underestimated. "`I think there's actually a bias among the people who run TV stations against science, and that's because most of them don't come from a science background and feel somewhat uncomfortable with it and they decide the community are not interested in it either. But they are[56].

Beyond 2000's recent history tends to demonstrate this. In a move which mystified many observers, the program was axed from one TV network, and has just finalised arrangements for a prime-time spot on a rival network. *Beyond 2000* complements *Quantum*: while *Quantum* looks at research still on the laboratory bench, *Beyond 2000* concentrates on the results of applied research and the latest technology. The programs have similar-sized audiences.

10.5 Radio

Items on S&T are broadcast on all radio stations as part of the regular news programs. They are more likely to be aired on ABC's comprehensive news broadcasts than the often niche-market commercial stations. Most news services have a heavy local bias in their coverage.

ABC chat shows run all day in all seven capital cities and offer a balance of music and interviews. They are a good avenue for scientists who can speak in an easy and entertaining manner about their work.

Radio magazine programs, which demand a harder scientific edge to their stories, are dominated by the ABC Radio National network. Flagship of the ABC's offerings is the long-lived (18 years) *The Science Show*. Others include: *Ockham's Razor*; *The Health Report*; *Green and Practical*; and *The Food Program*. They are produced by the ABC Radio Science Unit headed by Robyn Williams, which has a staff of 10, a budget of about $1.2 million per year, and over 600,000 people listening each week.

The Unit is a significant force in the reporting of S&T in Australia. Robyn Williams was President of ANZAAS and currently heads the Commission for the Future and the Australia Museum Trust; and his efforts in the public communication of science and technology have resulted in his being elected to the Australian Academy of Science.

Although commercial radio stations lag far behind the ABC, they have used S&T stories. Editor of *New Scientist* in Australia, Ian Anderson, notes that a "string of science writers are now bobbing up regularly on radio offering comments about the latest science[57]". For the last four years, the editor of *Search* magazine has run a one hour program on FM RRR in Melbourne called *Einstein a Go Go*.

10.6 Science journalism

The most influential figures in media coverage of S&T over the past decade have been a handful of specialist science writers. Prolific writers such as *The Australian*'s Julian Cribb (with 1000 published stories within 30 months) and the ABC's Robyn Williams are responsible for a high proportion of the total output.

Although science is gaining acceptance as a serious subject, journalists still face the problem of convincing their editors of its importance. Journalists from major national and State newspapers identified the following problems[58]:

emphasis on `gee-whiz' technology rather than difficult mainstream science such as molecular biology;

failure to appreciate the link between scientific progress and national economic success;

a lack of appreciation of science by senior staff;

the tendency to tuck science away in specialist columns instead of including it in general news;

the domination of the news agenda by politics and economics, mostly because science stories are hard and expensive to find while politics is easy and cheap.

10.7 Media influence and policy

Almost all major S&T policy initiatives of recent years have followed media campaigns by scientists aimed at stopping cuts to science funding. A 1984 campaign by scientists led to 150% tax concessions for industrial investment in R&D as well as the restructuring of CSIRO and other Government research laboratories, and the creation of FASTS.

Eckersley considers that "the mass media are of questionable use in making the public S&T literate, in the sense that they have a good understanding and knowledge of the subject ... But the evidence shows clearly that the media are a powerful group in mobilising the support of that `attentive' group within the community and so convincing governments of the need to act[60]."

10.8 Prizes for science communication

The Eureka prize is awarded annually in five categories, two being for the `Promotion of Science', and for `Environmental Journalism'. The prizes are worth $10,000 each, and in 1993 the presentations were televised nationally. They aim to encourage and reward excellence in scientific endeavour and raise the public awareness of the outstanding quality of Australian science.

The Michael Daley Awards are annual prizes totalling $15,000 given to encourage high quality radio, TV and print journalism in the field of science and technology.

12. Other science communication activities

12.1 Horizons of Science Forums

The Forums, organised by Peter Pockley at the Centre for Science Communication, University of Technology in Sydney, promote science to the media by inviting eight scientists to present an original paper to a media audience in a one day seminar. "The paper must not only contain some real news, but be scientifically authoritative, well written and pitched to the largely generalist reporters attending. It is recommended that it is accompanied by demonstrations or visual displays[61]."

The Forums on Chemistry, Astronomy, Water, and the Dynamic Earth attracted widespread media coverage. They cost about $16,000 each to run and attract some limited funding from DITARD. Although their success is widely accepted, the future of the forums depends on the provision of financial support.

12.2 The Great Australian Science Show (GASS)

GASS is an independent commercial operation which organises exhibitions consisting of individual displays by science organisations together with speakers, workshops and demonstrations. It aims to generate discussions of science and "to establish science 'entertainment' as a valued cultural event in its own right[62]."

Seven shows have been run so far, with an average attendances of 20,000, and three further events are planned for 1994.

12. Recent changes, current issues and future challenges

We asked 13 science communicators[63] these questions:

a. How has science communication changed over the last 20 years?

b. What are the current issues?

c. What are the future challenges?

What follows is a compilation of their answers.

The group identified several major changes over the last 20 years. There has been a growing pressure on the public purse and this has lead to increased demands for accountability - the demand for more relevance to national objectives, and bigger benefits to industry and other users. As science has come under pressure, scientists have become both more political and more ready to regard communication as a respectable activity.

Media coverage of science has increased, and increasingly it is aimed at a general rather than elite audience. The link between scientific achievement and national prosperity is gaining wider recognition.

Debate on the environment, nuclear issues and biotechnology have raised public interest in science, as a potential source of solutions - and a possible cause of the problems. "We need to guard against presenting science as if all breakthroughs and developments are beneficial ... We are aware of the dangers of presenting scientists as if they can do no wrong[64]."

The biggest issue confronting science communicators today lies in selecting a mechanism to present information to Joe (and Josephine) Citizen to enable them to participate in an informed debate about science. "The most pressing issue is to

get the public to understand the 'nature of science' and in particular its fallibility ... Science needs a well informed public who will be critical appraisers of its work[65]."

This means a change from the "pipeline" method of communication, a one-way process where the public was given what the science community saw fit to give. As the rate of technological change accelerates, people feel a growing lack of control in their lives. If they are to regain control, they need information on technology which is going to affect their lives and the opportunity to influence the applications of this policy. Interactive communication between scientists and the public is the way of the future.

Although the relevance of science to the national economic good is beginning to be recognised, it still remains peripheral to the mainstream of public and political debate. Science needs to push the relevance message hard, to bring science into the centre of the national debate - and it also needs an image change, to begin to attract the best and brightest of the university entrants.

The question of scarce resources looms over the future, and science is going to come under increased pressure to justify its existence. This may frustrate scientists who will argue the case for serendipity, but still have to adjust to greater interference in their work from non-technical people.

Australia is trying hard to establish links with Asia, and communicating across cultural values presents special challenges. Before science communicators tackle this issue, they could consider forming a professional association, aiming to lift their own performance and providing a forum to discuss the issues outlined above.

"A major challenge in science communication in the future will be to educate the public, not just about the new industrial technologies and environmental and resource management strategies and tools science is developing, but also about

how different the new scientific world view is from the old: more organic, less mechanistic; more inclusive, less alienating; emphasising our inter-relationship and inter-dependence with nature.

"This new world view could well transform western culture[66]."

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University, Perth; David Tulip, Queensland University of Technology, Brisbane; Professor Lesley Warner, University of Central Queensland.

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Table 1

Cooperative research centre communication

Centre	Science Communicator	Budget	Activities
Australian Photonics	No	$30,000	Annual report, media interviews, press releases, articles in handbooks, special interest days, workshops, short courses, publicity pack, community education program
Biological Control of Vertebrate Pests	No	$10,000 (formal publicity)	Colour brochures, seminars, public lectures, conferences, student sponsorship, field days, science displays, media interviews, public launch
Southern Hemisphere Meteorology	No (use experts from member organisations)	Not available	Seminars, workshops, exchange visits, newsletter, meetings, media releases, visits to schools
Temperate Hardwood Forestry	No (Educational assistant does some)	$20,000	Workshops, seminars, information sheets
Alloy and Solidification Technology	No (Part of duties of research administrator)	$11,000 (plus part of commercialisation budget of $30,000)	Quarterly newsletter, publicity brochures, media releases, attendance at exhibition
Vaccine Technology	No	None	Newsletters, publications, media releases, brochures, public seminars
Tropical Pest Management	Yes, part of the role of science administrator	$30,000	Cartoon booklets, talks to grower organisations, press releases, internal newsletter, biannual Tropical Pest News, open days, problem definition workshops
Australian Mineral Exploration Technologies	No (use experts from member organisations)	$125,000	Communication with stakeholders, general conferences, publicity material
Antarctic and Southern Ocean Environment	No	$15,000	Open public lectures, media interviews, talks to community groups, series of talks to key groups, artist in residence to create sculptural interactive display, visits to schools
Legumes in Mediterranean Agriculture	Yes part time 30%	$55,000	Farmer field days, technical training and update workshops, monthly seminars, input to University lectures, post doctoral research program, organised tours
Molecular Engineering and Technology: Sensing and Diagnostic Technologies	No	None (could use contingency fund)	Communication with CRC's and research groups, we actively avoid media exposure

Table 2

Other R&D organisations communication

Organisation	Number of Staff	Budget (excluding salaries)	Objectives	Target Audiences	Methods
Australian Nuclear Science and Technology Organisation (ANSTO)	3 full time and 2 part time	$250,000	1. Market services to specific industrial users 2. Inform public of activities 3. Inform local organisations and residents of issues related to safety	1. Industrial users 2. Public 3. Local organisations and residents 4. Government agencies	Brochures, articles, TV stories, advertisements in trade magazines, weekly article in local newspaper, fact sheets, "Nuclear science" for school teachers, courses for science teachers, regular briefings for industry, local liaison fora, open days, exhibitions, community talks
Australian Institute of Marine Science (AIMS)	3 full time and 3 part time	$100,000	1. To produce corporate publications to reflect the corporate image 2. To establish media liaisons to raise public profile 3. To assist scientists with graphics and photographic work	1. Other scientists 2. Users of marine science research 3. Government departments 4. General public	Publications, leaflets, videos, press releases, trade shows, exhibitions, biennial open day
Defence Science and Technology Organisation (DSTO)	19 full time and 1 part time	$700,000	To communicate the work of the organisation to key stakeholders, clients and the general public	1. Australian Defence Force 2. Dept of Defence 3. Government 4. Industry 5. Staff 6. Science community 7. General public	Printed material, use of mass media, displays, videos, personal contacts, presentations

Australian Antarctic Division	2 full time and 1 0.2 of a management position	$29,000	To develop understand and knowledge of Australia's Antarctic program and policies through information and education sources	1. Australian public (media and schools in particular) 2. Australian and international scientific communities involved in polar research 3. Special interest groups (eg. conservation groups) 4. Other influential groups or persons (eg. politicians, academia)	Pamphlets, talks, brochures, posters, media releases, maps, quarterly magazine, provision of berths to those who can offer wide exposure of the programs

Table 3

Science and technology museums

			BUDGET			
Name of Museum/Centre	General Activities	Number of Visitors from last available figures	Govt Funds	Admission Fees	Other	Total
The Sydney Children's Museum Inc.	Displays - Electricity, Computer, Lego, Hospital, Bubble, T.V. Studio, Air. Play - Creative, Co-operative, Touch & Feel, Infinity, Outreach program to cater for special needs groups	40,000	$10,000	$138,310	$76,885	$225,195
The Investigator Science and Technology Centre	Public visitors centre, with approximately 100 interactive exhibits, Hands-on, Science centre. Regular 25 minute science "shows" including demonstrations and public interaction. Science shop. Public lecture series. "Reachout", mobile science exhibits/shows to country areas. School holiday program for children. Special weekend/evening activities on various themes.	137,826	-	$647,000	$261,050	$908,050
Queensland Sciencentre, Museum	170 Exhibits - emcompassing Liquids, Gases, Heat, Magnetism, Electricity, Light, Rotation, Inertia, Gravity, Perception, Physiology & Maths	120,000	Concession on building lease fees	$341,000	$10,000	$351,000

Scitech Discovery Centre	Range of over 160 exhibitions including touching, pulling, pushing, climbing, listening to, taking apart or putting together - by "kids" of all ages.	215,298	$1,350,000	$1,378,300	$1,250,550	$3,978,850
Questacon - The National Science and Technology Centre	Nearly 200 exhibits. Visitors to the centre, with its six galleries, can pull levers, throw balls, control robotic microscopes, and get their feet, ands and whole bodies onto the exhibits. Exhibits cover elements of physics, biology, mathematics, optics and environmental issues.	331,059 Plus 150,000 to outreach programs	$4,209,000	$1,422,000	$1,705,000	$7,336,000
Powerhouse Museum - Museum of Applied Arts and Sciences	Range of displays including exhibitions and interactive exhibitions.	714,529	$22,705,000	$1,408,000	$7,302,000	$31,415,000
Scienceworks	Events, objects, audiovisuals, interactives, pre and post visit projects, school kits and other community resources.	385,000				
The Earth Exchange	Range of exhibitions - Geology, mining, energy and the Australian environment. 60% of exhibits Hands-on.	118,092	$1,655,000	$618,000	$1,882,000	$3,917,000

Table 4. Australian newspaper circulation[59]

Newspaper	State/National	Circulation	S&T journalist
The Australian	national	148,804	Mr Julian Cribb
Australian Financial Review	national	73,514	Nil
Sydney Morning Herald	New South Wales	266,699	Mr Richard Macey
The Daily Telegraph Mirror	New South Wales	438,185	Nil
Canberra Times	Australian Capital Territory	47,225	Mr David Mussared
Courier-Mail	Queensland	250,875	Mr Brendan O'Malley
The Advertiser	SouthAustralia	218,778	Mr Chris Brice
The Age	Victoria	237,474	*Dr Graeme O'Neill
Herald Sun	Victoria	575,317	Nil
West Australian	West Australia		
The Mercury	Tasmania	53,226	Nil
Northern Territory News	Northern Territory	20,356	Nil

* Graeme O'Neill recently resigned and was succeeded by Ms Tanya Ewing.

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