

**THE WINSTON CHURCHILL MEMORIAL TRUST OF AUSTRALIA**

**The Phyllis Primrose Whyte Churchill Fellowship**

**The structure and pedagogy of targeted  
school and community focussed science  
outreach programs in  
Singapore, Japan, USA, UK.**

**Report by Brent Banham - 2009 Churchill Fellow**

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Dated: 15/06/2010

## About the Author

Brent Banham is a science communicator with the Faculty of Science and Engineering, Flinders University. Brent came to science communication following a 12 year career as a senior and middle school science teacher both locally in SA and abroad in Papua New Guinea, Oman, Brunei and the USA. His formal training was in the areas of medical science, environmental studies and education. Brent has a breadth of experience and skills that he brings to the science communication role. His outside interests are broad - including a current term as an elected member with Local Government. He has a heightened regard for the contribution that the humanities and social sciences give toward understanding the physical sciences. Brent is charged with a broad portfolio at Flinders University – representing as he does the areas of chemistry, physics and environmental science. This Churchill Fellowship enabled him to explore best practice in science communication across all levels in a variety of settings.

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## Executive Summary

This Fellowship created an opportunity to study University-based science community outreach programs in Singapore, Japan, the USA and the UK and relate these programs to the Australian context.

The direct outcome of the study will be to inform development of science outreach programs at Flinders University in the material sciences, including nanoscience and nanotechnology. Also, in areas of the environmental sciences. These programs will actively seek to network with like-minded programs both in Australia and abroad. More diffuse outcomes include providing informed input into national debate on developments and directions in science communication.

This study followed a number of themes – each theme being viewed as an important element of achieving successful University-based science outreach. To thrive, University science outreach needs to be championed within the organisation. This was explored in [the role of scientists as science champions](#). Key external stakeholder groups also need to be engaged and this was studied around the themes [science associations as partners in outreach](#) and [publicly funded research organisations as partners in outreach](#). The potential for Universities to form museum partnerships was explored in [translating contemporary science through science museums](#).

The broad role of Universities as science outreach providers was examined in [science outreach as a part of the not-for-profit sector](#), [universities as science outreach providers](#) and [science outreach as a service industry within universities](#).

Outreach to secondary schools was analysed in [secondary school teacher professional development \(PD\)](#); [teacher-led professional development](#) and [emerging sciences as a vehicle for changing science teaching pedagogies and perceptions of science](#).

Outreach resources within Universities are scarce and need to be shared and utilized to maximum effect. This was examined in [hubs and networks](#); [community engagement with practical outcomes](#) and [a glut of resources](#).

One of the emerging trends in science outreach is to seek democratic forms of engagement with stakeholder groups. The role of Universities in meeting this end was studied in [modelling democratic forms of engagement](#).

Organisations visited as part of this study include:

- National University of Singapore
- Singapore Science Centre
- Miraikan – Japan’s National Museum of Emerging Science and Innovation
- Chubu University
- University of California-Berkeley
- University of Wisconsin-Madison
- University of North Carolina-Chapel Hill

## Acknowledgements

This study and the actions arising from it are dedicated to the memory of Professor Jean Primrose Whyte (1923 - 2003).

My thanks to the Churchill Trust for affording me this generous and singular opportunity to explore my area of research without encumbrance.

The existence of the Churchill Trust is an extraordinary thing. The way it goes about its function is a joy. The support the Trust has given at every step of the process has been much appreciated as has their faith in my endeavor. I also thank the Churchill Fellows Association of SA for the support they lend to members. Previous Australian Churchill Fellows have investigated aspects of science outreach and education. I thank them for their reports that have given additional guidance and insight.

The field of science communication is more diverse; more involved and more spirited than I gave it credit for before leaving home. Through this fellowship I have had the opportunity to look greedily across many aspects of the field. My convictions and sense of vocation has been sharpened from the experience. This has only been made possible by the practitioners in the field who gave of their time and expertise. Too numerous to mention here, they are listed in Appendix A.

I would particularly like to thank my wife, Wendy. This experience only happened because of her – she was encouraging from the very first idea of applying for a Fellowship, through to accompanying me abroad, through to this, the final report, and ... whatever might follow next ...

Also, thank you to family and friends for keeping things ticking over at home while we were away; to the Faculty of Science and Engineering, Flinders University and to the City of West Torrens where I am currently serving a term as an elected member for their understanding while I was away.

The travel associated with this Fellowship was contrived to correspond with winter – a beautiful time of year the world over.

A biography of Professor Jean Primrose Whyte's life by Dr Coralie Jenkin is available online from Monash University.

## Aims

This Fellowship created a timely opportunity to study University-based science community outreach programs abroad across the full scope of their operations – from broad-based organisational levels through to the specifics of particular programs - particularly in emerging areas of the material sciences (nanoscience and nanotechnology) as well as the environmental sciences. It allowed for exploration around the following framework:

1. the role of Universities as part of the broader science communication landscape in providing informal science outreach services to the general community;
2. the range of University-based outreach programs that exist as well as some measure of their efficacy;
3. The key elements necessary for Universities to engage in successful outreach, including organisational aspects; resourcing and stakeholder relations;
4. Opportunities for cooperation and collaboration between science outreach providers.

For the most part this report is descriptive of the themes followed and the people and institutions encountered - hopefully thereby giving a satisfactory account of the journey and the main line of thoughts pursued. By comparison, the outcomes listed are mostly written in the form of aspirations and goals for my current and future workplaces – these being my main forum for giving effect to the themes followed in the report. The outcomes also represent something of the types of convictions I now carry with me, independent of workplace.

## Outcomes

In the context of developing science outreach at Flinders University, seek to:

- be a national node for emerging material science outreach in nanoscience and nanotechnology;
- contribute as a willing partner to initiatives for environmental science outreach, particularly in the area of ground water management.

The outreach program will have the following objectives:

*Community outreach:* To facilitate the understanding by the general community through contributions to the public debate – this includes presenting at public forums and in various media (print, radio and television).

*Education:* To facilitate the creation and/or dissemination of education resources within the secondary education sector both in South Australia and nationally with a view to encouraging:

- a better engagement with emerging or key areas of science and technology;
- increased uptake of the study of science and technology and science and society by students through the use of emerging areas of science and applied science as a motivating factor and as a vehicle for new teaching pedagogies;

*Resource sharing with organisations with similar objectives:* To network in a transparent, cooperative fashion with organisations at all levels that have the shared objectives of science outreach, education and social equity. This includes seeking to use democratic models for engagement with key stakeholders.

The outreach program will be informed by the themes followed in this study – each theme being an important element of achieving successful University-based science outreach. To thrive, University science outreach needs to be championed within the organisation. This was explored in [the role of scientists as science champions](#). Key external stakeholder groups also need to be engaged and this was studied around the themes [science associations as partners in outreach](#) and [publicly funded research organisations as partners in outreach](#). The potential for Universities to form museum partnerships was explored in [translating contemporary science through science museums](#).

The broad role of Universities as science outreach providers was examined in [science outreach as a part of the not-for-profit sector](#), [universities as science outreach providers](#) and [science outreach as a service industry within universities](#).

Outreach to secondary schools was analysed in [secondary school teacher professional development \(PD\)](#); [teacher-led professional development](#) and [emerging sciences as a vehicle for changing science teaching pedagogies and perceptions of science](#).

Outreach resources within Universities are scarce and need to be shared and utilized to maximum effect. This was examined in [hubs and networks](#); [community engagement with practical outcomes](#) and [a glut of resources](#).

One of the emerging trends in science outreach is to seek democratic forms of engagement with stakeholder groups. The role of Universities in meeting this end was studied in [modelling democratic forms of engagement](#).

## Dissemination

The understanding and resources gleaned from this study will be used to directly inform science outreach programs run through Flinders University and its partners, including the overall structure, aspirations and content of the outreach programs as well as the types of relationships formed with outreach stakeholder groups.

*On a local level:* this includes the direct sharing of resources with secondary schools and a better informed relationship, principally with organisations such as the South Australian Science Teachers Association; the CSIRO; the other SA Universities and the Australian Science Communicators (SA) Branch. This includes contributions to publications and forums where the support of the Churchill Trust will be cited.

*On a national level:* the “Inspiring Australia” report contemplates that a “national framework-local action approach be adopted led by a national hub collaborating with Federal and State jurisdictions, business and the community (recommendation 13).” This Fellowship will inform contributions made to helping achieve the above objective and give a sense of preparedness when and if the recommendations from the “Inspiring Australia” report are adopted.

The “Inspiring Australia” report also contemplates a regular national science communication summit, part of which will be to determine optimal roles for different agencies and institutions. This Fellowship will inform input into this forum.

With regard to outreach in the material sciences and environmental sciences, networking with other like minded organisations such as interstate Universities is desirable. Insights from this Fellowship will be used to help achieve this end. Contributions are now being contemplated to involvement in national organisations such as the Australian Science Communicators national body and the Australian Science Teachers Association. This includes contributions to publications and forums where the support of the Churchill Trust will be cited.

*On an international level:* There is intent to foster some of the many relationships made possible through this Fellowship and to participate in overseas networks.

## Why visit Singapore, Japan, the USA and the UK to study science outreach?

*Singapore:* Singapore is a small Country with limited natural resources – particularly when contrasted with other Countries in its region. The small size of the Country as well as its overt public investment and confidence in economic development through the physical sciences makes Singapore an interesting microcosm to study - the people and the institutions that fuel science engagement are all in close proximity to each other; often with the same people working across institutions. The resources given to popularising science in Singapore appear to be generous and there is an eagerness to “give anything a go” when it comes to traditional forms of science communication that affirm the utility of science and technology.

*Japan:* While I visited Japan chasing specific programs, one of the broader aims was to get a feel for the links between the secondary and tertiary science education sectors in that Country. Of all the world’s Countries, Japan’s history of state support of techno-science is second only to that of Germany in terms of length. So, how has this long-term focus on techno-science affected the support of science in Japan’s secondary school system and the way science is communicated in that Country?

*USA:* With regard specifically to University-led science outreach, Land-grant Universities in the USA have a long standing tradition of providing science outreach to their respective communities. Strong mechanisms are in place that direct Universities to meet this end. It is almost the case, that if an outreach program can be conceived it has been tried in this Country. The informal education and outreach services provided by Universities are an integral adjunct to the primary and secondary education sectors in many, if not most states of the USA.

*UK:* The UK has an established tradition in science outreach that spans several centuries. However, rather than rest on established tradition, science communication in the UK and Europe is reinventing itself to meet new challenges. This need for reform has arisen out of the strength of public debate about the impacts of emerging areas in science and technology such as GM foods. The aim has become to seek models of public engagement that will yield more democratic involvement of public opinion in decision making – a marked shift from the still prevailing tendency elsewhere to see science communication as little more than a subset of public relations or a means to recruiting students. This visit to the UK presented an opportunity to explore emerging aspects of science communication in this Country. Australia continues to follow the path led by the UK with regard to science communication. So much so, it might be reasonably anticipated that if or when elements from Inspiring Australia (see below) are implemented they might follow UK models.

## The Australian Context

During 2010, the Federal Department of Innovation, Industry and Scientific Research at the behest of the Federal Ministers for Science and Education proposed a national science communication strategy - “Inspiring Australia: A national strategy for engaging with the sciences.” Inspiring Australia is “seeking a national approach for community engagement with the sciences” as well as “increased return on investment in research institutions, infrastructure and programs now and into the future.” A key part of the reports focus is on “motivating and inspiring youth to get involved with science and science related issues.” To achieve this as well as other goals, science institutions 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.” The report overtly flags that public funding for research and higher education will be “harnessed to achieve this.”

The report notes that this financial year (2009/2010) the Australian Government spent “about 8.6 billion on support for research and innovation – but only a small fraction of this was on communicating the results to a wider audience, thereby securing full economic, educational, environmental, social, inspirational and political value from it.”

The science communication landscape in Australia is fragmented. We have a wealth of institutions involved in the field but often either weak, poorly defined or the wrong connections between them.

The level of University involvement in science outreach is highly variable across the Country. At perhaps the top end of the scale, the Centre for Public Awareness of Science at the Australian National University is of international standing. Around another 6 Universities have formal teaching programs of one kind or other directly in science communication. Involvement of the other Australian Universities in the field becomes less distinct and less easy to characterise.

The focus of this study is largely on the tertiary-secondary interface. Universities clearly see the secondary sector as a key stakeholder. However, the mechanisms or signals are not there for the tertiary-secondary education relationship (and indeed other education sectors) to yield its full potential. Currently this relationship is predominantly fuelled by marketing budgets. The competencies of Universities in research and education are not being properly exploited.

## Why focus on emerging material sciences (including nanoscience) and the environmental sciences?

Around the world the emerging material sciences such as nanotechnology are already multi-billion dollar industries in Countries such as Japan, the USA and Germany. The rate of innovation as well as the rate of investment is set to increase rapidly. In Australia there is an obvious gap to fill in communicating the promises, opportunities and likely impacts of the emerging material sciences. Flinders University is invested in nanotechnology research and education. It is well placed to meet some of the need for communicating this area in South Australia and for participating in a national dialogue.

The importance of the environmental sciences is obvious. However, secondary teaching resources (or at least the awareness of these resources) in the environmental sciences in Australia are limited. While the status and resourcing of informal environmental science education opportunities in Australia is probably “not too bad,” there are clearly opportunities for marked improvement and some areas that are not really broached at all – such as groundwater awareness and management. Flinders University is at the hub of a national centre for Groundwater studies.

## Themes Studied

This Fellowship allowed for the vertical exploration of science communication from the broadest of organisational levels through to the level of specific programs. It also allowed for the comparison of programs horizontally across different institutions. The resources gleaned were overwhelming – with new organisations and programs encountered within my field and over 100 kg of printed publications shipped home. It is going to be a long-term project to distil the materials and ideas gathered.

Following is a vignette of the main themes that framed this study:

### The role of Scientists as Science Champions

“Whatever you do, don’t put your hand there,” he said while pointing to an empty space a foot in front of my chest.

He held up a piece of paper to demonstrate – immediately the paper burst into flames.

I was standing inside the laser laboratory of Dr Tsuyoshi Akiyama, an Assistant Professor at Chubu University, Japan. The optical equipment filled the room. It was only possible to move by taking short sideways steps. The walls pressed hard behind us on all sides.

As we edged our way around the room, Dr Akiyama avidly described his research while pausing now and then to ignite other bits of paper in random bits of air. He had a keen sense of the dramatic and went about it like was pulling rabbits out of a hat.

One of Dr Akiyama’s many research interests involves making laser diagnostic tools to analyse the plasma inside of fusion reactors. He is also is a keen communicator of science. Around 50 times a year he dresses as a clown and visits primary schools around Japan to talk science. Able to command multi-million dollar budgets, his office is littered with science toys he has made for his presentations – sophisticated devices made out of little more than foil, glue and cardboard. This almost bizarre dichotomy of senior researcher living a double life as children’s entertainer is a surprisingly common one among academic scientists. The desire to share their work with a broader audience is there. However, academic models of recognition rarely directly reward academics for their outreach activities – it is often treated as a hobby of extracurricular interest.

For science communication within Universities to thrive and be elevated above “hobby” status requires the active involvement of senior scientists as champions to promote, resource and find “space” for science communication in their field. For this to occur requires that the same sorts of energies and skills used to create a research group or organisation are diverted to science communication ends. This Fellowship gave an opportunity to look at the importance of science champions through the work of politically aware and raconteur scientists across several institutions. Specifically, the activities of individuals such as Dr Leo Tan Wee Hin, Director of the Singapore Science Centre and Dr Mamoru Mohri, Executive Director of the Miraikan, Japan’s first Astronaut and Flinders University Alumni.

## Science Associations as Partners in Outreach

Professional Science Associations lie within the first tier of stakeholder groups Universities need to ally themselves with to further the aims of Science outreach. While the involvement of western professional science associations in outreach activities is reasonably well characterised, this has not been the case for other regions such as SE Asia. This fellowship presented an opportunity to look at the involvement of professional science associations in Singapore in science outreach through a series of interviews with key position holders at the Singapore National Academy of Science; the Institute of Physics Singapore and the Singapore National Institute of Chemistry. Also, the opportunity to examine how these programs work in association with Universities, namely Nanyang Technological University and the National University of Singapore.

## Publicly Funded Research Organisations as Partners in Outreach

The Agency for Science, Technology and Research (A\*STAR) is Singapore's leading government agency dedicated to fostering scientific research and training research professionals in the biomedical sciences, physical sciences and engineering. It is driven toward achieving direct commercial outcomes through industry partnerships. A\*STAR is an immense, overwhelming enterprise, overseeing as it does 14 research institutes, seven consortia and extramural research projects with Singapore's universities and hospitals. The analogue of A\*STAR in Australia is the CSIRO.

This Fellowship afforded the opportunity to visit the A\*STAR Institute of Bioengineering and Nanotechnology (IBN) and gain an overview of their Youth Research Program (YRP) that has the aim of promoting a research culture among secondary school students. Comparisons were drawn with the poorly resourced "scientists in schools" program run by the CSIRO in Australia. The IBN has also produced a number of school-focussed nanotechnology teaching resources in kit form - Nano-Bio Kits - these kits are not available outside of Singapore. The visit presented the opportunity to evaluate these teaching resources – symbolic in a way of a top-down approach to developing teaching resources, evidently without secondary teacher input.

## Secondary School Teacher Professional Development (PD)

University Faculties of Science and Education around the world involve themselves in secondary school teacher professional development programs (here I mean Teacher PD of an informal kind rather than PD that might be obtained through formal avenues of study through Faculties of Education). The motive stems in part from a desire to relate contemporary areas of research to secondary teachers in the hope that this might be translated for use in the classroom. My belief is that in Australia more often than not these efforts fail for lack of resourcing; for want of understanding and for want of real effort to bridge the gap in any meaningful fashion between tertiary and secondary education sectors.

As part of this fellowship I was able to interview professionals across a range of organisations as to what makes for good Teacher PD as well as to explore programs in the USA that directly involve and resource teachers in translating contemporary science for the school classroom. The range of printed resources gathered in this area was overwhelming.

## Teacher-led Professional Development

One of the joys of my time in Japan was visiting the Aichi Physics Circle – an anarchic, informal group of secondary and tertiary physics educators who meet on a regular basis to share and brainstorm ideas and materials for teaching physics in secondary school. This group presents the purest expression of “bottom-up,” self sustained teacher-led, peer reviewed, creative innovation in science education I have witnessed. Umbrellas that double as detectors for the Earth’s magnetic field; assemblages of alfoil, copper wire and oven igniters that function as electromagnetic transmitters and receivers are all products of their philosophy – to translate concepts in physics for students by using common, everyday objects. Now over 40 years old, the Aichi Physics circle has published its ideas and philosophy in books and journals. However, little of their work is available in English. While their focus is still mostly on secondary education, they present activities for the general public at the Nagoya City Science Museum. During my time in the USA I chanced upon a similar “build” or “make” community with an expansive online and print presence.

## Translating Contemporary Science through Science Museums

This fellowship presented the opportunity to visit and in most instances meet staff from the following Science Museums:

- Singapore Science Centre
- Miraikan - National Museum of Emerging Science and Innovation, Tokyo, Japan
- Exploratorium, San Francisco, USA (including the Outdoor Exploratorium at Fort Mason)
- Lawrence Hall of Science, UC, USA
- Franklin Institute of Science, Philadelphia, USA
- Museum of Science and Industry, Chicago, USA
- Moorhead Planetarium and Science Centre, UNC, USA
- Smithsonian Institute, Washington, USA
- @Bristol

Represented on this list is the oldest, and perhaps most influential of interactive exhibit-styled science museums – the Exploratorium; as well as one of the newest that aims to link people directly with “the new wisdom of the 21<sup>st</sup> Century” – the Miraikan. Two of the museums are directly associated with Universities – the Lawrence Hall of Science at the University of California – Berkeley; and the Moorhead Planetarium and Science Centre at the University of North Carolina-Chapel Hill.

Highlighting the diversity evident between different science museums, each of the museums in the list vary in their aims, target audience, exhibit design and supplementary programs. The Fellowship gave an opportunity to compare these museums across a number of aspects, including: their affective, motivational, affirming as well as informative goals; the role of such museums in celebrating national achievements in technology; the role of such venues in fostering science communicators – both internally and externally; the challenges faced when funding and devising an exhibition.

Of particular interest for the purposes of this Fellowship were the exhibits given over to emerging areas of science such as nanotechnology and biotechnology as well as the attempt of exhibits to link science with contemporary issues, particularly in the environmental sciences.

Worthy of special mention is the Exploratorium’s outdoor exhibit at Fort Mason – an elegant collection of exhibits that tune visitors into noting science in context as they walk an outdoor, harbour side path. An energising and affirming experience.

### Emerging Sciences as a vehicle for changing science teaching pedagogies and perceptions of science

The emerging sciences can certainly be taught using traditional modes of science teaching. However, they offer the potential to help catalyse the shift of science teaching into using new types of non-traditional approaches. With new teaching approaches hastened along by developments in the emerging sciences, the way students perceive science and the world around them is set to change. This theme was pervasive through all stages of the Fellowship.

### Science Outreach as a part of the not-for-profit sector

On this particular theme I feel I had a small “road to Damascus” moment – although I fear to others it may appear self-evident. Whatever the case, during my time in the USA I discovered my brand of science outreach falls into the expansive and well articulated not-for-profit sector. The experience was like finding an experienced, diversified peer group. Other not-for-profit enterprises have now become case studies and role models as much, if not more so, than other science outreach programs.

### Universities as Science Outreach Providers

Science outreach programs were examined at the following three Universities in the USA:

- University of California-Berkeley;
- University of Wisconsin-Madison;
- University of North Carolina-Chapel Hill;

These expansive institutions each offer a wealth of programs and resources, including, but not limited to: summer camps; field trips; on campus museums and science shops; undergraduate and graduate outreach training programs; internships for secondary school teachers; academic enrichment programs; short daytime courses; alumni programs; science clubs and programs for generating secondary-school focussed educational materials.

With some few notable exceptions, outreach is not an overt part of Australian University culture. By contrast, in publicly funded USA Universities it is – and the contrasts are extraordinary. In Australian Universities it is easier to work with outsider groups that have an interest in science outreach than it is to work within one’s own organisation. Within USA institutions an outreach ethos already exists, is understood and valued.

With regard to outreach in the physical sciences, the University of Wisconsin is one of the strongest shining lights. The outreach philosophy of the University is enshrined in what is called the Wisconsin Idea:

"The boundaries of the University are the boundaries of the state."

The above means that the University should not be an ivory tower institution but should serve all the people of the state in relevant ways. As early as 1858 a Wisconsin state legislative committee defined the following role for state-supported universities:

"The general government has made a munificent donation to the people of Wisconsin. They have an unquestioned right to demand that it shall primarily be adapted to popular needs, that its courses of instruction shall be arranged to meet as fully as possible the wants of the greatest number of our citizens."

Whereas Australian Universities have written "community engagement" into their strategic plans they are yet to live it to its full potential.

## Hubs and Networks

Government funded science organisations in the USA are required as a condition of their funding to have an education or outreach component to their activities. This has yielded some excellent resources, including in area of the earth sciences and chemistry. (By comparison, Australia is quite bereft of earth science focussed secondary classroom resources and informal earth science outreach programs).

In recent years USA Federal funding has come with the further expectation that organisations work cooperatively. Consequently resource sharing networks have appeared. This Fellowship gave the opportunity to study one such network, the Nanoscale Informal Science Education Network. NISE Net is a national infrastructure comprised of science museums and university based research centres collaborating to foster public awareness. Funded by a 5 year cooperative agreement between the National Science Foundation (NSF) and Museum and University partners, NISE Net seeks to engage the public with nanoscale science, engineering and technology through "exhibits, programs, media, forums, and other kinds of informal educational products." Both the University of California-Berkeley and the University of Wisconsin-Madison are contributors to the NISE Network. Staff at both these institutions was interviewed as to how NISE Net operates (including the resources required to manage a national network); how it is evolving and how contributions are made. NISE Net is a rich resource and is welcoming international partners.

Another nano-outreach oriented NSF program, though not deemed as successful in achieving outcomes as NISE Net, is the National Nanotechnology Infrastructure Network (NNIN) - a consortium of university and industry scientists and engineers, community college and high school science faculty and museum educators. The vision of the NNIN is to create an interactive website where participants can remotely operate advanced microscopes and nano-fabrication tools.

In Australia such resource development and sharing networks have started to appear in informal science education based on both public and industry funded models – the later group tending to have to scrounge for resources. As might be expected, they meet with varying degrees of success.

### Community Engagement with Practical Outcomes

One of the aims of this Fellowship was to look at science outreach programs for their measurable impacts or outcomes – whether they be some measure of an altered appreciation of science at one end of the scale or increased enrolments in science-related courses at University at the other end of the scale. The bottom line is that programs are devised and evaluated according to the desired outcomes of the funding bodies involved – and these are varied, depending for example on whether the program seeks to be educational; an entertainment; specifically involve particular groups etc.

In the broadest of terms, programs can seek to either change attitudes of participants or change their behaviour.

Most programs witnessed or examined as part of this study sought outcomes in attitudinal change. By contrast, environmental awareness raising programs often seek to obtain outcomes in behavioural outcomes – i.e. practical outcomes. I had the opportunity to explore this through a visit to the Groundwater Foundation based in Lincoln, Nebraska - a producer and disseminator of high-quality groundwater-related educational materials that in broad terms seek to raise awareness of groundwater as a resource and bring about behavioural changes in its management. “Waterwatch” would be the closest Australian analogy to the Groundwater Foundation. However, the way in which these organisations are structured and receive their funding is markedly different.

### Science Outreach as a service industry within Universities

Federal research funding in the USA comes with the condition attached that a set proportion of the funds be given over to community outreach. If the recommendations of the “Inspiring Australia” report are adopted, this may become the required practice in Australia as well. When writing research grants the authors will need to demonstrate a community outreach component with the skills and resources necessary to follow through.

This Fellowship gave the opportunity to explore the approach taken to this outreach challenge by the Moorehead Planetarium and Science Centre at the University of North Carolina, Chapel Hill. The Moorhead has an established history of outreach and program development from exhibitions to presentations to multimedia to event management to publications. It is currently exploring running festivals based on UK Science Festivals. The Moorhead provides science education programming to more than 140,000 guests annually.

The Moorehead adopts as best it can an entrepreneurial approach. It offers a science outreach service to researchers on campus where it can assist in everything from quoting and writing the outreach component of grants through to devising, delivering and evaluating the final outreach programs. The aim is to:

“Take scientists research and couple it with Morehead’s strength in developing and delivering content. Thereby, meeting science outreach goals while minimising demands on researcher’s valuable time.’

## A glut of resources

This Fellowship afforded the opportunity to attend the National Science Teachers Association (NSTA) National Conference on Science Education in Philadelphia, Pennsylvania, March 18<sup>th</sup>-21<sup>st</sup>, 2010

To give an idea of the scale of this event, the conference occupied the entire Philadelphia Exhibition Building (2 entire city blocks) as well as the conference facilities of 4 adjacent multi-story hotels; had over 10,000 teachers in attendance and over 1500 scheduled presentations, workshops and ticketed events. The exhibitor hall was so large it would take 3 days to spend time at each display.

Within a single setting the conference offered the opportunity to:

- Visit exhibitor stands with a view to both gathering immediate resources while seeking to foster a longer-term relationship. It is notable that there were a multitude of USA based companies present that also have a presence in Australia. Yet, their culture of being involved in science outreach is not as developed in Australia as it is in the USA.
- Examine programs that were not otherwise on the route taken by this fellowship. These included meeting staff from:
  - University of Massachusetts-Amherst
  - Delta Program. State College Pennsylvania
  - Pacific Science Centre, Seattle, Washington,
  - University of Washington Institute for Science and Mathematics Education.
  - Harold Washington College, Chicago.
  - American Association of Physics Teachers (AAPT)
  - American Chemical Society (ACS)
  - American Geological Institute (AGI)
  - Centres for Ocean Sciences Education Excellence (COSEE)
  - National Earth Science Teachers Association
  - Cornell University

## Democratic forms of engagement

Science Communication has traditionally worked toward the goal of raising the “Public Understanding of Science” (PUS). When put into practice, this goal often translates into “marketing science” or science communication acting as a “science apologist”. The problem with these approaches is that they do not necessarily engender trust or dialogue. They do, however, attract at least some funding as organisations and institutions seek to present themselves in their best light.

In the UK and Europe there has been a widespread call in the last decade to shift from PUS toward PES - the “Public Engagement of Science”. PES might be characterised as framing science communication efforts around the public’s need to know. As well as around the democratic involvement of the public in the choices that are made about which areas of science are funded and under what conditions. In a broader sense, “engagement” is a word being widely used across levels of government; industry, organisations and institutions seeking to maintain credibility.

Programs that strive for the Public Engagement of Science were explored through visits to the offices of the British Science Association – a not-for-profit organisation that exists to further PES objectives. Also, on a regional basis, a visit to the offices of “Science Oxford” - a multifaceted organisation that

serves as everything from an incubator for science-based businesses through to providing science outreach on a contracted basis from organisations such as STEMNET ([www.stemnet.org](http://www.stemnet.org)). Both of these organisations operate programs that are exemplars for Universities seeking to engage with their main stakeholders, namely: schools, industry and government/regulators.

## Appendix A: Extended interviews were held with the following individuals

### Singapore

Professor Leo Tan Wee Hin	Director Special Projects	National University of Singapore
Professor Subramaniam	Secretary (Hon)	Singapore Association for the Advancement of Science
Professor Kwek Leong Chuan	President	Institute of Physics Singapore
Dr Leong Lai Peng	Honorable Secretary	Singapore National Institute of Chemistry
Mr Perry Lee	Associate Director Faculty of Science	National University of Singapore
Ms Kamaria A Ghani	Director Science Upstream	Singapore Science Centre
Ms Florence Francis	Manager Strategic Planning	Singapore Science Centre
Ms Eunice Choy	Corporate Communications Officer	Singapore Science Centre

### Japan

Nahoko Ando	Group Leader International Liaison Group Business Liaison Division	National Museum of Emerging Science and Innovation
Dr Yasushi Ikebe	Principle Investigator Science Communicator Group Leader of Research and Planning Group	Science Communication Management Division Miraikan
Kazuya Nakayama		College of Engineering Chubu University
Dr Shigeki Okajima		College of Engineering Chubu University
Dr Tsuyoshi Akiyama	Assistant Professor	National Institute of Natural Sciences National Institute for Fusion Research High Temperature Plasma Physics Research Division, Gifu
Norihiro Sugimoto	Aichi Physics Circle	Kikuzato High School, Nagoya
Professor Yoji Iida		Ritsumeikan University
Shirou Terada	Principal	Aichi Prefectural Meiwa Senior High School

## USA

Rashmy Nanjundasmy	Project Manager	Lawrence Hall of Science University of California - Berkeley
Cindy Kreifels	Executive Vice President	The Groundwater Foundation, Lincoln, Nebraska.
Kevin Niemi	Director	Office for Science Outreach University of Wisconsin-Madison
Margaret E. Mooney	Earth Science Outreach Specialist	Space Science and Engineering Centre University of Wisconsin-Madison
Greta M. Zenner Petersen	Director	Interdisciplinary Education Group Material Research Science and Engineering Centre (MRSEC) University of Wisconsin-Madison
Kristine Stepenuck	Volunteer Stream Monitoring Coordinator	Environmental Resources Centre UW Extension
John Greenler	Education and Outreach	Great Lakes Bioenergy Research Centre University of Wisconsin-Madison
Cheryl Redman	Outreach Teacher	UW Biotechnology Centre and UW-Extension University of Wisconsin-Madison
Dolly Ledin	Outreach Program Manager	Center for Biology Education University of Wisconsin-Madison
Sarah Wright	Outreach Specialist	Center for Biology Education University of Wisconsin-Madison
Ella Braden	Outreach Coordinator	Wonders of Physics Department of Physics University of Wisconsin-Madison
Michelle A. Harris PhD	Associate Faculty Associate	Biology Core Curriculum (Biocore), University of Wisconsin-Madison
Brittland DeKorver	Outreach Specialist	Institute for Chemical Education, University of Wisconsin-Madison
Todd Boyette	Director	Moorhead Planetarium and Science Centre
Denise Young	Director of Education and Planning	UNC Moorhead Planetarium and Science Centre
Crystal Harden	Director of External Programs	UNC Moorhead Planetarium and Science Centre
Jennifer Edgingron		Museum of Science and Industry, Chicago
April Chancellor		Museum of Science and Industry, Chicago
Robert Strong		SMART-Center, Wheeling, West Virginia

## Appendix B: Itinerary

Singapore	1 week	23 <sup>rd</sup> – 30 <sup>th</sup> January
Japan	2 weeks	31 January – 13 <sup>th</sup> February
USA	5 weeks	13 <sup>th</sup> February – 27 <sup>th</sup> March
UK	1 week	27 <sup>th</sup> March – 2 <sup>nd</sup> April