INSPIRING AUSTRALIA

A NATIONAL STRATEGY FOR ENGAGEMENT WITH THE SCIENCES

A report to the Minister for Innovation, Industry, Science and Research

For more information about this report please contact:

Manager
Science Communication and Strategic Partnerships
Questacon – The National Science and Technology Centre
Department of Innovation, Industry, Science and Research
PO Box 5322
Kingston ACT 2604

Telephone: +61 2 6270 2800
Facsimile: +61 2 6270 2808
Email: **Inspiring.Australia@innovation.gov.au**

You can access this report from the Department's Internet site at:

http://www.innovation.gov.au/

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Australian Government
Department of Innovation
Industry, Science and Research

Industry House, 10 Binara Street
CANBERRA CITY ACT 2601

GPO Box 9839
Canberra ACT 2601 Australia

Phone: +61 2 6213 6670
Facsimile: +61 2 6213 6657

Email: patricia.kelly@innovation.gov.au
Web: www.industry.gov.au

ABN: 74 599 608 295

Senator the Hon Kim Carr
Minister for Innovation, Industry, Science and Research
Parliament House
CANBERRA ACT 2600

Dear Minister

I am pleased to present to you the report Inspiring Australia: a national strategy for engagement with the sciences.

The Report is the product of significant research, broad consultations and, in particular, valuable input by CSIRO, the ABC and the Chief Scientist to the work of the Steering Committee. The Committee was encouraged by the breadth and diversity of science communication initiatives carried out by many organisations and individuals across Australia.

Nevertheless, Australia requires a national strategy that will mobilise and connect such activity, which is largely uncoordinated and fragmented. Many Australians are yet to engage with the sciences in ways that will enable them to participate fully in a society which embraces the Australian Government's innovation agenda.

This report and its recommendations propose a way forward for national leadership and coherent action in public engagement that will further harness the potential of Australia's investment in the sciences.

Yours sincerely

Patricia Kelly
Chair of the Steering Committee for a National Science Communications Strategy

14 December 2009

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Preface

Several previous government reports have indicated that existing science awareness activity required better coordination and refocusing of objectives, and that a higher priority needed to be placed on strategic leadership and policy formulation. These reports included the following:

- PMSEIC Working Group on Science Engagement and Education, *Science Engagement and Education,* 2003[i]
- Coordination Committee on Science and Technology, *Audit of Science Education and Awareness Initiatives* by Federal Government departments and agencies for the 2006–07 financial year[ii]
- DIISR *Review of Questacon — The National Science and Technology Centre*, 2008
- Cutler review, *Venturous Australia: Building Strength in Innovation*, 2008[iii]
- Evaluation of DIISR's Science Connections Program (SCOPE), 2009.[iv]

In 2009, the Questacon Division of DIISR was asked to examine these findings and to design a replacement for the SCOPE program, which terminates in 2011.

A Steering Committee, comprising the Chief Scientist for Australia, the Chief Executive of CSIRO, the Director of Questacon — The National Science and Technology Centre, a representative of the ABC and a DIISR Deputy Secretary as chair, was established. The Committee set the terms of reference for the development of a national science engagement strategy, which are to undertake an analysis of the existing science communication sector, conduct a program of consultations across Australia and develop a five-year plan in response.

The Director of Questacon and staff of the Division arranged and undertook consultations with a wide range of science communicators, educators, journalists and scientists in all states and territories. More than 230 people were consulted. The list of participants is in Appendix 1, and an overview of the findings is in Appendix 2. Individuals and organisations were also invited to make written submissions, and 22 were received. These are also incorporated into Appendix 2.

A study was commissioned of the science interests and needs of a typical regional centre, Ballarat (Appendix 3), and a Humanities and Science Workshop was held to solicit views of key academics from the social sciences and humanities disciplines (Appendix 4). A youth view was obtained from former participants of the National Youth Science Forum (Appendix 5).

Care was taken to consider communicating science and its benefits as broadly as possible, drawing participants not only from the natural and physical science disciplines, mathematics, engineering and health sciences, but also from the humanities, arts and social sciences.

The Minister for Innovation, Industry, Science and Research, Senator the Hon Kim Carr, has emphasised the importance of including the latter disciplines[v]:

> The humanities, arts and social sciences are absolutely central… First, they drive innovation themselves…. Second, they raise the standard of scientific and technical innovation by shining an inquiring and sometimes critical light on its ethical, historical, cultural and social consequences…. Third, they give people the skills they need to use the innovations coming out of our laboratories and R&D centres…. And fourth, they empower individuals and communities to deal with change—whether by adapting to it, or by asserting their own view of how it should happen.

Thus, the social sciences are considered essential for problem-solving in a societal context, while the humanities and the arts have the potential to connect with the public in ways that traditional science communication cannot.

State and territory consultations, held to support the development of this report, have proved an invaluable exercise. Not only have the participants made many worthwhile suggestions, but their comments have helped to sharpen the focus of the report. They have also highlighted some outstanding leadership—both within particular disciplines, such as mathematics; and within particular states, such as Victoria with respect to attitude surveys and Western Australia with respect to Web portals.

A range of activities was considered for communicating science—from telling Australia's story abroad and briefing politicians and policy makers, to enhancing the role of the media and staging novel events to stimulate interest and encourage dialogue.

In addition, relevant recent documents produced by the Federal Government and by state and overseas governments were examined to ascertain the current science communication context and trends. These are discussed further in section 1.8.

Although the focus of this report is much wider than the Innovation, Industry, Science and Research portfolio, DIISR will assume the leadership and coordinating role. The report sets the framework for cooperation and collaboration across Federal Government portfolios, jurisdictions, the private sector and community organisations.

Definitions

In this strategy, 'science' or 'the sciences' refers to the following:

- the natural and physical sciences, such as biology, physics, chemistry and geology
- the applied sciences, such as engineering, medicine and technology
- newly emerging and interdisciplinary fields, such as environmental science, nanotechnology and phenomics
- mathematics, a field of study in its own right, as well as an essential tool of the sciences
- the social sciences and humanities, critical to the interface between science and society.

This definition is far wider than test-tubes and lab coats. According to the Minister for Innovation, Industry, Science and Research, Senator the Hon Kim Carr, it means 'knowledge of the world.' As he stated recently[vi]:

> … the CSIRO has found that many of the problems it is working on cannot be solved by focusing solely on the biophysical dimension—problems like water scarcity, resource management and climate change. If we want to find solutions to these problems, we have to understand the social, behavioural and institutional dimensions as well. That's why the CSIRO is relying more and more on economists, human geographers, planners, sociologists and other specialists in the humanities and social sciences to provide the answers.

Inclusion of the social sciences and humanities as part of the sciences is especially relevant to discussions of public engagement with the sciences, science and society, and capacity building in the science communication sector. Public engagement requires not only awareness of the technical aspects of issues such as nuclear power or smoking, but also of the societal and attitudinal aspects.

For Australia to progress, contributions will be required not only from the natural and physical sciences, but also the social sciences, arts and humanities. Full exploitation of the benefits of the sciences will require attitudinal and behavioural changes in individuals, companies and communities in order to make a difference.

The phrase 'science and science-related areas' is also used. 'Science-related areas' refers to fields that are not strictly science, but need to draw on science knowledge or expertise. For example, science-related areas include health promotion, science teaching, nursing, agriculture, science and environmental policy development, etc.

'Communicating science and its benefits' refers to the wide range of activities that allow the public to interact with science, scientists and scientific issues and processes. In this report, it is often shortened to 'communicating science'. Again, it is important to acknowledge that communicating science is *not* just the role of the natural and physical sciences. To

understand, influence and change people's attitudes about complex scientific issues also requires the knowledge base of the humanities, arts and social sciences.

It is accepted that there are many different levels and kinds of science communication, with many organisations and individuals involved using many different media. The terms 'science communication' and 'communicating science' are used interchangeably; however, 'communicating science' is generally preferred, as it implies a more interactive process.

Finally, this report, *Inspiring Australia: A National Strategy for Engagement with the Sciences*, is referred to interchangeably as the 'national strategy' or the 'national initiative'.

Acronyms

Acronym	Definition
ABC	Australian Broadcasting Corporation
ANZAAS	Australian and New Zealand Association for the Advancement of Science
ARC	Australian Research Council
ANSTO	Australian Nuclear Science and Technology Organisation
ASTA	Australian Science Teachers Association
CAMD	Council of Australasian Museum Directors
CCI	Coordination Committee on Innovation
CCST	Coordinating Committee on Science and Technology
CRC	Cooperative Research Centre
CREST	Creativity in Science and Technology awards administered by CSIRO Education
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEEWR	Department of Education, Employment and Workplace Relations
DIISR	Department of Innovation, Industry, Science and Research
DSTO	Defence Science and Technology Organisation
FASTS	Federation of Australian Scientific and Technological Societies
ICT	Information and communication technology
NHMRC	National Health and Medical Research Council
PMSEIC	Prime Minister's Science, Engineering and Innovation Council
R&D	Research and development
SCOPE	Science Connections Program
STI	Science, technology and innovation
TAFE	Technical and further education

Executive summary

Sharing knowledge powers innovation. To fully realise the social, economic and environmental benefits of our significant investment in science and research, we must communicate and engage the wider community in science. Australia aspires to an innovative society with a technologically skilled workforce, a scientifically literate community and well informed decision makers. The *'Inspiring Australia'* strategy aims to build a strong, open relationship between science and society, underpinned by effective communication of science and its uses.

This *Inspiring Australi*a report on communicating science in Australia proposes a national strategic initiative that will help realise the goals articulated in *Powering Ideas: An Innovation Agenda for the 21st Century.*

Inspiration is simply too important to leave to chance. Now is the time to motivate and inspire young Australians to get involved with science and science-related issues to help solve the environmental, economic, social and humanitarian problems facing our country and the world.

This initiative will establish, for the first time in Australia, a national approach for community engagement with the sciences; it will increase the return on investment in research institutions, infrastructure and programs now and into the future.

This report acknowledges that the sciences—comprising the natural and physical sciences, the humanities, the arts and the social sciences—are fundamental elements of a 21st century creative economy. They underpin the continuing improvements in living standards that Australians expect and deserve.

The aspirational goal is for a scientifically engaged Australia—a society that is inspired by and values scientific endeavour, that attracts increasing national and international interest in its science, that critically engages with key scientific issues and that encourages young people to pursue scientific studies and careers.

If the communication of science is to be effective, it needs to recognise the audiences to be engaged. Activities need to be appropriate and relevant to local communities, and contextualised to acknowledge and value local perspectives. Activities need to build on each other, providing pathways to develop awareness and involvement.

THE CHALLENGE FOR AUSTRALIA

The Australian Government has made an unprecedented commitment to the advancement of scientific research in Australia, through 'Super Science' and other projects in areas including astronomy, space, marine science, climate change, clean energy, biological discovery, biotechnology development, nuclear science, nanotechnology and advanced ICT.

The Government has also made a strong commitment to support university research and business commercialisation.

Much of the Australian population, however, would not be aware of these commitments nor of their importance to Australia's economic prospects and the well-being of future generations. Neither is there a broad awareness overseas, especially among Australia's trading partners, of Australia's strengths in science and research.

Nationally, an awareness and understanding of why science and research are critical to our lives is essential for developing and sustaining an innovation culture. Internationally, Australia must fight hard to hold its place and advance its reputation as a first-class science and research performer and preferred partner in world-leading research collaborations.

To harness the full potential of its investment in the sciences, Australia requires a continuing supply of scientists, technologists, mathematicians and engineers to undertake research, generate knowledge and solve problems; a strong base of institutions, infrastructure and resources to secure Australia's future as a knowledge economy; decision makers and opinion leaders who have an appreciation of science and its contribution to solving complex issues; and a strong, open relationship between science and society, underpinned by effective communication of science and its benefits.

Australia is investing strongly in its research base and education. As we approach a future increasingly dominated by complex issues that require openness, dialogue and confidence in our science institutions, scientists and policy makers, the time is right to address the relationship between science and society.

ACTIONS REQUIRED

In order to achieve a scientifically engaged Australia, it will be necessary to develop a culture where the sciences are recognised as relevant to everyday life and where the government, business, and academic and public institutions work together with the sciences to provide a coherent approach to communicating science and its benefits.

It will require leadership by the Australian Government and a coordinated national framework for public engagement—a framework that recognises and harnesses the range of national, state and community-based activities undertaken by both professionals and volunteers and that is supportive of the conditions for increased participation and debate.

The national framework will be developed from existing key national infrastructure—CSIRO Education and Outreach and the state-based CSIRO Science Education Centres, the ABC multi-platform media network and Questacon—working with state-based science centres and museums, research agencies, universities, professional bodies, academies, the media, the business sector and community-based organisations.

The constituent parts of the national science engagement effort, as well as the links between those parts, will need to be strengthened, drawing on the natural and physical sciences, the humanities, the arts and the social sciences.

Australia must now implement sophisticated strategies to improve the promotion of our science and research achievements nationally and internationally. Our science institutions will be expected to share their knowledge to help realise full social, economic, health and environmental benefits of scientific research and in return win ongoing public support.

Institutions and policy makers will need to appreciate the importance of public engagement activity, support increased training and recognition for science communication practitioners, and seek, acknowledge and respond to public perspectives on science.

Australia's science communication providers have proved capable of generating many successful and effective activities. This national initiative will develop an appropriate balance between sustaining successful existing programs and creating new, strategically targeted programs reaching out to those not engaged through traditional science communication channels.

An effective national strategy cannot be delivered by governments or organisations acting alone. Concerted action is needed to ensure that the communication of science and its benefits has a coherent vision and direction.

WHAT HAS LED TO THIS

In 2003 a PMSEIC Working Group on Science Engagement and Education made a series of recommendations, some of which have been implemented (for example, *Primary Connections* and *Science by Doing*). A recommendation for coordinated outreach activities through a National Framework—Local Action model has yet to be introduced.

In 2007 Questacon undertook an audit of science awareness and education activities from Federal Government departments and agencies on behalf of the Coordinating Committee on Science and Technology and noted a large number of uncoordinated activities.

In 2008 there was a major review of the roles and responsibilities of Questacon — The National Science and Technology Centre, which recommended strengthening Questacon's resourcing and the development of stronger links with CSIRO and the ABC.

In 2008 the *Venturous Australia: Building Strength in Innovation* review urged the Government to facilitate favourable conditions for technological development, including through fostering public awareness and community engagement.

In 2009 Questacon was asked to undertake national consultations to inform the design of a replacement for the DIISR Science Connections Program (SCOPE), which terminates in 2011.

A Steering Committee was established to guide this work; it comprised the Chief Scientist for Australia, the Chief Executive of CSIRO, the Director of Questacon, a senior representative of the ABC and a Deputy Secretary from DIISR as chair.

Consultation was undertaken with a wide range of science communicators, educators, journalists and scientists in all states and territories. More than 230 people were consulted.

Individuals and organisations were also invited to make written submissions, and 22 were received. A study was commissioned of the science interests and needs of a typical regional centre, Ballarat, and a youth view was obtained from former participants of the National Youth Science Forum.

Care was taken to consider the communication of science as broadly as possible, drawing participants not only from the natural and physical sciences, mathematics, engineering and technological sciences, but also from education, social sciences and humanities. A Humanities and Science Workshop was held to solicit views of key academics from the disciplines of social sciences and the humanities.

INSPIRING AUSTRALIA: A NATIONAL STRATEGY

This report, *Inspiring Australia: A National Strategy for Engagement with the Sciences*, sets out why communicating science effectively is vital for Australia and why national leadership and coherent action is required (Chapter 1. The challenge for Australia). The report articulates key principles and sets out measurable outcomes and recommendations.

Australia is a high-performing country in a wide range of areas across the sciences, and this has to be acknowledged nationally and globally with appropriate reward and recognition (Chapter 2. Telling Australia's story).

Australia has a small population in global terms and cannot afford to squander its brain power. Therefore, it is important to develop the potential and interest of Australians irrespective of geography, ethnicity, age or social condition (Chapter 3. Engaging all Australians).

A capable science workforce is a prerequisite for the Australian Government's *Innovation Agenda*. Thus, students need enhanced experiences in science and mathematics to help ensure an adequate supply of professionals with appropriate skills (Chapter 4. Building Australia's capacity).

To build on national leadership and coherent action, a national framework—local action approach, a strong Web presence and improved information flow and organisational networking are required to achieve the goal of a scientifically engaged Australia. A supportive research and evaluation program is also needed to monitor progress and inform investment decisions (Chapter 5. Mobilising capability across Australia).

Key principles and recommendations

A NEW INITIATIVE

Australia requires a vigorous, high-quality national strategy for public engagement with the sciences as a vital complement to its *Innovation Agenda.* Such a strategy would increase appreciation of science in Australian culture, facilitate informed citizen participation in decision making and science policy development, boost confidence in the Australian Government's research investment, and ensure a continuing supply of well-qualified science graduates.

Recommendation 1

That DIISR's terminating Science Connections Program (SCOPE) be replaced with a broader national initiative designed to increase the level of public engagement in the sciences. Such an initiative would provide ongoing support for existing, successful activities while developing innovative approaches to effectively engage a wider audience.

VISION AND PRIORITY SETTING

The goal of this national initiative is to create a scientifically engaged Australia—a society that is inspired by and values scientific endeavour, that attracts increasing international interest in its science, that critically engages with key scientific issues and that encourages young people to pursue scientific studies and careers.

Recommendation 2

That the Australian Government strongly articulate the goal of a scientifically engaged Australia and support development of strategic national priorities for communicating science and its benefits.

LEADERSHIP

A coordinated national strategy for science communication will require leadership by the Australian Government to stimulate collaboration and co-investment by governments across jurisdictions; by academic, cultural and professional institutions; by business and industry; and by community organisations.

Recommendation 3

That leadership for this national initiative be provided by Questacon within DIISR, with input from a broadly constituted national advisory group to guide implementation, monitoring and evaluation, and reporting.

COHERENT ACTION

To maximise the effectiveness of science engagement activities across the nation, the significant number of organisations and individuals involved in the natural and physical sciences, the humanities, the arts and the social sciences must work in a consistent direction towards reaching an agreed vision.

Recommendation 4

That a science communication summit be convened to secure buy-in from the diverse range of organisations and individuals in the science communication sector and to identify strategic priorities and the optimal roles for different agencies and institutions.

PRIDE IN AUSTRALIAN ACHIEVEMENT

A key element of the national initiative is to inspire a sense of national pride by promoting activities that recognise and reward the achievements and successes of Australians in the sciences.

Recommendation 5

That the national initiative include continued funding for the highly regarded Prime Minister's Prizes for Science, with an enhanced promotional strategy targeting the wider Australian community and international audiences.

INTERNATIONAL RECOGNITION

It is important for Australia to promote its science achievements and its significant potential for further contributions in global contexts, through a program of activities strategically targeting Australian and overseas audiences.

Recommendation 6

That the national initiative support promotional and awareness-raising activities, including travelling exhibitions showcasing Australia's capability in the sciences and promotional materials for scientists, science policy makers, overseas counsellors and other potential Australian science 'ambassadors' to use abroad.

SCIENCE AND SOCIETY

It is time for Australia to invest in a significant Science and Society program, aligned with Australia's *Innovation Agenda*, to empower and engage citizens in decision making and to inform policy development in the sciences and science-related areas.

Recommendation 7

That a national Science and Society forum be held annually to focus on the priorities for community engagement in science and key issues where science can serve the needs of society.

ENGAGING AUSTRALIAN COMMUNITIES

It is important that Australia continue to deliver high-profile, nationwide science engagement activities providing opportunities for the entire community to participate.

Recommendation 8

That the national initiative provide continued funding to extend the successful community-based activities of National Science Week, stimulating and leveraging further contributions by organisations across Australia and targeting new and under-served audiences.

BUILDING PARTNERSHIPS—USING NETWORKS

Australia requires effective mechanisms to facilitate public information flow and information sharing in the sciences, utilising the knowledge and resources of existing organisations and networks.

Recommendation 9

That the national initiative include collaborative projects that stimulate science organisations and networks across Australia to work together to promote information sharing, including holding 'Hot Science' briefings for elected members and policy officers of Federal, state and local governments, and leaders in the legal and business sectors.

STRENGTHENING THE MEDIA'S ROLE IN COMMUNICATING SCIENCE

Programs that increase the potential of media and new media coverage of the sciences need to be supported and encouraged.

Recommendation 10

That the national initiative support science communication and media training for scientists and that a short-term working group be established to review mechanisms for further developing Australian science media content.

A FOCUS ON YOUTH AND THE FUTURE

It is imperative for Australia to address identified skills shortages in the sciences by encouraging young Australian scientists to communicate science and young Australian students to further their studies and take up careers in the sciences.

Recommendation 11

That a key focus of the national initiative should be raising awareness among young people of opportunities in science and research. The Australian Government's investment in schools, higher education and research should be harnessed to achieve this.

UNLOCKING AUSTRALIA'S FULL POTENTIAL

To ensure a more equitable Australia, a special focus is required to maximise the potential of people who may not previously have had interest in or access to science engagement activities.

Recommendation 12

That the national initiative support science communication exhibitions and programs that target under-served groups, such as those living in outer metropolitan, regional and remote areas; Indigenous communities; people for whom English is a second language; and people who are disabled or have limited mobility.

NATIONAL FRAMEWORK—LOCAL ACTION

Australia requires a 'national framework—local action' approach to deliver an effective and efficient national initiative that mobilises and connects otherwise uncoordinated, overlapping and fragmented activities.

Recommendation 13

That a 'national framework—local action' approach be adopted, led by a national hub collaborating with federal and state jurisdictions, business and the community. Such an approach should aim to increase cooperation amongst organisations involved in science communication down to the regional level, and drive partnerships and complementary activities.

UTILISING NEW MEDIA

The use of the Web and digital technologies in science communication is essential to capture new audiences in a cost-effective way; it should be a central element of the national initiative. The National Broadband Network will expand opportunities for exploiting these technologies.

Recommendation 14

That the national initiative include development of a national Web presence to increase the visibility of Australian science to national and international audiences, and to promote links to other relevant science-related sites.

DEVELOPING AN EVIDENCE BASE

Australia requires a strategic research and evaluation capability to design, target and review effective science engagement activities and to guide future investment.

Recommendation 15

That the national initiative support a program of research in science engagement—such as baseline and longitudinal attitudinal and behavioural studies, activity audits, program evaluations and impact assessments—to inform future investment decisions by government and its partners.

1 The challenge for Australia

By 2020, the Australian Government envisions a greater capacity '… to create jobs, build prosperity, save lives, eliminate disadvantage, protect our fragile planet, and increase happiness.' These outcomes are expected as a result of the major financial commitment made by the Australian Government in the May 2009 budget paper, *Powering Ideas: An Innovation Agenda for the 21st Century*.[vii]

These outcomes rely on the development and effective application of science to new products and services. But they also rely on an Australian public that is aware of and involved with science and science-related issues that affect their personal lives, their communities, their nation and the world—that is, 'a scientifically engaged Australia'.

This financial year, the Australian Government will spend about $8.6 billion on support for research and innovation[viii]—but only a small fraction of this on communicating the results to a wider audience and thereby securing full economic, educational, environmental, social, inspirational and political value from it.

Of an estimated 10 000–12 000 scientific research projects carried out in Australia each year, the results of fewer than 2000 are announced publicly.[ix] The public pays for much of this research and should be entitled to know the outcomes.

Nationally, an awareness and understanding of why research in the sciences is so central to our lives is essential for developing and sustaining an innovation culture. Internationally, in the intensely competitive world of research, Australia must fight hard to hold its place and advance its reputation as a first-class performer and preferred partner in world-leading collaboration.

Research in the sciences is fundamental to a 21st century economy. It underpins the continuing improvements in living standards that Australians expect and deserve. Many Australians do not fully understand or appreciate this relationship. Communicating science and its benefits will promote such understanding and appreciation.

This *Inspiring Australi*a report on engagement with the sciences in Australia proposes a strategic initiative that will help realise the goals articulated in *Powering Ideas: An Innovation Agenda for the 21st Century.* It will establish, for the first time in Australia, a national approach for the communication of science and its benefits to a broad range of stakeholders, including policy makers and the public, to create 'a scientifically engaged Australia'. This approach will increase the return on investment in research institutions, infrastructure, people and programs, now and into the future.

Many of the policies and programs proposed in this report fall within the Department of Innovation, Industry, Science and Research (DIISR) portfolio, but inevitably the focus of the report is much wider. It sets the framework for cooperation and collaboration across Federal Government portfolios, state jurisdictions and the private sector. It falls to DIISR, which is

currently responsible for the Science Connections Program (SCOPE) terminating in 2010–11, to provide leadership and mechanisms for coordination and networking.

The specific components of the strategy, and the section that addresses each component, are as follows:

- what 'a scientifically engaged Australia' means (section 1.1)
- why an investment in science communication is required (section 1.2)
- who science communication is being aimed at (section 1.3)
- who the providers are (section 1.4)
- what leadership is required (section 1.5)
- how coherent action can be initiated (section 1.6)
- what problems exist (section 1.7)
- what programs are required (Chapters 2, 3 and 4)
- how these programs can be coordinated and evaluated (Chapter 5).

Inspiration is simply too important to leave to chance. There is an urgent imperative to motivate and inspire young Australians and the wider community, leading to greater engagement with the sciences and science-related issues. Such engagement will help solve the environmental, economic, social and humanitarian problems facing our country and the world.

1.1 What is meant by 'a scientifically engaged Australia'?

To harness the full potential of its investment in the sciences, Australia requires:

- a continuing supply of scientists, technologists, mathematicians and engineers to undertake research, generate knowledge and solve problems
- a strong base of institutions, infrastructure and resources to secure Australia's future as a knowledge economy
- decision makers and opinion leaders who have an appreciation of science and its contribution to solving complex issues
- a robust, open relationship between science and society, underpinned by effective communication of science and its benefits.

The goal of this national initiative is to develop the relationship between science and society, and thus enable the sciences to achieve greater value by creating 'a scientifically engaged Australia'. By this we mean a society that is inspired by and values scientific endeavour, that attracts increasing national and international interest in its science, that critically engages

with key scientific issues and that encourages young people to pursue scientific studies and careers.

Over the next three to five years, this national initiative will implement programs aimed at creating a scientifically engaged Australia, with outcomes as described in sections 1.1.1 to 1.1.4 below.

1.1.1 Outcome 1: A society that is inspired by and values scientific endeavour

This means that Australia provides reward and recognition for our scientific achievements; that the public is proud of these achievements; and that they can easily learn more about them through sources such as the radio or television news, the internet, public festivals or events, school teachers or the local library.

We will know we are achieving this outcome when each year, through surveys, an increasing majority of 'ordinary people'—especially those who claim they are not interested in science—are aware of Australia's participation in international scientific research. They can name some of Australia's leading research scientists, not just our footy stars. They can refer to fields, such as astronomy or marine biology, where we are among the world's leaders, and they can identify the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and other research agencies and describe briefly some of their activities.

1.1.2 Outcome 2: A society that attracts increasing national and international interest in its science

This means that our near neighbours and our trading partners—and especially those countries targeted for research and development (R&D) cooperation—perceive Australia as an innovative country and are aware of Australia's research strengths. They know which institutions are leaders in their field, and they want to initiate contact. They also want to invest in our science- and technology-led industries, such as pharmaceuticals, photovoltaics and molecular farming.

We will know we are achieving this outcome when, measured annually, there is growth in international research partnerships and inward investment, an increasing number of overseas university staff take research sabbaticals and exchanges in our universities and research institutions; an increasing number of Australian researchers are invited to give papers at overseas meetings and conferences; and an increasing number of overseas students apply to study for master's and PhD degrees in science, engineering and mathematics in Australian universities and undertake post-doctoral research in Australian institutions.

1.1.3 Outcome 3: A society that critically engages with key scientific issues

This means that people find out about, speak up and act on scientific, environmental and health issues that affect them. Such issues may be local, national or global. Not every person engages with every issue, but overall, the population is aware of the major issues and takes small but positive steps towards resolving them.

We will know we are achieving this outcome when, measured regularly, the commercial television and radio stations present an increasing number of science programs and news items; the Australian Broadcasting Corporation (ABC) increases the percentage of its budget allocated to science-related programming; print and Web news services offer an increasing number of science-related articles and letters to the editor; people talk about the sciences in social settings; the number of public science-related events increases, as does attendance at these events; and targeted behavioural modifications linked to major science promotional campaigns show an appropriate change.

1.1.4 Outcome 4: A society that encourages young people to pursue scientific studies and careers

This means that those organisations with a vested interest in education and career guidance work in a coordinated way with schools and state education departments to stimulate and motivate young people to consider careers in science.

We will know we are achieving this outcome when an increasing number of students enrol in science and advanced mathematics subjects throughout high school; an increasing number of students, especially those from outer metropolitan, regional and remote areas, participate in science clubs, camps, challenge events or other special programs; an increasing number of students access information about science careers through well regarded Web sites; and research institutes, universities, and science and engineering companies offer students an increasing number of opportunities to undertake visits, work placements and internships.

1.2 Why should Australia invest in communicating science?

There are four key reasons why the Australian Government should invest in science communication, alongside investing in science. These are to increase appreciation of science in Australian culture, facilitate informed citizen participation in decision making and science policy development, boost confidence in the Australian Government's research investment and ensure a continuing supply of well-qualified science graduates.

1.2.1 Increasing appreciation of science in Australian culture

Science is integral to Australian culture. It is important that Australians know about, appreciate and discuss science in an Australian context, just as they know about, appreciate and discuss history, the arts or sport. In a study of community interest and engagement with science in Victoria, 45 per cent of respondents indicated they saw and heard too little information about science, compared to 45 per cent who saw and heard the right amount and 6 per cent who saw and heard too much.[x]

Communicating science well can create positive and appreciative attitudes, regardless of people's feelings about science. *How?* Interactive science and technology centres, museums, zoos and botanical gardens build understanding in engaging and non-threatening ways. The ABC offers science, health and environmental television and radio programs that inform while they entertain, and a Web site where people can find information and give feedback.

Science festivals and one-off events are newsworthy activities that can project a 'wow' factor and inspire people to further their interests in a topic.

1.2.2 Facilitating informed citizen participation in decision making and science policy development

With a greater awareness of science and scientific processes, the community is more capable of engaging with and utilising science information on a needs basis, and more confident in participating in public discussion and contributing to informed decision making. Such awareness helps create knowledgeable and discerning purchasers of food, transportation, energy, medical services and consumer goods; it also creates more sustainable communities.

The 2005 Eurobarometer study found that 58 per cent of European Union citizens did *not* agree with the statement that 'the public is sufficiently involved in decisions about science and technology'.[xi] Informed public discussion and debate are necessary to deal with many of the complex, multi-factorial issues now facing our communities and our nation—from water shortage, land degradation, decreasing biodiversity and global warming to cancer and heart disease, obesity, genetically modified organisms, pandemics, food security, nanotechnology and stem cell research.

Communicating science can contribute to critical thinking and informed discussion and decision making. *How?* Science briefings provide politicians, policy makers, chief executives, investors, judges and other opinion leaders with authoritative background knowledge. Well-trained science journalists present complex issues clearly and succinctly to a broad audience through the print and broadcast media, as well as through Web sites and blogs. Public hearings and consultations give citizens an opportunity to listen to the views of scientists and to present their own ideas and opinions in an open forum.

1.2.3 Boosting confidence in the Australian Government's research investment

The more familiar that people are with science and scientific processes, the more likely they are to support the Government's investment in it[xii]. They understand that research takes time and that it may not yield results in the short term. The Pew Research Center survey conducted for the American Association for the Advancement of Science found that 73 per cent of respondents thought that government investment in basic scientific research paid off in the long run; and given the power, 39 per cent said they would increase funding for scientific research, 40 per cent said they would keep to current spending levels, and only 14 per cent said they would decrease it.[xiii]

Communicating science can contribute to maintaining public support. *How?* News articles, information brochures and Web site information written in lay terms make the public aware of the types of research being funded and what Australia hopes to achieve. Chief scientists and other spokespeople can create enthusiasm for discoveries and inventions, as can exhibitions and public forums.

1.2.4 Ensuring a continuing supply of well-qualified science graduates

To support the many projects coming onboard through the *Innovation Agenda*, Australia will need an increasing supply of well qualified and inventive scientists, mathematicians and engineers, as well as science and mathematics teachers and lecturers. Unfortunately, however, there has been a decrease in the percentage of students studying science and more-demanding mathematics subjects.[xiv] At university level, the sciences have not been attracting enough of the 'best and brightest', except for veterinary, medical and dental studies.[xv]

To try to deal with this problem, the Australian Government has lowered the HECS fees for science undergraduates and increased the number of postgraduate fellowships. Some of the state governments have developed 'fast track' programs for science graduates who want to move into science teaching.

But students need more immediate incentives. As indicated in the 2005 Eurobarometer study, an average of 82 per cent of respondents from the 25 European Union member states agreed, as against only 5 per cent who disagreed, that 'young people's interest in science is essential for our future prosperity'.[xvi]

Schools, teachers, and state education departments are key to addressing this problem. The Department of Education, Employment and Workplace Relations (DEEWR) is coordinating the development of a national curriculum covering science and mathematics, and is considering additional ways in which the Federal Government can assist school science education.

Communicating science more widely is important to create student interest in pursuing careers in science. *How?* Well chosen scientists, engineers and mathematicians telling their personal stories can be inspirational role models. Promotional campaigns can make students aware of the importance of 'sticking with' mathematics and science through high school to increase their employment options. Science clubs, camps and challenge events can inspire students who show special interest or promise. The internet can provide students and their parents with up-to-date and relevant information about a wide range of science careers, and research institutions can open their doors to provide speakers, guided tours and work placements.

In the way that the moon landing inspired a generation and inspired the world, we need to inspire our young people. They will be the ones to develop solutions to the challenging science and science-related issues facing the world and future generations.

A NEW INITIATIVE

Australia requires a vigorous, high-quality national strategy for public engagement with the sciences as a vital complement to its *Innovation Agenda.* Such a strategy would increase appreciation of science in Australian culture, facilitate informed citizen participation in decision making and science policy development, boost confidence in the Australian Government's research investment and ensure a continuing supply of well-qualified science graduates.

Recommendation 1

That DIISR's terminating Science Connections Program (SCOPE) be replaced with a broader national initiative designed to increase the level of public engagement in the sciences. Such an initiative would provide ongoing support for existing, successful activities while developing innovative approaches to effectively engage a wider audience.

1.3 Who does this national strategy target?

Australia is made up of individuals and groups. To communicate with and engage them in the sciences requires an understanding of their nature and character. Who are they? How do they think? What are their habits? What are their attitudes to the sciences? What can influence those attitudes? What behaviours do they exhibit in relation to the sciences? What can be done to change these behaviours?

Australians vary greatly in how much they are aware of and how interested they are in the sciences. In the past, when science communicators talked about *groups* such as 'young people' or 'the general public' or 'scientists', they treated these groups as if they were homogeneous. For example, the 2007 Coordination Committee on Science and Technology *Audit of Science Education and Awareness Initiatives* listed 26 different audience groups, of which four—students and teachers, adults, the general public, and scientists and researchers—were targets for more than 30 per cent of the activities.[xvii]

But groups are not always homogeneous. Communicating science effectively requires an understanding of group members' attitudes and behaviours, and what shapes public opinion. As Nisbet and Schefele[xviii] stated recently:

> Over the past few years, there have been signs of a gradual shift in how the scientific community in the United States views public engagement. One can detect a growing recognition that effective communication requires initiatives that sponsor dialogue, trust, relationships, and public participation across a diversity of social settings and media platforms. Yet, despite notable new directions, many communication efforts continue to be based on ad-hoc, intuition-driven approaches, paying little attention to several decades of interdisciplinary research on what makes for effective public engagement.

A strong message from the state and territory consultations was that communicating science must not be a one-way channel out, telling the public what they should know or believe. To create a scientifically engaged Australia, it must be a multi-way channel—ears as well as

voices—facilitating public dialogue with scientists and policy makers, intellectual involvement and active participation.

Another strong message was that most communication activities are conducted under short-term funding—often for one year or two years. For activities to develop sustainable operations and to have impact, they require longer-term funding arrangements. This is even more critical for those activities carried out in remote areas where it takes time to build effective working relationships.

VISION AND PRIORITY SETTING

The goal of this national initiative is to create a scientifically engaged Australia—a society that is inspired by and values scientific endeavour, that attracts increasing interest from overseas, that critically engages with key scientific issues and that encourages our young people to pursue scientific studies and careers.

Recommendation 2

That the Australian Government strongly articulate the goal of a scientifically engaged Australia and support development of strategic national priorities for communicating science and its benefits.

1.3.1 What does research show about attitudes toward science?

In June 2007 a research report prepared for the Victorian Department of Innovation, Industry and Regional Development analysed community interest and engagement in science in Victoria. It identified six segments of the Victorian population:

- *Segment 1*: 23 per cent of the population
  Interested in science, but not active in searching for science information
- *Segment 2*: 27 per cent of the population
  Interested in science, active in searching for science information and able to find information they can easily understand
- *Segment 3*: 16 per cent of the population
  Interested in science and active in searching for science information, but either unable to find it or having difficulty in understanding it if they find it
- *Segment 4*: 8 per cent of the population
  Neutral towards science and not actively searching for science information
- *Segment 5*: 19 per cent of the population
  Not interested in science and not actively searching for science information
- *Segment 6:* 8 per cent of the population
  Neutral towards or not interested in science, but active in searching for science information.[xix]

(Note that these segments do not add to 100 per cent because of rounding.)

Despite only 27 per cent of the population (Segment 2) being interested, active and able to understand science information, a much higher percentage expressed positive interest in the impact science makes in several areas. These include health and medicine (97 per cent), water (95 per cent), the environment (93 per cent), climate change (91 per cent), food (84 per cent) and communications (81 per cent).[xx]

A survey in March 2008 by the Research Councils UK and UK Department for Innovation, Universities and Skills on *Public Attitudes to Science* looked at attitudes by various groups, including the adult population, youth aged 16–24, and ethnic minorities. Through cluster analysis, the study identified five attitudinal groups. These were the confident (21 per cent), the sceptical enthusiasts (14 per cent), the less confident (25 per cent), the distrustful (17 per cent) and the indifferent (22 per cent).[xxi]

Again, despite the unsympathetic orientation of most of these groups, 95 per cent of the respondents as a whole were moderately or very interested in health issues, 89 per cent in environmental issues, 88 per cent in medical discoveries, 79 per cent in new inventions and technologies, and 77 per cent in new scientific discoveries. The interest in all categories has increased since 2000.[xxii]

1.3.2 What are the implications of this research?

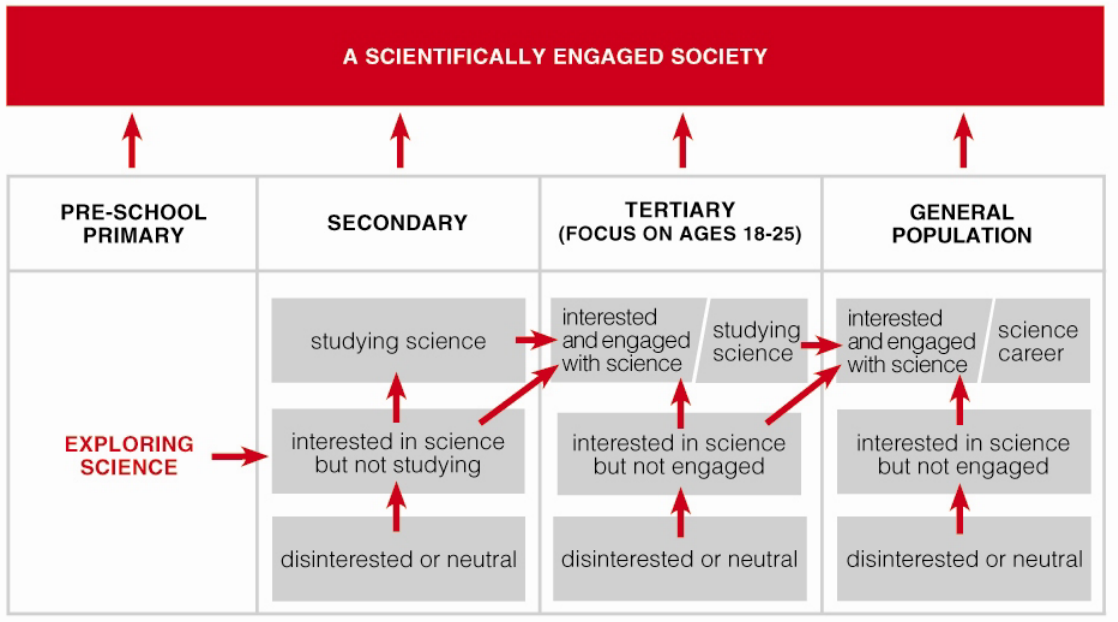
Australians are not uniform in their interest or involvement in science: there is no general public view or whole-of-society understanding, nor even a common view held by particular groups. A person's interest can be influenced by motivation, mood or issue. There are times when individuals may want nothing more than information, and other times when they might want to engage more meaningfully.

For example, some Australians may passionately follow science in general, while others will pursue a particular aspect, such as birds, in a recreational capacity. Others may dip in and out of science, their interest triggered by personal curiosity, a community concern, a medical problem, a consumer purchase, work or study. Still others may engage with science, but never describe themselves as doing so—for example, in seeking health information on the internet.[xxiii]

Thus, people can move in and out of the various attitudinal groups almost daily. What these studies usefully show, however, is that although people's attitudes to science can be segmented, their attitudes do not necessarily correspond to their behaviour or their understanding.

Much more research is needed to examine and understand the attitudes and behaviours of Australians toward science, and this is discussed in section 5.6. Nonetheless, until such research can be carried out, it is useful to think in terms of the diagram in Figure 1, which integrates the traditional science communication approach of targeting particular groups with the research findings of a society segmented by level of science interest and involvement.

Figure 1 Developing levels of interest and engagement in science



This diagram suggests pathways along which segmented groups can be encouraged to increase their interest in and engagement with science. Although it is necessarily simplistic and progression is not linear, it provides helpful markers for communicating science to ensure greater equity in reaching under-served parts of the community.

One of the messages from the state and territory consultations was that current activity tended to involve those who are already 'interested and engaged', rather than targeting those who are 'not interested or not engaged'. It may not be a priority to run events for the general public aimed at raising an interest in science when a large proportion of those who come are already interested. The focus may need to be directed to those who are interested but not engaged, or who are not interested or neutral, in order to create a scientifically engaged and inclusive Australia.

The segmented groups and the types of activities most appropriate to each are outlined in Appendix 6. As further research adds light to current understanding, this thinking must be open to testing and revision. A caveat is that the diagram is based on a study undertaken only in Victoria. It is not unreasonable to assume, however, that people across Australia will fit into this segmentation, although the percentage in each might vary among states.

It will also be important to examine in more detail the differences and different needs between those in remote and regional locations and those in metropolitan areas. Similarly, it will be important to examine the special needs of Indigenous Australians and of speakers of English as a second language.

This section tried to answer the question: Who are we targeting in communicating science? The next section tries to answer the question: Who is already communicating with these groups?

1.4 Who are Australia's science communication providers?

Currently there are many organisations and individuals communicating science in Australia. They have different goals and different strengths, and their programs are aimed at different population groups. Nonetheless, all have a role to play in creating a scientifically engaged Australia.

The ABC, the CSIRO and Questacon are federally funded organisations, active in communicating science nationally. The 2008 review of Questacon acknowledged the key role of these organisations in improving national coordination to ensure more effective science awareness, engagement and education.[xxiv] The Office of the Chief Scientist also plays an important role.

1.4.1 The ABC

The ABC is a diversified, multi-platform media enterprise; it is the largest broadcaster in Australia, with more than 4000 full-time equivalent staff. It operates five national radio networks, including some 60 regional and metropolitan radio stations; provides three national digital television channels; is a major publisher and retailer; hosts ABC Online with more than 3.8 million pages of Web content; and offers new services through broadband, SMS, podcasting, video-on-demand and other devices. It also offers radio and television services in Asia and the Pacific.[xxv]

With respect to the sciences, the ABC offers a range of science, health and environmental television and radio programs that inform while they entertain, and many of the presenters, such as Robyn Williams, Dr Karl Kruszelnicki and Ruben Meerman, have a strong following. The Science Web site (**www.abc.net.au/science**) contains news stories, science forums, teaching resources, quizzes and games, science events around Australian in The Big Diary, and The Lab search gateway.

As of June 2008, the ABC's combined reach across television, radio and online was 72 per cent, consistent with the result recorded in June 2007 (also 72 per cent). In an increasingly fragmented media environment, the ABC is largely maintaining its traditional television and radio audiences, while its online audiences grow at a rate three times faster than total Australian internet usage.[xxvi]

1.4.2 CSIRO

CSIRO has a strong commitment to science outreach through its education and scientific publishing activities. Communicating scientific research helps raise the profile of science within the community. CSIRO conducts a range of science education programs for primary and secondary students and their teachers. CSIRO also operates CSIRO Publishing as an independent science and technology publisher with a global reputation for quality products and services covering a wide range of scientific disciplines.

Science education facilities include the CSIRO Discovery Centre in Canberra, the Parkes Radio Telescope in New South Wales, the Canberra Deep Space Communication Complex and the network of nine CSIRO Science Education Centres in each capital city as well as in Townsville.

Programs include the Double Helix Science Club, Science by Email, the Creativity in Science and Technology (CREST) awards, a children's science television show on Network Ten, a Web site (**www.csiro.au/resources/Education**), and *The Helix* and *Scientriffic* magazines.

Their aims are to alert school students, their families and science teachers to the contribution of CSIRO and scientific research to our community; encourage students to pursue careers in science, engineering and technology; and engage, enthuse and educate students, teachers and the wider community about science and its applications. In 2008, more than 689 000 people participated in these programs or visited these facilities.

An evaluation of the Scientists in Schools program, involving over 1200 partnerships, indicated significant impacts on students—showing scientists as real people, increasing students' knowledge of contemporary science and raising student interest in science-related careers.

CSIRO multimedia initiatives deliver Web-based science and mathematics learning resources for the national schools curriculum project, and CSIRO's film archive is being released on YouTube to provide awareness of CSIRO's heritage.

1.4.3 Questacon

Questacon is a much-loved, well-respected national institution located in the Parliamentary Zone of the national capital. Established as Australia's National Science and Technology Centre in 1988, Questacon has developed 'an international reputation as a leader in the interactive science communication field'.[xxvii] Questacon runs the world's most extensive outreach program. Its flagship program, the Shell Questacon Science Circus, will be celebrating its 25th year of operations in 2010.

Questacon has inspired the wider Australian community, including future scientists, by demonstrating the importance of science to everyday life and to our nation's future wellbeing. In 2008–09, Questacon provided science engagement activities as follows:

- exhibition and program facilities in Canberra—over 419 000 visitors
- touring exhibitions—over 475 000 visitors
- outreach programs—over 230 000 participants
- Web site (**www.questacon.edu.au**)—over 1 million visitor sessions.[xxviii]

From July 2009, Questacon has had responsibility for SCOPE, an administered program with average funding of approximately $4.4 million annually through to 2010–11. This program supports the Prime Minister's Prizes for Science and National Science Week.

The aim of these and other SCOPE initiatives is to increase public appreciation of the contribution of science, technology and engineering to Australia's economic, environmental and social wellbeing; highlight the outstanding contributions made by Australian researchers and science teachers; and encourage Australia's youth to study science and mathematics beyond the compulsory years of schooling and to consider entry into science-based careers.

1.4.4 Office of the Chief Scientist

In addition to the national roles of the ABC, CSIRO and Questacon, the Office of the Chief Scientist within DIISR has a key role. In November 2008, the position of the Chief Scientist for Australia expanded from part-time to full-time. In addition to providing high-level advice to the Government, fostering relationships with science organisations and industry groups, and stimulating community thinking on the big scientific issues of our time, the Chief Scientist has a vital role in encouraging young Australians to take up careers in science and engineering. The Chief Scientist is in a position to stimulate informed, evidence-based discussion about science and society, advocating for science and its value to society.

1.4.5 Other providers

Federal and state government science agencies also provide a wide range of science engagement activities. The main providers include the following:

- DIISR, which provides funding for Questacon and the SCOPE program, described above
- other Federal Government bodies, particularly those that are members of the Coordination Committee on Innovation (CCI), which publicise their research, work collaboratively with the corporate sector and provide resources for teachers and schools. These include government departments and agencies, such as Geoscience Australia, the National Water Commission and the Australian Antarctic Division; research funding agencies and research centres, such as the Australian Research Council (ARC) and the Cooperative Research Centres (CRCs); and research performing organisations: CSIRO, the Australian Nuclear Science and Technology Organisation (ANSTO) and the Defence Science and Technology Organisation (DSTO).
- state chief scientists, who act as 'science champions', role models and spokespeople to stimulate informed debate
- state government departments of science and innovation, which develop strategies for promoting economic development through science, technology and innovation, and carry out related promotional activities
- local councils, which provide funding for parks, libraries, sports grounds and community centres that from time to time offer science engagement activities for children and the community.

The mass media are crucial in bringing science awareness to the wider public. In addition to the ABC, the main providers include the following:

- commercial and community media, which create perceptions—sometimes true, sometimes false—of what science is and what scientists do
- the Australian Science Media Centre (**www.aussmc.org**), which works with the print and broadcast media to improve the quality of reporting related to science by linking journalists to relevant experts.

Much science engagement activity is aimed at young people. In this regard, the key providers comprise the following:

- local schools and their staff. Science and mathematics teachers and career counsellors are the 'frontline' in this respect
- state education departments, which support schools in dealing with issues such as curriculum reform, teacher recruitment and retention, and teacher professional development. This has a strong bearing on the quality of mathematics and science taught
- DEEWR, which is coordinating the development of a national curriculum in science and mathematics and provides additional funding support.

These organisations cannot offer all the experiences that inspire students in science. Other providers with a vested interest or assets can also contribute to increasing the level of student interest and engagement in the sciences and science careers. These include the following:

- universities and TAFE colleges, which provide teacher training and continuing professional development, as well as holding outreach and challenge activities for school students. They also present science lectures and exhibitions for the wider public
- professional teacher associations, which offer professional development, teaching materials, conferences and publications
- the Australian Academy of Science (**www.science.org.au**), the Australian Mathematical Sciences Institute (AMSI) (**www.amsi.org.au**) and the Curriculum Corporation (**www.curriculum.edu.au**), which create and publish innovative, high-quality curriculum materials
- national and state museums, botanic gardens, zoos, aquaria and science and technology centres, which provide facilities and interactive activities that inspire students and their families while building understanding; they also present outreach programs to excite students in regional and remote communities
- the Royal Institution of Australia (**www.riaus.org.au**), recently founded with support from the Australian Government, which is set to play a national role in connecting people to science and science to the people through talks, briefings and webcasts
- research institutions, which provide resources, discoveries and other content for news stories, and opportunities for school students to undertake research
- professional associations in specific science disciplines, which develop careers materials and Web sites, and interact with early career professionals
- scientific societies with cross-disciplinary membership, such as the Royal Societies of Australia and the Australian and New Zealand Association for the Advancement of Science (ANZAAS) (**www.anzaas.org.au**), which offer public lectures and other opportunities for participation

- Federation of Australian Scientific and Technological Societies (FASTS) (**www.fasts.org**), which holds the annual 'Science Meets Parliament'
- corporations, businesses and trade associations, which offer partnerships, sponsorships, work placements and internships
- publishers of relevant books, magazines, newsletters, reference material and other print and electronic communication means
- community organisations, such as land care and local environmental groups; bird watching, field naturalist, astronomy, bush walking and similar clubs; and volunteer health promotion and fundraising organisations for disease such as breast cancer, SIDS and HIV/AIDS
- parents, who purposely or unwittingly influence their children's level of interest in the sciences, their school subject enrolment choices and their choice of careers.

One of the strongest messages to come out of the state and territory consultations was that no one at the national level was articulating the vision, goals, priorities and desired outcomes for communication across the sciences. Participants overwhelmingly mentioned the need for leadership and a national framework through which all providers can work toward common goals. They consistently expressed a willingness to share best practice, set industry standards for communicating science and look for ways to complement each other's activities.

One of the major challenges in Australia is to ensure that these organisations are working to the best of their potential while cooperating with their peers, so as to reduce duplication and to maximise outcomes. As was found on a state-wide basis in Western Australia, 'a cohesive and coordinated strategy is required that draws these players together to promote science under the one banner in order to achieve agreed outcomes'.[xxix]

1.5 Why does Australia need national leadership to communicate science?

Strong central leadership is needed to develop a vision, goals, priorities and desired outcomes for communicating science in Australia; to encourage greater collaboration and cooperation with and among relevant science organisations; and to ensure that the programs implemented through this national strategy are closely aligned with the Australian Government's strategic policy directions. In effect, national leadership will enable the nation to work together so that the whole becomes 'greater than the sum of its parts'.

A review of the SCOPE program in 2009 found that 'there is a need for greater strategic leadership across Australian Governments efforts in science awareness', recommended that 'DIISR take a lead role in coordinating science awareness activities across the Australian Government', and indicated that an area, section or agency within the portfolio should be assigned a leading role in the coordination of science awareness activity'.[xxx]

DIISR is best placed to provide national leadership through Questacon — The National Science and Technology Centre. Questacon is already involved in numerous networks and actively connected across Australia and globally.

Questacon is represented on coordinating bodies such as the CCI, the Council of Australasian Museum Directors (CAMD), the Heads of Collecting Institutions (HOCI), the Association of Science and Technology Exhibitors Network (ASTEN) and the Square Kilometre Array Education Advisory Group. Internationally, Questacon plays a lead role in the Association of Science-Technology Centers and the Asia Pacific Network of Science and Technology Centres.

Questacon has responsibility for managing the current SCOPE program, which includes major activities such as National Science Week, and is well placed to build connections with other departments and coordinating bodies, as well as with national, state and local providers. Thus, DIISR could to a large extent use existing Questacon roles and activities to undertake this extended function of national leadership.

A broadly constituted national advisory group is also needed to provide advice and guidance to Questacon and to facilitate national coordination. Such a body might comprise representative membership as follows:

- national academies
- national and state chief scientists
- CSIRO and other research agencies
- universities
- media
- young scientists
- policy officers
- business leaders
- lay members, such as representatives of an ethnic community or environmental group.

Australia has not had a national coordinating body dedicated solely to communicating science. State and territory consultations indicated that existing federal-state coordinating bodies already had well-defined roles that were useful but different, and that these bodies would be less effective than establishing a new ‘purpose-built’ one.

LEADERSHIP

A coordinated national strategy for science communication will require leadership by the Australian Government to stimulate collaboration and co-investment by governments across jurisdictions; by academic, cultural and professional institutions; by business and industry; and by community organisations.

Recommendation 3

That leadership for this national initiative be provided by Questacon within DIISR, with input from a broadly constituted national advisory group to guide implementation, monitoring and evaluation, and reporting.

1.6 How can coherent action best be initiated?

Australia is a long way from 'working together' or 'speaking with a consensus voice' in communicating science. It is critical to have conversations among organisations that are currently operating separately and allocating their assets and resources without considering the question: Could we have a greater impact if we were to work with others? Creating opportunities for cooperation and coordination is key to implementing this national strategy.

To support and enhance national coordination, one of the main functions of both Questacon and the national advisory group through their national leadership will be to build alliances with other national organisations (for example, CSIRO, the ABC, the ARC, the National Health and Medical Research Council (NHMRC), the Royal Institution of Australia and the Australian Science Media Centre), and Federal and state government science administrations and agencies.

Similarly, they will need to build alliances with other coordinating bodies such as CAMD, CCI, FASTS, the Commonwealth and State Advisory Council on Innovation, the Forum of Australian Chief Scientists, the Cooperative Research Centres Association and the CRC Communications Officers' Network, the National Academies Forum, the Council of Heads of Australian Botanic Gardens and the Deans of Science, Engineering and Medicine.

Finally, Questacon guided by the national advisory body will need to build alliances across disciplines, for example, the Australian Mathematical and Sciences Institute, the Australian Science Teachers Association (ASTA), the Australian Association of Mathematics Teachers, Engineers Australia, the Council for the Humanities, Arts and Social Sciences (CHASS), and environmental, health and related organisations.

One of the significant aspects of the consultations was that they brought together science communicators from across each state and territory; surprisingly, many had had little previous interaction with each other. There was common agreement about the value of getting together, and that there should be more opportunities to meet formally and informally in the future.

The Australian Science Communicators was mentioned as an important vehicle for ongoing interaction. However, because this is an individual membership association, it cannot expect

to represent all organisations involved in communicating science. Therefore, it was suggested that a national summit be held to bring together the science communicators from relevant agencies in all states and territories, to share ideas for achieving the goal of a scientifically engaged Australia. The Australian Science Communicators will continue to play a role in improving quality and professional standards in the sector.

To reach this goal, it is important for the Prime Minister and the Minister for Innovation, Industry, Science and Research to clearly articulate an aspirational 'science self-image' for Australia. Acting as science 'champions', they can provide a strong focus and direction for communicating science and its benefits across the nation. They can also directly influence the many institutions and agencies involved to commit support and resources towards this vital national initiative.

It is equally important that all relevant institutions and agencies have a voice in setting priorities for communicating science. Participants in the state and territory consultations indicated their appreciation for having an opportunity to meet and exchange views. This positive feedback and goodwill needs to be supported and extended to ensure that the nation is taking coherent action.

COHERENT ACTION

To maximise the effectiveness of science engagement activities across the nation, the significant number of organisations and individuals involved in the natural and physical sciences, the humanities, the arts and the social sciences must work in a consistent direction towards reaching an agreed vision.

Recommendation 4

That a science communication summit be convened to secure buy-in from the diverse range of organisations and individuals in the science communication sector and to identify strategic priorities and the optimal roles for different agencies and institutions.

1.7 What issues affect science communication?

This diversity of providers creates not only a wide range of opportunities, but also some problems. Many of these came to light during the state and territory consultation process.

Although the need for public communication is included in most science agency charters, many science communicators felt that it is often paid only lip service. In particular, it is less valued compared to research and publication. Communicating science to audiences other than their peers is not a performance expectation for most scientists, and many find it difficult to explain their work and its value in lay terms. Few scientists are properly trained in media or public communication skills.

Many science-based organisations treat communication as an 'added extra' that can be reduced or dispensed with altogether in a tight budgetary situation. While some scientists are interested in communicating their research, this effort may not be supported by

management. Thus, it is important to find ways to involve science agencies more actively in public communication and engagement.

This attitude was confirmed in a recent survey in the United Kingdom by the Royal Society, which obtained input from scientists and engineers undertaking research in higher education institutions. Key findings were as follows:

- Engaging with non-specialists is needed to promote public understanding of science so that the public become better informed and understand the relevance of science to everyday life.
- The most important audiences to engage directly are policy makers, schools and industry.
- Three-quarters of those surveyed had taken part in at least one science communication or public engagement activity in the last year.
- There was a strong positive relationship between the number of activities undertaken by a scientist and their perceived importance of public engagement.
- The need to spend more time on research was the most likely reason for scientists not to be involved in public engagement.
- A fifth of respondents said that taking part in public engagement activities was perceived as a barrier to career progression by their peers.
- The majority of junior staff would participate more if it helped with their career.
- The best incentive for public engagement would be that it generates more money for a scientist's department.
- Funders should support public engagement activity, although this should be an optional rather than mandatory requirement of funding agreements.
- Most of those surveyed had no media, communications or public engagement training.[xxxi]

A few Australian science organisations serve as positive models in public communication. For example, the Grains Research and Development Corporation 'invests around $15 million (15 per cent) of its annual funding in communicating research outcomes to farmers and the public. For applied research, this is a sensible ratio and guarantees a public return on the science investment.'[xxxii]

Thus, part of the national leadership role must be to contemplate policy changes that support the public communication of science. This might include consideration of how the ARC, the NHMRC and the CRCs could be encouraged, as part of their funding agreements, to require researchers to demonstrate a communications plan to engage the broader public.

Despite the many reward and recognition programs and events that profile the achievements of Australian scientists and their work, there is need to address the low level

of media promotion of these successes and to involve award winners in public engagement opportunities and as science 'champions'.

Although the Australian Science Media Centre has been very active in its efforts and appears to have had some impact, the decrease in the number of specialist science journalists and the increase in science coverage as part of major political and economic debates, such as climate change, an emissions trading scheme, bushfires and broadband, raise new challenges for the quality reporting of science. While the ABC in some form reaches nearly three-quarters of the Australian population each month,[xxxiii] there is a perception that it caters primarily to the 'already converted'.

In general, there is a lack of interest from the vast majority of the population in participating in science-related events and activities. Although National Science Week activities are generally well attended, they also tend to appeal to the 'already converted'.

Australia's long distances between urban centres and small population relative to land area mean that it is difficult to find a critical mass except in the capital cities. Hence, a great deal of the science engagement activity is 'metro-centric', catering primarily to capital city residents clustered along the coast.

The arid 'red centre' comprises approximately 70 per cent of Australia's landmass. This remote region is central to many of the science issues of our generation, including climate change, salinity, water sufficiency and mineral extraction. It is also home to a significant number of Australia's Indigenous people. But communicating science in these remote areas is difficult and costly; and the results rarely flow back to city dwellers. Geographic isolation requires disproportionate effort to create equity of opportunity.

With respect to science education, teachers often feel 'bombarded' by the curricular and extra-curricular science opportunities for their students. This is because the activities are often competing rather than complementary and do not provide integrated pathways for students at different levels of interest to develop their science understanding.

Australia is home to a large second-language English population. The needs of this group are highly variable, ranging, for example, from Asian immigrants whose children may excel in science and mathematics to recent African arrivals who have not been able to complete even their primary schooling because of the ravages of civil war. A very wide range of science engagement activities is required to cater for the differing needs of this diverse group.

Stereotypical and inaccurate perceptions of scientists persist, contributed to by some sections of the media. Students and their key influencers (including peers, teachers, school career counsellors and parents) lack awareness of the variety of careers in science, mathematics, engineering and technology and what they entail. In regional and remote areas, there are even fewer opportunities for students to become aware of science-based career opportunities in context.

Finally, the impact of science communication activities is mostly anecdotal. Over the past 10 years, there have been no significant studies of the level of scientific literacy of the

Australian population and only one study, undertaken by the Victorian Department of Innovation, Industry and Regional Development, of public attitudes to science (section 1.2.1 above). This makes it difficult to track increases in public engagement and awareness, and to know what activities have contributed most strongly to the increases.

Some of the many tasks required to help solve these problems are discussed in Chapter 5.

1.8 What is the federal, state and international context?

Successive Australian Governments have recognised the role and importance of science communication as an adjunct to science innovation and infrastructure policies, although funding has not always been concomitant with this recognition. Most recently, the government's *Powering Ideas* innovation agenda focused on 'the production, *diffusion* [emphasis added] and application of new knowledge'[xxxiv].

One of the priorities of this agenda is to build the innovative capacity of public research institutions. The government acknowledges that for society to reap the expected economic and social benefits from this endeavour, it must be accompanied '… by action to make the results of public research widely accessible.'[xxxv] This is one of the many purposes of communicating science.

A number of other reviews and reports have also called for communicating science and its benefits more widely. The *Powering Ideas* innovation agenda grew out of the 2008 Cutler Review of the National Innovation System. Three smaller-scale science-related reviews have also reported to the government over the past year. These, in turn, drew on a Prime Minister's Science, Engineering and Innovation Council (PMSEIC) review in 2003. Some of the recommendations from these reviews that are most relevant to this report are outlined in Appendix 7.

In addition, most of the states and territories have issued science development strategies, many of which give specific mention to communicating science. Some of these are also outlined in Appendix 7.

Simultaneously, there have been a number of similar undertakings overseas. In 2007, the Canadian government launched a science and technology strategy, with the vision of making Canada a '… more attractive international destination for research, investment and work in the fields of science and technology'.[xxxvi] In 2008, the Department for Innovation, Universities and Skills in the United Kingdom published *A Vision for Science and Society*, which reported on a new, comprehensive strategy for scientific engagement across society.[xxxvii] The main recommendations from these and other overseas reports are also summarised in Appendix 7.

Concerted action is needed to ensure that activities to communicate science and its benefits are heading in a consistent direction and are aligned with the goals of the Government's *Innovation Agenda.* Having clear outcomes is vital. Having innovative programs to achieve these outcomes is just as crucial. This is the substance of Chapters 2, 3 and 4.

2 Telling Australia's story

This chapter describes two programs that will tell Australia's story of science achievement to the nation and to our global R&D partners. These programs will inspire Australians and develop a sense of national pride. They will also promote Australia's science capability to the world through activities that recognise and reward achievements and successes.

2.1 Pride in Australian Achievement

The first program, Pride in Australian Achievement, will enable the Australian Government to present a positive 'science self-image' of Australian science to Australians. It will provide inspiration to all Australians by sharing our discoveries, and will encourage young people through stories of frontier research. It will contribute to the achievement of **Outcome 1: A society that is inspired by and values scientific endeavour**, **Outcome 2: A society that attracts increasing national and international interest in its science,** and **Outcome 4: A society that encourages young people to pursue scientific studies and careers.**

2.1.1 What does the evidence indicate?

The March 2009 review of the SCOPE program found that the Prime Minister's Prizes for Science 'play a useful role in promoting and valuing science and building bridges between the Australian Government and the science sector.' Data showed that the number of nominations for the prizes has risen slowly but steadily since its inception in 2000. A survey of past recipients and of science organisations found that the impact of the prizes is higher with peer groups than with the public. Thus, one of the recommendations was that the recipients undertake a greater ambassadorial role to promote the prizes and the importance of science.[xxxviii]

The review of the SCOPE program also commented briefly on its funding for three of the Eureka Awards, noting particularly the People's Choice Award as 'an effective means of exposing students to tangible examples of young people who have gone on to pursue successful careers in science.'[xxxix] The Australian Museum Eureka Prizes, now in the 21st year, are highly regarded. In 2009, the Eureka Prizes generated extensive media coverage reaching an audience of 35 million. 11 000 people also voted in the Eureka Prizes People's Choice Award, with 65 per cent of votes coming from secondary schools. The Australian Museum attracted 22 sponsors to support the 2009 Eureka Prizes.

In addition to the Prime Minister's Prizes for Science and the Eureka Awards, there are many organisations that offer prizes in science. In fact, the SCOPE reviewers commented that they were 'surprised at the totality of the awards open to Australian scientists, researchers and science teachers', and listed those offering awards as Australian Government agencies such as CSIRO and DSTO, state governments, universities, the private sector (such as BHP Billiton Science Awards and the L'Oreal-UNESCO Awards for Women in Science), and various science teaching awards.[xl]

The appearance of Australian scientists in recent Australian of the Year Awards shows a measure of good public support for their work, and recent Australian Nobel Laureates demonstrates highly significant international recognition for the work of Australian scientists. As noted in the *Western Australian Science Communication and Public Engagement Plan*, 'Raising the profile of scientists and science organisations within the community will enhance public perceptions of the important role that science plays.[xli]

2.1.2 Who is being targeted?

This program targets the Australian science community. Among their peers, recipients are rewarded for their efforts. It also targets Australian and overseas media, politicians, business leaders, investors, and decision-makers, in order to make the recipients' achievements more widely known and acknowledged.

But just as importantly, this program targets all Australians, in promoting a 'positive self-image' about Australian science. Much more extensive promotion of the winners can make all Australians proud—just as do Olympic medals or Academy Awards—whether members of the population are interested in science or not.

2.1.3 What does this program offer?

This program will maintain support for the existing Prime Minister's Prizes for Science, which have proven very successful. To date, the vast majority of effort has gone into staging the presentation ceremony; much more effort needs to be focused beyond this event, to ensure that key messages are reaching the target audiences and that greater media coverage is encouraged and facilitated nationally and internationally.

The program will have several new components to give 'more bang for the buck'. Ideally, a short-term working group will review the variety and range of science prizes in Australia, and develop a plan for promoting winners, nationally and internationally, to increase public recognition of Australia's capability in the sciences. Specific opportunities within this program will enable the Australian Government to do the following:

- provide the Prime Minister, the Minister for Innovation, Industry, Science and Research, the Minister for Foreign Affairs and Trade, senior public servants, ambassadors and counsellors with strategic opportunities through both the initial award announcements and continuing media promotion, to state the value of Australia's scientific achievements—not just to the science community, but to the community at large and to Australia's global R&D partners
- utilise the award recipients as goodwill ambassadors and role models, with public speaking engagements, business boardroom presentations, media interviews, etc
- create 'hooks' for the media, especially the commercial media, and exploit the new media such as YouTube, blogs and social networking Web sites, for telling these Australian stories of scientific development and discovery

- build a climate of 'valuing science' around the prize recipients that will give parents, teachers and career counsellors 'ammunition' to encourage young Australians to consider further studies and careers in science.

PRIDE IN AUSTRALIAN ACHIEVEMENT

A key element of the national initiative is to inspire a sense of national pride by promoting activities that recognise and reward the achievements and successes of Australians in the sciences.

Recommendation 5

That the national initiative include continued funding for the highly regarded Prime Minister's Prizes for Science, with an enhanced promotional strategy targeting the wider Australian community and international audiences.

2.2 International Recognition

The second program, International Recognition, will help ensure that science carried out in Australia or by Australians is acknowledged and appreciated internationally, leading to greater international collaboration. This program is a main contributor to **Outcome 2: A society that attracts increasing national and international interest in its science.** This includes countries worldwide, but particularly strategically important countries in Asia, Europe and North and South America.

2.2.1 What does the evidence indicate?

The *Community Interest and Engagement with Science and Technology in Victoria Research Report* found that 'the more information that is available on scientific and technological developments, as well as the more proof of their effective and safe integration into our lives, the more comfortable and supportive Australians are. The unknown still scares us, so it will be important for new developments to be backed up by an appropriate level of information to mitigate the sense of risk'.[xlii]

Further, this research report found that 54 per cent of Victorians agreed that Australia was a world leader in science and technology. However, qualitative research showed that they thought Australia was good at '… creating but not necessarily maximising the commercial benefits of scientific endeavour.'[xliii]

The Eurobarometer 2005 study on *Europeans, Science and Technology* across 25 European Union countries found widespread agreement that internationally funded collaborative research funded by the EU would become more and more important (71 per cent supported, 5 per cent opposed), is in industry's interest (69 per cent supported, 6 per cent opposed), is in the national interest (65 per cent supported, 9 per cent opposed), and is more creative and effective (60 per cent supported, 10 per cent opposed).[xliv]

The 2009 *Progress Report on Mobilizing Science and Technology to Canada's Advantage* shows how aggressively the Canadian government is pursuing international R&D policy. The

report speaks of the Canadian government's initiatives to 'brand Canada as a destination of choice for talented, highly qualified S&T workers and students', and notes that 'key partners from business, academia and other governments have been inspired to join us by investing in Canada's future through S&T'.[xlv]

2.2.2 Who is being targeted?

Audiences targeted include overseas and Australian media; politicians; business leaders and investors; decision-makers in targeted countries and regions, especially International Science Linkages Program priority countries; and international government and non-government organisations. Creating awareness of Australia's achievements in a global context will be aimed at the Australian community at large.

2.2.3 What does this program offer?

This program will promote awareness of Australian capability and potential to make significant contributions to science in a global context, emphasising especially Australia's 'big science' agenda. To date, there are many separate institutional, departmental and agency activities, but they are not communicated as a coherent 'set' to improve Australia's position and branding internationally as well as domestically.

It could be argued that most endeavour in Australian science is globally connected and significant. However, well planned information and promotional programs related to a few significant projects (for example, the Square Kilometre Array bid, events that bring the world together around 'International Year of …' programs, and national infrastructure such as the Synchrotron that demonstrate Australia's state-of-the-art research facilities) will build a climate of support for Australia to play a significant role in an international context.

It will be advantageous for a short-term working group to review Australia's science image abroad and develop a plan for enhancing this image. Options to consider are wide-ranging; for example, they could include travelling exhibitions; presentations at international conferences and meetings; briefings for key business leaders and investors; briefings and tours for international media; a range of promotional materials aimed at various audiences (such as an updated version of the 1999 publication, *Australian Science: Building Our Future*); public lectures and forums; a strong, well-linked Web presence; equipping Australian personnel working abroad with materials to promote Australia's capability in science; and using English language teaching programs in targeted countries to raise awareness of science in Australia.

Specific opportunities within this program will enable the Australian Government to do the following:

- provide Australian leaders with opportunities to promote Australia's capability and potential in the sciences to audiences overseas, as well as in Australia
- influence decision-makers to position international investment in Australian R&D

- celebrate Australia's successes (especially if the Square Kilometre Array project bid is successful) through promotional and awareness-raising activities and festive events that are reported through the mass media and new media
- profile Australian science infrastructure and research programs of international significance, such as the Australian Synchrotron, the Australian Telescope National Facility and the Integrated Marine Observing System
- exploit high profile events such as 'International Year of …' programs to stimulate and leverage contributions from a range of Australian and international partner organisations
- offer popular media stories, such as launches, showcases for new discoveries and young talent.

INTERNATIONAL RECOGNITION

It is important for Australia to promote its science achievements and its significant potential for further contributions in global contexts, through a program of activities strategically targeting Australian and overseas audiences.

Recommendation 6

That the national initiative support promotional and awareness-raising activities, including travelling exhibitions showcasing Australia's capability in the sciences and promotional materials for scientists, science policy makers, overseas counsellors and other potential Australian science 'ambassadors' to use abroad.

3 Engaging all Australians

The four programs described in this chapter will improve public perceptions of science and also its value and relevance to the wellbeing of individuals, communities and the nation. Continuing successful programs, such as National Science Week, will re-focus on attracting new target audiences and on increasing leverage to involve a wider range of organisations at national, state and local level.

The programs will have an impact on every segment of the population. The first step is to 'raise Australia's science temperature'—that is, attracting the attention of people who are not interested in science and making them aware of its importance to society. The next step is to target people who are already interested in science with programs to help them take the next step towards critical and intelligent engagement, not only in their own interest, but in the national interest.

Overall, these programs will help move the nation along the track to creating a scientifically engaged Australia. All will help achieve **Outcome 1: A society that is inspired by and values scientific endeavour** and **Outcome 3: A society that critically engages with key scientific issues**. One of the programs, Engaging Australian Communities, will also contribute to **Outcome 4: A society that encourages young people to pursue scientific studies and careers**.

3.1 Science and Society

The first program, Science and Society, will enable the Australian Government to promote science as relevant to Australian society and to target and engage audiences that are currently not being reached effectively. Conversely, it would give Australians a much wanted voice in the development of science related policy.

Strong cooperation and collaboration will be required from across the disciplines: the natural and physical sciences, humanities, arts and social sciences. This approach will not only enhance research outcomes by integrating technical knowledge and societal attitudes; it will also develop society's understanding of the value of investing in research institutions, infrastructure and programs and will increase uptake of research outcomes by industry and the community.

3.1.1 What does the evidence indicate?

Consultation with representatives from the social sciences and humanities (see Appendix 4) provided strong support for a Science and Society Forum to be held annually.

With respect to public involvement in policy development, the *Community Interest and Engagement with Science and Technology in Victoria Research Report* found that the majority of the population believes the community should be consulted about advances in

science and technology (83 per cent), but that the Government does not do enough to seek out (66 per cent) or listen to (58 per cent) community views about the development of science and technology. Only a very small proportion (11 per cent) believe they have any influence on policy making about scientific issues that are important to them.[xlvi]

The *Community Interest and Engagement* report also concluded that the vast majority of the community agreed on important propositions relating to building awareness of science and technology. For example, virtually all agree that:

- it is important for the wider community to be aware of what's happening in science and technology (95 per cent agree)
- it is important for scientific breakthroughs to be well publicised (94 per cent agree)
- it is critical that young people learn about science so they can effectively participate in society when they are older (93 per cent agree).[xlvii]

Given that many people are not interested in science and technology, it is worth noting that:

- 74 per cent would be more interested in science and technology if they were discussed in everyday language
- 67 per cent would like to have more information about science
- 66 per cent would like to have more information about technology
- around half feel they don't get enough information about either science or technology from the media (46 per cent and 50 per cent respectively).[xlviii]

Finally, the *Community Interest and Engagement* report stated that '… expecting 100 per cent of Victorians to jump for joy in relation to science and technology and shout its virtues from the rooftops is unrealistic. However, practically all Victorians have some potential to increase their awareness and appreciation of science and technology and for many to also increase their regular engagement with it'. In particular, the report noted that health, water, the environment, climate change and food were the areas of greatest concern in the community'.[xlix] These, then, are the areas in which science communication is best placed to increase promotion and awareness.

3.1.2 Who is being targeted?

The adult general public is the target population; in particular, this program tries to develop new methods for reaching new audiences—described in the state and territory consultations as the 'unconverted' and in the *Community Interest and Engagement with Science and Technology in Victoria Research Report*, as those who are neutral toward or uninterested in science[l] (see section 1.2.1).

A dialogue is not a one-way conversation, however. Policy and decision makers, scientists, and practitioners and academics from the socials sciences, arts and humanities disciplines are an equally important target population. All of these groups should anticipate having their attitudes and actions challenged and changed as a result of their participation.

3.1.3 What does this program offer?

This program will offer a range of activities and events promoting dialogue and participation in areas of science most likely to be of interest to those who are not interested in science; and using methods and venues 'outside the norm' for science communication. They will include the following types of activities:

- an annual science and society forum in conjunction with organisations representing a wide range of natural and physical sciences, social sciences, arts and humanities disciplines
- use of less conventional approaches—for example, café scientifique, science in the pub, moderated television and radio programs, online forums, social networks and Twitter—to carry on dialogues with the public, scientists and policy makers about science issues of interest to people's everyday life, such as water, food, health, climate change and energy.

Such a program will require dialogue activities that must be set up properly to be effective. Expertise in this area will need to be developed progressively. An annual forum will enable practitioners to share best practice in different types of dialogue activity, identify what works well and raise the general awareness of the processes of effective dialogue. The forum will allow different perspectives to be brought to bear on selected issues.

SCIENCE AND SOCIETY

It is time for Australia to invest in a significant Science and Society program, aligned with Australia's *Innovation Agenda*, to empower and engage citizens in decision making and to inform policy development in the sciences and science-related areas.

Recommendation 7

That a national Science and Society forum be held annually to focus on the priorities for community engagement in science and key issues where science can serve the needs of society.

3.2 Engaging Australian Communities

This program will offer an inspiring range of activities to engage the broad community and targeted sectors within it, especially those who are interested in science but not actively engaged (see section 1.2.1). What is important for this segment of the population is to develop continuing year-round public activities to provide pathways for science engagement, especially for the public and for tertiary students not enrolled in science courses.

3.2.1 What does the evidence indicate?

The *Audit of Science Education and Awareness Initiatives* for the Coordination Committee on Science and Technology (CCST) showed that approximately 67 per cent of CCST member activities were aimed at increasing awareness of or enthusiasm toward science; and that

approximately 65 per cent was aimed at increasing awareness of the role of scientific research. The level was even higher for research performing organisations, at approximately 88 per cent for both of these measures.[li] The study revealed little formal evaluation to judge success.

The recent SCOPE review showed that in 2008, National Science Week met its key performance indicator of undertaking over 600 events; totals were in fact 658 public events and an additional 120 school events. The Newspoll survey indicated that 51.7 per cent of Australians were aware of National Science Week, and that 13.4 per cent of them attended an event, equating to roughly 1.06 million people nationally. The event generated 1642 news items, equivalent to about $5.2 million in media coverage.[lii]

In 2009 there were 1029 events registered. The Newspoll survey indicated that 49.4 per cent of Australians were aware of National Science Week, and that 16.1 per cent of them attended an event, equating to roughly 1.36 million people nationally. The events generated 2003 news items, equivalent to about $8.9 million in media coverage, and leveraged an estimated $11 million of activity for an investment of $1.4 million from the Australian Government.[liii]

In 2008 the Australian Science Teachers Association carried out a survey of the impact of National Science Week in schools, with 490 respondents. In the table below, 5 equals most effective and 1 equals least effective.[liv]

Category	5	4	3	2	1
Raised awareness of science (%)	48	37	13	2	1
Added value to the school curriculum (%)	38	39	17	5	1
Involved more staff and students (%)	48	34	12	5	1
Increased understanding of science (%)	30	42	22	5	1

The South Australian Department of Further Education, Employment, Science and Technology undertook a survey of 1000 South Australian adults living in urban and regional locations and their awareness of science, technology and innovation (STI). The respondents were very comfortable with environmental research (global warming, water quality, marine research), and moderately comfortable with domestic (food, agriculture, work, defence) and medical research (IVF, stem cell), although views were less positive about human cloning. Respondents identifying themselves as well informed about STI (who were also the most highly educated) were more aware of South Australian initiatives, had more positive attitudes about the benefits of STI and were more comfortable with STI research than those who identified themselves as not informed. Although only 14 per cent of respondents had visited a science and technology centre, this minority had more positive attitudes toward the benefits of STI research than those who had not.[lv]

3.2.2 Who is being targeted?

This program will target children and families in particular, but also tertiary students and the wider adult population. It will encourage those uninterested to become interested, and

those interested to become more engaged. Some activities, especially during National Science Week, will continue to be aimed at teachers and students.

3.2.3 What does this program offer?

This program will offer a wide range of activities, such as the following:

- National Science Week and associated science festivals, with a focus on attracting new audiences (as informed by evaluations of events from the Science and Society program)
- innovation in science communication embracing new ways to engage audiences such as art, film, poetry and theatre
- citizen science research projects, providing one or more opportunities each year for the general community to contribute data and observations to input to Australian research in the sciences
- promotion of Web links (see section 5.4) as a means for the general community to discover the rich and diverse activity happening across the sciences in Australia
- a feasibility study into the potential of developing science tourism as a means of communicating science and its prospective economic benefits.

ENGAGING AUSTRALIAN COMMUNITIES

It is important that Australia continue to deliver high-profile, nationwide science engagement activities providing opportunities for the entire community to participate.

Recommendation 8

That the national initiative provide continued funding to extend the successful community-based activities of National Science Week, stimulating and leveraging further contributions by organisations across Australia and targeting new and under-served audiences.

3.3 Building partnerships—using networks

This program will target science organisations and networks, encouraging them to work together to raise awareness of Australia's science capability in areas reflecting Australian Government priorities. It is also intended to improve communication flow between scientists and other sectors of the community, such as politicians and corporate leaders.

3.3.1 What does the evidence indicate?

All state and territory consultations suggested the need for greater cooperation and coordination among science organisations, and more interaction between scientists and outside interest groups, including opinion leaders and decision makers.

Some states have well established briefing programs for Members of Parliament and parliamentary staff, which could serve as a model. In Victoria, the Presiding Officers briefings are delivered through the Australian Academy of Technological Sciences and Engineering. This has now been rolled out to New South Wales, with funding from the New South Wales Parliament. In the past, CSIRO offered similar briefings to the Federal Parliament.[lvi]

3.3.2 Who is being targeted?

This program targets all major science organisations, as well as politicians and their advisers at all levels of government, business and industry executives, judges, and other opinion leaders.

3.3.3 What does this program offer?

This program will offer activities such as the following:

- one or more national collaborative projects involving museums across Australia to leverage state investment and museum expertise (for example, presenting marine science research and biodiversity as a project for the 2010 International Year of Biodiversity)
- a scheme to capitalise on the Integrated Marine Observation System, the Atlas of Living Australia, the Census of Australian Marine Life and other high-profile research programs
- 'hot science' briefings by science organisations for key national and state leaders in the political, legal and business sectors.

It could also be useful to convene a short-term working group to review mechanisms for science-based briefings and communication between scientists and opinion leaders, and to develop a plan for more effective communication between scientists, media professionals and policy influencers.

BUILDING PARTNERSHIPS – USING NETWORKS

Australia requires effective mechanisms to facilitate public information flow and information sharing in the sciences, utilising the knowledge and resources of existing organisations and networks.

Recommendation 9

That the national initiative include collaborative projects that stimulate science organisations and networks across Australia to work together to promote information sharing, including holding 'Hot Science' briefings for elected members and policy officers of Federal, state and local governments, and leaders in the legal and business sectors.

3.4 Strengthening the media's role in communicating science

State and territory consultations indicated that there were problems in the relationship between science and the media. There are very few full-time science journalists in Australia. Although the Australian Science Media Centre is a resource for non-science journalists and is having some impact, the mass media in general have little interest in communicating science, or in communicating it well. The role of the ABC is strongly valued, especially in regional and remote areas, but there are many who do not watch or listen to the ABC regularly.

This program provides a range of activities to improve the quality of science-related television, radio and online journalism in Australia. It was also suggested that a short-term working group be set up to develop a plan, aligned with Government priorities, as to how science coverage could be further improved in a rapidly changing media environment.

3.4.1 What does the evidence indicate?

The March 2009 SCOPE evaluation considered the performance of the science projects it funded at the ABC: ABC Science Online, a cross-media cadetship program and involvement in National Science Week. Data compiled by Nielson Online showed that ABC Science reached 407 000 viewers in August 2007, the highest result on record. ABC Science Online won numerous internet awards. The ABC was also benchmarked against other online science sites, and quarterly audience reach compared favourably with other sites such as National Geographic, NASA and CSIRO.[lvii]

As indicated previously, the ABC's combined reach across television, radio and online is 72 per cent. It is largely maintaining its traditional television and radio audiences, while its online audience is growing at a rate three times faster than total Australian internet usage.[lviii]

The European Research Advisory Board report on *Research and Societal Engagement* recommended that university research students should be trained to engage with society; and that, since scientists tend to think that public engagement can be counterproductive to their careers, the European Commission should act to highlight the value of greater dialogue with society and how this could advance research careers.[lix]

A recent article in *Nature Biotechnology*[lx], which summarises the outcome of an interdisciplinary workshop, provided recommendations with respect to science and the media:

- scientists and science organisations should pursue a trust- and dialogue-based relationship with the public
- scientists and science organisations need to recognise the importance of framing science-related issues
- graduate students at science institutions should be taught the social and political contexts of science and how to communicate with the media and numerous publics
- factors that facilitate media hype and errors should be recognised and addressed
- science engagement initiatives should investigate new forms of digital media and film, moving beyond traditional popular science outlets, including finding ways online to create opportunities for incidental exposure among key audiences not actively seeking science-related content
- scientific organisations need to track science-related media coverage to be aware of the numerous cultural contexts through which the public interprets science
- journalism schools and news organisations should develop a science policy beat to address the gap between journalists covering science and those covering politics
- new models of journalism—whether foundation, university or government supported—are needed.

In a recent article in the *American Journal of Botany,* Nisbet and Schefele[lxi] reviewed research from the social sciences on how the public makes sense of and participates in community decision making about science and technology. They underscored the role of the media and challenged the assumption that lack of scientific literacy was the major obstacle. They reviewed the topics of evolution, climate change, food biotechnology and nanotechnology, and recommended science communication initiatives guided by careful formative research, spanning a diversity of media platforms and audiences, and facilitating 'conversations' that recognise, respect and incorporate differences in public knowledge, values, perspectives and goals.

3.4.2 Who is being targeted?

Scientists and the media are the immediate targets of this program, but the results should increase science awareness and knowledge by the Australian population more generally.

3.4.3 What does this program offer?

This program will offer activities such as the following:

- media training for scientists

- training and professional development opportunities for working journalists to build their knowledge of science
- 'science hero' and 'science media personality' activities—targeting young Australians by developing positive role models to influence further studies and career choice in the sciences, and targeting community and business leaders and decision-makers by building a climate of support for science
- local ABC radio programming to develop community appreciation and engagement in science in the local region
- a coordinated effort to provide appropriate Australian science content for radio, television news channels, suburban newspapers and online (including YouTube and social networking sites).

STRENGTHENING THE MEDIA'S ROLE IN COMMUNICATION SCIENCE

Programs that increase the potential of media and new media coverage of the sciences need to be supported and encouraged.

Recommendation 10

That the national initiative support science communication and media training for scientists and that a short-term working group be established to review mechanisms for further developing Australian science media content.

4 Building Australia's capacity

A skilled science workforce is a prerequisite for the Australian Government's *Powering Ideas: An Innovation Agenda for the 21st Century*, the May 2009 budget response to the recommendations of the Cutler review of the National Innovation System. The second priority of the innovation agenda is 'a strong base of skilled researchers to support the national research effort in both the public and private sectors'.[lxii] This requires an increasing supply of talented and competent science, mathematics and engineering graduates, postgraduates and research technologists.

The schools, state education departments, TAFE colleges and universities have primary responsibility for science and mathematics education, supported federally by DEEWR. However, to a limited extent, DIISR and other Federal Government departments and agencies can assist by providing a deeper and richer environment in which students can learn science and mathematics. In particular, they can provide enrichment activities and opportunities for remote access to students living in regional and remote Australia, who are otherwise disadvantaged.

Thus, this chapter outlines programs for enhancing students' experiences in science and mathematics to help ensure an appropriately skilled workforce. These programs will contribute primarily to **Outcome 4: A society that encourages young people to pursue scientific studies and careers**. To a lesser extent, they will contribute to **Outcome 1: A society that is inspired by and values scientific endeavour**, especially for outer metropolitan, regional and remote communities; and to **Outcome 3: A society that critically engages with key scientific issues**, especially for students keen to take advantage of the opportunities on offer.

4.1 A focus on youth and the future

In order to meet the challenges of the government's *Innovation Agenda*, Australia needs a greater proportion of the student population undertaking science and advanced mathematics courses through high school, as well as gaining higher-level and higher-quality science, mathematics and engineering qualifications at university.

4.1.1 What does the evidence indicate?

Overseas studies have showed the importance of studying mathematics at secondary school. A study from the United States shows that the more mathematics courses that students take in high school, the more likely they are to earn a bachelor's degree: 7.8 per cent of those who complete Algebra 1; 23.1 per cent who complete Geometry; 39.5 per cent who complete Algebra 2; 62.2 per cent who complete Trigonometry; 74.3 per cent who complete Pre-calculus; and 79.8 per cent who complete Calculus.[lxiii] A study from the UK found that those who took A-level mathematics on average earn 10 per cent more than those who did not.[lxiv]

However, these important research findings have not translated into practical results for Australian students. The percentage of Year 12 students in advanced and intermediate mathematics has fallen slowly from 2001 to 2007; while those enrolled in less-demanding mathematics subjects has increased.[lxv] A somewhat similar pattern holds for the sciences more generally. The percentage of Year 12 students enrolled in biology, chemistry and physics slowly decreased from 1980 to 2002. Enrolments in all science subjects have remained relatively stable to 2007.[lxvi]

Many reasons have been suggested for their lack of interest in studying science and the more challenging mathematics subjects. These include poorly trained science and mathematics teachers, an uninspiring curriculum, strong family or peer influence, inadequate career counselling and the stronger appeal of other careers.[lxvii]

One tactic for addressing this problem has been the Science and Engineering Challenge. The number of students involved has risen steadily since 2000; in 2007, there were more than 15 000 participants from about 550 schools, and in 2008, there were 17 400 students from 660 schools.[lxviii] The SCOPE evaluation found that the Science and Engineering Challenge 'has been influential in having participants consider the option of taking up science related subjects in senior high school years'.[lxix]

In noting the decline in student enrolment in science and mathematics in high schools and the concomitant reduction in the number of tertiary science graduates in the state, Queensland Chief Scientist Peter Andrews stated that 'a key factor in this decline is the lack of obvious connection, in the eyes of secondary students, between these core science subjects and subsequent careers. This perception can—and should—be reversed through closer involvement of industry and universities in the provision of career advice informed by real-life developments in science and technology, and more frequent exposure to practising scientists and engineers as role models for these activities'.[lxx]

A tactic for specifically addressing the problem of enrolment in mathematics is the You Can Do Maths public service advertising campaign, which was spearheaded by the Australian Association of Mathematics Teachers and launched in January 2009. The advertisements have played on various television stations nationally, and can be downloaded from **www.youcandomaths.com.au** and YouTube. In the first eight months, there were over 25 000 visits to the site. At this stage, however, it is too early to assess impact.[lxxi]

This campaign was a successor to the Maths Multiplies Your Choices campaign, which was carried out in Victoria in 1989. The campaign, aimed at high school girls, used television and radio commercials, and press advertisements, including in the ethnic press; it is still regarded as one of the most successful. It showed both high awareness (over 90 per cent of girls and their parents) and high impact (substantial increase in number of girls choosing mathematics and science subjects after Year 10).[lxxii]

In 2008 and 2009, there was a marked increase of 17 per cent in university applicants for the natural and physical sciences. This increase in demand followed a suite of measures introduced by the Australian Government in the 2008–09 budget.

Prior to this, statistics for university enrolments did not revealed any clear trend. Between 2001 and 2008, the number of domestic undergraduate enrolments in natural and physical sciences courses increased by 4.1 per cent. However, the number of commencements and completions decreased by 5.3 per cent and 4.6 per cent, respectively. Commencement and completion figures have fluctuated over the years.

With respect to the number of domestic postgraduates in the natural and physical sciences, there was in increase in the enrolments (29.0 per cent), commencements (28.0 per cent) and completions (35.3 per cent) between 2001 and 2008. However, all three sets of figures have fluctuated from year to year.[lxxiii]

4.1.2 Who is being targeted?

This program targets high school students, to encourage them to continue their study of science and advanced mathematics by offering interesting and challenging opportunities. It provides a chance to undertake informal, rather than formal learning, and can be largely self-directed.

Any program needs to be cognisant of existing successful activities and work in collaboration and conjunction, rather than competition, with these. Such programs include the science and mathematics Olympiads, the Harry Messell International Summer School, Youth ANZAAS, CSIRO Education's CREST awards, the Science and Technology Education Leveraging Relevance (STELR) project developed by the Academy of Technological Sciences and Engineering, Questacon's Invention Convention, and the Australian Science Teachers Association Science Program Exciting Children Through Research Activities (SPECTRA) awards.

To the greatest extent possible, they should reinforce and extend the science and mathematics school curriculum, and build on programs such as the Academy of Science's *Primary Connections* for primary schools, the new *Science by Doing* for lower secondary schools, and *Nova: Science in the News* online resources, and the Australian Mathematical Sciences Institute's *ICE-EM Mathematics*.

4.1.3 What does this program offer?

This program will encourage schools, the higher education sector and research institutions to support activities such as the following:

- continuation and enhancement of successful youth-targeted programs, such as the Science and Engineering Challenge, to raise awareness of opportunities in emerging areas of science research and the role of the sciences in the future of business and industry
- support for the National Youth Science Forum and other youth-focused activities, such as science clubs, young scientists on the Web and science internships. These will provide young Australians with opportunities to pursue extra-curricular interests in the sciences and to visit science-based institutions and industries to experience the breadth of science-based careers

- brokerage of opportunities for students to do 'real science' using Australian research facilities and data. Outstanding Australian school students should have opportunities to use research infrastructure such as a neutron beam line at ANSTO, a beam line at the Synchrotron, telescopes and astronomical observational data, museum taxonomic collections, and environmental and earth imaging data
- brokerage between the needs of the school sector and the ability of the research community to provide resources to support learning.

A FOCUS ON YOUTH AND THE FUTURE

It is imperative for Australia to address identified skills shortages in the sciences by encouraging young Australian scientists to communicate science and young Australian students to further their studies and take up careers in the sciences.

Recommendation 11

That a key focus of the national initiative should be raising awareness among young people of opportunities in science and research. The Australian Government's investment in schools, higher education and research should be harnessed to achieve this.

4.2 Unlocking Australia's full potential

Through the state and territory consultations, it appears that some regional and remote areas—especially those that provide pleasant respite from winter cold—are much more popular than others for outreach programs developed in the urban centres. It was strongly recommended that there be a nationally coordinated approach to the provision of science outreach programs and travelling science exhibitions to ensure greater equity. Thus, the aim of this program is to reach out to communities in outer metropolitan, regional and remote parts of Australia, to support greater equity of opportunity and thereby unlock Australia's full potential.

4.2.1 What does the evidence indicate?

Reaching All Australians, a report on delivering science, mathematics, engineering and technology education and awareness programs to regional, rural and remote Australia, made many relevant findings:

- Such programs increased student interest and skill levels.
- Presenters brought new approaches, content, techniques and resources to the classroom, benefiting both students and teachers.
- The number and frequency of programs did not meet existing demand.
- The greater the distance from capital cities, the less likely schools were to be able to take advantage of such programs.

- Only 7 of 57 outreach programs surveyed operated exclusively in regional, rural and remote areas; most focused on capital cities and the larger regional towns.
- During the year reviewed, only one-quarter of the outreach programs surveyed visited an Aboriginal or Torres Strait Islander community.[lxxiv]

The South Australian *Shaping the Future* report, which offered a 10-year vision for science, technology and innovation, noted that 'raising community awareness requires education and communication across all demographics and communities. It needs to capture 'mind-space' by appealing to personal interests. And, it needs to become perceived as central to community life—rather than as a detached realm of 'scientific wizardry'.[lxxv]

There are significant learning benefits when formal and informal educational activities complement each other. The US National Research Council study of *Learning Science in Informal Environments: People, Places, and Pursuits* c concluded that:

- informal settings provide space for all learners to engage with ideas
- learners thrive in environments that acknowledge their needs and experiences, which vary across the life span
- learning experiences should reflect a view of science as influenced by individual experience as well as social and historical contexts
- adult care-givers, peers, teachers, facilitators, and mentors play a critical role in supporting science learning
- partnerships between science-rich institutions and local communities show great promise for structuring inclusive science learning across settings, especially when partnerships are rooted in ongoing input from community partners
- programs, especially during out-of-school time, afford a special opportunity to expand science learning experiences for millions of children.[lxxvi]

4.2.2 Who is being targeted?

This program will target schools and communities in outer metropolitan, regional and remote areas, and especially Indigenous and multi-ethnic communities. It is aimed at students, their parents and their teachers, and will provide incentives and encouragement for students to stick with science and mathematics at school, in order to increase their career opportunities.

Programs targeting Indigenous people should be informed by research such as the *Maningrida Study*, carried out by the Northern Territory Government in 2008. This analysis compares the Maningrida community in Arnhem Land with similar-sized mainstream communities with respect to economy, demography, and infrastructure, and suggests a 'whole of community' approach to Indigenous enterprise and employment.[lxxvii]

It will also target hard-to-reach population sectors, including those who are not interested or engaged in the sciences, people for whom English is a second language, and people who are disabled or have limited mobility, such as the elderly.

4.2.3 What does this program offer?

This program will include activities such as the following:

- coordination of outreach programs delivered by national, state and local science communication organisations and individuals, to provide greater equity of opportunity for regional and remote communities
- extension across Australia, especially to Indigenous and remote communities, of events such as 'Science in the Bush' that leverage support and contributions from others and that broaden audiences to include not just schools, but the wider community
- development and touring of exhibitions and exhibits to regional centres, telling the story of Australia's capability in the sciences and helping communities to understand how science impacts their lives
- a small grants program to develop and pilot innovative approaches and partnerships to engage audiences who are difficult to reach
- a small grants program to present appropriate interactive science activities at non-science events, such as arts or food festivals, sports competitions or agricultural shows.

UNLOCKING AUSTRALIA'S FULL POTENTIAL

To ensure a more equitable Australia, a special focus is required to maximise the potential of people who may not previously have had interest in or access to science engagement activities.

Recommendation 12

That the national initiative support science communication exhibitions and programs that target under-served groups, such as those living in outer metropolitan, regional and remote areas; Indigenous communities; people for whom English is a second language; and people who are disabled or have limited mobility.

5 Mobilising capability across Australia

This chapter considers how the programs described in Chapters 2 to 4 can be undertaken most effectively. While Chapter 1 called for national leadership and coherent action, the recommendations in this chapter describe the 'nuts and bolts' needed to support national leadership and coherent action.

The recommendations are based on input from the state and territory consultations (see Appendices 1 and 2), and an analysis of recent government reviews and successful overseas strategies, particularly in Britain (see Appendix 7). They include a national framework—local action approach, convening of short-term working groups as required, a strong Web presence, improved information flow, organisational networking and reporting. A supportive research and evaluation program is also needed to monitor progress and inform investment decisions.

5.1 What steps are required?

In order to achieve a scientifically engaged Australia, it will be necessary to develop a culture where the sciences are recognised as relevant to everyday life and where the government, business, and academic and public institutions work together with the sciences to provide a coherent approach to communicating science and its benefits.

It will require leadership by the Australian Government, in conjunction with the science communication sector, to enunciate a vision, goals and priorities for science engagement. It will also require a coordinated national framework for public engagement—a framework that recognises and leverages the range of national, state and community-based activities undertaken by both professionals and volunteers and that is supportive of the conditions for increased participation and debate.

The national framework will be developed from existing key national infrastructure—CSIRO Education and the state-based CSIRO Science Education Centres, the ABC multi-platform media network and Questacon—working with state-based science centres and museums alongside research agencies, universities, professional bodies, academies, the media, the business sector and community-based organisations. The constituent parts of this network, and the links between these parts, will need to be strengthened.

Australia must implement sophisticated strategies to improve the promotion of our science and research achievements nationally and internationally. Our science institutions will be expected to share their knowledge to help realise full social, economic, health and environmental benefits of scientific research and in return win ongoing public support.

Institutions and policy makers will need to acknowledge the importance of public engagement activity, support increased training and recognition for science communication practitioners, and seek, recognise and respond to public perspectives on science.

Australia's science communication providers have proved capable of generating many successful and effective activities. This national initiative will develop an appropriate balance between sustaining successful existing programs and creating new, strategically targeted programs reaching out to those not engaged through traditional science communication channels.

An effective national strategy cannot be delivered by governments or organisations acting alone. Concerted action is needed to ensure that the communication of science and its benefits has a consistent vision and direction. Key strategic priorities and messages must be developed and targeted effectively to achieve the optimal outcomes.

5.2 What is the best approach?

While there is considerable activity at the local level, it is often uncoordinated, overlapping and fragmented. Although most museums, professional associations, universities and research institutions have set aside resources for communicating science, there is considerable variability in focus and audience. The extent to which organisations coordinate activities with their peers is also variable.

There are some well-functioning cross-institutional networks that provide connections or coordination at the local level. These include, for example, the education officers seconded to CSIRO Education Centres in cities across Australia, the communications officers from the Cooperative Research Centres, and active state and territory branches of the Australian Science Communicators.

These and other national networks are not currently resourced to provide a broader coordinating role across all proposed elements of this national initiative. Thus, to get the most value and impact from the abundance of local activity, it will be extremely valuable to establish a **'national framework-local action' approach**. Such an approach will enable activities carried out locally to be better coordinated, better integrated and better able to contribute to the national agenda.

A **national framework** means the usage of federally funded national infrastructure and a central coordinating mechanism. This will most likely take the form of a defined and visible 'knowledge brokering' centre or hub, which will undertake the following:

- provide the vehicle by which strong leadership from the Government is communicated
- set up and facilitate short-term working groups to address particular priority issues
- leverage additional support to maximise the benefits of activities
- enhance the growing science and society research agenda
- identify and share best practice methods for engaging stakeholders
- provide connectivity between officials and practitioners and clear points of contact at all levels

- build the capacity of the science communication sector to facilitate better measurement and reporting of science impact
- commission research studies to provide baseline and longitudinal attitudinal data, benchmarking, program evaluation and impact assessment
- monitor and provide accountability for the performance of the national strategy against clearly defined outcomes
- report regularly in 'state of the nation' reports, highlighting activity levels, progress against goals and emerging priorities.

The concept of **local action** recognises the key roles of the states and territories and of state- and territory-based organisations as funders and providers of science communication activities. This concept was suggested in all of the state and territory consultations, though it was referred to by various names, such as a state or regional coordinator, information broker, secretariat or hub. In effect, it constituted a point of contact in each state and territory, along with locally appropriate coordination mechanisms.

One possible model for a national framework-local action approach is provided by National Science Week, which, through its coordinator and volunteer coordinating committee, achieves relatively high public visibility. The coordinator is supported by DIISR through the CSIRO Science Education Centre in each state and territory. There is a significant amount of goodwill, time and resources contributed to events during National Science Week, but it will be difficult, if not impossible, for most contributors to sustain such effort throughout the year.

Another possible model is the state-wide coordination in Western Australia through the engagement of Scitech as a node of leadership. This is effected through allocated staffing, program support and the Science Network WA Web portal (**www.sciencewa.net.au**) to which many organisations in the state contribute.

It is expected that any investment by the Australian Government in developing a national framework-local action approach would need to be supported by financial or in-kind commitments from the states. The level of commitment could be assessed by requests for tender from a range of organisations in each state and territory, acting individually or as a consortium, to accommodate a local coordinator. Options for placement of a local coordinator could be as part of:

- an existing national network, such as CSIRO Science Education Centres
- the current structure and coordinating mechanisms for National Science Week, which will require further funding to fulfil this role year-round
- state government science departments or Chief Scientists' offices
- science centres, museums or other bodies (such as the Royal Institution of Australia in Adelaide or the Royal Society of New South Wales) within each state.

Since much of the current activity is 'metro-centric', local coordinators, as part of the national framework-local action approach, will need to promote and expand activities for regional and remote communities, and especially Indigenous communities.

In some regional areas, there is a perception that the location of resources in capital cities does little to serve local needs. This is particularly true for the arid zone, where many of the common problems bear no relationship to state boundaries. Thus, in order to coordinate activities across the desert regions of the Northern Territory, Western Australia, South Australia, New South Wales and Queensland, it may be appropriate to identify a point of regional leadership and contact in Alice Springs. This is also true for the tropical zone across northern Western Australia, the Northern Territory and Queensland, where coordination of activities might best be addressed, not by a single state contact, but by a point of regional leadership and contact operating across the northern tropical zone.

NATIONAL FRAMEWORK – LOCAL ACTION

Australia requires a 'national framework—local action' approach to deliver an effective and efficient national initiative that mobilises and connects otherwise uncoordinated, overlapping and fragmented activities.

Recommendation 13

That a 'national framework—local action' approach be adopted, led by a national hub collaborating with Federal and state jurisdictions, business and the community. Such an approach should aim to increase cooperation amongst organisations involved in science communication down to the regional level, and drive partnerships and complementary activities.

Once leadership for local action has been established, the network of these local coordinators will be required to undertake the following:

- strengthen leadership within each local and regional context
- undertake activities to build the professionalism of local science communicators
- inspire and instigate local activities to support the national goal of developing a scientifically engaged Australia
- promote this national strategy and its programs in relation to the Australian Government's national innovation agenda
- encourage strong collaboration among state governments through chief scientists and other federal-state consultative bodies
- coordinate the various types of events offered and their scheduling, to avoid conflict, duplication and overlap
- create opportunities to develop activities involving several organisations in a spirit of cooperation

- foster cooperation among local organisations to build on each others' activities, to provide integrated pathways for increasing community engagement
- integrate science engagement activities into successful 'non-science' events, such as film or writers' festivals, community celebrations, food and wine displays, and art exhibitions
- broker and leverage partnerships and sponsorships with local universities, businesses, research institutions, trade associations and other groups
- respond to enquiries and support greater knowledge transfer and sharing of information
- monitor and contribute to science Web linkage (see section 5.4)
- generate a year-round program of events to communicate science, including high-visibility activities in and around National Science Week, to further develop people's level of interest and engagement
- contribute to the forthcoming International Years of Biodiversity and Chemistry and any subsequent 'International Year of …' programs by creating local events and resources
- feed into and get feedback from activities happening in other states or nationally, sharing expertise and good practice
- provide assistance to local organisations with program evaluation, benchmarking and impact assessment
- support and lead advocacy on behalf of the science communication sector
- contribute data for each national 'state of the nation' report.

5.3 How can the best expertise be used?

At times, neither Questacon nor the national advisory body will have the expertise and knowledge required to address some of the complex and challenging issues that arise in communicating science. Neither will they have the breadth of experience that draws on the range of disciplines that deal with human interactions.

Short-term working groups will provide such expert advice; they will be constituted as needed, drawing on expertise from across the natural and physical sciences, social sciences, the humanities, industry and policy makers to develop action plans aligned to Federal and state government policy goals. As indicated by Queensland Chief Scientist Peter Andrews, with respect in dealing with issues in the state: 'Increasingly, researchers in the humanities and social sciences will work together with other scientists and engineers to solve the big issues facing Queensland, and indeed the world, today'.[lxxviii]

A short-term working group to review mechanisms for further developing Australian science media content was part of Recommendation 10. While not formally part of a recommendation, other short-term working groups were suggested to undertake the following:

- review the variety and range of science prizes in Australia, and develop a plan for promoting winners, nationally and internationally, to increase public recognition of Australia's capability in the sciences
- review Australia's science image abroad and develop a plan for enhancing this image
- review mechanisms for science-based briefings and communication between scientists and opinion leaders, and develop a plan for more effective communication between scientists, media professionals and policy developers
- develop a plan for identifying and sharing best practice in science engagement.

5.4 How can this approach be supported online?

A network of local coordinators cannot be expected to provide information to everyone all the time. During the consultations, it was suggested by participants in every state and territory that the Web be used to provide continuous access to information. For example, use of a wiki and co-creation of content will build a national database and encourage collaboration.

In addition to providing an up-to-date schedule of local and national events, participants suggested that a science Web presence—such as a new Web site, portal or extension of an existing site—could serve many additional functions. These include the following:

- provide an access and entry point for audiences in Australia and overseas to find out about Australia's science infrastructure, activities, policies and achievements
- facilitate dialogue and the sharing of information and best practice between those working in the sciences and in science communication
- provide information on opportunities for Australians to engage in dialogue on science issues affecting our nation and the world
- disseminate useful science resources, especially materials written in lay language
- circulate articles and video clips about local science research
- host science blogs
- provide a mechanism for community feedback and evaluation
- publicise data on the impact of science engagement activities—that is, what works and what does not.

The science Web site or portal could be developed as an extension of one of the Web sites already well established—for example, from the Australian Government's **www.science.gov.au** science portal, the National Science Week Web site (**www.scienceweek.gov.au**), the ABC Web site (**www.abc.net.au/science**), the Queensland Science and Technology Web site (**www.science.qld.gov.au**) or Science Network WA

(www.sciencewa.net.au). Alternatively, it could be built 'from scratch' in partnership with one of the companies at the forefront of Web-based communication and information management. The Parliamentary Office of Science and Technology in the United Kingdom might also offer an interesting model (www.parliament.uk/parliamentary_offices/post/about.cfm).

These ideas must be considered in the context of the Australian Government's plan to build a new, 'super fast' National Broadband Network in partnership with the private sector. This will be the single largest infrastructure project in Australian history.

This new National Broadband Network will:

- connect 90 per cent of all Australian homes, schools and workplaces with broadband services with speeds up to 100 megabits per second, 100 times faster than those currently used by many households and businesses
- connect all other premises in Australia with next generation wireless and satellite technologies that will deliver broadband speeds of 12 megabits per second.[lxxix]

UTILISING NEW MEDIA

The use of the Web and digital technologies in science communication is essential to capture new audiences in a cost-effective way; it should be a central element of the national initiative. The National Broadband Network will expand opportunities for exploiting these technologies.

Recommendation 14

That the national initiative include development of a national Web presence to increase the visibility of Australian science to national and international audiences, and to promote links to other relevant science-related sites.

5.5 How can Australia build capacity in science communication?

Professional science communicators are a key component of the national strategy and their initial training and continuing professional development need to be supported as part of the interface between scientists, institutions and the public. An important task of the national framework—local action approach is to facilitate appropriate training and opportunities for interaction among science communicators to build professionalism and excellence.

Good science communication can be dazzling, but effective science communication requires a strong foundation in the sciences, as well as highly developed interpretative and communication skills. In one sense, science communication is a very specialised profession; in another sense, it shares characteristics with many other professions, such as journalism, film and television production, acting, creative writing, teaching, marketing, public relations, research and public speaking, which are grounded in the social sciences, arts or humanities disciplines.

Within science communication, there have developed many sub-specialties, both by discipline and by aspect. For example, there are now specialist medical writers; environmental advocates, actors and musicians; and even mathematics comedians!

Nonetheless, they all have in common the goal of engaging and communicating with their audience. Thus, Australia needs to harness its most creative and talented communicators to achieve the goal of a scientifically engaged Australia.

There are a number of possible activities that could lead in this direction:

- science journalism training, cadetship and internship programs across a range of media platforms
- encouraging universities to incorporate communication training as part of their undergraduate and postgraduate science studies
- professional recognition of science communicators as occurs in other professions, such as journalism, public relations and librarianship
- availability of online science communication training packages
- small grants to enable young science communicators to attend conferences and short courses, or to undertake short internships in other institutions
- convening of a short-term working group to develop a plan for identifying and sharing best practice in science engagement.

5.6 What research is required?

Several needs were highlighted in the state and territory consultations with respect to a research agenda for understanding science engagement in Australia. To undertake a research agenda as indicated below will require the involvement of researchers in the humanities, arts and social sciences, as well as the natural and physical sciences. Briefly, the needs are as follows:

- to gain greater understanding of Australian attitudes toward science in terms of level of interest and engagement. In this respect, Victoria and the UK provide good models (see section 1.2.1). There is a need for a series of baseline and longitudinal studies to be carried out in all states and territories, as well as to address particular population groups, such as Indigenous people, speakers of English as a second language, women, the elderly, and those living in regional and remote areas
- to be aware of the full range and reach of science engagement activities. A broad audit of current science engagement activity will identify key providers able to supply input to the science Web presence (see section 5.4)
- to evaluate programs to determine what works best with particular target audiences. Developing an evaluation pro forma or core set of performance indicators that collects data consistently will allow comparison among various activities. Systematic evaluation

is also necessary to add to the knowledge base of which types of activities work best with different segments of the population

- to assess the impact of science engagement activities with respect to long-term behavioural change. For example, what makes students decide to continue studying science and mathematics at Year 11 and 12? What sparks a grandparent's interest in taking their grandchild to a science centre instead of a football game? What triggers concerned citizens to write letters to the editor or blog about science issues that affect their lives?

Developing such a research agenda will enable the Australian Government and all those investing in science communication to direct their available resources more effectively:

- to identify gaps in provision and develop interventions that better target the needs of the Australian population
- to facilitate collaboration among, broker partnerships with, and leverage contributions from government, business, academia, research and the broader community to address priority areas
- to monitor the performance of the nation in relation to international benchmarks.

DEVELOPING AN EVIDENCE BASE

Australia requires a strategic research and evaluation capability to design, target and review effective science engagement activities and to guide future investment.

Recommendation 15

That the national initiative support a program of research in science engagement—such as baseline and longitudinal attitudinal and behavioural studies, activity audits, program evaluations and impact assessments—to inform future investment decisions by government and its partners.

5.7 How can the national strategy encourage sustainability?

To ensure fair and equitable distribution of funding for science communication activities, a number of funding principles have been suggested. They could include the following, as well as others:

- Funded activities, where appropriate, are required to adopt a national framework-local action approach that encourages partnerships and co-investment by other Australian Government departments and agencies, state and territory governments, business and industry, academic and research institutions and community organisations.
- Funded activities, where appropriate, are required to have a plan for sustainability that does not continue to rely on maintaining the level of investment by the Australian Government, but that seeks to source other investment over the longer term.

- Funded activities, where appropriate, should encourage involvement by 'non-traditional' providers.
- Funded activities are required to have clear and strategic targets, including population groups and segments—such as Indigenous communities and second language English speakers—that are challenging to engage through traditional means.
- Administrative costs and overheads should be kept to a minimum.

5.8 In conclusion

The Australian Government has made an unprecedented commitment to the advancement of scientific research in Australia, through 'Super Science' and other projects in astronomy, space, marine science, climate change, clean energy, biological discovery, biotechnology development, nuclear science, nanotechnology and advanced ICT. The Government has also made a strong commitment to university research and to business commercialisation.

Most of the Australian population, however, would not be aware of these commitments; neither would they be aware of the importance of these developments to Australia's economic future and the wellbeing of the next generation. Neither is there an awareness overseas, especially among Australia's trading partners, of the many important Australian developments in science infrastructure and research. This is despite funding by successive governments of programs in science communication.

Although these previous science communication programs funded many high-quality, individual events, including the prestigious Prime Minister's Prize for Science and extensive National Science Week activities, they have been undertaken without a holistic national strategy, overarching national leadership or a supporting infrastructure.

As a consequence, organisations such as CSIRO, the universities and the CRCs are yet to align their support and coordinate their activities to feed into a cohesive national science engagement agenda. Although there is a rich variety of local events, the lack of any coordinating mechanism continues to create actual or perceived duplication, overlap and fragmentation.

In some cases, this has led to competition and rivalry for audiences and in others to gaps in services, particularly to groups such as Indigenous people and English second-language speakers. Although both Federal Government and state jurisdictions have been funding initiatives, they have not been working together strategically in the national interest. There has been little exchange of best practice among states, or even among regional centres within states. Some outer metropolitan, regional and remote areas are often left out completely. There is no long-term, and very little short-term, evaluation of impact, making it difficult to learn from either science communication successes or failures.

If science communication is to be effective, it needs to take cognisance of the audiences to be engaged. The activities need to be appropriate and relevant to the local community, and contextualised to acknowledge and value local perspectives.

Activities need to build on each other, to provide pathways towards various stages of awareness and involvement. The Australian Government must act nationally and collaboratively to create pathways for lifelong engagement in science through the wide range of local science-related institutions, including schools, universities, government agencies, industries, community groups and cultural institutions, including museums, science centres, libraries, botanic gardens, zoos and aquaria.

Implementing the recommendations in this national strategy will help ensure that:

- the nation is working together to realise the goal of creating a scientifically engaged Australia
- key audiences and national priorities are addressed
- there is a central point of leadership responsible for communication and information flow, knowledge management, brokering of partnerships and national monitoring of performance
- there is a broadly constituted advisory body to facilitate a strategic and coordinated approach and to stimulate national 'conversations' across the natural and physical sciences, the social sciences, and the arts and humanities
- short-term working groups will provide expert advice on how best to address complex and challenging issues of strategic importance
- investments by DIISR and other Federal Government departments leverage national, state and local contributions for optimal effectiveness and efficiency
- federal and state jurisdictions agree on strategic priorities and co-investment opportunities
- programs are developed and delivered based on best practice, informed by up-to-date audience research, and measured uniformly and consistently for outcomes and impact.

The government has made a solid commitment to science and innovation through its *Innovation Agenda*. The potential to maximise benefits will be increased if the *Innovation Agenda* is communicated loudly and strongly across Australia. If communicated appropriately, it should move the uninterested to become interested, the interested to become engaged, and a greater proportion of Australia's young people to undertake challenging and fulfilling careers in the sciences.

Now is the time to motivate and inspire Australians. It is imperative that they be involved with science and science-related issues to help solve the environmental, economic, social and humanitarian problems facing our country and the world. Inspiring Australia is too important to leave to chance.

Appendix 1 Participants in consultations and written submissions

Over 230 people across Australia contributed their time and input through group discussions, workshop discussions and one-on-one conversations. In addition, 22 written submissions were received.

Name	Position	Organisation	State/ Territory
Abbott, Prof Lyn	Head of School/Winthrop Professor, School of Earth and Environment	The University of Western Australia	WA
Addicott, Ms Pamela	President	Probus Club of Ballarat South	VIC
Ahern, Ms Kylie	Publisher/Chief Executive Officer	Luna Media	NSW
Ainsley, Dr Phil	Germplasm Research Coordinator	Adelaide Botanic Gardens, Department of Environment and Heritage	SA
Aitken, Ms Robyn	President	Science Teachers Association of Tasmania	TAS
Allen, Mr Ian	Executive Producer, Content	ABC Innovation	ACT
Anderson, Ms Margaret	Chair of CAMD	Director, History Trust of South Australia	SA
Andrews, Prof Peter	QLD Chief Scientist	Office of the Queensland Chief Scientist	QLD
Angus, Ms Rosemary	Regional Education Officer	Highlands Regional Waste Management Group	VIC
Ashworth, Ms Peta	Team leader and Social researcher	CSIRO Energy Transformations Flagship	Nat
Awabdy, Ms Doreen	Bright Minds—UQ Science Education Manager	The University of Queensland, Faculty of Science	QLD
Ayers, Dr Greg	Director of Meteorology and Chief Executive Officer	Bureau of Meteorology	VIC
Bagg, Dr Melanie	Team Leader, Marketing and Outreach, Faculty of Sciences	The University of Adelaide, also affiliation with Australian Science Communicators and Australian Society for Medical Research	SA
Baker, Prof Joe	Visiting Science Fellow	Queensland Primary Industries and Fisheries, Department of Employment, Economic Development and Innovation	ACT
Banham, Mr Brent	Science Communications Officer, School of Chemistry, Physics and Earth Sciences	Flinders University, Faculty of Science and Engineering	SA
Bastin, Mr Gary	Research Scientist	CSIRO Sustainable Ecosystems, Alice Springs	NT
Baxter, Miss Suzy	Director—Business Development	KPMG	QLD
Beaumont, Dr Karin	Proprietor, Artist and Science Communicator	Oceanides—Art of the Ocean	TAS
Beazley, Prof Lyn	Chief Scientist of Western Australia	WA Department of Commerce	WA
Beswick, Dr Deborah	Manager of Science	Elizabeth College, Hobart	TAS
Bilimoria, Mr Reza	General Manager, Business Services Branch	National Measurement Institute, DIISR	NSW
Bleathman, Mr Bill	Director	Tasmanian Museum and Art Gallery	Tas
Bradley, Mr Brian	Director General	Commerce WA	WA
Brady, Dr Tess	Artistic Director	Clunes Back to Booktown	VIC
Brien, Mr Alan	Chief Executive Officer	Scitech	WA
Britton, Dr Adam		Big Gecko Crocodilian Research and Consulting	NT
Brown, Mr Anthony		Office of the Queensland Chief Scientist	QLD
Brown, Prof Gavin	Inaugural Director	The Royal Institution of Australia	SA

Name	Position	Organisation	State/ Territory
Burnet, Prof Frank	Emeritus Professor of Science Communication	University of West England, Bristol	UK
Byford, Ms Lyndal	Media Manager	Australian Science Media Centre	SA
Byrne, Prof Aidan	Dean of Science	The Australian National University	ACT
Byron, Dr John	Executive Director	The Australian Academy of the Humanities	ACT
Cairney, Dr Sheree	Post Doctoral Research Fellow	Menzies School of Health Research	NT
Calati, Mrs Francesca	Outreach and Curriculum Development Officer	La Trobe University, School of Molecular Sciences	VIC
Calladine, Mr Steve	Communications Manager	CODES—Australian Research Council Centre of Excellence in Ore Deposits	TAS
Campbell-Fraser, Mr Colin	Principal Adviser, External Relations and Advocacy, Vice Chancellery	The University of Western Australia	WA
Cansfield-Smith, Ms Christine	Director	CSIRO Discovery	ACT
Carter, Ms Angela	Manager	Discovery Science and Technology Centre, Bendigo	VIC
Cerini, Ms Bobby	Art/Theatre Science Communicator	The Australian National University	ACT
Chambers, Ms Jasmine	Director, Science Marketing and Communication Unit	The University of Sydney	NSW
Christou, Ms Gerarding	Neighbourhood Renewal Manager	Victorian Department of Human Services	VIC
Clark, Dr Doreen	Fellow	Australian Academy of Technological Sciences and Engineering	NSW
Clark, Ms Kate	Director	Historic Houses Trust of NSW	NSW
Clingan, Mr Philip	Executive Officer	Highlands Regional Waste Management Group	VIC
Connell, Mr Matthew	Principal curator	Powerhouse Museum	NSW
Cooper, Ms Linda	Project Director, Bragg Initiative/Royal Institution of Australia	SA Department of the Premier and Cabinet	SA
Cormick, Dr Craig	Manager	Australian Office of Nanotechnology, DIISR	ACT
Crawshaw, Mr Anthony	Communications Manager	CSIRO Australia Telescope National Facility	NSW
Cribb, Prof Julian	Science Communicator		ACT
Cribb, Mr Andrew	Manager Corporate and Community Relations	WA Department of Fisheries	WA
Crowley, Dr Gabriel	Biodiversity Information Officer	Tropical Savannas Cooperative Research Centre	NT
Curran, Dr John	General Manager	CSIRO Communications	ACT
da Silva, Mr Wilson	Editor	Cosmos Magazine	ACT
Danos, Mr Trevor	President	University of Sydney, Science Foundation for Physics	NSW
Davies, Dr Jocelyn	Principal Research Scientist, Geographer	CSIRO Sustainable Ecosystems	NT
Davies, Ass. Prof Jim	Principal	Australian Science and Mathematics School	SA
Day, Prof David	Dean	University of Sydney, Faculty of Science	NSW

Name	Position	Organisation	State/ Territory
Denley, Miss Samantha	Principal Communication Officer	Queensland Primary Industries and Fisheries, Department of Employment, Economic Development and Innovation	QLD
Devitt, Ms Denise	Principal Education Officer Science	Department of Education, Curriculum Team	TAS
Dignard, Ms Sharon	Senior Adviser Industry Policy	WA Chamber of Commerce and Industry	WA
Dircks, Ms Ruth	Previous recipient of 2002 Prime Minister's Prize for Excellence in Science Teaching in Secondary Schools		NSW
Dodds, Prof Sue	Dean of Arts	University of Tasmania	ACT
Donnelly, Ms Emma	Science Outreach Coordinator	Curtin University of Technology	WA
Dow, Ms Susan	Manager, Integrated Technical Services	Centre for Appropriate Technology	NT
Duff, Prof Gordon	Chief Executive Officer	CRC for Forestry	Tas
Eliott, Dr Susannah	Chief Executive Officer	Australian Science Media Centre	SA
Ellis, Ms Robyn	Technical Trainer/Akaltye Program Manager	Centre for Appropriate Technology Inc.	NT
Erskine, Dr Nigel	Curator—Exploration and European Settlement	Australian National Maritime Museum	NSW
Fahey, Ms Genevieve	Manager, Scienceworks	Museum Victoria	VIC
Farrell, Ms Rebecca	Communications and Public Relations Officer	Desert Knowledge Australia	NT
Ferguson, Ms Jan	Managing Director	Desert Knowledge Cooperative Research Centre	NT
Filmer-Sankey, Mr Patrick	Director	Queen Victoria Museum and Gallery	QLD
Finkel, Dr Alan	Chancellor	Monash University	VIC
Finlay, Prof David	Dean, Faculty of Science, Technology and Engineering	La Trobe University	VIC
Foley, Dr Cathy	Former President, The Australian Institute of Physics	President Elect, Federation of Australian Scientific and Technological Societies	NSW
Freys, Ms Louise	Manager, School Programs and Undergraduate Recruitment, Science Marketing and Communication Unit	University of Sydney	NSW
Galloway, Dr Ian	Chief Executive Officer	Queensland Museum	QLD
Gardiner, Mrs Helen	Chair	National Science Week Victorian Coordinating Committee	VIC
Garnett, Prof Helen	Board Chair	Australian Biosecurity Intelligence Network, Former Vice Chancellor of Charles Darwin University	NT
Gascoigne, Mr Toss	Science Communicator and Executive Director	Australian Science Innovations	ACT
Gobbey, Mr Rod	Executive Director—Primary Industries	Department of Regional Development, Primary Industry, Fisheries and Resources	NT
Goninan, Mr Wayne	Faculty Manager	University of Tasmania, Faculty of Science, Engineering and Technology	TAS
Goodrum, Prof Denis	Managing Director	Australian Academy of Science, Science by Doing	ACT

Name	Position	Organisation	State/ Territory
Goodwin, Dr Miriam	Director	Goodnews Marketing and Communications Pty Ltd	NSW
Gower, Major General Steve	Director	Australian War Memorial	QLD
Gower, Dr Steve	Head of External Relations	Australian Synchrotron	Vic
Gray, Ms Melanie	Manager	Office of the Queensland Chief Scientist	QLD
Greene, Dr Patrick	Chief Executive Officer	Museum Victoria	Vic
Grocott, Mr Paul	Senior Media Officer	University of Western Sydney, Office of Public Affairs	NSW
Gromadzki, Mr Adam	Manager	Southern Queensland CSIRO Education	QLD
Grose, Mr Simon	Science Journalist	Independent	ACT
Gunn, Mr John	Chief Scientist	Australian Antarctic Division	Tas
Haddy, Mr Brian	General Manager	SciWorld with roles in National Youth Science Forum, National Science Week Committee and the Australian Science and Mathematics School Foundation	SA
Haggman, Ms Kate	Senior Communications Officer	Office of the Queensland Chief Scientist	QLD
Hall, Mr Graeme	Manager Quality Teaching Initiatives	Teaching Australia—Australian Institute for Teaching and School Leadership Limited	ACT
Harper, Ms Angela	Senior Science Communicator	Queensland University of Technology, Faculty of Science and Technology	QLD
Harris, Ms Annie	Senior Project Officer	Department of Employment, Economic Development and Innovation, Science Partnerships and Engagement Branch	QLD
Harvey, Mr Michael	Head of Exhibitions and Creative Services	Australian Museum, Public Programs and Operations	NSW
Hatherly, Ms Janelle	Manager Public Programs	Botanic Gardens Trust, Sydney	NSW
Hayes, Ms Katrina	Community Liason Officer	Department of Agriculture and Food	WA
Heard, Ms Marian	Programs Manager	CSIRO Education	ACT
Herbert, Dr Jeannie	Vice-Chancellor	Batchelor Institute of Indigenous Tertiary Education	NT
Hobbs, Ms Bernie	Science Journalist, Broadcaster	ABC	NSW
Holzapfel, Ms Simone	Founding Partner	shac Communications	QLD
Hopkins, A.Prof Andrew	Head of AAT Science	Anglo-Australian Observatory	NSW
Horstman, Mr Mark	Reporter, Catalyst	ABC 2	NSW
Howarth, Mr Frank	Director	Australian Museum	NSW
Jenkins, Ms Natalie	Education Coordinator	Museum and Art Gallery of the Northern Territory, Department of Natural Resources, Environment, the Arts and Sport	NT
Jones, Ms Diana	A/Chief Executive Officer	WA Museum	WA
Kahler, Ms Jane	Manager, Science and Community	CSIRO	ACT
Keay, Dr Sue	Communication Manager	CAST CRC	QLD
Kelly, Dr Lynda	Head of Australian Museum Eureka Prizes, Web and Audience Research	Australian Museum	NSW
Kelly, Ms Sharon	Media Adviser	ANSTO	NSW

Name	Position	Organisation	State/ Territory
Kempler, Mr Leon	Chair	Questacon Council	Vic
Kennedy, Mr Cris	Chair	National Science Week ACT Coordinating Committee	ACT
Kenny, Ms Diane	Marketing and Communications Coordinator	Mater Medical Research Institute	QLD
Keppel, Mr Peter		CFA Ballarat	VIC
Kidd, Dr Evan	Charles La Trobe Research Fellow	La Trobe University	VIC
King, Ms Mary Anne	Manager	Australian Science Innovations	ACT
Kingsland, Mr Ross	Manager	CSIRO Education	ACT
Klomp, Prof Nicholas	Dean, Faculty of Science	Charles Sturt University	NSW
Krishna-Pillay, Mr Chris	Manager	Victoria CSIRO Education	VIC
Kroker, Ms Jenny		Centre for Appropriate Technology	NT
Kruszelnicki, Dr Karl	Julius Sumner Miller Fellow	The Science Foundation for Physics	NSW
Kuczer, Ms Larelle	Acting—YHQ Coordinator	City of Ballarat Youth Services	VIC
Lawrence, Mr Greg	Communication Manager	Future Farm Industries CRC	WA
Leach, Dr Joan	Lecturer	Science Communication Network, School of English, Media Studies and Art History, University of Queensland	QLD
Lee, Ms Frankie	Science Events Manager	ABC	ACT
Lee, Mr Nick	Executive Producer, Catalyst	ABC TV	NSW
Leroi, Ms Jeannie-Marie	Chair	National Science Week Tasmania Coordinating Committee	TAS
Lieberman, Dr Sophie	Coordinator, Science Communication	Australian Museum	NSW
Lloyd, Mr Andrew	A/Assistant Principal, Teaching and Learning	Centralian Senior Secondary College	NT
Loney, Dr Prue	Communications Manager	Cooperative Research Centre for Forestry	TAS
Longnecker, Assoc Prof Nancy	Coordinator, Science Communication Program	The University of Western Australia	WA
Lucas, Mr Tim	Fresh Scientist (2008)	Queensland Primary Industries and Fisheries, Department of Employment, Economic Development and Innovation	QLD
Lund, Assoc Prof Mark	Head of the School of Natural Sciences	Edith Cowan University	WA
Lyons, Ms Suzannah	Producer	ABC Science Online	NSW
Macaulay, Mr Craig	Communications Officer	CSIRO Marine and Atmospheric Research	TAS
Malcom, Ms Lynne	Executive Producer	ABC Radio Science	NSW
Malgorzewicz, Ms Anna	Director	Museum and Art Gallery of the Northern Territory	QLD
Mart, Ms Bronwyn	President	South Australian Science Teachers Association	SA
Maunder, Ms Libby	Academic Support Officer and PhD Student	Research School of Astronomy and Astrophysics, The Australian National University	ACT
McCalman, Prof Iain	ARC Federation Fellow	University of Sydney	ACT
McLeod, Mr Peter	Director	Museum of Tropical Queensland	QLD
Meek, Dr Sue	Chief Executive	Australian Academy of Science	ACT

Name	Position	Organisation	State/ Territory
Mergard, Ms Jackie	Marketing Officer, Faculty of Science	The University of Queensland, with involvement in ANZAAS, National Science Week QLD Coordinating Committee	QLD
Metcalfe, Ms Jenni	Director (past President, Australian Science Communicators)	Econnect Communication	QLD
Miller, Prof Suzanne	Director	South Australian Museum	SA
Miller, Mr Anthony	Development Officer	Chamber of Minerals and Energy of WA	WA
Monteath, Ms Sue	President	Science Teachers Association of Queensland	QLD
Mooney, Ms Meg	Land and Learning Program Manager	Tangentyere Council, Alice Springs	NT
Moore, Mr Glen	Director	Science Centre and Planetarium, University of Wollongong	NSW
Morland, Ms Louise	General Manager, Strategic Communication and Marketing	Department of Primary Industries and Fisheries	QLD
Morley, Ms Muriel	Retired, former TAFE teacher		WA
Morony, Mr Will	Executive Officer	Australian Association of Mathematics Teachers	SA
Morrison, Mr Allan	Museum Magnet Schools Project Officer	Queensland Museum	QLD
Morrison, Prof Robert	Freelance Science Broadcaster and Writer	Right Angle Publications; Patron of National Science Week SA; Chair of SciWorld	SA
Morton, Mr Craddock	Director	National Museum of Australia	QLD
Nagle, Mr Glen	Education and Outreach Manager	NASA Canberra Deep Space Communication Complex	ACT
Nicholas, Mrs Marianne	Science Coordinator/Class Teacher	Department of Education and Children's Services	SA
Nicholls, Mr Paul	Director Science Partnerships	Scitech	WA
Nielsen, Mrs Louise	Principal Consultant Policy and Advice—K–12 Curriculum, Assessment and Reporting, Science	WA Department of Education and Training	WA
Nowak, Dr Rachel	Consultant	Science, Media and Communication	VIC
O'Connor, Prof John	Head of School and Oversight of Science and Engineering Challenge, SMART programs	University of Newcastle, School of Mathematical and Physical Sciences	NSW
O'Grady, Ms Lynda	Member	Questacon Council	NSW
O'Kane, Prof Mary	NSW Chief Scientist and Scientific Engineer	Office of the NSW Chief Scientist and Scientific Engineer	NSW
O'Neil, Ms Helen	Executive Director	Council for the Humanities, Arts and Social Sciences	ACT
Page, Ms Melanie	Publicity, Events, Radio	Pushka Management (National Science Week Media, Tas)	TAS
Pampena, Mr Simon	Mathematics Comedian		VIC
Paterson, Dr Adrian	Chief Executive Officer	ANSTO	NSW
Pay, Mr Clive		eLabtronics	SA
Pegg, Prof Graham	Dean, Faculty of Education, Health and Science	Charles Darwin University	NT
Penna, Mr Chris	Monitoring and Evaluation Officer	Alice Solar City/Desert Knowledge CRC	NT

Name	Position	Organisation	State/ Territory
Pfitzner, Dr Darius	Science Communications Officer	Flinders University of South Australia, School of Computer Science, Engineering and Mathematics	SA
Pockley, Dr Peter	Science Writer and Broadcaster		NSW
Poiner, Dr Ian	Chief Executive Officer	Australian Institute of Marine Science	QLD
Reade, Ms Jillian	Secretary	Science Teachers Association of Tasmania	TAS
Reeves, Mr Andrew	Science Adviser	Office of Minister for Innovation, Industry, Science and Research	ACT
Reid, Dr Ian	Education Services Manager	International Centre of Excellence in Water Resources Management (ICE WaRM)	SA
Rennie, Prof Leonie	Research Professor	Curtin University of Technology	WA
Riddles, Dr Peter	Chief Executive Officer	ViciBio Pty Ltd	QLD
Riedl, Ms Rosa	Manager, Research and Development	Bond University	QLD
Rifkin, Dr William	Director, Science Communication Program	Faculty of Science, University of New South Wales	NSW
Ronald, Ms Sara	Policy Adviser, Office of the Treasurer	Office of WA Minister for Commerce; Science and Innovation	WA
Rooke, Ms Anna	Chief Executive Officer	QUT Creative Enterprise Australia	QLD
Rowley, Prof Sue	Former Deputy VC of Research	University of Technology, Sydney	ACT
Russo, Mr Peter	Chief Executive Officer	Australian Science Teachers Association (ASTA)	ACT
Sage, Ms Cathy	Principal	SageWords Communications	Vic
Sakko, Ms Rona	National Science Week SA Coordinator	CSIRO Education	SA
Samardzic, Dr Olivia	Co-Director Centre for Australian Space Education	Honorary Secretary, Australian Institute of Physics	SA
Sanders, Mr David	Rotarian, Wendouree Rotary Club	Smart Options Ballarat	VIC
Satterthwaite, Mr David	ScienceNetwork WA Editor	Scitech	WA
Scott, Mr Mark	Managing Director	ABC	NSW
Scouller, Ms Rebecca	Member	National Science Week ACT Coordinating Committee	ACT
Seddon, Mr Thomas	Chief Executive Officer	The Bendigo Trust	VIC
Shanahan, Mr John	NTCE Implementation Office, Senior Years Team	Department of Education and Training	NT
Shore, Dr Jesse	Science communicator	Prismatic Sciences	NSW
Single, Ms Ann	Manager, Science Partnerships and Engagement	Department of Tourism, Regional Development and Industry	QLD
Smith, Ms Julie-Anne	Manager Education	Perth Zoo	WA
Speer, Mr Stephen	Assistant Director Communications and Visitor Services	Australian National Botanic Gardens	ACT
Spelman, Ms Emma	Manager, Visitor Experience	National Film and Sound Archive	ACT
Spierings, Ms Janelle	Education Officer	Sovereign Hill Museum	VIC
Sproul, Ms Linda	Manager, Public Programs	Museum Victoria	VIC
Stanley, Mr Ken	Manager Tasmania	CSIRO Education	TAS
Stephens, Mr Peter	Director, Diagnostic Services Division	Department of Regional Development, Primary Industry, Fisheries and Resources	NT

Name	Position	Organisation	State/ Territory
Stocklmayer, Prof Sue	Director, Associate Professor	Centre for the Public Awareness of Science, Australian National University	ACT
Sturgess, Ms Louise	Manager, Corporate Communications and Marketing	Queensland Museum	QLD
Sullivan, Mr Tim	Deputy Chief Executive Officer and Museums Director	Sovereign Hill Museums Association	QLD
Surrey, Mrs Kate	Education and Community Liaison	ANSTO	NSW
Taylor, Dr Peter	Executive Director	Australian Mathematics Trust	ACT
Thwaites, Mr Tim	National President	Australian Science Communicators	VIC
Tomkins, Dr Andrew	Director, Biosecurity Division	Department of Regional Development, Primary Industry, Fisheries and Resources	NT
Torok, Dr Simon	Communication and Marketing Manager	CSIRO Marine and Atmospheric Research	VIC
Trotter, Mr David	National CSIROSEC Manager	CSIRO Education	VIC
Turton, Ms Kylie	South Australian Manager	CSIRO Education	SA
Tyndall, Ms Amanda	Head of Programs	The Royal Institution of Australia	SA
Uldridge, Ms Ann	Director	Queensland Community TV	QLD
Underwood, Ms Penny		Mediawise	VIC
Vella, Dr Karen	Manager, NRM Plan Coordination Unit	QLD Terrain Natural Resource Management	QLD
Vogrig, Mr Darren	NSW Manager	CSIRO Education	NSW
Waldren, Ms Mary-Anne	Executive Director	Australian Science Festival	ACT
Wallis, Ms Georgia	A/Principal Policy Officer	Office for Science and Medical Research, Industry and Investment NSW	NSW
Ward, Prof Jo	Dean, School of Science	Curtin University of Technology	WA
Webb, Prof Grahame	Chairman, NT Research and Innovation Board	Northern Territory Government	NT
Webster, Dr Diane	Research Fellow	Monash University	VIC
Williams, Mr Robyn	Science Journalist and broadcaster	ABC	NSW
Williams, Ms Mary-Louise	Director	Australian National Maritime Museum	QLD
Williams, Ms Wendy	Manager, Science and Community	Department of Innovation, Industry and Regional Development	VIC
Williamson, Mr Derek	Education and Program Development	Powerhouse Museum	NSW
Woodbury, Mr Robert	Science/Agriculture Coordinator	Department of Education and Children's Services, Gawler High School	SA
Yates, Mr Peter	Chairman	Australian Science Media Centre, Royal Institution of Australia	SA

Note: state is listed as the state in which the consultee participated in a session

Appendix 2 Summary feedback from nationwide consultations

FINDINGS FROM CONSULTATIONS

Consultations with groups and individuals have been held in Adelaide, Alice Springs, Ballarat, Brisbane, Canberra, Darwin, Hobart, Melbourne, Perth, Sydney and Townsville. These consultations provided:

- insights into state and local science communication activities
- suggestions on how state and local initiatives might benefit and develop through linkages to a national framework
- suggested actions that could enhance science communication outcomes in the next one to five years.

A number of needs and issues were identified and a number of potential responses were proposed through these consultations. The ones reported here are those put forward in several consultations and which appear to have widespread support.

Needs and issues identified by participants

- No one at the national or state level is articulating the vision, goals, priorities or desired outcomes for science communication:
  - there is a need for leadership that encourages buy-in, alignment and coordination across a very broad and diverse science communication landscape.
- 'Science' and 'science communication' have different meanings for different people. When engaging different stakeholders in a broad science communication initiative, it will be critical to value and to articulate the perspectives of these stakeholders in relation to agreed definitions.
- There is a need for science communication not to be just one way, but to involve dialogue, participation and engagement.
- Science communication should be seen neither as one-dimensional nor as linear because of the interactions among diverse actors. For example, industry can be both a producer of research and a user of information about research.
- The system of science communication forms part of the broader national innovation system, interacting with other parts of that broader system.
- Much of the activity is 'metro-centric':
  - there is a need to promote and expand activities for regional, rural and remote communities.

- Current activity tends to involve those who are already 'interested and engaged' rather than targeting those who are 'not interested or not engaged':
  - activities held in 'scientist-owned' spaces, such as universities and research institutes, are not likely to be attended by the larger population who sees such venues as 'for the intellectual elite'.
- While there is considerable activity at the local level, it is often uncoordinated, overlapping and fragmented:
  - National Science Week, through its coordinating mechanism, achieves relatively high public visibility, but activity at other times during the year tends to have lower visibility
  - while there are some well-functioning networks, for example CSIRO Science Education Centres) and some specialist resources (for example education officers seconded to CSIRO Science Education Centres or cultural institutions), resources for wider coordination are lacking
  - there is no central 'place'—be it person or Web site—where providers or the general community can find out about science communication initiatives nationally (outside of National Science Week), although Western Australia provides a good model for state coordination.
- There is a significant amount of goodwill, investment of time and resources contributed to events such as National Science Week, but this is difficult, if not impossible, for most contributors to sustain at other times.
- Most professional associations, universities and cooperative research centres have some resources for science communication activity; however there is considerable variability in focus and audience.
- Schools are a key part of the science communication ecosystem, and the needs that have been articulated in recent years (for example in the areas of curriculum reform, teacher recruitment and retention, teacher professional development and standards) continue to persist:
  - there is a need not only for those with direct responsibility for the quality of science and mathematics education and careers education, but also for those with a vested interest in or with assets to contribute to (for example trade associations or local industries) to increase the level of student interest and engagement in science and science careers
  - teachers sometimes feel 'bombarded' by the curricular and extra-curricular science opportunities for their students, but the activities are often competing rather than coordinated and do not provide integrated pathways for students to develop their science understanding.

- Science-based organisations tend to treat communications as an extra that can be reduced or dispensed with altogether in a tight budgetary situation:
  - while there may be strong interest in undertaking and enhancing science communication at middle management levels, there may not be the same level of interest at senior management levels
  - there is a role for external organisations, with expertise in science communication, to work with and enhance the science communication efforts of science-based organisations and industries.
- There is insufficient emphasis on science by mainstream media which limits the extent of broad community engagement. This is despite a number of commercial programs having a science base, such as programs about wildlife, archaeology, engineering feats, and CSI:
  - the role of the ABC is strongly valued, especially in rural and remote regions. However, there are many who do not watch or listen to the ABC. Therefore there is a need for programs on the commercial media to help increase interest and engagement in science.
- There are very few full-time science journalists in Australia. Although the Australian Science Media Centre is a resource for non-science journalists, the general media have little interest in communicating science:
  - greater opportunities for cross-media cadetships, internships and training opportunities are needed for young journalists interested in science.
- Many scientists find it difficult to explain their work and its value to the general public:
  - for most scientists, it is not a performance expectation that they communicate science to audiences other than their peers
  - many scientists are not trained in media or general communication skills. Nor are there quick access online media training opportunities or similar resources to assist scientists to develop these skills.
- Stereotypical and inaccurate perceptions of scientists persist, often contributed to by the general media. This results in students and their key influencers (including teachers, school career counsellors and parents) not understanding the variety of science-based careers (that is, careers in or using science, mathematics, engineering and technology). There is a little evaluation and impact analysis in assessing science interest, awareness and engagement across most sectors of the community. In particular, there is very little information on adult science literacy. Although output data (for example, participant numbers) and anecdotal evidence exists, there is a need for more baseline analysis and profiling of community levels of interest and engagement, and for evidence of the impact of science communication initiatives over time.

- There is a need to tap the full potential of new media, including You Tube and other Web 2.0 social networking technologies, to increase interest and engagement in science among the growing numbers of people using new media.
- Most science communication activities are conducted under short-term (one year, or at best, three years) funding. Activity providers consistently state that, for activities to develop a sustainable operation and to have impact, they require longer-term funding arrangements. This is even more critical for remote area initiatives.
- While people resources to coordinate science communication activity would be welcomed in each state/territory, the location of such resources in capital cities may not best serve regional needs.
- Science communication activity needs to be cognisant of the audience and community to be engaged (that is, appropriate and relevant for the local community, contextualised to acknowledge and value Indigenous perspectives, etc).
- There are many 'reward and recognition' programs and events (for example the Prime Minister's Prizes for Science, the Eureka Awards, the ATSE Clunies Ross Awards, etc) that profile the achievements of Australian scientists and their work. There is a need to address the low level of media promotion of these successes and to involve award winners in public engagement opportunities.

Potential responses proposed by participants

Consultations welcomed a 'national framework—local action' approach, and expressed considerable support for the following strategies and actions.

- Set a vision for Australia to provide a high-level focus and direction for science communication initiatives across the nation:
  - this vision should aspire to what Australia could be like in the medium to longer term as a result of effective science communication strategies and interventions aligned with clear goals and with clearly identified population sectors
  - for many institutions and agencies, a clear national vision and goals will encourage buy-in by stakeholders and provide guidance as to how best to commit what resources they have.
- Encourage Australians at the highest level, led by the Prime Minister and the Minister for Innovation, Industry, Science and Research, and supported by state Premiers and territory Chief Ministers, to articulate an aspirational 'science self-image' for Australia.
- Establish a point of national leadership to:
  - manage the implementation of the national science communication strategy
  - establish a central point/Web site for science communication exchange to collect, promote and communicate activities, resources and data across Australia and internationally

- establish mechanisms for sharing best practice that, in turn, will assist in the development of solutions to address local issues
- monitor and provide accountability for the performance of the national strategy against clearly defined outcomes
- establish a strategic alliance among Federal Government departments, agencies and institutions with major contributions to the communication of science, including CSIRO, Questacon — The National Science and Technology Centre and the ABC, as well as others such as the Australian Research Council, the National Health and Medical Research Council, and the Bureau of Meteorology
- promote a whole-of-government response in the realisation that much science lies outside the Innovation, Industry, Science and Research portfolio
- promote, across all levels of government, consistency and alignment with best practice approaches to communicating science
- facilitate coordinating mechanisms to plan and focus science communication activities around 'International Year of …' opportunities
- develop a nationally coordinated approach to the provision of science outreach programs, travelling science exhibitions, science festivals, citizen research programs, etc.

- Utilise and work with existing national networks and mechanisms to develop further support and resources for a national science communication strategy:
  - potential networks and bodies could include the Chief Scientist for Australia and state chief scientists; relevant ministerial councils; Commonwealth and State Advisory Council on Innovation (CSTACI); Coordination Committee on Innovation (CCI); Council of Australasian Museum Directors (CAMD); Deans of Science in Australian universities; the Cooperative Research Centre Association and the CRC communications officers' network
  - the current structure and coordinating mechanisms for National Science Week provide an organised and coherent 'national framework—local action' model for science communication.
- Advocate policy changes that would appropriately value and reflect the role that effective science communication will contribute to a better Australia. Policy initiatives that could make a significant contribution could include:
  - science communication as a key function of science agency charters; this could, in particular, focus on the development of science communication skills among early career researchers
  - a communications plan to engage broader population sectors as a requirement of Australian Research Council and Cooperative Research Centre funding agreements

- a science communication course as a requirement in tertiary science programs.

- Develop a nationwide science communication research agenda to better understand community and population profiles in terms of levels of interest and engagement in science, to target various population sectors more effectively with science communication activities and to improve overall outcomes and impacts:
  - encourage systematic evaluation of science communication programs and activities by developing an evaluation framework that collects impact data relevant to the goals of the national strategy
  - align research and evaluation with the need to identify and make room for new and innovative approaches to communicating science, not only existing approaches
  - encourage university research in science communication. Currently there is no recognised 'Field of Research' code for Science Communication within university research.
- Stimulate national discussion, ideas and action on identified priority needs. Priority needs could include:
  - creating pathways for lifelong engagement in science through local community science-based institutions, including industries, museums, botanic gardens, zoos, amateur scientist groups, etc, in the local community
  - communicating science-based career opportunities in local contexts
  - improving public perceptions of science and its value and relevance to individuals, to communities and to the wellbeing of the nation
  - providing accurate, succinct briefings on science developments and issues to politicians, decision makers, business and community leaders
  - building further on initiatives such as the Australian Science Media Centre to improve the quality of science coverage by the media, and to increase the uptake of science in the media
  - providing central coordination for 'International Year of …' activities
  - increasing the profile of Australia's science capability and achievements, not only within Australia, but also internationally.
- Broker local collaborations and opportunities to engage local communities in science. Mechanisms that might facilitate this could include:
  - establishing a person in each state and territory to work with state and local governments, institutions and businesses, community and volunteer organisations in brokering and leveraging partnerships to conduct and support a year-round program of science communication activities, targeted to meet state/local needs and goals.

Consideration should be given to the location of such a person to ensure that regional and remote needs are addressed

- focusing on one or two major issues for the nation (such as climate change, marine science, or food) and select a state/territory to take a lead role, establishing a node to leverage further resources and contributions elsewhere in the country to develop science communication activities addressing the major issue
- generate year-round opportunities, including through using a high-impact activity such as National Science Week, to further develop people's level of interest and engagement in science
- foresight opportunities for local activities and resources to contribute to International Year of Chemistry and following 'International Year of …' programs
- integrating science communication activities into successful 'non-science' festivals and activities such as writers' festivals, community festivals, food and wine exhibitions, art and film events
- generating contact databases, at local and state levels, to build a national database for the science communication sector.

FINDINGS FROM WRITTEN SUBMISSIONS

In addition to the findings from the national consultation meetings, 22 written submissions were received. There were a number of wide ranging views expressed and ideas proposed. The following points are indicative of the views and ideas.

National vision for science communication

- The goal of Australian science communication should be to share scientific knowledge with all those who need it, in as effective, swift and universal a manner as possible. It should observe four principles:
  - knowledge is the common heritage of all people
  - the sharing of knowledge is as important as its discovery
  - science should engage the community in a discourse about human advancement, each recognising the other as an equal partner
  - knowledge sharing is essential to the peace, security, well-being, health and sustainability of humanity.
- Science communication policy should recognise that:
  - science not communicated or badly communicated is of little use to anyone
  - communication is a two way street—not just science to society but also society to science

  - most Australian science has been paid for by the Australian people and they have a right to know and receive the outcomes.

- Higher attention is needed for mathematics and the mathematical sciences.
- There is a need to integrate the social sciences into the entire communications strategy.
- It is important to articulate what is meant by science communication, that is making science more meaningful to the public; to recognise that science communication needs to be a two-way process and to build in mechanisms for public response and engagement; and to address appropriately three major categories of science communication—institutional, public awareness and science journalism.

Leadership and coordination

- There is a need for coordination nationally. However, it needs to be recognised that each jurisdiction, through its respective leading science agency, will continue to work in collaboration with key stakeholders to implement science communication strategies at a state level.
- There should be state level participation in working groups to develop an overarching national strategy with aligned national and state priorities.
- The strategy should be implemented through a number of national working groups for each priority area, comprising key stakeholders from each state.
- Any national science communication strategy should reference other science communication activities undertaken by the Australian Government. For example, science literacy outcomes delivered through the national science communication strategy are likely to enhance Australians' response to public health campaigns. Similarly deficits in community capability identified by content specific campaigns might usefully identify areas, such as community understanding of peer review, to address in the national science communication strategy.
- The lead agency needs to be independent and to make funding decisions, once the key structural reforms are put into place.
- Cooperative Research Centres are well placed to contribute to the national coordination need due to their diverse locations and collaborations. These centres have science communication as a key aspect of what they do, and there is a coordinated network of CRC communications officers.
- There is a need for a nationally coordinated science Web presence or portal. ScienceNetwork WA may be an appropriate model for a national solution to this need.
- It would be appropriate for Questacon, as part of the Department of Innovation, Industry, Science and Research to undertake the central coordinating role for implementing a national science communication strategy.

- It would be helpful to have a central mechanism to evaluate applications for funding of local initiatives, as well as to evaluate funded initiatives and to facilitate the expansion of successful initiatives to other locales.

Evidence, evaluation and audience appropriateness

- Goals need to be appropriate for evaluation, and evaluation processes designed to measure impacts over time.
- Resources need to be set aside for ongoing evaluation and measurement of outcomes of science communication activities in each state, including studies on effective techniques and use of new interactive media.
- There is a need for an audit of current initiatives nationally.
- There is a need to establish benchmarks for science communication and to provide examples of best practice.
- Examples of performance criteria for science communication programs developed by UK based Professor Frank Burnet and reported in a paper commissioned by the Victoria Government are:
  - promote two way communication between science, scientists and society
  - take science to new audiences
  - operate nationally rather than locally
  - deliver value for money in terms of the cost set against the potential audience numbers and the impact on the audience
  - sustain themselves beyond the time span of the start-up funding.
- Other performance criteria for science communication programs could be:
  - quality science and quality engagement, for example ensure all programs are informed by an expert scientist and designed and delivered by an expert science communicator
  - innovation, for example make funding available for program development as well as for program delivery
  - critical mass, for example a critical mass of activity is required to engage a population segment in a community with science; sparse delivery is not as effective
  - mature the sector, for example investment should both deliver quality programs and mature the science communication sector.
- There is little research into the impact that media has on communities' understanding of science.

- Fund a science and community research program to:
  - map participants in science engagement against population segments. This could be achieved through a standardised exit survey for use across the country. Data could be entered into a national database
  - map existing science communication activities for Australians by population segment and identify the gaps and strategic opportunities
  - develop a classification of engagement activity for reporting and monitoring types of activity delivered across Australia.
- Require that Commonwealth funded science engagement activities:
  - have an expert science communicator and a reference scientist overseeing or undertaking the development and delivery of the program
  - meet defined program objectives and deliver to a priority target population segment.
- It is important to cover the gap between younger children (under 12 years) and high achieving high school students. There are not many programs designed specifically for general teenagers.
- A gap exists in the engagement of the general public, that is connecting real people to real issues.
- There is a need to identify ways of ensuring policy and public opinion are well informed by evidence-based science and to provide opportunities for scientists, policy makers and the community to dialogue about advances in science and technology in Australia.
- There is an urgent need to invest in programs for rural, regional, isolated or disadvantaged areas.

Science communication and the media

- There is a world wide slump in science journalism. The ABC remains the only place in Australia for training across all forms of media—radio, TV, on-line, writing.
- There is a need to increase the interaction between scientists and the media.
- There is further potential to utilise the Australian Science Media Centre and the network of science media centres around the world.
- It would be helpful to develop:
  - a national Science Newswire modelled on Reuters and AAP
  - national science news podcasts.

- The number of science journalists in major media could be expanded through a model such as Germany's Bosch Foundation which selects ten science graduates, trains them in journalism, places them in major media outlets, and pays their salary for the first year. Most positions are continued by the media after the first year because media outlets find the impact so significant.
- There is a need to:
  - boost the number of science communication internships
  - encourage more journalists to specialise in science reporting, for example by creating an annual Walkley Award for Science Journalism, funding the establishment of a science journalism course at a major university, developing a 'Journalist in Residence' program at major research centres, or funding a placement of Australian journalists in the Knight Science Journalism Fellowship at MIT Boston.
- Provide seed funding for monthly science lift-outs in national newspapers.
- Encourage the Literature Board of the Australia Council to introduce a science journalism stream, to develop science writing as a literary discipline.
- Renew funding for:
  - media traineeships at the ABC—previous trainees have become very successful science journalists
  - science media fellowships at the ABC where senior scientists join the ABC for two to six weeks to develop science communication skills.
- There is a need for specific media training for early career researchers.

Developing science communication capability

- There is a need for the Federal Government to recognise the significant role that science communication plays by encouraging programs for educating and training science communicators in Australia, and for supporting professional science communicators and promoting interaction with their peers internationally.
- The communication activities of researchers should be recognised and rewarded in salary and promotion reviews at all Australian Government scientific institutions and facilities.
- Tertiary institutions should be encouraged to develop media awareness and communication skills as part of all research based degrees as a key competency.
- All Commonwealth Government research budgets and grants should include a specified allocation to be spent on public communication, engagement and knowledge transfer to the general community.

- In addition to undertaking communication activity to support their business activity, ARC and NHMRC grant recipients should be required to direct a small proportion of their grant funding to community engagement that delivers against specified objectives for particular population segments.
- Establish an Arts-Sciences Communication Initiative'—a course that integrates disciplines within both arts and sciences to encourage cross pollination of knowledge and creativity.

Engaging Australians nationwide

- Develop and deliver national science engagement activities that tour the country and deliver to both regional and metropolitan audiences.
- Develop successful state-based programs (for example the University of Queensland's 'three minute' thesis and the University of Tasmania's 60 seconds of fame) as national programs.
- Develop high profile summits and events, such as a proposed 'Sustain Australia' event to showcase the best of innovation in Australia.

Leveraging support for science communication

- Commission a study on business models to establish a foundation or other body to:
  - leverage funding for community engagement, science education and careers promotion from business industry and philanthropic groups
  - broker partnerships between potential sponsors and science engagement and education contractors.
- Identifying how to usefully 'invest' in the sector is one of the challenges facing industry and philanthropy. The Australian Business Arts Foundation could provide a useful model for such activity.

Appendix 3 Summary of regional workshop in Ballarat

This workshop was led by Rob Curnow, Research Director, Community Change, and Wendy Williams, Manager, Science and Community, Department of Innovation, Industry and Regional Development, Victoria on 21 September 2009.

COMMUNITY CONVERSATIONS

To supplement the multidisciplinary expert practitioner consultations conducted elsewhere, Community Conversations were convened in a regional centre with participants from government agencies, youth organisations and the not-for-profit, tourist and private sectors.

Conversations were designed to help science communication move from mere persuasion and information exchange to more interactive approaches likely to support community engagement.

THE OBJECTIVE

The objective was to create an inclusive, productive and open context to better understand how a national policy framework and a forward strategy might advance a broadening of community engagement in science.

Views were sought from a broad spectrum of actors who contributed personal insights and understanding of the challenges and possible solutions for helping science to be more visible and relevant to everyday life.

Facilitation focused on creating an engaged and respectful atmosphere where participants were encouraged to listen to all perspectives and enjoy interacting with people outside their regular networks or social settings.

THE PROCESS

A convenience sample of regional community contacts were invited to attend the conversations and with relatively short notice two community conversations were conducted. The participant list has been included at the end of this report.

Participants were asked to present their own experiences, provide insights from their work and to:

- embrace broad definitions of science, science communication and community engagement
- identify factors facilitating and preventing community engagement
- suggest ways to improve local impacts and optimise opportunities for building community engagement with science.

INSIGHTS

Insights were explored, discussed with the group and recorded on a whiteboard for participants to review. The key outcomes have been summarised below to illustrate the main points derived from the experiences in a regional centre. Comments include some direct quotes to illustrate the points shared by participants. Whilst not representing radical departures from existing understandings, these insights nevertheless provide an opportunity for influencing how we talk about science with the Australian community.

Some participants suggested that these insights may well help to shift some of the social norms, policies, culture and social relations that underpin reforms needed for engaging Australians in science.

INTRODUCTION

Science was seen as a tool kit that individuals and the community could use to solve problems.

Interest and active engagement extended across a variety of areas and levels and did not necessarily equate to positive attitudes and support for all science activity.

Some expressed interest in relation to:

- Avid interest and enjoyment in all science all the time—browsing for new information as a major recreational activity, 'I love searching for new information and can't miss watching catalyst'.
- Interest in some part of science, but not all—browsing for new information, particularly in relation to working role 'access to the net is vital for me to explore the latest developments in solar technology for my business'.
- Interest when I have a need:
  - curiosity—sparked by news, media, natural phenomena.
  - interest (positive or negative) in a matter of community interest (global warming, climate change), 'wow factor to impress and educate friends'.
  - matter of personal interest—health or illness issue for self or someone close, researching a product or service, lifestyle, quality of life. 'When I got sick I spent a lot of time researching the latest medical findings, diagnoses and treatments.'
  - work and study
  - problems to solve 'whether it is a recipe or a current affair issue I want to learn about how it works'.

In contrast some participants said they were not really interested in science and members of the group then attempted to convince them that they really were into science. The process of invalidating the experiences of 'non science interested participants' was used to illustrate

and introduce the discussion of some of the barriers to science communication and engaging the public.

BARRIERS DISCOURAGING PEOPLE FROM TAKING AN INTEREST OR ENGAGING IN SCIENCE

Barriers identified were:

- the assumption from science interested people that I won't understand their work 'my son would not discuss his research thesis because he said I would not understand it', 'people appear to assume it will be too hard for others unless they are given reasons to think otherwise'
- for some—'it's something I grew up with at home and school while for others it is not relevant'
- there is a lack of early exposure to science, 'my daughter wanted to study science at high school and the subjects were not offered in local schools at senior level so the conclusion is that it's not valued in the curriculum'
- some suggested that 'young people seemed to be less interested in the 'why' questions than us older members of the community'
- others indicated science used exclusive language, jargon and reward systems that create and emphasise the differences/divide between us and them. There was some debate about whether this a higher education/professions issue generally or purely a science issue
- locally there were communication/difficulties with slow access to the internet restricting ability to access information and increasing frustration
- lack of time was seen as an issue for some people
- barriers to a career in science were reported as the experience of many of the participants family members:
  - I advised my kids that 'science can be great provided you don't want to make money'
  - there are real difficulties in getting a job or post-doc position in your field in Australia. 'My son had to go overseas to do his post doc fellowship in nanotechnology once he completed it he came back home could not get a job so went back to uni and is now a patent attorney but science is his first love'
  - locally there is limited access to good science career information or descriptions of clear pathways and directions
  - large HECS cost of science based subjects and suggestions it should be made more affordable or at similar cost to Arts programs (debate around the user pays philosophy behind HECS)

- some debate over whether there was a gender bias restricting access for females or just limited opportunities. 'My daughter has studied genetic engineering and we want her to come back home to get a job but it is not likely'.

APPROACHES TO SCIENCE COMMUNICATION TO ADDRESS BARRIERS

Aids to surmounting barriers:

- access to and confidence in using sources (most recently the internet) makes accessing science information considerably easier than pre internet when people needed to use libraries. 'My Probus members have time but need ways to be able to engage, particularly as we love to discuss science involved in social issues'
- find ways to focus on the science that matters to the individual and meets community members where their interests lie (health and wellness, community issues). 'My work at the tourist centre and farm is looking to engage young people with science as part of the whole experience'
- link science to other areas of interest in a more holistic approach to understanding the world, as opposed to science being a silo. Embed science in existing cultural activity and cultural programs. 'We need to bring people along to make it happen and can include it in our activities as a regular part of an event'
- focus on raising awareness and genuine engagement activities rather than changing attitudes or using gimmicks
- utilise local talent to mentor and develop 'up and comings' and young people's interest. 'We are not really making the most of our local talents and need to keep expertise here'
- encourage and teach analysis and critical thinking, possibly integrating 'hands on' learning as young people like to do 'hands-on' activities
- under 25s more technology focused
- science on free to air TV provided in ways to engage, eg Dr Karl. 'I really loved the Julius Sumner Miller approach and we could bring that type of activity and enquiry back to mainstream media'.

IS SCIENCE IN THE GRAMPIANS REGION ALIVE AND WELL?

A lot of discussion was generated by the question and the group held strong views that:

- science was less 'well' than previously and that 'its absence is strongly felt'. 'You can no longer study science or engineering at local university'
- science was not always offered in final years of secondary school. 'This has become a self fulfilling cycle where lack of student numbers and a lack of Yr 11 and 12 science over time deliver a community less comfortable and confident in interacting with science'
- science is inputting into farming but it is not obvious to the community

- there is some active community based environmental science groups.

OTHER COMMENTS

- Impact of government policy on translating Aus IP into products and jobs particularly associated with brain drain, loss of expertise and limited opportunities here.
- Impact on small business of government's inconsistent and changeable policy settings.

BALLARAT COMMUNITY CONVERSATIONS PARTICIPANT LIST

Name	Organisation
Pam Addicott	Probus Club of Ballarat South
Rosemary Angus	Highlands Region Waste Management Group
Dr Tess Brady	Artistic Director, Clunes Back to Bookroom
Phil Clingin	Highlands Region Waste Management Group
Gerardine Cristou	Neighbourhood Renewal Manager
Peter Keppel	Country Fire Authority Ballarat
Larelle Kruczer	Acting Youth Head Quarters (YHQ) Coordinator, City of Ballarat Youth Services
David Sanders	Smart Options Ballarat
Janelle Spierings	Education Officer, Sovereign Hill Museum

Appendix 4 Summary of Humanities and Science Workshop

On 14 September 2009, the following invited people met at Questacon to consider the contribution of the humanities and social sciences towards a national science communication strategy:

- Professor Graham Durant, Director, Questacon Division, DIISR
- Professor Julian Cribb, Science Communicator
- Dr John Byron, Executive Director, The Australian Academy of the Humanities
- Professor Iain McCalman, ARC Federation Fellow, The University of Sydney
- Professor Sue Dodds, Dean of Arts, University of Tasmania
- Ms Margaret Anderson, Chair of the Council of Australasian Museum Directors
- Ms Peta Ashworth, Team Leader and Social Researcher, CSIRO Energy Transformations Flagship
- Professor Sue Rowley, former Pro Vice Chancellor of Research, University of Technology, Sydney
- Dr Sue Meek, Chief Executive, Australian Academy of Science
- Mr Andrew Reeves, Science and Research Adviser, Office of the Minister for Innovation, Industry, Science and Research.

SUMMARY OF DISCUSSION

Science definition

- There is a need for an increased connection between science and society. This is an often neglected consideration. Most focus has been on research and infrastructure.
- A clear definition of science is needed. Should 'science' be limited to traditional research areas? Traditional sciences have developed knowledge sharing mechanisms, whereas the social sciences and humanities need increased recognition of their structures and knowledge sharing mechanisms. Should the sciences be defined as 'the sum of all knowledge'?
- Social sciences and humanities need to be recognised within traditional science as having expert knowledge and useful understanding in many science-related areas. This lack of recognition can result in a failure to harness this expertise leading to decreased understanding of problems and reduced effectiveness of solutions.

Science developed solutions

- There needs to be increased acknowledgement that all problems are multidisciplinary and that the best solutions will also be multidisciplinary. Working within a narrow frame and perspective can lead to narrow assumptions and potentially mislead directions for solutions. For this strategy, it needs to be recognised that sharing needs to be in both directions between the social sciences and traditional sciences.
- There can be a tendency that for science activity to be considered valid it needs to be seen primarily as a technical fix rather than as a quest for general enhanced knowledge and understanding. This can result in direct technical solutions that fail to consider useful humanities and social sciences perspectives that would generate better and more holistic solutions.
- There needs to be a broadening of the focus of research questions for the nation—more focus is needed on questions about science in society such as cultural diversity and an aging society.
- There are both positives and negatives related to having expert involvement. Respect for the detailed knowledge held by an expert can introduce a perception of aloofness and disengagement from general society and everyday life.
- Science can be seen as a specialised and difficult domain. The public doesn't own it but has a right to criticise if it doesn't deliver what the public wants. Citizens need to feel some ownership of science to be comfortable in making informed decisions. Therefore there is a need to break down the mystique of science, particularly around critical current issues. The Toowoomba recycled water issue is a good example. A suggested role for social scientists in community engagement is to provide an understanding of what a community needs (information or otherwise) to make a decision.

Science communication

- The perception of what is demanded from scientists in their communication can be quite different. Society wants accurate statements (for example 'Can you guarantee that this is perfectly safe?') with no vagaries or opinions. However scientists won't generalise or compromise about scientific facts. This situation can limit the effectiveness of a scientist's communication to general audiences. It needs to be more widely recognised across the community that science is not absolutely definite, that knowledge needs to be taken as fit for its purpose, and that risks are raised within the context of current understanding and needs.
- It is important to address trust issues in science. An increase in discussion of doubts will actually increase the level of trust. Therefore it is better to increase the level of openness and realism rather than to only put out 'good news stories'.
- Future challenges for society will require a change in behaviour by the whole population rather than just a technical fix. There is a need for a robust discourse that encourages strong decisions to be made by communities. Science communication is instrumental in helping these discourses lead to informed decision making.

Towards a national science communication strategy

Suggested initial steps should be to:

- develop a clear national declaration of visions and principles with high level endorsement and buy-in by government
- encourage engagement and buy-in from partners through establishing a reference group to connect stakeholder communities. This needs to be broadly constituted, and it may be best to focus on non-mission directed bodies. Partners could include the academies individually or through NAFF, CRCs, R&D corporations, universities, CSIRO, ANSTO, museums, etc
- work towards a national summit to bring together wide ranging stakeholder groups. This could include a policy debate on how and what, a showcase of best practice and learning from 'not best practice', and a rewarding of best practice. It could be conducted in the timeframe of the Eureka Prizes to allow cross promotion. It will be important to clarify the roles of the Federal and the state governments in the summit, and to use a consortium approach with all partner organisations
- conduct a study on the use and potential of social networking to develop science communication.

An overall vision for a national strategy should:

- acknowledge the need to work using multidisciplinary and cross-disciplinary approaches
- acknowledge communication needs across all levels from the general public to policy and decision makers, and between all sectors
- acknowledge the importance of two way communication (for example, ask politicians what they need to know rather than just communicate one way to them). It may be helpful to use the term 'engagement' rather than 'communication' since communication can be perceived as one-way transmission
- emphasise that the success of a national strategy is dependent on the extent to which all concerned sectors work towards the common vision and goals.

General mechanisms supporting a national strategy should:

- utilise experts (for example, the Institute of Sustainable Futures consulting expertise on how to form policy that will have 'take-up'
- focus on the demand side rather than the supply side. It needs to be based on an understanding of what is needed by society to reach the goals of the strategy
- focus on two-way dialogue (for example, round table discussions). They should move away from 'straight presentation' situations

- use public-funded activities such as government-funded research, to allocate a percentage of funding for communicating not only with the end user group but also with the entire community
- investigate the use of social networking and make more use of the premise that people will seek out information they need. There is a need to understand how this approach works when sharing scientific information using these community engagement tools, and how the issue of 'trusted knowledge' can be addressed
- focus more on issues-based engagement
- professionalise the communication of the sciences (including the humanities and social sciences). For example, university degrees could include a component of communication
- encourage the communication and sharing of knowledge, ensuring that scientists are encouraged and not discouraged to communicate (accepting that there can be legal, financial or management issues at stake.

Coordination efforts should:

- Adopt a more strategic approach to deal with top level humanities/science issues. This could be a role for an Academies forum within the context of a national science communication strategy.
- Improve dialogue across researchers and across disciplines, and provide incentives for cross-disciplines working (both across the humanities and the traditional sciences) through funded initiatives or recognition programs.

Models that could be considered include:

- Danish Board of Technology and its dissemination of knowledge about technology, its possibilities and its effects on people, on society and on the environment; its promotion of ongoing discussion about technology; its evaluation of technology and its advice to the Danish Parliament and other governmental bodies in matters pertaining to technology
- CSIRO Energy Transformations Flagship and its Carbon Footprint Initiative, providing an example of science knowledge sharing, and its method to identify what individuals need to know for understanding and behavioural change which has resulted in a 37 per cent reduction in carbon footprints of participants.

Appendix 5 Summary of youth input from National Youth Science Forum alumni

The National Youth Science Forum (NYSF) contacted their large alumni group to seek input to the development of a national science communication strategy. The alumni were asked to provide a brief response to two questions:

- What have been the major influences affecting the level of your interest and involvement in science?
- What do you think are the top one to three things that would make a difference to turning people (especially young people) onto science?

Emailed responses were received from 85 NYSF alumni. Some respondents included information on the year in which they had participated in the NYSF program and regarding their current role and career path. Of these, the majority were recent alumni under the age of 25 and currently completing university studies or commencing their careers. A few identified themselves as older alumni with greater experience in science and science-related industries.

Responses to Question 1 on major influences

A number of trends were noted across the responses despite the open ended nature of Question 1 regarding influences on their interest and involvement in science. The following categories of influence were identified:

- intrinsic motivation
- science communication
- school
- teachers
- events
- parents/family
- TV/mass media
- work experience
- peers.

The following categories were reported as the most influential.

1. Events (such as NYSF)

73 per cent of respondents indicated:

- events such as NYSF were crucial to 'cementing' their appreciation of science, and help them decide about their 'future studies and career in science':

> Before I went to NYSF I was not considering this career option [biomedical engineering] as I had no idea it existed.
>
> Attending the National Youth Science Forum in 2009 has really opened my eyes to science.

- over half made reference to being around other participants at these events:

> … being with so many like minded people and being exposed to so many different aspects of science is incredible.

- training opportunities at NYSF were frequently mentioned:

> NYSF gave me the skills I needed to overcome any communication barriers…It gave me a network of like-minded people around Australia, and the world.
>
> … generated my passion for science through many site visits, guest speakers and hands-on learning.

2. Teachers and schooling

Teachers were widely recognised (46 per cent) as being crucial to early interest in science. When combined with the school category, this increased to 65 per cent of respondents. The distinction comes with schools providing opportunities, resources and culture; and teachers providing inspiration, knowledge and enthusiasm.

> My senior high school teachers were passionate about science and passed this passion on through their interesting lessons.
>
> It was science subjects that were respected and supported by the school.
>
> If I knew of awards to nominate [my physics teacher] for, I would. His attitude towards his students and increasing their knowledge is unbelievable.

3. Intrinsic motivation (I just liked it) and parents

When combined, 61 per cent made reference to these personal influences. The majority suggested an initial love of discovery initiated and/or supported by parents and other early childhood influences.

> … fortunate to have two parents who are both good teachers and have exposed me to a broad range of ideas and areas. They helped me to develop a curiosity for the way the world worked which fuelled my interest in science.
>
> In my own case, it was purely a personal interest in 'how things work'.
>
> Having few public resources in the country town I grew up in, I spent most of my pocket money, and requested birthday/xmas gifts, on science books and periodicals.
>
> I think that to attract teenagers to science we need to influence their parents as well the kids.

> Primarily my interest in science stemmed from a curiosity of how the world works from a very young age. This interest was sparked and then encouraged by my parents.

4. Media, science communicators

45 per cent of respondents indicated that science communication played a crucial role in switching them on to science; through mass media, in-school performances and science centres.

> Scientific literature and TV programs promoting science concepts and applications.

> … programs like Gardening Australia, Catalyst and Landline on the ABC exposed me to, and encouraged my interest in, science and related fields.

> I think my fascination with science began to develop in grade 2 when a science demonstration group came to visit my class.

> From an early age, my parents have been giving me books about science, science kits and going to Scienceworks in Melbourne regularly, which over time, developed a curiosity to know what was going on.

RESPONSE TO QUESTION 2 ON THINGS THAT WOULD MAKE A DIFFERENCE

Responses to the second question on suggestions of ways to make a difference to turning people onto science included both fanciful and practical suggestions. The trends that emerged from responses can be summed up as:

1. Stronger support for the teaching of science

Responses included improving teaching standards through enhanced professional development of teachers, and increased early intervention, particularly in primary school. A heavy emphasis was placed on sparking students' interest at primary school by having specialist science teachers.

2. Greater role for science communicators

Comments on the role of science communicators included: breaking down the stereotypical view of science and of scientists; increasing the public profile of science and its endeavours; increasing media exposure, from print to television; and more/bigger science centres.

3. More events like NYSF

NYSF was not the only event named, but was the only one consistently named, which is understandable given the respondent group.

4. More financial reward/incentive

Suggestions included: salaries of researchers should be increased to be commensurate with doctors' salaries; more funding support for science from the Australian Government; and lower fees for tertiary science courses.

Appendix 6 Developing interest and engagement in science by population segment

This appendix considers various age groups, and suggests the extent to which each age group can be segmented with respect to the typology used in *Community Interest and Engagement with Science and Technology in Victoria Research Report—June 2007* prepared for the Victorian Department of Innovation, Industry and Regional Development.

SCHOOL AGE—BEFORE SUBJECT CHOICE

Children are innately curious and usually very receptive to science activities. Therefore, it is probably best to assume that this age group is willing to be engaged whenever they have an opportunity, either at school, with their family, through television or through informal or structured extra-curricular activities. Furthermore, we can expect to influence their attitude and behaviour towards science in a positive way.

Federally, the responsibility for this group resides with the Department of Education, Employment and Work Relations (DEEWR), although the primary responsibility for science education is with the state education departments and individual schools. In the science communication sphere, science centres, museums, CSIRO Education Centres, festivals, publications such as *The Helix*, and science clubs seek to provide information and opportunity for engagement that supplement the primary educational responsibility.

SCHOOL AGE—AFTER SUBJECT CHOICE

With respect to science and mathematics education, major responsibility for this age group also lies with the individual schools, the state education departments and DEEWR. Nonetheless, science communication providers can offer many supplementary, experiential activities.

In mid- to late high school, students make decisions about studying science and mathematics, influenced mostly by their parents, their teachers and their peers. Most teenagers will know their level of ability and interest, so their habits of engagement can be studied.

Thus, science communication providers can start to identify segments of the population and key activities that can be aimed at each segment:

- *Those uninterested.* There is likely to be a segment of students who are undecided, and activities that can help persuade them in their decision making will be invaluable. The main reasons for developing activities for this group is to encourage them to stick with mathematics and science courses throughout secondary school, so as to optimise their career prospects.

  It will also be important to ensure that students who are not interested and do not enrol in science or mathematics courses are still regularly made aware of how science has an

impact on their lives and how government decisions about science and technology will shape their future.

- *Those interested but not studying science.* The school curriculum can influence only students who are studying science and mathematics. Some students, however, may be interested in, say, computing or electronics, but not formally studying science. When it comes to developing a scientifically literate and engaged society, it will be important to provide opportunities for ongoing learning and engagement in science and mathematics for these students.

- *Those studying science.* Although schools bear the primary responsibility for teaching the science and mathematics curriculum, it is important to understand what additional activities can help students engage with science beyond the classroom and to obtain career advice.

  For some students not pursuing careers in science and mathematics, it is a choice based on lack of ability rather than lack of interest and engagement. For others, however, it may be lack of awareness of the wide range of challenging and fulfilling science careers open to them. Therefore, it is important to give these students ample opportunity to engage with and experience 'real' science and mathematics, and to understand their future potential as a career.

  Among those studying science it is also useful to target a smaller subgroup for special consideration—in particular, the 'elite' students who would benefit from inspirational and challenging activities such as participation in extra-curricular activities such as science and mathematics Olympiads, the National Youth Science Forum, the Science and Engineering Challenge, and the Harry Messel Science School.

TERTIARY STUDENTS

Much of what was said in relation to secondary school students applies to tertiary students, especially when it comes to engaging those studying science in 'real' science and mathematics experiences and providing appropriate career advice. Thus, it is important to undertake the following:

- *Those uninterested.* Keep awareness of science in front of the students who are neutral or uninterested through clubs, activities and popular events such as 'Science in the Pub'.

- *Those interested but not studying science*. Provide opportunities for those not pursuing science careers to develop habits of science learning and engagement for life, such as through online forums, discounted subscriptions to popular science magazines or membership in field naturalist or environmental activities.

- *Those studying science.* Show them the importance, value and opportunities for science careers. Influence tertiary institutions to develop science communication as part of the science teaching program.

ADULT PUBLIC BEYOND STUDY

The general adult population can be expected to fall within all six segments of the Victorian typology. When planning science communication activities, it is essential to build in methods for determining the segments attracted and to measure the impact the activity has had. Only by increasing our knowledge will we be able to better target audiences and provide appropriate science communication activities in the future.

There are many types of activities that need such measurement and evaluation. These activities enable various segments of the adult population to move towards greater interest and participation in science over time. They include:

- *Those uninterested.* Keep awareness of science in front of these people, sparking their curiosity about science through entertaining and unusual news and events
- *Those interested but not in a science career.* Provide opportunities for these people to continue their habits of science learning and engagement for life through a wide range of activities, such as festivals, lectures and interactive Web sites.
- *Those interested and engaged in science.* Continue to develop this community so that it is active in advocacy and able to contribute intelligently to public debate about issues involving science and society
- *Those in science careers.* Assist scientists to build their communication skills so that they can have a positive influence on public perceptions of science. Celebrate and congratulate those in science careers so that their importance is publicly valued

SUBGROUPS OF THE ADULT PUBLIC

If is often very useful to target subgroups within the general adult population, particularly because of the roles they assume or work they carry out. Such subgroups include the following:

- politicians and their advisers
- public servants
- CEOs in business and industry
- judges
- secondary school teachers
- primary school teachers
- school careers counsellors.

Within each of these subgroups, there will still be those that fall into the various population segments—that is, those who are not interested, those who are supportive, and those who are already engaged. Within these subgroups, it is still important to develop activities to appeal to those in each of the segments.

Appendix 7 Snapshot of relevant Australian and international reports

Successive Australian Federal Governments, as well as many state governments, have recognised the role and importance of science communication as an adjunct to science innovation and infrastructure policies. Various governments have also carried out reviews related specifically to science communication or education.

Internationally, the trend has been similar; to some extent, countries in Europe and North America are more advanced in their development than Australia, and this has informed some of the recommendations in this national science communication initiative. Some of the important policy documents and reviews are outlined below.

AUSTRALIAN GOVERNMENT

- ***Powering Ideas: An Innovation Agenda for the 21st Century*. Canberra: Commonwealth of Australia, 2009**

  Most recently, the Government's *Powering Ideas* innovation agenda selected seven priorities 'to focus the production, *diffusion* [emphasis added] and application of new knowledge (p. 25). One of these priorities is to build the innovative capacity of public research institutions. The Government acknowledges that for society to reap the expected economic and social benefits from this endeavour, it must be accompanied '… by action to make the results of public research widely accessible (p. 31). However, such action has not been specifically funded in the innovation agenda.

- ***Venturous Australia: Building Strength in Innovation*. Melbourne: Cutler & Company, 2008.**

  This review urged the Government to facilitate favourable conditions for the development and use of new and emerging technologies. Among the various strategies to achieve this goal was recommendation 7.6 'to foster public awareness and community engagement' (p. 93).

- **Coordination Committee on Science and Technology, Science Education and Awareness Standing Group. *Audit of Science Education and Awareness Initiatives Delivered by CCST Member Organisations in 2006/07 Financial Year, Results and Recommendations*. Canberra: CCST, 2008.**

  This audit of science education and awareness initiatives by CCST member organisations listed 146 initiatives with 533 discrete components. The three recommendations were that an audit continue to be conducted annually, that evaluation initiatives be developed, and that communication and information sharing among the CCST agencies be expanded (p. 3).

- ***Stepping Up to Meet National Needs: Review of Questacon — The National Science and Technology Centre*. Canberra: Department of Innovation, Industry, Science and Research, 2008.'**

  The Questacon review panel, among its other findings, recommended that the Government endorse Questacon's mandate 'to inspire future scientists and the wider community and enhance awareness and understanding of the contribution of science to Australia's future' (p. 6). They also recommended that Questacon, CSIRO and the ABC cooperate in improving national coordination of science communication, awareness and education resources and activities (p. 8).

- ***Science Connections Program Evaluation Report*. Canberra: Evaluation and Business Planning Section, Department of Innovation, Industry, Science and Research, 2009.**

  An evaluation panel made a number of findings and recommendations about the SCOPE program, the funding for which ceases in 2010–11. Among the findings are that the case for Australian Government promotion of science awareness remains strong and that there needs to be greater strategic leadership and coordination. It recommends specifically that DIISR take a lead role in this regard (pp. 8–9).

Some of the recommendations that come out of the reports listed above in fact reiterate findings and recommendations made in reports issued five years earlier, which looked specifically at improving science engagement for young Australians.

- **PMSEIC Working Group on Science Engagement and Education. *Science Engagement and Education*. Canberra: PMSEIC, 2003.**

  'Australia's success as a 21st century knowledge society will depend on having a technologically-skilled workforce and a science-literate community'. The report defined 'science-literate' as 'people who can think clearly, assess information accurately, solve problems and make decisions based on factual evidence. Science literacy also embodies a general understanding of science and its role in society' (p. 3).

  The report suggested that youth exposure to science was '…discontinuous, uneven in quality and, in places, extremely fragile' (p. 7). It noted that there was a clear need for a framework that 'coordinates science outreach at the national level to deliver better services at the local community and school level, achieve greater efficiency and make better use of existing resources' (p. 8).

- **Garnett, Robin. *Reaching All Australians*. Canberra: National Reference Group and Questacon, 2003.**

  A National Reference Group assembled by Questacon — The National Science and Technology Centre reported on the delivery of STEM education and awareness programs to regional, rural and remote Australia. This group recommended a national framework of action to bring together national, state and local resources for the greatest impact and efficiency to address the gaps experienced in regional, rural and remote schools and communities (p. xi).

STATE GOVERNMENTS

Many state government science policy documents have sections that are relevant to this strategy. They are summarised below.

New South Wales

- ***New Direction for NSW: NSW Government Statement on Innovation*. November 2006.**

  This statement provides broad principles on innovation that indirectly apply to science engagement: that focus should be on industries producing benefits for the broader economy, that Government support should be based on innovation processes specific to those sectors, and that the Government's role should be complement the market (p.2). Two of the five goals broadly support the general aims of this science communication strategy: to improve human capital, especially by linking schools, TAFE and local businesses; and to upgrade knowledge and information infrastructure by supplementing and supporting the private sector (p. 5).

Northern Territory

- ***Strategic Objectives 2007–2014.* Northern Territory Department of Natural Resources, Environment and the Arts (NRETA).**

  This document demonstrates a broad vision to 'enable Territory communities to flourish in healthy and productive environments and be inspired through understandings of natural systems, our culture and history.' This includes approaches to increase community engagement and understanding of natural and cultural issues—for example:

  - to improve public understanding of the role and significance of reference collections
  - to improve public access to collections
  - to provide easy, reliable and comprehensive access to information and experience for protecting natural and cultural assets and achieving sustainable development (p. 6).

- ***A Smart Territory: Fresh Ideas—Real Results. Strategic Plan 2009–2012*. Northern Territory Department of Education and Training.**

  The document discusses education-specific strategies but, in relation to science engagement, the plan supports the intentions of:

  - cross-cultural understanding
  - focus on regional and remote sectors
  - strong community engagement
  - industry-driven partnerships
  - cross-agency approach

- beyond school pathways for continued learning.

Queensland

- **Peter Andrews, *Queensland Science—Building a Smarter Future (Part 1 & 2)*, 2006**

  Queensland Chief Scientist Peter Andrews has made statements relevant to a number of sections of this report. He spoke of the need to bring the wider community together to build a prosperous future, which will require '… not just great science, but also the ongoing interest and commitment of governments and oppositions, researchers and educators, investors and industries, individuals and communities' (p. 33). He emphasised the need to restore the stocks of scientists and engineers by 'capturing the excitement of science in the early years of schooling, as well as promoting its relevance at senior levels' (p. 5) and to develop the vocational skills to drive knowledge-intensive industries through long-term strategic partnerships between industry and education' (p. 32).

South Australia

- ***Shaping the Future—STI[10]: A 10-Year Vision for Science, Technology and Innovation in South Australia.* Adelaide: South Australian Department of Further Education, Employment, Science and Technology, Science and Innovation Directorate, 2004.**

  Engaging the broad community is a strong feature of the plan. The most relevant of the Ten Point Vision are point 8 (Targeted and relevant STI education and skills development) and point 9 (Community awareness and engagement) cited below:

  - the community better understands the importance of STI and its impact on society and environment
  - citizens can better debate the merits of new technology and associated ethical issues
  - citizens link STI investment to future job opportunities and their family and community wellbeing
  - leaders recognise the need for ongoing state and private investment in STI as a key component to the state's future economic growth
  - multiple events and awards recognise, celebrate and reward the state's best and brightest in STI (p. 6).

- ***STI[10]: Progress Report 2004–2009*. Adelaide: South Australian Department of Further Education, Employment, Science and Technology, Science and Innovation Directorate, 2009.**

  South Australia has developed a number of activities supporting a 'society and the citizen alliance'. These include Adelaide Thinkers in Residence; Connecting Up—'a national conference that brings together the non-profit sector to discuss and present solutions to social inequity'; the Centre for Social Innovation—'to develop effective remedies to key social issues'; and the Desert Knowledge CRC—'committed to creating

economic opportunities for desert people… to apply social science insights into governance, human capacity, and the design of appropriate institutions' (p. 20).

- **STI[10] Case Studies. Innov8: Wide-ranging Program Improves Science Awareness. Adelaide: South Australian Department of Further Education, Employment, Science and Technology, Science and Innovation Directorate, February 2009.**

  Examples of relevant science communication activities within South Australia include the following:

  - Flinders Centre for Science Education in the 21st Century
  - CSIRO Science Education Centre including Lab-on-Legs, CREST (Creativity in Science and Technology)
  - National Science Week—Science Alive!
  - South Australian Science Excellence Awards
  - Tall Poppy Campaign.

Victoria

- **Quantum Market Research*, Community Interest and Engagement with Science and Technology in Victoria Research Report*. Melbourne: Victorian Department of Innovation, Industry and Regional Development, June 2007**

  The purpose of this survey was to gain a greater understanding of community attitudes to science and technology, and the factors that influence these attitudes. The four broad aims were to:

  - gain an understanding of attitudes to science and technology in the community including levels of interest and knowledge, perceptions of research and emerging technologies, and opinions about policy makers and regulators
  - explore preferred communication methods and channels for science and technology information and how this differs by segments in the population
  - uncover the key drivers that shape community attitudes to science and technology and in particular which are likely to engage the population
  - identify media preferences and modes of engagement that resonate (p. 2).

  Many of the findings from the report are cited in this science communication strategy, especially in section 1.2.1.

Western Australia

- ***Western Australian Science Communication and Public Engagement Plan*. Scitech and Western Australia Office of Science and Innovation, 2006.**

Through extensive stakeholder consultation, the need was identified for the development of an integrated science communication and public engagement plan for Western Australia, to provide short- and long-term economic and social outcomes for the community. Among the outcomes expected are the development of a scientifically literate population that can make informed decisions about issues affecting their daily lives, targeted initiatives that influence attitudes towards science and produce behavioural change, and a platform of relationships, partnerships and activities (p. iii). For the public to gain sufficient understanding to become informed citizens, generational change and a long-term commitment by successive Governments will be required. (p. 11)

INTERNATIONAL REPORTS

Many government science policy documents from overseas have components that can usefully inform this strategy. They are summarised below.

Canada

- ***Mobilizing Science and Technology to Canada's Advantage Progress Report*. Ottawa: Industry Canada, 2009.**

  Although much of this report focuses on research and commercialisation, there is a section on fostering a strong S&T culture through innovative science outreach programs. These include National Science and Technology Week, the science.gc.ca Web site for S&T information, the Great Canadian Science Race outreach initiative to over 325 000 children and 14 000 teachers, and the Canadian Institute of Health Research's Synapse Youth Connection, which supports mentoring of youth about careers in health (p. 39).

- ***Trajectory Project—The Study, Analysis, Envisioning and Strategic Advancement of a Scientific Culture in Alberta*. Science Alberta Foundation, 2007.**

  Science education is an integral part of today's society but its role in developing a scientifically literate society is clouded. There is a need to understand science education and awareness within the context of broader social policy.

  This study considers the breadth of literature on scientific literacy and sets out various arguments for promoting it, including economic, democratic, utility, social and cultural arguments. It then examines some key elements of informal science education and articulates several strengths, including connecting people to the 'real world' and therefore the relevance of science. The study refers to Questacon and CSIRO in Australia and their informal programs which enhance the relevance of science. It concludes by acknowledging that it is too much to ask of formal science education to be the single influence in creating a science culture. Informal science education and awareness is critical to making science a common and influential part of each individual's life.

China

- **China Association of Science and Technology Initiatives**

In 2002, China issued a law for science popularisation. It is half a century since the China Association for Science and Technology (CAST) was founded to promote and popularise science. CAST acts as a bridge between the scientific community, the Communist Party and the Chinese Government. It has campaigned hard to spread scientific knowledge via exhibitions, lectures, popular books and magazines, and field guides on agricultural technologies for remote communities. It encourages scientists—both directly and through its 200 or more affiliated academic societies—to visit schools, factories and rural communities to talk about science.

As part of the Scheme for the Advancement of Chinese Scientific Literacy, launched in 2006 and adopted by 14 national ministries, CAST, the Ministry of Science and Technology and other government departments have run popularisation campaigns on topics such as SARS (severe acute respiratory syndrome), H5N1 bird flu, China's manned space mission, and its moon exploration project.

Europe

- ***Research and Societal Engagement: European Research Advisory Board Final Report* June 2007.**

  The European Research Advisory Board (EURAB) established a working group to address the means for engagement and dialogue between societal actors and the research community. With public mistrust in certain research-based institutions on the rise, there is growing concern to engage more at the societal level. Progress is being made by researchers in communicating their work to the wider public, but there is little sustained interaction with non-economic societal actors. While the European Union has provided support for science festivals, consensus conferences and other science communication activities, this report focuses on recommendations to researchers to engage with other relevant segments of the public in order to take societal questions and concerns more into account.

United Kingdom

- ***A Vision for Science and Society: A Consultation on Developing a New Strategy for the UK*. London: Department for Innovation, Universities and Skills, 2008.**

  This report developed a new, comprehensive strategy for scientific engagement across society. The vision that encapsulates their ambitions is 'a society that is excited about science, values its importance to our social and economic wellbeing, feels confident in its use, and supports a representative well-qualified scientific workforce' (p. 14).

  Both the process and outcomes of this report are very well documented. Many of the issues outlined—including the perception that scientists who engage with the public are not properly rewarded or valued, that better measurement and evaluation of the impact of science communication is needed, and that there should be greater interaction with the corporate sector—were also raised as issues in the consultations for this report.

- ***Science into Policy: Taking Part in the Process*. Second edition, Natural Environment Research Council (NERC), UK 2009**

  This publication provides guidelines for NERC scientists and staff to engage with policy-makers. It aims to help them: (1) recognise the relevance of their science to policy-makers and engage with science-to-policy activities; (2) identify opportunities, routes and best practice to inform policy-making; and (3) communicate science in an appropriate and accessible way, to the appropriate policy-makers, showing how it fits their needs. This initiative is part of the Living with Environmental Change (LEWC) program launched in 2008. This £1 billion ten-year research and policy initiative brings research organisations in numerous disciplines together with policy-makers and the private sector to give decision-makers the information they need to address critical environmental issues.

  The publication emphasises the importance of scientists communicating with the public as a key aspect of translating science into policy. It also concedes that not many policy-makers have a scientific background, that some may not appreciate the relevance of science to their work, and that they may often obtain scientific information from secondary sources that simplify complex analyses—such as newspaper reports or Wikipedia—rather than from scientific papers.

- **Kevin Burchell, Sarah Franklin and Kerry Holden, *Public Culture as Professional Science: Final Report of the ScoPE Project*. September 2009**

  The Scientists on Public Engagement: From Communication to Deliberation? (ScoPE) project in the UK, funded by the Wellcome Trust, was a three-year social science research project conducted in the BIOS Centre for the Study of Bioscience, Biomedicine, Biotechnology and Society. The project was inspired by developments in official and institutional approaches to the relationships between science and the public. The findings confirm the significance of a major shift in professional scientific culture toward an endorsement of, and participation in, public engagement as a key component of scientific research and innovation. Public engagement skills are increasingly seen by scientists to be as important to a successful scientific career as scientific, clinical and teaching skills.

  Science's varied publics are often seen to be in possession of a broad-based social knowledge that is valuable because it is distinct from the more narrowly specialised and technical knowledge of scientific experts. 'Lay' publics emerged from the interview data less as social actors in need of reassurance about science, but increasingly as legitimate and capable citizen-partners in the effort to determine appropriate courses of action for scientific and medical innovation. However, while strongly endorsed as valuable and worthwhile, the means to facilitate new public-science partnerships were widely acknowledged by scientists to be challenging, time-consuming and a professional anomaly. Public engagement activity is seen to be potentially detrimental to a professional scientific career.

- ***Report of International Indicators of Science and the Public Workshop, 5–6 November 2007*. The Royal Society, 31 January 2008**

  As part of its Science and Society Program, the Royal Society hosted a workshop to review existing international indicators of the public's knowledge, interests, attitudes and engagement with science and technology. Analyses were presented using data from complementary sources such as the mass media, science education, science communication and public engagement activities. Central concepts included scientific knowledge, opinions and attitudes regarding science, confidence and trust in science and scientific institutions, and interest, engagement and participation with science. In policy discussion, science communication and public engagement are increasingly important for the governance and development of science. Of the studies which are relevant to international indicators of science and the public, only a few are designed for the purpose of drawing international comparisons.

United States

- **Committee on Learning Science in Informal Environments, National Research Council. *Learning Science in Informal Environments: People, Places, and Pursuits*. (Washington, DC: The National Academies Press, 2009).**

  The Committee on Science Learning in Informal Environments was established to examine the potential of non-school settings for science learning. The committee, comprising 14 experts in science, education, psychology, media, and informal education, conducted a broad review of the literature that informs science learning in informal environments. They assessed the evidence of science learning across settings, learner age groups, and varied spans of time; identified the qualities of learning experiences that are special to informal environments and those that are shared (e.g., with schools); and developed an agenda for research and development.

  The committee organised its analysis by looking at the places where science learning occurs as well as cross-cutting features of informal learning environments. The 'places' include everyday experiences, like hunting, walking in the park or watching a sunrise; designed settings, such as visiting a science centre, zoo, aquarium, botanical garden or planetarium; and programs, such as after-school science or environmental monitoring through a local organisation. Cross-cutting features that shape informal environments include the role of media as a context and tool for learning and the opportunities these environments provide for inclusion of culturally, socially and linguistically diverse communities.

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