ATSE

FOCUS

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Bringing relevance to STEM education

Contributors focus on education – including ATSE's role – and key aspects relating to engineering, mathematics, curriculum, technical education and skills development

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Photo: University of Adelaide

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FOCUS

ATSE *Focus* is produced to stimulate discussion and public policy initiatives on key topics of interest to the Academy and the nation. Many articles are contributed by ATSE Fellows with expertise in these areas. Opinion pieces on topics of national interest, particularly the Academy's key interest areas – climate change, water, energy and education – will be considered for publication. Items between 800 and 1500 words are preferred. Please address comments, suggested topics and article for publication to editor@atse.org.au.

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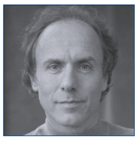
Bringing relevance to science education through STELR

ATSE has initiated a science and technology education program for secondary schools with the ultimate aim of building the basis of a national science curriculum



By Alan Finkel
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As professionals, Academy Fellows are concerned about the education of their successors, the next generation who will underpin Australia's long-term ability to capitalise on its current economic prosperity. Beyond this job-skills need, it is important to broaden the reach of science education within the general population to maximise the viability of Australia's participatory democracy.

The future voters of this country need an appreciation of science and technology in order to interpret and contribute to national debates about issues such as vaccination, water desalination and recycling, medical therapies, nuclear energy, environmental sustainability and genetic modification.

It is well known that participation rates in secondary school science have been declining steadily, especially in the so-called 'enabling' disciplines of physics, chemistry and mathematics. There are many reasons for this, not the least of which is that there is little reason for students to choose 'difficult' subjects in Year 12 given that, at most universities, physics, chemistry and mathematics are no longer prerequisites for entry into science; even engineering faculties, in many cases, have only a single science subject as prerequisite.

Numerous studies have been published on the reasons for the decline in participation rates in secondary school science and they all share a common theme: the problem of lack of motivation. Time and again it is reported that students do not see science and technology as relevant, either to their daily lives or their future careers, despite living in a world driven by and dependent on science. For example, Goodrum and Rennie's 2006 issues paper said: "Many students find the school science curriculum on offer to be unimportant, disengaging and irrelevant to their life interests and priorities."[1]

One way to tackle this problem is through the provision of extracurricular activities. However, as good as they are, the innovative extracurricular activities on offer suffer from several limitations. First, they do not reach all secondary school students. Second, they mainly appeal to students who already have a commitment to science and technology. Third, they are of limited duration.

Inside the classroom, some well-resourced and high-initiative schools have been able to modernise their secondary school science programs and are enjoying participation rates in Year 12 science in excess of 50 per cent, several times the national average. However, the majority of secondary schools do not have the equipment or personnel to reform their curricula to introduce contemporary science and technology into their programs in a way that will engage students' interest.

To positively influence declining national participation rates, new curriculum-level initiatives based on a highly relevant context are needed, and ultimately should be made available to all secondary schools. Further, to compensate for whatever lack of expertise teachers may have in contemporary science and technology, it is necessary to help them acquire the knowledge they need and to facilitate their efforts by providing curriculum support material and professional training.

Capturing student interest - Professor Ian Frazer FAA FTSE, former Australian of the Year and 2007 Florey Medal and ATSE Clunies Ross Award winner, works with students at the 2007 Extreme Science Experience.

To address the issues of relevance and the facilitation of teacher training and resources, the Academy has initiated a novel, curriculum-based secondary school science and technology education program known as STELR, an

Practical classes based on the use of wind turbines and solar panels to create electricity, and based on the conversion of vegetable oils and sugars to biodiesel and bioethanol can be combined with inquiry-based learning methods to stimulate students' interest in physics, chemistry, biology and mathematics.

acronym for Science and Technology Education Leveraging Relevance. If all goes as planned, the educational modules in STELR will serve as a testbed for elements of a future national science curriculum.

The first challenge for the STELR program is the matter of relevance. There are numerous science and technology issues that attract substantial press coverage, including genetic modification, nanotechnology, cancer therapies, stem cells and human genetics. But none of these has such extensive media coverage as climate change. Further, climate change is a topic that students care about. A survey this year by the Australian Childhood Foundation found that 52 per cent of children were worried about not having enough water in the future and 44 per cent were worried about the impending impact of climate change.

Yet climate change, in its broadest context, is not a suitable subject for teaching the enabling science and technology disciplines, because it is highly complex and multidisciplinary. There is, fortunately, a subset of climate change that is simpler than the whole, but nevertheless sufficiently sophisticated that it forms a powerful platform for teaching the fundamental science and technology disciplines. This subset is renewable energy.

Practical classes based on the use of wind turbines and solar panels to create electricity, and based on the conversion of vegetable oils and sugars to biodiesel and bioethanol can be combined with inquiry-based learning methods to stimulate students' interest in physics, chemistry, biology and mathematics.

The second challenge for the STELR program is to facilitate the jobs of existing teachers, through the creation of curriculum units that will build upon the supplied renewable energy technology and provide support materials and professional development training. These units will facilitate the teaching of the fundamentals in physics, chemistry, biology and mathematics that students should be exposed to by Year 10, which is, at present, the last compulsory year.

A similarly motivated program is also being trialled by the Australian Academy of Science. Its Science by Doing program also seeks to provide a relevant context and teacher-support materials based on modern pedagogical principles. Our two projects are independent but loosely linked through an exchange of ideas and funding, and in future there may be a merging of ideas.

The STELR project is at a fledgling stage. Since securing funding for the proof-of-concept program, we have established a steering committee of teachers, university education specialists and nominees from the various representative associations concerned with science and technology education. In 2008, the proof-of-concept program will be offered in four schools for Years 9 and 10. If, after an evaluation process, the proof-of-concept program is deemed to be successful, further funding will be sought to broaden the reach into more schools in all states. The eventual goal is for the technology and the teacher-facilitation materials developed in the STELR program to contribute to a national science curriculum.

Further, while the STELR approach is expected to work well for Years 9 and 10, there is so much scope within the renewable-energies context for teaching the fundamental principles of science, technology and mathematics that it should also be highly applicable in Years 11 and 12.

There are so many competing choices for students when selecting subjects, and so many high-tech products such as iPods and PlayStations fill their lives, that unless we add a modern, extremely relevant context to secondary school science and technology education there is no reason for the majority of students to choose science subjects.

The necessary changes to reverse the existing trends will require a commitment to curriculum reform, teacher support and the provision of resources. The STELR program and other curriculum-based initiatives will explore this approach and, if successful, will serve as a guide to the development of a national science curriculum. ◀

1. Denis Goodrum, Mark Hackling and Leonie Rennie, *The Status and Quality of Teaching and Learning of Science in Australian Schools*, research report prepared for the Department of Education, Training and Youth Affairs, Canberra, c2001, 5.

DR ALAN FINKEL AM FTSE, an electrical engineer and neuroscience Research Fellow at ANU, founded Axon Instruments in California in 1983 to supply electronic and robotic instruments and software for cellular neurosciences, genomics and pharmaceutical drug discovery. Axon was sold in 2004 and Dr Finkel co-founded *Cosmos*, a magazine of science in society, and *G*, a lifestyle magazine about sustainable living. He is Chairman of the National Research Centre for the Prevention of Child Abuse, a Governor of the Clunies Ross Foundation, Chairman of the Australian Course in Advanced Neuroscience, and a Board member and Governor of the Florey Neuroscience Institutes. From January 2008 he will be Chancellor of Monash University.

Education: a core ATSE priority

As one of ATSE's four priorities, mapping a way forward in STEM education in Australia is important, but prioritisation is even more important

By Lesley Parker
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After many years of valuable work by the ATSE Education Working Group, the Academy's involvement in education took an exciting new direction recently with the establishment of education as one of four priority areas in the 2006–12 Strategic Plan. The others are water, energy and climate change, and each is served by a topic forum.

This is a timely step forward and recognises the crucial role of education in building the scientific and technological capacity of Australia and opening up discussion among Fellows about ways in which ATSE can act to initiate and enhance activities in this area. In clarifying and enacting its role in relation to the education focus, ATSE has indicated that its emphasis will be on the impact and influence the Academy can have and on positioning the Academy as an important player.

Background

ATSE's commitment occurs against a background rich in evidence about science, technology, engineering and mathematics (STEM) education, national and international. In recent years, many Australian reports have drawn attention to inadequacies in STEM education. In 2002, the Academy's own report, *The Teaching of Science and Technology in Australian Primary Schools: A Cause for Concern*, based on a national research project, proposed a number of urgent reforms in Australian primary schooling and teacher education to address readily identifiable shortcomings.

Over the past two decades in Australia, millions of dollars have been invested in national, state and local programs aimed at the problems, particularly at upper primary and secondary school levels.

Research, together with programs such as these, has led to some improvements, especially in relation to understanding some of the issues (such as the major barrier posed by students' perception of STEM studies as 'irrelevant') and of the basic tenets of good teaching in these subjects.

In addition, during the decade from the mid-1980s some projects that focused specifically on making science more inclusive were associated with gains in female participation and achievement, but the gains appeared to reach a plateau once the appetite for funding such programs disappeared. Most recently, resources have been dedicated to the development of high-quality, online science and mathematics curriculum materials by the Learning Federation (www.thelearningfederation.edu.au).

Keeping the focus – ATSE sponsors STEM teaching awards. ATSE SA Division President Dr Rob Lewis with Salisbury High School Assistant Principal and science teacher Debra Turley, the 2007 ATSE award winner, and school principal Helen Symeonakis.

It is disappointing that, despite these kinds of investments, the fundamental problems remain: the participation of students in the enabling sciences continues to decline and the critical shortage of people with STEM knowledge and skills continues to be a national concern.

Perhaps because of the apparently modest return on investments to date, the most recent reports at national and state levels have shifted from documentation of research to recommendations for the development of 'action plans'. For example, the Commonwealth has sponsored the initial phase of production of a National

Action Plan for Australian School Science Education 2008–12, the Queensland Government has produced a discussion paper putting forward possibilities for a 10-year plan for STEM education and skills, and the WA Government has produced 'Creating a Future with Science', which recommends a range of actions aimed at capacity-building in STEM. This shift to an emphasis on action plans is mirrored by the UK and the US.

Taking stock

At the Academy's strategic planning meeting in August 2007, discussions about STEM education revealed four main areas of concern for Fellows:

- inadequate student enrollments in the enabling sciences at secondary and post-secondary levels;
- the quality of students' educational experience in STEM subjects at all levels of education (a matter involving teachers and curriculum);
- the standard and appropriateness of student learning outcomes (in terms of STEM-related knowledge, skills, attitudes and values) at all educational levels; and
- the limited understanding of STEM career possibilities by the community (including parents and teachers).

As with other focus areas, ATSE's education aims involve identifying the unique or distinctive contribution ATSE can make, then planning and implementing action to achieve desired goals, taking account of possible impediments to and metrics for determining success. The reports mentioned earlier send a clear message about the need for new and innovative solutions to the problems underlying Fellows' concerns, and regarding ways in which ATSE can act to complement rather than replicate existing initiatives. In some cases the message has already been heard – for example, the Academy's highly innovative STELR project (Science and Technology Education Leveraging Relevance) builds on understanding of 'relevance' as an issue.

Other important messages concern are:

- the need for sustained effort (as shown by the reduction of female participation and achievement once special initiatives were discontinued);
- the importance of university prerequisites as determinants of students' STEM choices and success in those areas of study; and
- the existence of gaps in policies and programs that may signal areas in which ATSE could make a significant contribution (for example, early childhood education and higher education).

The conundrum for ATSE involves where best to place its collective effort, recognising successes and failure of the past, and recognising that constraints on ATSE's potential contribution (in terms of funds, skills and Fellows' time) tend to dictate that ATSE's work will need to be carried out in partnership with government and/or industry.

A way forward

Drawing on the discussion at the August meeting and taking heed of the Academy's concerns and resources (real and in-kind), it appears feasible for ATSE to move forward on four main fronts in education. These reflect the Academy's previous commitments to engage with government, industry and the community; to provide a forum for debate; to undertake projects in key areas; to foster and recognise excellence; and to raise the profile of science and engineering.

Contributing to debate and policy

1 Ideas already put forward in this area include highlighting key issues through, for example, an ATSE 'distinguished lecturer' national program or the choice of education as the theme for a future symposium. Other strategies are more of an ongoing nature. For example, providing thoughtful and academically sound responses to reports, and participating in reviews of STEM areas, such as the National Numeracy Review and the current Review of Engineering Education in universities funded by the Carrick Institute (www.carrickinstitute.edu.au). Strategies include ATSE ensuring that its voice is heard in the policy area, for example, seeking representation on bodies such as the proposed National Council for School Science Education, and also relationship building with state departments of education and training and with state-appointed chief scientists. All of these kinds of activities would also serve the purpose of highlighting the profile of ATSE in education.

Helping increase STEM education enrolments

2 Strategies in this area would help position ATSE as a key stakeholder in STEM education, prepared to make an active and purposeful contribution. This would involve initiating strategic alliances (for example, with universities to pursue possibilities for ARC and Carrick grants) and building on existing initiatives (for example, the ATSE 2002 report and the STELR project). It could also involve leveraging ATSE's expertise in laboratory/workshop occupational health and safety, given the identification of health and safety requirements as an impediment to practical activities in school STEM.

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Rethinking Australian engineering education

The needs of future engineers will be at the heart of a new national review of tertiary engineering education, supported by ATSE

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At this time of high demand for engineers, the Academy is supporting a national project to review and scope future directions for Australia's engineering education system. The project is being undertaken by the Australian Council of Engineering Deans (ACED) with support from Engineers Australia, the Academy and the Australasian Association for Engineering Education (AAEE). The project is funded as a discipline-based initiative of the Carrick Institute for Learning and Teaching in Higher Education.

Due to report in February 2008, the main objective of the project is to provide recommendations for action by the higher education sector, the engineering profession, industry and government, which will, quoting the project brief:

ensure that the engineering education sector across Australia's universities produces, in a sustainable manner, a diverse supply of graduates with the appropriate attributes for professional practice and international relevance in the rapidly changing, competitive context of engineering in the 21st Century.

In formulating its recommendations, the project will also reflect on changes and achievements in engineering education in the higher education sector since the publication, in 1996, of the report of the previous review of engineering education, *Changing the Culture: Engineering Education into the Future*. Over the past eight months, the project team has met with, and received submissions from, more than 1000 students, graduates, academics and members of the engineering industry and profession.

The architects of the project see engineering education underpinning a broad occupational area that must make major contributions, including leadership, to maintaining and improving Australia's economic and environmental health and the wellbeing of its people. Engineering practice is multi-level, and is also highly diverse in terms of its science and mathematical foundations and their development in specific engineering sciences and specialisations.

Engineering education faces several problems:

- the number of Australian school leavers choosing engineering is too small and a declining proportion of women students have taken school mathematics and science;
- the higher attrition from engineering programs (particularly the professional engineering B.Eng.); and
- changing corporate operations (such as specialisation and outsourcing), globalisation and the emergence of new science and technologies, for example, continually change engineering practice, with consequent impact on education.

Similar dynamics and trends have also been reported in studies in the US and UK. Australian dimensions of these trends need to be understood before proposing systemic change.

Clearly, much has been achieved by the participants in the engineering education sector since the mid-1990s. Engineers Australia has led the way on focusing program accreditation processes strongly on the generic attributes of graduates entering professional engineering. This accreditation process is recognised internationally through the Washington Accord.

Most employers contributing to the present study acknowledge that typical contemporary engineering graduates have good verbal communication and presentation skills, and are better team players than previous graduates. Modern graduates are also likely to be adept at using advanced software, and understand the contexts of engineering practice better than previous generations, perhaps at the expense of what older engineers describe as 'being able to work from first principles'. Many students express commitment to environmental sustainability, with a passion to 'make a difference' on national and global issues in areas such as energy and water, and to exploit new sciences in medical applications and product manufacturing.

The 32 universities now offering engineering programs in 17 Australian cities have adapted to develop and sustain their engineering schools and engineering research while their resource base has been declining. The growth and embedding of research can be seen with most of the larger engineering schools participating in one or more Cooperative Research Centre or being associated with an ARC Centre of Excellence.

Engineering has been one of the three main areas of internationalisation in Australian higher education (along with business and information technology) through recruitment of large numbers of overseas students into undergraduate and postgraduate coursework programs.

Several engineering schools have worked in collaboration with industry and government sectors (such as the minerals and electrical industries, defence and water) to form consortia to develop industry and government-sponsored Masters-by-coursework degree programs to meet specific skills needs.

In their provision of undergraduate engineering education, most engineering schools have revised their Bachelor of Engineering curricula significantly to improve student outcomes (such as in the areas of generic attributes), and offer advanced pathways to selected students, and foundation or bridging pathways to those who commence at university without the traditional prerequisite knowledge in mathematics and sciences.

New programs that cross traditional engineering disciplines have emerged. Curriculum innovations within engineering programs include more active, project-based and industry-based learning. Several engineering schools have developed 'learning spaces' for students for strengthening interdisciplinary collaboration and project work. Many engineering schools now offer both Associate Degrees in Engineering (two years of post-secondary study) and three-year Bachelor of Engineering Technology programs, reflecting industry need for university-educated employees in vital paraprofessional roles.

Staff and students from most engineering schools are actively engaged in innovative, but usually under-resourced, outreach programs to secondary schools.

Much of the outreach activity reported above may not be necessary, or would take different forms, if engineering was regarded as a high-prestige area of study. School students, and others, report that engineering, and the work of engineers is 'invisible' to them; similar findings have been reported in a recent quantitative UK study.

This apparent invisibility is likely to contribute to the low level of participation in engineering at university. In 2006, DEST reported that only 5.15 per cent of students commencing higher education entered engineering and related studies. Countries such as Finland and Korea report engineering participation rates more than double the Australian figure.

Students also report that engineering has the reputation of being a hard study area, and one in which the (long-term) career returns are not likely to match others, such as medicine, law or business. Setting the qualifying cut-off tertiary entrance rank for engineering lower than that of those disciplines, as many universities do in order to meet place quotas, may also deter some of the best students.

This is offset by many highly qualified school leavers taking engineering in degree combinations with these disciplines. That many engineering students also express the intention to move into 'management' early in their careers also raises further concern about the medium-term health of engineering as a strongly technically oriented discipline, as surely it must remain.

But herein also lies an opportunity for many of Australia's engineering-educated business leaders to be public advocates for their core discipline and the values of an engineering degree to business in general.

The project is therefore exploring several key issues.

The requirements of tomorrow's engineers

1 Great diversity: some future professional engineers may work in advanced engineering science and technologies, others may manage advanced and complex systems. Engineering technologists may be component specialists, or be responsible for systems operation/maintenance. Most will need to be effective project managers. Graduates need to possess fundamentals and contemporary knowledge and be effective lifelong learners.

Fundamental knowledge requirements

2 Engineering programs naturally possess many desirable generic graduate attributes, but we need to express much more clearly the key elements of engineering. A possible list for professional engineers includes: mathematical modelling, engineering design (as constrained creativity), systems integration, understanding uncertainty (of various kinds), logistics and project management. New educational program structures and employment patterns may be needed to accommodate the diversity of occupational needs more effectively than they do at present, while giving students flexibility to choose their study and career entry pathways.

Resourcing these needs

3 Academic staff and laboratories will need to be deployed more collaboratively between universities and use advanced information technology increasingly more effectively. Laboratories and design spaces must be equipped with modern instrumentation and relate to real practice environments. Industry must provide more 'mutual benefit' support to universities. The educational roles of academic staff will need strong developmental support to meet the demanding needs of contemporary students and the changing requirements of industry.

Undoubtedly, engineering educators must work more closely with science and mathematics teachers in schools and curriculum reform to demonstrate the excitement and creativity of science and engineering, to increase the population of school students with the required aptitudes and knowledge.

A concerted effort, engaging all of the stakeholders of engineering in business and government, will be needed to raise public understanding of the importance of engineering to Australia's future.

1 Institution of Engineers (1996), *Changing the Culture: Engineering Education into the Future*, Institution of Engineers, Australia, ACT
2 National Academy of Engineering (2005), *Educating the Engineer of 2020*, National Academies Press, Washington DC.
3 Royal Academy of Engineering (2007), *Educating Engineers for the 21st century*, RAE, London
4 *Public Attitudes to and Perceptions of Engineering and Engineers 2007*, a study commissioned by The Royal Academy of Engineering and the Engineering and Technology Board, UK. See www.raeng.org.uk.

EMERITUS PROFESSOR ROBIN KING was Pro-Vice-Chancellor of the University of SA's Division of Information Technology, Engineering and the Environment from 1998 to his retirement in March 2007. Now he is managing the Carrick Institute-funded project on the supply and quality of engineering graduates on behalf of the Australian Council of Engineering Deans. He is a Fellow of Engineers Australia and of the UK Institution of Engineering and Technology, Chair of the Accreditation Board of Engineers Australia, and a Board member of the CRC for Integrated Engineering Asset Management and the International Centre of Excellence in Water Resources Management.

MARY O'KANE FTSE is a company director and a specialist in high-technology commercialisation, national and international research strategy and higher education policy. She is Executive Chairman of Mary O'Kane & Associates Pty Ltd, which advises governments, universities and the private sector on innovation, research, education and development. Professor O'Kane was Vice-Chancellor and President of the University of Adelaide from 1996 to 2001 and Deputy Vice-Chancellor (Research) from 1994 to 1996. She was also Professor of Electrical and Electronic Engineering at the university.

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Recognising and rewarding excellence in STEM education at all levels

3 A wide range of prizes already exist for students or teachers who excel in STEM, but ATSE could have an impact by focusing on rewards at the whole-of-school level. For example, in each state ATSE could institute an annual award for the school with the highest number of students progressing to post-secondary STEM study.

Increasing the visibility and appeal of careers in science and engineering

4 It is clear from national and international research that careers in STEM are not consistently attractive to young people, with the current exception of engineering, where labour-market demand and remuneration levels are relatively high. There is also a prevailing view among some STEM researchers and practitioners that students are not choosing STEM studies and careers because they lack real knowledge of them and/or are uninspired by the knowledge they do have. Fellows lament that today's students are not inspired by STEM studies in the way they themselves were as students. Changing student and community attitudes about STEM is not an area where the Academy can act alone. However, it could work with professional organisations to produce materials and presentations that convey information not only about careers in science and engineering, but also about the fact that such careers are enjoyable, rewarding and vital to the wellbeing of modern societies and economies.

Prioritisation is imperative

There are many possibilities for ATSE in education, and further discussion of and prioritisation of these is imperative. There is also a need to recognise that individual Fellows are already part of relevant initiatives through their professional associations or through activities at state level – such as science councils, working parties, projects and reviews – and that the key to a coherent national contribution from ATSE may well be an effective internal communication strategy to integrate activities of relevant professional associations, ATSE State Divisions and, in many cases, individual Fellows.

An important role for each of the Academy's topic forums will be to ensure that this kind of communication takes place. ◄

EMERITUS PROFESSOR LESLEY PARKER AM FTSE graduated with a BSc, BEd and PhD. Her career has included leadership, research, teaching and policy in all sectors of education, at state, national and international levels. Most recently she was Senior Deputy Vice-Chancellor of Curtin University of Technology (1997 to 2004) and Inaugural Director of the national Carrick Institute of Learning and Teaching in Higher Education (2005-06). At present, while maintaining a commitment to science and mathematics education at Curtin University, she is also working on educational projects in Australia and overseas.

Maths matters

Reversing the decline in the number of students taking mathematics at senior secondary level is the concern of a number of recent reviews

By Kaye Basford
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As my initial university degree was a BSc with First Class Honours in mathematics, it is not surprising that I believe the discipline of mathematics matters. I would even go so far as to say that it is a crucial foundation for almost all careers in science, engineering and technology. A couple of fairly influential people have similar views:

Every advanced industrial country knows that falling behind in science and mathematics means falling behind in commerce and prosperity.

– UK Chancellor of the Exchequer Gordon Brown, Budget speech, March 2006.

In this ever more competitive global economy, Australia's science, engineering and technology skills need to match the best in the world.

– Prime Minister John Howard, speech in Sydney, September 2006.

These quotes are on the back cover of *Mathematics and Statistics: Critical Skills for Australia's Future, the National Strategic Review of Mathematical Sciences Research in Australia.*[1] It was commissioned by the Australian Academy of Science and launched in December 2006. I was a member of the Advisory Council for that review because I was then President of the Statistical Society of Australia Inc., which had commissioned the December 2005 Review of Statistics at Australian Universities.[2]

Unfortunately, young people today do not share the view that mathematics is important. In an analysis of participation in Year 12 mathematics across Australia from 1995 to 2004, Frank Barrington[3] found that although the overall proportion of mathematics enrolments had been maintained, there had been a net loss of students taking intermediate and advanced options in which higher-level skills were taught. He inferred that "this impacts on the ability of students to undertake tertiary studies in the quantitative sciences, and for the national capacity for innovation in engineering and technology".

What has contributed to this net decline in take-up?

Secondary school students are increasingly told to take subjects in their senior years that they like or are likely to do well in. This trend is sustained by a belief that, under those circumstances, students will score well in the Equivalent National Tertiary Entrance Rank (or other tertiary entrance scores) and hence be afforded the opportunity to undertake tertiary studies.

Universities have probably contributed to this viewpoint by discarding advanced or even intermediate mathematics as prerequisites for entry into certain programs. Students can study intermediate and/or advanced mathematics at university (if they have not passed these subjects at Year 12 level) and, on successful completion, receive credit for them as electives within a particular program.

This process is viewed by some academics as 'dumbing down' science, engineering and technology programs, as it means that more advanced disciplinary courses are displaced. Others see it as an educational advantage by enabling students to make decisions at a later stage in their development, rather than during their mid-teens. It fits quite comfortably with the concept of one's first university degree being somewhat general, but followed by a two-year focused masters program (such as in the University of Melbourne's new model).

In any case, the declining take-up of intermediate and advanced mathematics at senior secondary school level seems to be an inevitable outcome of current subject selection practices in secondary and tertiary education. To one who regards mathematics as a central pillar of scientific endeavour, this outcome is concerning. My apprehension is shared by many in business, industry and government. Two key recommendations from the mathematical sciences review[1] address the challenge of reversing this decline:

- ensure that all mathematics teachers in Australian schools have appropriate training in the disciplines of mathematics and statistics to the highest international standards; and

- encourage greater numbers of high school students to study intermediate and advanced mathematics.

Perhaps the best way to achieve the second outcome would be to promote the vast and increasing range of rewarding careers available to those who obtain some training in mathematics and statistics. Their pervasiveness is not well understood by the community – just about every area of employment depends at some point on handling and interpreting data, and on predicting and modelling outcomes.[4] Jobs requiring analytical skills are advertised in areas ranging from finance and commerce to the natural sciences and engineering. More specifically, undertaking mathematics in the senior school years opens up science, engineering and technology as possible career paths.

The other key recommendations from the mathematical sciences review were:

- significantly increase the number of university graduates with appropriate mathematical and statistical training;
- broaden the mathematical sciences research base; and
- identify, anticipate and meet industry needs for a pool of tertiary-trained expert mathematicians and statisticians.

If all five recommendations were accepted and enacted, we would be able to build a critical mass of research, education, industry and government interaction, and ensure we maintained our technical and problem-solving capability, particularly in science, engineering and technology. We could also improve the percentage of university graduates with a mathematics or statistics major from the current 0.5 per cent a year to at least the OECD average of 1 per cent.[1]

I believe these reviews[1,2] have contributed to a major change in the way mathematics and statistics are viewed by those in the Federal Government. The last Budget greatly improved the state of mathematical sciences in Australia. The disciplinary areas of mathematics and statistics are now in a higher funding band shared with computer science, with an increase of about 50 per cent in financial support per student. This is an excellent outcome that will have a big effect on relevant academics, with resulting benefits for their students.

Unfortunately, there does not appear to be a corresponding change in the way state governments view tertiary education in comparison with vocational education and training (VET), where skilled-labour shortages have been evident for some years.

In Queensland, for instance, where the government has supported higher education through its Smart State Strategy, a recent discussion paper, entitled 'Towards a 10-year plan for science, technology, engineering and mathematics (STEM) education and skills in Queensland', identified some areas of concern in professional/tertiary STEM training. However, the Queensland Government does not seem to be as proactive in addressing these issues as it is for those in the VET sector, where it is clearly very active.

Even though university education is primarily a Federal Government concern, state governments must also commit resources to encourage secondary school students to consider STEM training at tertiary level. This should happen now. Employers have already stated that they have not been able to source graduates within Australia in the enabling mathematical sciences[1], as illustrated by the following:

Over the past few years it has been difficult for us to recruit top-class graduates in specific areas of the mathematical sciences from Australian universities. We have sought to recruit operations research and optimisation specialists from the US and Europe because of the difficulty of recruiting [them] ... within Australia.

– BHP Billiton questionnaire submitted to the National Strategic Review of Mathematical Sciences Research in Australia, 2006.

I will close on a positive note. Any mathematical training is going to be useful, whether that be for everyday life or for career choices. Intermediate and advanced mathematical skills are essential if you want any sort of career in science, engineering or technology.

These analytical skills can be obtained at secondary school or university, but the earlier they are learnt the more advantaged the logical reasoning and problem-solving skills will be in other disciplinary areas.

Mathematics does matter!

1 Australian Academy of Science, 2006, *Mathematics and Statistics: Critical Skills for Australia's Future*
2 Statistical Society of Australia Inc., 2005, *Statistics at Australian Universities*
3 Barrington F, 2006, *Participation in Year 12 mathematics across Australia 1995-2004*, ICE-EM Publications in Education
4 International Centre of Excellence for Education in Mathematics, 2006, *Maths ad(d)s: A guide for students to the job market 2006/07*

KAYE BASFORD FTSE is Head of the University of Queensland's School of Land, Crop and Food Sciences, a multi-disciplinary cross-campus school focused on agricultural, environmental and food sciences. She is immediate Past President of the Statistical Society of Australia Inc. As Professor of Biometry, her teaching and research is at the forefront of statistics and quantitative genetics through the development and dissemination of appropriate methodology for the analysis and interpretation of genotypic adaptation in large-scale plant breeding trials. Her awards include the 1998 Medal of Agriculture from the Australian Institute of Agricultural Science and Technology and a 1986 Fulbright Postdoctoral Fellowship to Cornell University.

The future of schooling from a STEM perspective

Increasing numbers of students find maths and science too hard or irrelevant – how can a national curriculum help reverse this trend?

By David Beanland
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National goals for schooling in the 21st century[1] were jointly agreed by the Commonwealth, states and territories in 1999 and, over the past year, a steering committee appointed by the Council for the Australian Federation (CAF) (which comprises the premiers and chief ministers of all states and territories) has been reviewing these goals with a view to refining them.

The steering committee's report[2] has been adopted by CAF, endorsed by state and territory ministers for education, and supported by the Catholic and independent schools authorities subject to the endorsement of the Commonwealth. It is yet to be considered by the Ministerial Council on Education, Employment, Training and Youth Affairs, the all-government forum of education ministers.

The report first addresses the effectiveness of school education in Australia and uses in its considerations the international benchmarking undertaken regularly by the OECD's Program for International Student Assessment. This compares the performance of a sample of 15-year-olds in reading, science, mathematics and problem solving in about 40 countries. Australian students rank relatively well on the basis of the mean performance of students in these assessments: 4th in reading, 11th in mathematics, 6th in science and 8th in problem solving.

The review process concluded that:

- Australia's overall education standards compare fairly well on an international basis, but the aim should be to perform better;
- the relatively competitive position of Australian schooling will not be maintained without improvement;
- the main area of poor performance is among students from the lower socio-economic groups;
- student performance is relatively independent of school type when the correlation with socio-economic background is also considered; and
- the percentage of students progressing to Year 12, or equivalent – relatively low in Australia (below 80 per cent) and of concern as many unemployed peoople come from the group who do not progress – has been relatively static for the past 15 years.

The states are keen to focus additional resources on supporting the education of students from the lower socio-economic groups, because improvement there is considered to be the most efficient way of lifting Australia's overall performance.

On national curriculum goals, the review group concluded that:

- more than ever, education is recognised as an investment crucial to securing Australia's future economic prosperity and meeting changing workforce demands;
- young people need the right skills and knowledge to thrive in an information-rich world;
- information is critical to understand and address emerging environmental challenges;
- education can promote social cohesion by giving students the skills to relate their own values with the experience of others;
- education is a critical driver for delivering equality of opportunity in society; and
- while responding to these increased economic and social demands, education remains an important contributor to the spiritual, moral, cultural and physical development of young people.

Taking these issues into account, the review report suggested modifications to a national curriculum, although the proposal for such in the report is no more than a skeletal overview of the fields to be studied. These are: English; mathematics and science (including physics, chemistry and biology); languages; humanities and social sciences (history, geography, economics); the arts (performing and visual); health and physical education; and cross-disciplinary 21st century learning areas (technology, including ICT and design, civics and citizenship, and business).

To influence the detail of the curriculum, ATSE and others with an interest in the outcome will need to interact with the taskforces involved in its realisation.

What are the most important changes required in a revised curriculum? The most obvious problem to address is that the school system is not producing sufficient students who are interested in proceeding into science, technology and engineering (STEM) programs at university and TAFE. Students rule out the possibility of a career in these fields by choosing to drop the prerequisite subjects when this becomes an option from Year 10 onwards.

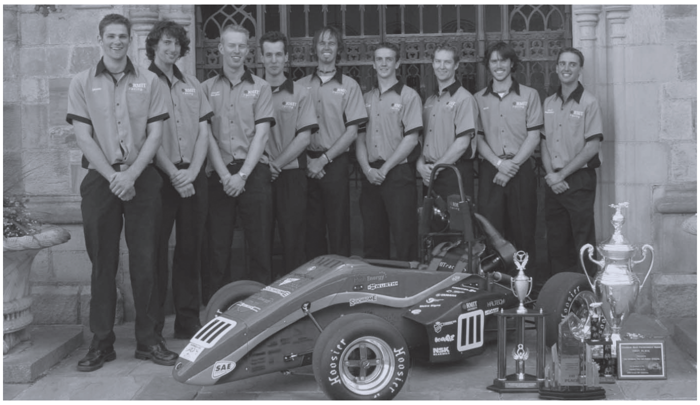
This problem is not unique to Australia; it is evident in many western countries. This disaffection of senior high school students with science and mathematics obviously has several causes that need to be analysed carefully if the trend is to be reversed. (Participation in science and technology programs at Year 12 level fell from 19.1 per cent in 1993 to 15.4 per cent in 2003.) The starting point is that the approach to science and mathematics is not perceived to be relevant or interesting by the majority of students, which indicates that it fails the test of being useful to know or of being essential for an attractive career.

The traditional curriculum approach to science and mathematics emphasises the ordered development of content and understanding through the exploration of more complex and detailed topics. Although this approach suits some students, and we are fortunate that many excellent students complete their studies with distinction, an increasing number find the challenge of these subjects too hard or irrelevant and choose an alternative.

Another key factor is that the school environment does not provide strong advocacy for STEM. Very few teachers have studied science or mathematics to a level at which they could be considered to have competency in these disciplines. Many who teach these subjects have an inadequate preparation. Consequently they are unable to provide an adequate context for the subject and do not elicit a very high level of student commitment.

The shortage of appropriately qualified and trained teachers in science and technology has been with us for more than 50 years. It is time that addressing this deficiency became a national priority in education. The strategy of giving non-scientific teachers an introduction to science and mathematics, sufficient to teach a syllabus, is clearly inappropriate and ineffective. The achievement of a relevance that can produce motivation in students cannot be achieved without teachers who are familiar with and committed to these disciplines. Although there are exceptions, the current social and philosophical factors in schools will often produce a demotivating environment for STEM.

There is no doubt that science, technology and mathematics education in schools urgently requires fundamental change in the area of achieving effective learning and student commitment through experiential learning. The detailed knowledge acquired is now far less important than the development of the abilities to analyse problems, learn independently, find information, think consistently, understand interactions, draw conclusions and present results.



Making it applicable – relevant projects create exciting learning opportunities.

The use of creative hands-on projects to establish interest and relevance, such as is proposed by ATSE's STELR project[3] is a good demonstration of a realistic new approach to learning. It needs to be supported by the provision of qualified teachers, investment in laboratory equipment, use of e-learning, and the development of new curriculum materials for staff and students.

If this problem is not addressed, the community will suffer even greater shortages of scientists, engineers and technologists and will have increasing difficulty in establishing informed discussion about the technological issues affecting our future.

1 *Common and agreed national goals for schooling in Australia*, (AEC) 1989. www.mceetya.edu.au/mceetya/default.as?id==11577
2 *The Future of Schooling in Australia*, (Federalist Paper 2) September 2007, www.education.vic.gov.au?futureofschooling
3 Science and Technology Education Levering Relevance (STELR), ATSE July 2007

EMERITUS PROFESSOR DAVID BEANLAND AO FTSE is an electronic engineer who spent most of his career at RMIT until retiring as Vice-Chancellor. He is a member of the DEST committee advising on major research infrastructure, a consultant to universities and vocational institutions in Vietnam, and an adviser to East Timor in relation to human resources development.

Education shortcomings limit opportunities

Can Australia create the leadership, foster the skills culture and mobilise the energy to really address STEM shortages?

By David Hind
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It is certainly not new news that Australia has a shortage of scientists, technologists, engineers and mathematicians. There is also a shortage of school, vocational and higher education teachers and students of these disciplines. The causes are no surprise: a strongly growing economy, underinvestment in education, particularly over the past decade, and a perception of relative unattractiveness of these disciplines as courses of study and as the basis for employment and career opportunities.

The effect of these shortages is to restrict the nation's ability to solve many of its societal problems, threaten competitiveness and limit the ability to create future wealth.

Despite Australia being well aware of the science, technology, engineering and mathematics (STEM) skills shortages, business and political response so far has been less than comprehensive. As a short-term measure there has been a very large increase in skilled migration and the use of temporary employment visas, and in the past 12 months re-investment has begun in vocational and higher education.

Many initiatives have been put in place to reassert the importance of STEM at the individual institution, enterprise and school levels. The decision by the Academy to make education one of its four priority forums is one welcome example and provides the Academy with the opportunity to reawaken public and political interest. But a broadly based intellectual and financial reinvestment in STEM is unlikely to happen in isolation from a recommitment to investment in higher and vocational education more broadly.

As an important step in identifying the quantum and operating model for re-investment, we should take the opportunity to briefly reassess Australia's skills needs for the future.

In November 2005, the Business Higher Education Round Table (BHERT), of which I am President, hosted a summit on Emerging Skills 2020 and Beyond (the papers are at www.bhert.com). The key themes presented a strong case that 'more of the same with fine tuning' will not provide adequate preparation for the challenges and opportunities of the future.

- More than 85 per cent of jobs in a competitive future Australia will require post-secondary education, but less than half the current working population studied beyond Years 9 and 10. "All workers are (and will be) knowledge workers."
- More than 90 per cent of school leavers will need to complete Year 12 or equivalent, yet the figure has been stuck at 75 per cent for a decade.
- We need Australians to have the skills to work longer in life and have the flexibility to change careers. Within a career, deeper and more specialist skills will be required. Many skills cross several industries with convergence of technologies and operating systems.
- In addition to the 'core' academic content of disciplines, employees need to be skilled in safety, customer service, innovation and creativity, and have broader horizons beyond just the economic and shareholder value aspects of work, important as they are. The concept of 'learning ecologies' was described, recognising that the future will not be about 'work/life balance', but the interconnectedness of all aspects of people's lives and their place within a global society and local communities.
- Workplaces will be more flexible, utilising opportunities provided by the continuing IT revolution.
- A critical mass of people with STEM skills and knowledge will be a key factor for the future.

Let us look briefly at where we are, how we got there, the size of the gap and the feasibility of closing it.

By global standards, Australia is recognised as having a reasonably good education research and teaching platform. We have examples of global excellence and are relatively free of poor facilities and highly marginalised communities, except for Indigenous Australians. Literacy and numeracy is high by world standards at the upper levels of competence, although we do have a long tail. Australia's provision of preschool education is at the lowest level in the OECD. Schools have seen a big funding and population shift from public to private, with underinvestment in a public system that still has between 65 and 70 per cent of the nation's students.

Since the innovation of the early 1990s, our vocational education and training (VET) system has an operating model that is being copied by several countries, but has been starved of funds. VET has been regarded as the 'second-class' education pathway, in contrast to the culture in several of our competing and benchmark countries.

Depending on the global index used, Australia has two or three universities in the top 100 and all our universities provide good education. But investment in higher education has been on a plateau over the past decade and, alone in the OECD, public investment in higher education as a proportion of GDP has dropped. As a result, student/staff ratios have increased by more than 50 per cent and universities have become too reliant on HECS fees and international student income, resulting in serious threats to quality.

Rather than advocacy, recognition of outcomes and encouragement, the political debate has an overemphasis on managerialism and ideology, combined with insufficient engagement from the business community.

In 2003, BHERT produced a publication, *Leading Edge*, that described many areas of public-sector research excellence. Australia's Cooperative Research Centres (CRCs) are globally recognised and provide high returns on the dollars invested, but are under constant managerial review for survival and have limited funding horizons. Our overall R&D financial commitment is low by world standards (about 1.7 per cent of GDP compared with three per cent for leading countries). Although there would be merit in focusing additional resources in developing one or two of our universities into the world's top 10 or 20, *Leading Edge* output suggests there may be more merit in targeting innovation and creativity across a focused range of societal problems and economic opportunities.

The gap between the STEM higher and vocational-education systems we have and what we need and can afford is large, but Australia can close the gap if it wants to. As a precondition, education, creativity and innovation will need to gain a new level of public respect, attracting and justifying the required increased intellectual and financial investment by government, businesses and philanthropists.

Common features of previous successful changes in Australia and other countries would (when translated into a resurgence in STEM) consist of:

- forceful and sustained leadership at the political and government level – this includes a combination of a compelling 'business case', clarity of direction, an investment surge and a range of individual and enterprise incentives. In today's world, this is only likely to be electorally sustained when combined with very visible leadership, advocacy and 'skin the game' from a range of stakeholders, including industry;
- a greatly heightened skills culture within enterprises;
- dynamic leadership, combined with financial 'headspace' to implement change, at educational institutions; and
- high levels of collaboration between industry, schools, higher and vocational educational institutions, and government.

When these factors have been evident, Australia has a history of implementing great change. Just two examples would be the nation's improved sporting results following the perceived debacle at the 1976 Montreal Olympics, and the revitalisation of several industries that were pronounced to be in terminal decay in the 1970s.

Several other countries have substantially changed their educational direction, operating models and funding over the past decade. They include New Zealand, Singapore, Ireland, Finland and Denmark.

Many Australian universities and vocational education institutions are taking more ownership of their strategic direction and setting individual missions, recognising their current and future local community needs and leveraging the capabilities they have built up over decades. The Australian Technology Network of (five) universities provides specific focus in the STEM arena.

A large structural and conceptual step change is taking place in Tasmania ('Tasmania Tomorrow'), aimed at dramatically increasing Year 12, or equivalent, completion rates and the skill levels of mature-aged Tasmanians, leading to improved individual opportunity and a step-change in productivity. Some of the Year 11 and 12 secondary colleges will become 'academies'. A 'polytechnic' will be created to cover the range from Year 11 to advanced diploma, with articulation options to and

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PhD DECLINE A RISK TO AUSTRALIA'S FUTURE

Australia is not producing enough highly skilled graduates to sustain economic growth, nor enough new researchers to replace those leaving the workforce, let alone expanding the nation's capacity to meet the challenges of the future, according to the Group of Eight universities (Go8).

"Australia's productivity and competitiveness requires a reversal of these trends," says Professor Ian Chubb, ANU Vice-Chancellor, on behalf of the Go8. "At the current rate, Australia will not be able to supply even half the future requirement of PhD graduates for high-end knowledge skills.

"In the middle of Australia's mining boom, only 65 Australian students commenced a PhD in geology last year. And, at a time when the world is facing unprecedented environmental stresses, a mere 53 new PhD students are undertaking environmental studies. Overall, the number of Australian students starting higher degrees by research fell by 30 per cent from 1995 to 2006.

"As the Australian economy becomes more knowledge-based, an increasing proportion of research degree graduates (73 per cent in 2006) are working outside the academic sector, many in innovating enterprises. Government and industry investment in research and development has grown in recent years, in part stimulated by the Backing Australia's Ability initiatives I and II. Yet Australia's proportion of doctoral graduates in the workforce is slipping behind our competitors."

Professor Chubb says that over the next decade some 40 per cent of the academic workforce will either retire or move into other jobs. He says training new researchers, through their PhD and postdoctoral studies, take seven to 10 years, which means urgent action is required to provide teaching and research capacity for the future.

Professor Chubb says Australia must increase the availability of scholarships to attract quality international PhD students: "We are turning away hundreds of good international applicants because we can only go so far in finding funds for them without weakening our research capacity. International students made up only 19 per cent of PhD enrolments in 2005 compared with 22 per cent of enrolments in Bachelor degrees and 53 per cent in Masters degrees.

"In the US, almost half of all international graduate students, and two-thirds of foreign PhD students, are financed by scholarships or work in universities. By contrast, fewer than 25 per cent of international graduate students in Australia receive support from Australian sources."

Professor Chubb concludes: "The Go8 calls on the incoming Federal Government to boost the number of HECS-exempt domestic PhD places and allocate them on the basis of capacity to provide quality research training; expand the number and value of stipends for research students; extend support for early-career and mid-career researcher development; and initiate measures to attract quality international PhD students."

◀ FROM PAGE 15

from university and with strong linkages to graduate employment. A 'training enterprise' will deliver customised skills development to industry.

BHERT fosters collaboration between industry and academia through a combination of collaboration awards, seminars, meetings between industry, academia and ministers, position papers, and research projects on a variety of higher education issues. Examples include *Emerging Skills: 2020 and Beyond*, and *Tomorrow's Universities: the Need for Change in Australia*. The next seminar is scheduled for February 2008 on Building Tomorrow's Engineers. BHERT issued a 2007 election manifesto, *Closing the Gap*, giving a detailed academic/industry policy position.

Using role models – Dr James Moodie (centre), from CSIRO International – the ATSE WA Division's 2007 Eminent Speaker – talks to students attending his Perth public lecture.

Many examples of increasing business/academia collaboration exist in the STEM area, including the Warren Centre at the University of Sydney and the Industry Advisory Network at the University of Technology, Sydney. Fostering this kind of collaboration is another area where universities require financial headspace.

There are many examples of and ways for industry enterprises to collaborate with schools to expose students, parents and careers advisers to the world of STEM. This is particularly relevant during Years 8 to 10 to create a positive image and peer environment for STEM as an educational and career option. ATSE's STELR project to be launched in 2008 is a great example.

The record shows that Australia can dramatically increase the contribution of science, technology, engineering and mathematics. But can it now create the necessary leadership, develop the will to foster the skills culture, and mobilise the energy to embark on the step change in collaboration?

DAVID HIND FTSE is President of the Business Higher Education Round Table (BHERT) and was recently appointed Chair of Skills Tasmania, an independent statutory authority on skills development reporting to the Tasmanian Government. He is a director of Redkite, an organisation that provides practical support to families of children undergoing treatment for cancer. He was the final Chair of the Australian National Training Authority and in 2005 retired as managing director of Process Gas Solutions, South Pacific, part of the BOC Group. He previously held senior positions with the group in the UK, Thailand, Japan and Australia. David was a member of the Business Council of Australia from 1998 to 2005.

Technical skills: demand and supply issues

It is widely believed that Australia has a technical skills shortage, but major problems arise in assessing both demand and supply

By Peter Laver
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There is a widespread belief that Australia has inadequate numbers of people with technical skills. Shortages exist in many branches of science, engineering, mathematics and other technology areas, at all qualification levels. Furthermore the shortages are likely to get worse as the education and training systems are not yielding sufficient numbers of graduates and the past reliance on bridging the gaps through immigration becomes more difficult as competition for skilled migrants increases.

In March 2006, the Minister for Education, Science and Training released a report on a science, engineering and technology (SET) skills audit that attempted to determine the extent of Australia's current and likely future skills shortages. It concluded that the shortage was serious and would continue to grow, and outlined a range of research projects and other initiatives that were needed.

The problem encountered in the audit was that neither demand nor supply could be readily assessed; the error arising from subtracting one large and uncertain number from another can be quite considerable.

Demand factors

Traditionally, there have been a number of observable indicators that would lead to a conclusion that demand for skilled people was exceeding supply (see table).

In general, despite some contradictory indicators, there is enough evidence to support the thesis that there is a skills shortage but the extent varies considerably with discipline and location.

Part of the problem in assessing present and future demand is definition. Do SET skills (or more correctly STEM, as mathematics needs to be included) include groups such as medical and IT professionals, science teachers or technically trained government employees?

Even more of a problem is the changing patterns of trained people working in roles where their qualification is not essential or is not being used. Again, the numbers are unclear, but based on anecdotal evidence the situation could be summarised as essentially showing that by about the age of 50, about half the qualified people in the workforce are no longer directly using their qualifications. This is not to say that they derive no benefit from this background; ATSE welcomes more technically qualified people in all walks of life. The technology-unrelated category figures also include full-time mothers and early retirees.

Demand for skilled workers

INDICATOR	CURRENT SITUATION
Increased relative salaries	Apparent in some sectors and places, but generally only partly evident, particularly for less-experienced people
Increased job advertisements	Not strongly evident, although there may be an increasing number of jobs where direct recruitment is used
Increased migration demand	Strong growth, but some signs that high-quality trained people are becoming scarcer
Project delays	Some evidence in places, particularly in the resources sector
High turnover	Figures unclear, but do not appear to have increased greatly
Sub-optimal qualifications	Significant evidence apparent, with employers being increasingly prepared to train people on the job
Retirees defer/return	Growth of older 'contractors' – retirees return to their old jobs, sometimes on a part-time basis
Demand for higher education/TAFE places	Entry scores and enrolments increasing

Assessing future demand for skills requires predicting how this pattern of skills utilisation is likely to change. Assumptions also need to be made about how future industry trends (rates of growth of technological-intensive industry relative to rates of growth in technical productivity, for instance) will change the overall numbers and mix of skilled people required.

Means of managing future demand are available:

- providing better career structures and reward systems to retain skilled people in skilled jobs;
- less early-year specialisation to retain flexibility and maximise career options;
- mid-career development opportunities and retraining, both on and off the job;
- job redesign to make best use of skills; and
- greater efforts to retain women in the workforce.

Supply factors

It can be safely assumed that the rate of demand for skills will grow at least as fast as GDP. On present trends it is far from certain that this increase will be met, so some further actions are required to stimulate the supply of high quality and appropriately qualified people graduating from all forms of technical education and training.

The problem is complex but most commentators agree that the key steps include:

- more school students undertaking technology-oriented studies or at least ensuring a much higher proportion than at present choose subjects that expand their post-school study options;
- more – and more inspirational – teachers for STEM studies in all sectors, which will require examination of teacher training and development, career structures, in-service support and rewards;
- provision of professional development for technical employees and better support to assist career change, including moving into the teaching profession; and
- attracting more appropriately qualified school leavers into tertiary STEM studies.

In any school cohort there are inevitably two 'hard-core' groups: one, no matter what the quality of the resources provided, will pursue a technically oriented career; the other would never be inclined that way. Between these extremes are a large number of students for whom the school experience can be critical in determining whether, after leaving school, they will be interested in anything related to technology. This experience can include teachers, facilities, curriculum, pedagogy and the learning environment.

Possible initiatives to improve this school experience might include:

- supplementary funding for schools, based on their success in attracting students to tertiary STEM studies;
- provision of more meaningful and structured work experience;
- teachers with greater practical experience, including mature-age entry for STEM professionals into teaching; and
- greater curriculum relevance.

Both the Australian Academy of Science's Science by Doing and ATSE's STELR programs have been developed with the aim of providing greater relevance – teaching science in a practical context rather than as abstract principles.

Conclusion

Despite difficulties in assessing and predicting demand and supply for skilled technical people, there are a number of practical measures, some summarised in this article, that could well be adopted to reduce the risk of future skill shortages. Responsibility for these measures rests with governments, employers, educators and a broad range of sources of influence on students, including parents, the media and those – such as ATSE – who are already committed to the cause of advancing science, engineering, mathematics and technology in society.

This paper is derived from a presentation made at an APESMA-sponsored Skills Summit in Canberra in June 2007.

PETER LAVER AM FTSE is a metallurgical engineer who spent his working career with BHP companies, including senior roles in mining, steel, transport, research and external affairs. He has held several key positions, including Chancellor of Victoria University, Chairman of the Australian Building Codes Board, Chair of the National Board of Employment, Education and Training, and Chair of the Victorian Learning and Employment Skills Commission.

CRCs have impact at 'all levels' of education

The Cooperative Research Centres (CRC) program has made an "enormous contribution" toward combating the skills shortage in science, the CRC Association says in a fact sheet, *The Impact of Cooperative Research Centres on the Australian Education System'.*

It highlights programs that have been developed by CRCs not only at tertiary levels, but also at secondary and primary levels, and which encompass vocational training and wider education aimed at the general community.

The CRC Association's Chief Executive, Michael Hartmann, says the contribution of CRCs to education in Australia is normally associated with the postgraduate programs that are a core component of every CRC.

"This fact sheet highlights specific examples where CRCs have voluntarily gone beyond their brief and instigated initiatives that foster the development of our future science capacity throughout all levels of Australia's education system," Mr Hartmann says.

"Combating skills shortages is vital for the future prosperity of Australia, and no more so than in the field of science and innovation. The CRC program is a leading light not only in industry-focused applied science, but now also in the field of science education."

The fact sheet is available at the CRC Assocation website (www.crca.asn.au).

URBAN WATER PLANNING BELOW PAR, SAYS ATSE

Report addendum

The launch of *Urban water: review of water supply planning for Australia's non-metropolitan urban water utilities*, at the Sydney offices of Sinclair Knight Merz (SKM), was followed by a seminar with presentations on the report by its authors John Radcliffe and Rory Nathan, and Mr Stewart McLeod, Chair of the NSW Local Government Water Directorate and Director of Technical Services for Dubbo City Council. Mr McLeod said he felt certain aspects of the report made unjustified criticism of the NSW situation and pointed out a couple of minor errors of fact in the report. After discussion with Mr McLeod and review by the authors, ATSE has added a small addendum to printed copies of the report, as follows:

At the public launch of this report on 5 October 2007 it was noted that it contains a couple of minor errors, not material to its arguments, and that new information has become available since printing. These are detailed in an Addendum on the ATSE website, adjacent to the report, at: www.atse.org.au/index.php?sectionid=128.

Malcolm Turnbull under the media spotlight at the launch of ATSE's *Urban water* report.

There are serious gaps in water-supply planning in some parts of Australia that must be addressed if water supplies are to be adequately maintained in the face of uncertainties about future water availability and demand.

There is a variance between the quality of water planning in the different states and territories, with significant aspects of one or both of two key elements of water-supply planning – institutional support and technical rigour – largely absent in some states and territories.

These are key findings of a study by ATSE that reviewed water-supply planning by Australia's non-metropolitan urban water utilities. The study report provides a snapshot of the status of long-term urban-water-supply planning by these water utilities.

The urban water study report, *Urban water: review of water supply planning for Australia's non-metropolitan urban water utilities*, was launched in Sydney in October by the former Minister for the Environment and Water Resources, Malcolm Turnbull. The launch attracted considerable media attention with ATSE exposure on ABC and SBS television nationally.

Print coverage was achieved in *The Australian* and 20 regional newspapers in Queensland, NSW and Victoria, radio coverage on national, capital city and regional stations, and electronic coverage included ABC Online, The Age Online, AAP Newswire and Science Alert.

The report notes that maintaining a reliable urban water supply to more than six million residents outside of Australia's capital cities is important for the ongoing success and livelihood of those communities. The review emerged from concerns about the ability of water utilities in some regional urban centres to undertake adequate planning in the context of highly variable and changing supply and demand conditions.

The report highlights stark contrasts in the quality and extent of water-supply planning across Australia. It questions the efficacy of water utility institutional models operating in some states, and highlights those, such as in Victoria, operating effectively to achieve water-supply-planning outcomes.

It notes that no monitoring of progress by water utilities towards development of long-term water supply plans takes place in Queensland, while less than one-third of water utilities in NSW had commenced preparation of their water supply plan some two years after guidance had been made available to them by the NSW Government. NSW has a target of June 2008 for completion of its long-term water supply plans.

The report says the regulatory approach adopted in Victoria to ensure completion of water-supply plans in accordance with state guidelines was found to be more effective than the financial incentives offered in NSW and Queensland.

It notes that water-supply planning should be linked with energy and land-use planning decisions in an integrated manner, and points out that Australian states and territories typically do not give adequate consideration to uncertainty in their water-supply planning.

The report makes a number of recommendations related to water-supply planning in various states and territories, calls for a more uniform approach to ensure optimum water-supply planning and continuing review of the process.

The authors of the report were: Mr Brad Neal CPEng MIEAust, water resources planning Practice Leader with Sinclair Knight Merz (SKM); Dr John Radcliffe AM FTSE, an agricultural scientist, Commissioner of the National Water Commission, former Deputy Chief Executive of CSIRO, previous Director-General of Agriculture in SA, and a Murray–Darling Basin Commissioner; Professor Emeritus Tom McMahon FTSE, who is recognised nationally and internationally for his work in hydrology; and Dr Rory Nathan CPEng MIEAust, practice leader for hydrology with SKM and winner of the 2000 national Civil Engineer of the Year.

The project was funded by the Australian Research Council under the Linkage Learned Academies Special Projects program.

Urban water: review of water supply planning for Australia's non-metropolitan urban water utilities is available from the ATSE website (www.atse.org.au).

Engineers under the research spotlight

The UK's Royal Academy of Engineering (RAEng) and the Engineering and Technology Board (ETB) have recently published a report entitled *Public attitudes to and perceptions of engineering and engineers*.

This major piece of research provides a UK-representative picture of public perceptions, knowledge and views of engineering and engineers. In addition to providing a baseline measure of the public's knowledge and understanding of engineering, the study incorporated some interesting and creative methodologies to explore the drivers of engagement with engineering, and probed the reasons why 'mis-perceptions' of engineering are so common. The results provide valuable evidence to inform communication action plans and build engagement with society.

Key findings included:

- a widespread limited understanding of engineering was identified (among younger people, in particular) and was related to age, gender and socio-economic grouping;
- public perceptions show the profession to be more closely associated with fixing things/construction rather than innovation or as a driver for change;
- those with the highest awareness of engineering perceived the profession as a more creative and cerebral profession;
- engineering was perceived as making a good contribution to society and was said to be involved with several important issues; and
- drivers of engaging with engineering, including simplicity, the 'wow' factor, social relevance and potential to make an impact.

An electronic copy of the report is available at: www.raeng.org.uk/pa

UK Sainsbury Review urges a technology 'race to the top'

The *Sainsbury Review of Science and Innovation*, released in the UK in October, concludes that the UK is well placed to take advantage of the new markets opened up by globalisation. Conducted by Lord Sainsbury of Turville, the review examines the role of science and innovation in ensuring the UK remains competitive in an increasingly globalised economy.

The report says Britain has an extraordinary record of scientific discovery and a rapidly growing share of the world's high-technology manufacturing and knowledge-intensive services. The amount of knowledge transfer from British universities has increased substantially, as has the growth of exciting high-technology clusters around many of Britain's world-class research universities.

According to Lord Sainsbury, "The challenge is not to hide behind trade barriers or engage in a 'race to the bottom', but to invest in the future, in areas such as knowledge generation, innovation, education, re-training and technological infrastructure.

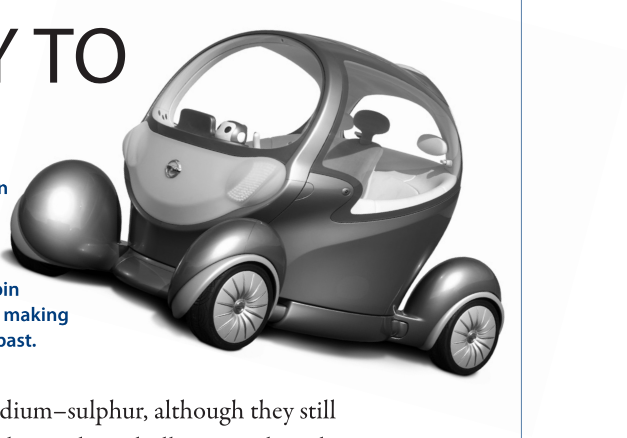
"Twenty-five years ago it would not have been possible to imagine the UK as a global leader in science and innovation in the world economy, but today it looks like an attainable goal. We can be one of the winners in 'the race to the top' but only if we run fast."

In response to the report, the British Government will invest £1 billion over the next three years to boost business innovation and technology development and will create a new science and innovation strategy, to help position Britain as a key knowledge economy at the forefront of 21st century innovation.

It will also implement new measures to further improve the teaching of science, technology, engineering and mathematics (STEM) subjects by boosting investments in the training of specialist science teachers, improving STEM careers advice and doubling the number of science and engineering school clubs.

The full report and associated media releases are online at: www.hm-treasury.gov.uk/independent_reviews/sainsbury_review/sainsbury_index.cfm

DO *PUTS* HOLD THE KEY TO URBAN TRANSPORT?



A new approach to urban transport: the Nissan Pivo II. Powered by lithium-ion batteries, it has a 360° rotating cabin and 90° rotating wheels, making reversing a thing of the past.

By Alek Samarin
asamarin@eng.uts.edu.au

The main disadvantages of public transport systems are the restrictions imposed on freedom of movement for their users travelling from outside the central and suburban business districts (CSBD). The use of a private motorcar provides a superior degree of freedom, with some restrictions on its parking location within the CSBD.

However, conventional petrol or diesel engine cars have been reported to be the main sources of urban air pollution in major Australian cities – pollutants such as carbon monoxide, oxides of nitrogen, sulphur dioxide, particles (up to 50 microns) and lead – as well as being considerable contributors to greenhouse gas emissions.

Some reductions in these emissions are possible either by improving the engine performance or by using alternative fuels (such as compressed natural gas, liquefied petroleum gas and hydrogen). However, the reductions are often only marginal and may come at a considerable cost. Improvements in the environmental impact of car emissions can also be made by introducing travel demand management (TDM) and the intelligent transport systems (ITS).

The most effective way of reducing pollutants is through use of electric vehicles (EVs), which are approximately 97 per cent cleaner than petrol-powered cars. Battery-powered cars were originally designed and produced in the late 1880s, and by the 1920s they competed favorably with petrol-fueled vehicles. However, as travel distances increased, the main drawback of an electric car – its capacity for storing sufficient energy in the battery – became apparent. While one kilogram of regular petrol stores some 11,860 watt-hours of energy, a conventional lead–acid battery can, at best, store about 44 watt-hours.

The revival of EVs in the 1960s, as a consequence of a sudden increase in the cost of petroleum-based fuels, led to the development of new types of batteries, specifically designed for the use in electric cars. Advanced batteries that show promise in this specific application include lithium–iron sulfide, zinc–chlorine, nickel metal hydride and sodium–sulphur, although they still suffer some drawbacks, such as bulkiness, relatively high expense and appreciably lower capacity of energy storage, in comparison with the petroleum-base fuels.

At present there is a substantial variety of commercially produced EVs, ranging from the modest Korean CT&T city-class electric car, to the American-made Commutercar Tango and, at the top of the range, the electric sports car Venturi Fetish, which sells for US$540,000 and can accelerate faster than most of the fastest conventional sports cars. The somewhat restricted range of even the most modern EVs compared with petroleum-based engines presents a significant limitation in the use of an electric car as a family or a general-use commercial vehicle. However, it is not a limitation if EVs are used as a private urban transportation system (PUTS).

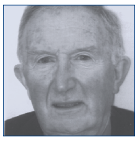
The concept of PUTS requires that a customer be sold not a car, but a service, consisting of a relatively large fleet of electric vehicles and a dozen or more strategically placed service stations for these cars, located in and around CBD and, in large cities, in the major suburban shopping centres.

The car can be a two-seater, "spartan" interior design which is easy to clean and maintain. An ubiquitous "smart" credit card and a computerised service would ensure that the first available electric car from any of the service stations in the network, already fully charged, serviced and cleaned, would be made available on demand to the card-holder. A credit could be provided for customers who recharged the batteries at home.

The service should be very attractive to customers, who currently drive conventional petroleum-fueled cars to CSBDs and incur a substantial cost in maintaining, running and parking their cars in and contribute extensively to the air pollution of CSBDs.

PROFESSOR ALEK SAMARIN FTSE is a private consultant and adviser in the development and implementation of the concepts of sustainable development. From 1980 to 1994 he was Director of Research at Boral Ltd and Professorial Fellow at the University of Wollongong, and was then was appointed Adjunct Professor with the Faculty of Science, University of Technology, Sydney (UTS). He is currently with the Centre for Built Infrastructure Research, Faculty of Engineering, at UTS.

Issues in nanotechnologies for Australia



By Greg Tegart
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The Australian Government in late 2005 created a National Nanotechnology Taskforce that produced a paper, 'Options for a National Nanotechnology Strategy', in November last year. As an input to the National Nanotechnology Strategy Taskforce, in early 2006 the National Academies Forum was contracted by the Department of Industry, Tourism and Resources to produce a report Environmental, Social, Legal and Ethical Aspects of the Development of Nanotechnologies in Australia *(which is available at www.naf.org.au/symposia). The report drew on the expertise of Fellows from the four Academies in workshops in Melbourne and Sydney and from discussions with other experts, and expressed its outcomes as a set of opinions to assist in developing guidelines for a National Nanotechnology Strategy.*

A report by the Prime Minister's Science, Engineering and Innovation Council (PMSEIC) in 2005 estimated that, in 2003, Australian governments and the private sector were spending about $100 million on nanotechnologies, with at least half coming from government sources.

This major R&D effort has developed strengths in nanoelectronics, nanobiotechnology, nanomedicine and nanomaterials. However, the PMSEIC report noted that Australia's research base was small by global standards and that there was a need to improve linkages between research and commercialisation and to increase industry awareness of the potential of nanotechnologies. It also noted that there were expressed concerns about safety and ethical issues associated with the production, use and disposal of nanoproducts.

Until the past five years there has been little debate about these issues in nanotechnologies in Australia, but this is changing. Thus there was recognition in the PMSEIC report of the need to consider the concerns relating to free nanoparticles generated in production and either intentionally or unintentionally released to the environment or actually delivered directly to individuals through the use of a nano-based product. Such concerns arise from the fact that the toxicology of nanoparticles cannot be deduced from that of the same matter at the macroscale.

This stems from two factors dependent on size: the larger surface/volume ratios leading to higher activity, and the potential for nanoparticles to penetrate cells more easily than larger particles.

Environmental aspects of nanotechnologies

There has been considerable debate overseas about the risks of nanotechnologies, particularly of nanoparticles and nanostructures, which are the same scale as cellular components and larger proteins. The suggestion has been made that they might evade the natural defences of humans and other species and damage cells.

Data from some animal studies indicate that inhaled free nanoparticles, particularly carbon nanotubes, can induce inflammation in the respiratory tract and can be transported through the bloodstream to other parts of the body resulting in cardiovascular and other effects on the lungs, brain and liver. An extensive literature is developing in this field and Australian researchers have formed a network called Nano Safe to coordinate their research in nanotoxicology.

In considering real risks in nanotechnologies the NAF report used a strategic framework based on the standard format of: risk = hazard x exposure.

The first step is to identify hazard by answering the question: 'Is there reason to believe that this process or substance could be harmful to humans or the environment?' The second is to characterise hazard by answering the question: 'How, and under what conditions, could it be harmful?' The third is to assess exposure by answering the question: 'How will people and the environment come into contact with this process or substance?' Only when these questions are answered is it possible to characterise risk.

The NAF report considered nanoelectronics and nanophotonics; nanobiotechnology; nanomedicine; and nanomaterials, and examined hazard and exposure to characterise real risk in each of these. It concluded that, in general, the existing regulations were adequate to allow development and application of these nanotechnologies to continue in Australia, but that regulations needed to be periodically reviewed as new nanomaterials were developed.

As a basis for continued risk management, there is a need for more detailed information on aspects of nanoparticle production, application and disposal; on toxicity of nanoparticles to humans when inhaled, ingested or applied to the skin; and on toxicity in the environment stemming from contamination of soils and water supplies. Further, there is a need for regulations to ensure safe disposal of products containing nanomaterials.

Social, legal and ethical aspects of nanotechnologies

Much of the debate about nanotechnologies and their development and use revolves around perceived risks. Such risks are contextual and depend on the existing social structure. Perceived risks relate to issues such as privacy and security of personal data, medical applications, military uses and terrorism, which could be exacerbated by developments in nanotechnologies.

To discuss perceived risks, the NAF report suggests using a format analogous to the real risks format – risk = hazard x outrage – where the outrage term captures the lack of trust that lay members of a society have in the professionals. Thus, a small hazard may generate a big outrage in a society and hence a high perceived risk.

Once a certain opinion has become established in a society it is extremely difficult to persuade people to the contrary view. Instead, it is easier from the outset for the public to realise that a new technology not only can solve problems but can also create them. Social and ethical concerns rarely arise as a result of the underlying science and technology. Rather they are associated with specific applications of technologies.

The NAF report examined a number of aspects where concerns have been expressed about specific applications of nanotechnologies such as medical aspects, privacy and personal data, legal issues, and military and terrorism issues. It concluded that there was a need for medical scientists and bioethicists in Australia to examine the benefits and risks associated with applications of nanomedicine with a view to enhancing the quality of health care, and for the potential security risks to Australia to be evaluated.

A better understanding of nanotechnologies at all levels of society is a critical factor in promoting better awareness and debate of these rapidly developing technologies.

Conclusion

If nanoproducts are perceived by Australians as potentially dangerous or life-threatening, rather than beneficial, then the development of nanotechnologies could be slowed or even halted.

There appears to be little concern in the Australian community at this stage, as shown in the results of a national survey of more than 1000 people in mid-2005, which was commissioned by a consortium put together by Nanotechnology Victoria. General awareness of nanotechnologies is low, but there is considerable optimism about medical advances enabled by nanotechnologies.

However, there is concern about fear of the unknown and of possible side-effects. Most people would like to know if the products that they buy involve nanotechnologies.

A better understanding of nanotechnologies at all levels of society is a critical factor in promoting better awareness and debate of these rapidly developing technologies. A number of Australian universities have introduced degree courses in nanotechnologies and the TAFE system in some states is moving to develop lower-level courses. Modules on nanotechnologies for senior grades are being introduced in Victorian schools. This is a rapidly developing field overseas and Australian educators need to track progress. ATSE will need to keep involved in monitoring developments.

Acknowledgements

The report was a joint project of the four academies and the strong support of the participating Fellows, of external experts and of the staff of the Australian Academy of Technological Sciences and Engineering is gratefully acknowledged.

PROFESSOR GREG TEGART AM FTSE retired from the Australian Public Service as Secretary of the Australian Science and Technology Council. Since then he has been a Visiting Professor of Science Policy at the University of Canberra and is currently a Professorial Research Fellow in the Centre for Strategic Economic Studies, Victoria University. He is also Chairman of the International Advisory Board of the APEC Centre for Technology Foresight in Bangkok.

Henzell's remarkable history of Australian agriculture

By Neil Inall
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It was the Christmas holidays in 1950 when I went to a school friend's sheep property at Crooble near Moree. It was an exciting time for me. I had a lot of fun chasing fly-blown sheep. It had been a very wet year – one of the wettest – and wool prices were at record levels, a bit like the rainfall figures.

But the boss taught me some lessons I have never forgotten. "They're mad," he said, "cutting good grazing blocks into 1000-acre places for fat lambs. Mad! Don't they realise it'll probably never rain like this again and wool prices won't stay high. Never have!"

Apart from this warning the boss also hated anyone who clear-felled valuable scrubland for cropping: "Ruins the soil", he said. I knew what he meant when years later I saw the severe erosion on the place next door, which had been completely cleared.

Ted Henzell's significant book, *Australian agriculture: its history and challenges*, highlights the consequences for Australia from the madder closer-settlement schemes and the over optimism of the post-war years when we deluded ourselves about our ability to feed the world. Even the postage stamps of the day entreated us to 'PRODUCE FOOD'. This promoted a mind-set that leaving almost any land undeveloped was a crime.

Henzell writes: "While the political justification for closer settlement was reasonably obvious, its social and economic effects were questionable. There was near universal tendency to go too far; to make the blocks too small to make a decent living."

Later he highlights the over-optimism of the day with these words: "An honest assessment of the limitations of the native pastures in northern Australia [an area Henzell knows intimately] would have required Australians to face up to deficiencies in natural resources of a large part of the continent. The early part of the 20th century was an era of proud and sometimes narrow-minded nationalism during which any such admission was often seen as downright disloyalty."

What is important is that Henzell knows very well what he is writing about. After all, he grew up on a farm in Queensland, was a graduate of the Universities of Queensland and Oxford, was director of what was CSIRO's second-largest institute (the Institute of Plant Production and Processing) from 1988–92, Chief of CSIRO's Division of Tropical Crops and Pastures for 10 years, and chairman of the Sugar Research and Development Corporation from 1992–95.

This work of Ted Henzell's is remarkable in a number of ways. First, the writing is clear, very clear – our thanks for that. Second, no one has written a history of grain crops, sheep and wool, beef and dairy products, working bullocks and horses, sugar cane, cotton, fruit and vegetables, and grapes and wine in one publication before. And his research (as we might expect) is amazing, going back to the origins of most of those industries in Great Britain and their influence here. The very long list of references will hopefully inspire other researchers to follow these leads.

What is disappointing for me is that there is no political or institutional intrigue, no scandals (although most of closer settlement fitted in that category) and no conflict. Aren't histories mostly about conflict?

Henzell is loud in his praise for the significant genetic advances in the wheat and dairy industries. He mentions that Australia had become the world's biggest beef exporter at the end of the 20th century and how its revitalised dairy industry was one of the success stories of the 1990s. I could quibble and say that there is not enough information about the success of the lamb industry in the 1990s and since.

However, he does not mention the part played in productivity improvements in most industries by a small army of extension worker – both public and private – the often very committed people who encouraged and guided hundreds of farmers with methods of increasing production, so helping them to stay ahead of the cost-price squeeze in the latter half of the 1990s.

And a history cannot ignore significant administrators, such as Walter Ives who headed the federal Department of Primary Industries and persuaded the Whitlam Government to establish the maximum-security Animal Health Laboratory at Geelong and to continue funding the highly successful BTEC program (the brucellosis and TB eradication scheme), putting the beef industry on such a healthy footing today. It also overlooks educators such as Bill McClymont at the University of New England, and Bruce Davidson at the University of Sydney, and – besides them – the long list of farmers who made it all happen.

Despite this I am fairly sure that no one has tackled the history of Australia's fruit and vegetable industries before. Henzell highlights the fact that "by the beginning of the 21st century 19 per cent of the nation's vegetables, 50 per cent of its fruit and nuts and 63 per cent of its grapes were being produced in the Murray and Murrumbidgee Irrigation Schemes." Sobering facts.

He adds this reality: "Imports pose a serious threat to the future of Australia's fruit and vegetable industries. Very little fresh produce has been allowed into Australia so far, but the question is will this situation continue indefinitely? Other countries can be expected to improve their ability to satisfy our (quarantine) requirements." (After all, the ATSE Crawford Fund has run workshops for scientists from developing countries to help them conform to Australia's quarantine rules).

Henzell says: "It would be consistent with this country's stance on free trade if we were to specialise in a more limited range of fruits and vegetables and not try to produce them all." He acknowledges that such a policy would be very difficult to implement. "Where would you start and, even more importantly, where would you stop?" he asks.

Henzell's book is entitled *Australian agriculture: its history and challenges* and he sounds a number of warnings about the future, which it is to be hoped that farmer/politicians will pursue. He says:

If Australian agriculture if to fulfil its future potential [he does not say what that is], farmers and graziers will have to remain as adept as they have been for most of their history in picking up new practices from all over the world and in coping with the vagaries of global markets.

Our scientists will have to continue to provide cutting-edge research applied to industry issues, including climate change and the many other challenges to Australian agriculture.

Dr Ted Henzell AO FTSE at the launch of his book, *Australian agriculture: its history and challenges*, in Melbourne. Destined to become a classic reference on the history of Australian agriculture, this CSIRO publication, financially supported by the ATSE Crawford Fund, highlights the lively history of agriculture in Australia and describes the major issues it faces as it enters the 21st century.

I am most concerned that governments may allow our world-class laboratories and their focus on industry problems, as well as agricultural courses in our universities, to fade away through lack of funds.

The latter situation is highlighted by the current sharp drop in enrolments in university courses around Australia – a real concern at a time when Australian agriculture faces massive restructuring again and the challenges Ted Henzell mentions. Henzell suggests that a substantial fall in R&D funding this century "would put the future of the increasingly research dependent agricultural sector at risk. The institutional arrangements are likely to be equally dependent."

Of course, a history of Australian agriculture has the potential to be dull, but Ted Henzell's tome has many fresh gems, such as his quote from the Australian National Dictionary of 1888 which recorded that, in the early days: "You must never refer to a grazier as a farmer. A farmer is a lower type of human" – a common attitude in the mid-1900s!

The author's favourite story is from WA, where Georgina Molloy – whose name has been made famous in recent times because of Janet West's play about her and the sale of Georgina wine – wrote to a friend in Scotland in 1833 saying: "the thistle seed never came up; please send me some more!" Wonderful innocence!

NEIL INALL, co-founder of the rural consultancy firm Cox Inall Communications, is best known for his work in rural radio and television and spends much of his time chairing agricultural forums, facilitating workshops, and speaking at conferences. He was Chair of the NSW Native Vegetation Advisory Council, a board member of NSW Forests and Rangelands Australia, and NSW state coordinator of Topcrop – the national extension program of the GRDC. In 1990 he won an IBM significant achievement award for presenting a series of videos about sustainable farming systems entitled *On borrowed time*.

SUSTAINABLE ENERGY 'ROAD MAP' – IAC REPORT

Many of the world's leading scientists, including those from major emerging economies, have set out a road map for a future of sustainable energy for all, highlighting the need for immediate action to meet basic global-energy requirements. This includes providing energy to the two billion people who are currently without it, and responding to growing environmental and energy security risks.

Lighting the way: toward a sustainable energy future, published by the InterAcademy Council (IAC), calls for greater energy efficiency, the development of renewable-energy technologies and carbon capture and storage, and a price to be put on carbon emissions by all governments.

The report also highlights the need for at least a doubling of private and public-sector investment in energy research and development.

"We face massive challenges on energy and it is now time to start addressing them," Martin Rees, President of the Royal Society said. "Some countries, including the UK, are making a little progress in areas such as investment in new technologies, but a sustainable energy future is not a problem that will be solved by individual countries. The stakes are high – the world spends trillions of dollars each year on energy. It is time more of that was invested in developing a sustainable future."

"Science and industry can help provide solutions, but it has to be within a framework put in place by governments, and it has to be supported by changes in the behaviour of individuals. There is unlikely to be a 'silver bullet' solution."

The main actions recommended in the report cover energy demand and supply solutions, and include:

- the transfer of appropriate technologies to the developing world to ensure that energy is delivered to those living without it;
- energy-efficiency standards to be applied to all new appliances and equipment and regularly updated;
- all governments to introduce a clear carbon price signal for reducing carbon emissions, promote investments in improved energy efficiency, and reduce or eliminate distorting subsidies (especially for fossil fuel consumption);
- technology improvements and infrastructure investments to tap the full potential of renewable energy resources;
- governments should facilitate the development of carbon capture and storage technologies by making funds available;
- carbon capture and storage should be installed in all new energy plants; and
- unlinking of profits from energy sales to encourage energy efficiency.

Lord Rees continued: "Science and industry can help provide solutions, but it has to be within a framework put in place by governments, and it has to be supported by changes in the behaviour of individuals. There is unlikely to be a 'silver bullet' solution. A sustainable energy future will require the investment of time and resources, an ability to learn from past mistakes and a willingness to cooperate internationally."

The InterAcademy Council (IAC)

The InterAcademy Council (IAC) produces reports on scientific, technological, and health issues related to the great global challenges of our time, providing knowledge and advice to national governments and international organisations. The 18-member IAC Board is composed of presidents of 15 academies of science and equivalent organisations — representing Brazil, Chile, China, France, Germany, Hungary, India, Iran, Japan, Malaysia, Turkey, the UK, and the US, plus the African Academy of Sciences and the Academy of Sciences for the Developing World (TWAS) – and representatives of the InterAcademy Panel (IAP) of scientific academies, the International Council of Academies of Engineering and Technological Sciences (CAETS), and the InterAcademy Medical Panel (IAMP) of medical academies.

AUSTRALIAN ACADEMY OF TECHNOLOGICAL SCIENCES AND ENGINEERING

ATSE IN FOCUS

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'Science Davos' in Kyoto

Academy President Professor Robin Batterham AO FREng FAA FTSE attended the Science and Technology in Society Forum in Kyoto in early October. The 600 leading scientists, policy makers, business executives and media leaders from 71 countries who attended gave the forum an air of a 'science Davos'.

The theme of the forum, the fourth held, was 'Harmony with Nature and Innovation'. Climate change and the need for a new international framework featured highly, as did energy, water and education.

Professor Batterham said the big question under discussion was how we might generate more economic resilience to encourage faster movement down the learning curve. He led one of the discussion groups at the forum and gave an opening address, which focused on the points below.

"The latest IPCC assessment is far more certain about the science behind climate change, particularly for greenhouse gases. It is highly likely that much of the observed recent rise is anthropogenic in nature. However, this assessment admits there are still some big questions surrounding clouds and aerosols, as well as the detail needed for regional predictions.

"My own take on all of this is that there are several tipping-point phenomena that could kick in much faster than is allowed in the current projections – for example, ice sheets slipping more rapidly into the oceans. These are large-risk, low-probability events with very dramatic impact. This all suggests to me that we need to move much faster both on mitigation and adaptation.

"The science and technology of adaptation still leaves many gaps, especially in the needs of urbanising populations. For example, do we spend the money on storm barrages for protection or desalination? We are unlikely to be able to do both.

"There is a mis-match between economic resilience and the rate that nature can change – a 2˚C change may wipe out 20 per cent of all known species; a 5˚C change, 80 per cent. This has happened in the past with drastic changes to biodiversity. What is our vulnerability – for the food chain, for health?

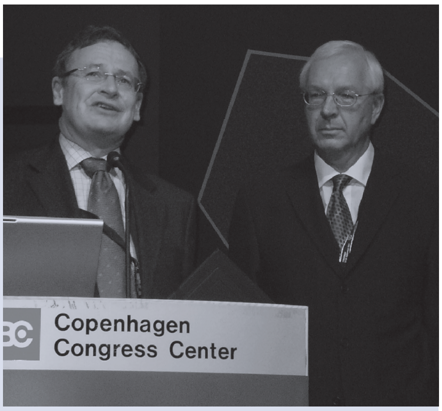
"We need a wedges approach: every which way, especially for major technologies. Nuclear, carbon capture and storage and geothermal will all be required, together with a list of other worthies.

"The current economics such as carbon trade/tax and clean development mechanisms, and large-scale demonstrations do not address the learning curves for major new technologies. The most significant cost reductions come when large, commercial-scale plants are built and operating experience is gained.

"Small-scale demonstrations, at a tenth or so of expected economic size, simply do not get us down the learning curve fast enough. Current economics such as carbon trade and tax, CDM and demonstrations don't get us in to the large-scale deployment of major new technologies.

"The more recent economic modelling suggests that the cost of inactivity far exceeds the cost of a proactive approach to adaptation and mitigation. It is my opinion that we simply do not have 20 years to slowly cruise down the learning curve of major new technologies."

The forum closing statement is at http://stsforum.org (go to (Press Room then Press Releases).



Honour for CEO

ATSE CEO Trevor Evans (left) responds after being presented with Honorary Membership of the European Federation of Chemical Engineering (EFCE) at the 6th European Congress of Chemical Engineering in Copenhagen. The award, relating to Trevor's former role at the Institution of Chemical Engineers (IChemE), was presented by EFCE President Jiri Drahos (right), a Vice-President of the Czech Academy of Science.

Award for Martin Green

Professor Martin Green FAA FTSE, Scientia Professor at the Centre for Photovoltaic Engineering, University of NSW, has been awarded the 2007 SolarWorld Einstein Award for his work in photovoltaics, developing new solar-power technologies.

Professor Green has been working for decades with great success on the development of new technologies in the field of solar-power technology and is the author of many books and publications in periodicals.


Martin Green

"Martin Green is an outstanding scientist who time and again shows us new horizons, and who has fundamentally advanced the photovoltaic science," said Dr Holger Neuhaus, head of research of the SolarWorld subsidiary, Deutsche Cell GmbH.

Industry leaders elected Fellows

Leading business, academic, research and government names are among the 31 new Fellows elected to the Australian Academy of Technological Sciences and Engineering for 2007. Leading business figures include Dr Zygmunt Switkowski FTSE, Chairman of ANSTO; Mr Graeme Liebelt FTSE, CEO and MD of Orica Ltd; Mr John Grill FTSE, CEO of WorleyParsons Ltd; and Dr John Baxter FTSE, Joint Managing Director, Bishop Innovation Ltd.

Other prominent names include Mr John Pizzey FTSE, Director of AMCOR Ltd, Iluka Resources Ltd; Dr Ian Gould FTSE, Chair of CSIRO Mineral Resources Sector Advisory Committee, Australian Institute of Marine Science (AIMS); Mr Ron Spithill FTSE, Director of Telecom New Zealand, Telecommunications Advisor at Macquarie Bank, and Chairman of Alcatel Australia; and Mr Chris Vonwiller FTSE, Director and CEO, Appen Ltd.

Mr Michael Taylor AO FTSE, Secretary of the Department of Transport and Regional Services; Dr Stephen Gumley FTSE, CEO of the Defence Materiel Organisation; Dr Peter Lilly FTSE, Chief of CSIRO Exploration and Mining; Dr Deborah Rathjen FTSE, CEO and MD of Bionomics Ltd; Dr Graeme Woodrow FTSE, Chief of CSIRO Molecular and Health Technologies; and Dr Christopher Nicol FTSE, chief technology officer for embedded systems, National ICT Australia (NICTA) were also among those elected.

The new Fellows (listed in alphabetical order) are:

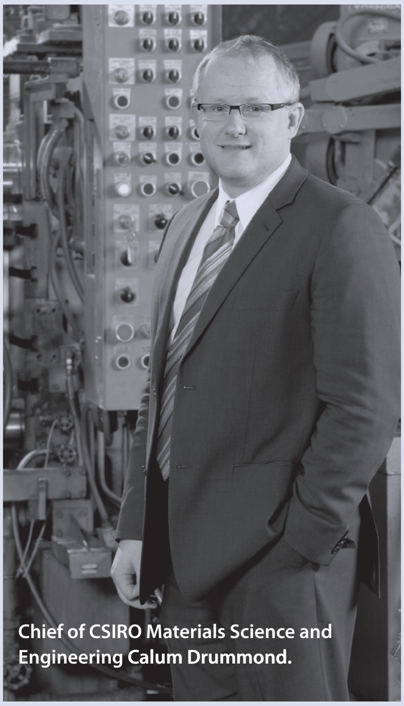
- NSW – **Dr John Baxter FTSE** Joint Managing Director, Bishop Innovation Ltd – for his brilliant engineering innovation and his record of successful conversion of ideas to high-value products.
- NSW – **Professor Mark Bradford FTSE** Director, Centre of Infrastructure Engineering and Safety, University of New South Wales – for his outstanding research and his published work on steel and composite engineering structures, which has had widespread practical application.
- Victoria – **Professor Xiao Dong CHEN FTSE** Chair of Biotechnology and Food Engineering; Professor of Chemical Engineering, Monash University – for his outstanding research and inventions and his application in benefiting the food and bio-processing industries in Australasia.
- Victoria – **Professor Yi-Bing CHENG FTSE** Professor of Materials Engineering, Monash University – for his major contributions through leadership in advanced-ceramics research and the development of new classes of advanced ceramic and composite materials.
- Queensland – **Professor Stuart Crozier FTSE** Professor and Director of Biomedical Engineering, University of Queensland; consultant, Magnetica Pty Ltd – for his distinguished contributions to research and innovative design of medical devices and imaging technology with national and international commercial outcomes.
- SA – **Professor Graeme Dandy FTSE** Professor of Civil and Environmental Engineering, co-convenor of the Water Research Cluster, University of Adelaide; Director, Optimatics Pty Ltd – for his international achievements in the development and commercial application of genetic algorithms and artificial intelligence techniques in water resources engineering.
- NSW – **Professor Neil Foster FTSE** Professor of Chemical Sciences and Engineering, University of NSW – for his technological advancement of nanoparticle and microparticle formation in super critical fluid solvents with particular application to the pharmaceutical industry.
- SA – **Dr Ian Gould FTSE** Chair of CSIRO Mineral Resources Sector Advisory Committee, Australian Institute of Marine Science (AIMS), South Australian Minerals and Petroleum Expert Group (SAMPEG) and Toro Energy Ltd – for his major impact on the minerals industry through innovative management and leadership and championing improved environmental practice.
- NSW – **Mr John Grill FTSE** CEO of WorleyParsons Ltd – for his contribution over more than 35 years to the development of WorleyParsons as a leading international engineering business and his contribution to the development of expertise in project delivery in the resources and energy industries.
- Victoria – **Dr Stephen Gumley FTSE** CEO of the Defence Materiel Organisation (DMO) – for his leadership of technological change in the aviation and defence industries for 20 years.
- Victoria – **Professor Anthony Guttmann FTSE** Director of the ARC Centre of Excellence for the Mathematics and Statistics of Complex Systems (MASCOS), Professor of Mathematics, University of Melbourne – for his outstanding research leadership and his substantial impact on practical applications for mathematics and on mathematics education.
- Victoria – **Mr Graeme Liebelt FTSE** CEO and MD of Orica Ltd – for his leadership of a global company and its innovation in explosives, chemicals, coatings and consumer products under leading brand names over nearly 20 years.
- WA – **Dr Peter Lilly FTSE** Chief of CSIRO Exploration and Mining – for his outstanding contributions to Australia's minerals sector through scientific research, research management, tertiary education, engineering consultancies and service to professional associations.

- Victoria – **Professor Arthur Lowery FTSE** Head of the Department of Electrical and Computer Systems Engineering, Monash University – for his successful research on computer-aided design of photonics for the global marketplace.
- NSW – **Professor Iain Mason FTSE** Professor of Geophysics, University of Sydney; Emeritus Professor, St John's College, Oxford; Director, Geomole Pty Ltd, Geosonde Pty Ltd – for his exceptional achievements as a scientist and engineer in creating novel instrumentation and software for earth resource imaging.
- Victoria – **Professor Colin Masters FAA FTSE** executive director, Mental Health Research Institute of Victoria (MHRI); Laureate Professor, School of Medicine, University of Melbourne; executive director, Prana Biotechnology Ltd – for his internationally acclaimed work in neuroscience, his discovery of the key molecular processes responsible for Alzheimer's Disease and his successful commercialisation of neuro-active pharmaceuticals.
- NSW – **Dr Christopher Nicol FTSE** chief technology officer for embedded systems, National ICT Australia (NICTA) – for his invention of widely used integrated circuit design techniques and his leadership in the development of pioneering mobile wireless products.
- Victoria – **Mr John Pizzey FTSE,** Director, AMCOR Ltd, Iluka Resources Ltd; former Chairman, London Metals Exchange; former Director, WMC Resources Ltd, Alcoa of Australia Ltd – for his leadership and service to the aluminium industry and international metals industry.
- SA – **Dr Deborah Rathjen FTSE** CEO and MD, Bionomics Ltd – for her substantial contribution to Australia's biotechnology sector as an inventor, commercial developer and entrepreneur, and her outstanding impact on the biotechnology industry.
- NSW – **Professor Veena Sahajwalla FTSE** Professor, School of Materials Science, University of NSW – for her achievements as an exceptional, innovative engineer with an established record of successful conversions of research to high-value products.
- Victoria – **Professor German Spangenberg FTSE** Research Director of Plant Genetics and Genomics, Director of Plant Biotechnology Centre, Victorian Department of Primary Industries; Adjunct Professor, Department of Botany, La Trobe University – for his inspiring and innovative research in agricultural biotechnology and as a world leader in pasture-plant genomics and gene technology.
- NSW – **Mr Ron Spithill FTSE** Director, Telecom New Zealand; Telecommunications Advisor, Macquarie Bank; Chairman, Alcatel Australia; Director, Alcatel Shanghai Bell, China – for his leadership of a global telecommunications company with outstanding success in Australia, Asia and Europe.
- Victoria – **Dr Zygmunt Switkowski FTSE** Chairman of ANSTO; former CEO, Telstra; Chair, Uranium Mining, Processing and Nuclear Energy Review (UMPNER) – for his achievements in the leadership in the telecommunications industry and his contribution to the field of nuclear science.
- Victoria – **Mr Michael Taylor AO FTSE** Secretary of the Department of Transport and Regional Services, Canberra since 2004 and previously the Secretary of the Department of Agriculture, Fisheries and Forestry (2000-04) – for his visionary and proactive leadership in applying science and technology in wide-ranging public policy areas for national benefit.
- Queensland – **Dr Kelly Thambimuthu FTSE** CEO, Centre for Low Emission Technology, Queensland Centre for Advanced Technologies (QCAT); Chair, International Energy Agency (IEA) – for his international leadership in clean-coal technology and his distinguished contributions to innovations in greenhouse gas abatement technologies
- NSW – **Professor Anh Kiet TIEU FTSE** Head of the School of Mechanical, Materials and Mechatronic Engineering, University of Wollongong – for his leading-edge research in tribology and rolling technology, which has won him an international reputation and the application of which has provided significant benefits to industry.
- NSW – **Mr Chris Vonwiller FTSE** Director and CEO, Appen Ltd; Deputy Chairman, Warren Centre; former Chairman, Pacific Telecommunications Council; Foundation Director, Intelsat Ltd – for his outstanding leadership in international telecommunications and advanced ICT, including the creation and introduction of Telstra BigPond.
- Victoria – **Dr Keith Watson FTSE** WEHI Fellow and Laboratory Head, Walter and Eliza Hall Institute of Medical Research – for his unique success in the conception and synthesis of commercially important bioactive molecules.
- Victoria – **Professor Andrew Wilks FTSE** Chief Science Officer, Cytopia Ltd – for his outstanding track record of innovative and practically oriented medical research, and commercialising his discoveries.
- ACT – **Dr Ian Williams FTSE** Senior Fellow, Research School of Earth Sciences at ANU and Chief Scientist, Australian Scientific Instruments Pty Ltd – for his contributions to the development of Sensitive High Resolution Ion Microprobe (SHRIMP) technology and its geoscientific applications as well as its successful marketing.
- Victoria – **Dr Graeme Woodrow FTSE** Chief of CSIRO Molecular and Health Technologies – for his exemplary leadership of R&D enterprises, particularly biotechnology, for the benefit of Australian industry and community health.

Calum Drummond heads CSIRO's new manufacturing division

CSIRO has formed a new division – CSIRO Materials Science and Engineering (CMSE) – to support Australia's manufacturing industry.

The result of the amalgamation of Melbourne-based Manufacturing and Materials Technology and Sydney-based Industrial Physics, CMSE will seek to transform segments of the Australian manufacturing sector into sustainable and globally competitive industries. It is headed by Dr Calum Drummond FTSE, former Chief of Industrial Physics.



Chief of CSIRO Materials Science and Engineering Calum Drummond.

"CMSE provides a coordinated approach to materials design, creation, characterisation and application, particularly for the manufacturing industry," Dr Drummond said. "Our goal is to be the provider of choice for innovative research and development in materials science and engineering to Australia's manufacturing industry."

CMSE is CSIRO's fourth-largest division, with 310 research staff. It is spread across six sites in Victoria, Queensland, NSW and the ACT.

CMSE's ancestors have a long track record of applying world-class science to benefit local industry. For example:

CSIRO's lightweight concrete, HySSIL, creates building panels that are half the weight of conventional material but just as strong. Under a joint venture between CSIRO spin-off company HySSIL Pty Ltd and Westkon, one of Australia's premier precast concrete companies, a pilot plant is being constructed in Sunshine, Victoria, to complete large-scale process development and supply panels to projects earmarked to use HySSIL.

CSIRO's magnesium casting technology, T-Mag, is also about to go full-scale under a joint venture with spin-off T-Mag Pty Ltd and three Adelaide-based companies. T-Mag is a highly energy- and metal-efficient process producing strong, lightweight castings without the flow lines or internal porosity defects typical of existing technology.

In a five-year partnership with Electrolux, CSIRO designed the direct-drive, switched- reluctance motor and the power and control electronics for the Westinghouse SensorWash washing machine. These large-capacity machines carry a 'AAAA' water-efficiency rating.

Sir George Fisher

The Academy notes with regret the recent death of Sir George Fisher CMG FTSE.

Sir George, a Foundation Fellow and a former CEO and Chairman of MIM Holdings Ltd and Chancellor of James Cook University, was 104.

He spent 50 years in Australian mining and much of the years his since retirement serving the community.

From 1925 to 1951, apart from a period on war service construction in Darwin, Sir George worked for the Zinc Corporation at Broken Hill and rose through the ranks to become General Manager and Director.

By the time he moved to Mount Isa in 1952 he was already a leading figure in Australian mining. He was Chairman of Mount Isa Mines during the company's major expansion of copper and silver-lead-zinc production in the 1950s and 1960s.

He was one of the founders of the Australian Mining Industry Council (now the Minerals Council of Australia), serving as inaugural President in 1967. He was President three times and also Vice-President and Councillor of the Australasian Institute of Mining and Metallurgy, a Director of the Australian Industry Development Corporation and a Patron of the Mining Hall of Fame.

Don Nicklin

The Academy regrets to note the death of Emeritus Professor Don Nicklin AO FTSE in Brisbane on 29 October.

Professor Nicklin was an ATSE Councillor and Queensland Division Chair. He was formerly Professor of Chemical Engineering and Pro Vice-Chancellor of the University of Queensland (UQ). A former member of the Prime Minister's Science, Engineering and Innovation Council (PMSEIC), he was instrumental in setting up the Queensland Sciencentre, while on the Board of the Queensland Museum.

In 1993 he left UQ to practise as an independent consultant with a special interest in the engineering–economics interface. He served on the Board of TICOR, the Sugar Research Institute and the Industry Research and Development (IR&D) Board. He also served as Chairman of of Austa Energy Corporation Ltd and the Centre for Mining Technology and Equipment.

He was awarded the Chemeca Medal – the highest award within the chemical engineering profession in Australia – in 1987.

Oliphant Conference

ATSE will manage a Sir Mark Oliphant conference – 'Old Forests, New Management: Conservation and Use of Old Growth Forest in the 21st Century' – in Hobart, 17 to 21 February 2008.

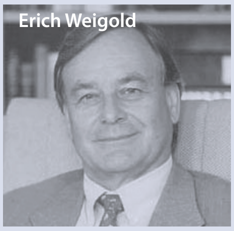
The conference will bring together researchers from a range of disciplines from Argentina, Australia, Brazil, Canada, Chile, Germany, Sweden and the US. Speakers will include Professor Tom Spies from the US, Professor Jürgen Bauhaus from Germany and Professor Ivan Tomaselli from Brazil.

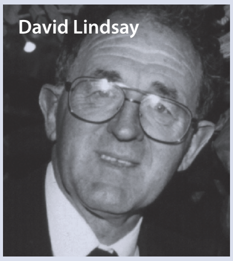
ATSE has major role on RQF Assessment Panels

ATSE Fellows are playing a major role in the RQF (Research Quality Framework) assessment process, with 18 Fellows serving on seven of the 13 Assessment Panels – each with 12 members – announced by the former Minister for Education Science and Training Julie Bishop.

Our 18 Fellows make up 11.5 per cent of the 156 panel members, and dominate the Engineering and Technology Panel, with eight members.

ATSE Fellows are chairing three of the panels – Professor Erich Weigold FAA FTSE (Physical, Chemical and Earth Sciences), Professor Max Lu FTSE (Engineering and Technology) and Professor David Lindsay AO FTSE (Agriculture, Veterinary, Food and Environmental Sciences).


Erich Weigold


David Lindsay


Max Lu

Joining Professor Lu are four Federation Fellows – Professor Chennupati Jagadish FAA FTSE, Professor Yu-wing Mai FAA FTSE, Professor Anton Middelberg FTSE and Professor Mark Randolph FREng FAA FTSE – plus Professor Aibing Yu FTSE, Dr John Burgess FTSE and Dr Don Gibson FTSE.

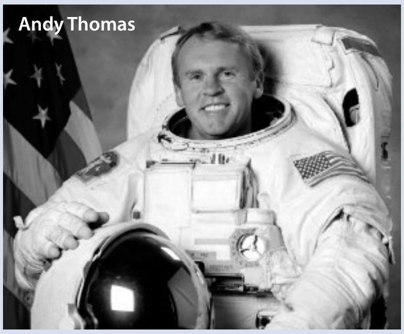
Professor Ross Large FTSE and Dr Robert Watts FAA FTSE are serving with Professor Weigold and Dr John Radcliffe is serving with Professor Lindsay's panel.

Professor Ramamohana Kotagiri FAA FTSE and Professor Antonio Cantoni FTSE are on the Mathematics and Information Sciences and Technology Panel; Mr John Grace FTSE is on the Clinical Sciences and Clinical Physiology Panel; Professor James Reid FTSE is on the Biological Sciences Panel; and Emeritus Professor Bruce Thom FTSE is on the Social Sciences and Politics Panel.

Astronaut Andy Thomas a 'stellar' attraction

Australian NASA astronaut Andy Thomas will be a key attraction at the 2008 ATSE Clunies Ross Awards dinner at the Sofitel, Brisbane, on14 May 2008, and at the Extreme Science Experience, also at the Sofitel.

Planning for both events is now well underway. Award judges are reviewing the 2008 Award nominations to decide the winners. The Awards will be publicly announced and formally presented at the 2008 Awards Dinner.


Andy Thomas

The following day, some 300 Year 10 students are expected to participate in the Extreme Science Experience, meeting and working with Dr Thomas and the 2008 Award winners in a day-long workshop.

New websites for both the ATSE Clunies Ross Foundation and the Extreme Science Experience have been launched recently at www.cluniesross.org.au and www.extremescience.org.au.

Fumio Nishini

The Academy regrets to note the death on 6 May of Professor Fumio Nishino. Elected a Foreign Fellow of the academy in 1998, Professor Nishino was an Emeritus Professor of the University of Tokyo and ATSE's only Japanese Fellow.

A civil engineer, Professor Nishino served in the Civil Engineering Department of the University of Tokyo for 30 years to 1995. He was the Japanese representative of the APEC Engineer Coordinating Committee, a former Vice-President for Academic Affairs, Asian Institute of Technology, and President of the Federation of Engineering Institutions of South-East Asia and the Pacific.

Professor Nishino was highly regarded in Japan and overseas. He was the first recipient of the International Contribution Award from the Japan Society of Civil Engineers in 1994 and was awarded its Award of Merit and the first Award for Achievement from the Asian Civil Engineering Coordinating Council, both in 2007.

Meryl Williams chairs ACIAR

Dr Meryl Williams FTSE has been appointed inaugural Chair of the newly formed Commission for International Agricultural Research of the Australian Centre for International Agricultural Research (ACIAR).

Dr Williams, an ATSE Councillor, has extensive experience in international agricultural research. Her previous experience includes positions as executive officer of the Future Harvest Alliance Office, Director-General of the WorldFish Center in Malaysia, Director of the Australian Institute of Marine Science, and Chair of the ACIAR Board of Management.


Meryl Williams

The Hon. Neil Andrew FTSE, Chair of the ATSE Crawford Fund and an ATSE Councillor, has been appointed to the Commission. He has had a life-long association with the irrigation industry, particularly horticulture and viticulture and is a former Speaker of the House of Representatives.

ATSE at CAETS

ATSE President Professor Robin Batterham AO FREng FAA FTSE, technical director Vaughan Beck FSE, and international relations manager Elizabeth Meier represented the Academy at the 17th CAETS Convocation in Tokyo in October, along with Dr John Zillman, immediate past President of the Academy and former President of CAETS.

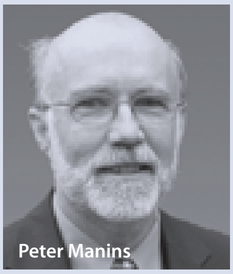
Other Fellows attending included Mr Ken Dredge FTSE, Mr Ron Hardwick FTSE, Dr Norton Jackson AM FTSE and Professor Aibing Yu FTSE. Key sessions focused on global environmental issues, technological challenges and scenarios for sustainable growth.

ATSE hosted the 16th CAETS Convocation in Cairns in July 2005.

Peter Manins wins Clean Air Medal

Dr Peter Manins PSM FTSE, of CSIRO Marine and Atmospheric Research in Melbourne, has won the Clean Air Medal, the premier award of the Clean Air Society of Australia and New Zealand (CASANZ).

Last awarded in 2002, the medal has only been presented 14 times in CASANZ's 40-year history.


Peter Manins

Dr Manins, a chief research scientist at CSIRO, with internationally recognised expertise in air pollution meteorology and modelling, received the award for distinction in the atmospheric sciences, at a dinner at the World Clean Air Congress in Brisbane.

In making the presentation, CASANZ President Dr Gerda Kuschel said: "Dr Manins is an extremely deserving recipient who has devoted his career to the science of air quality and environmental protection."

Dr Manins has been an expert adviser on several public infrastructure projects and major industrial developments, including Sydney's Lane Cove Tunnel. He also led the major Latrobe Valley Airshed Study in the 1980s and has worked as an international adviser for the World Health Organization, the UK Science Council and the World Meteorological Organization.

Dr Manins founded CSIRO's Environmental Consulting Research Unit in 1989 – based on advanced-air-pollution modelling – and led CSIRO's air pollution program from the mid-1990s.

Michael Eyles on FIG team

Dr Michael Eyles FTSE, executive director of Leadership and Cross-organisation Development at CSIRO, has been appointed to a new advisory group established to strengthen the Australian food industry's innovation and profitability.


Michael Eyles

The group will assess grant applications under the Australian Government's new $54 million Food Innovation Grants (FIG) Program, which provides competitive grants to Australian-based food businesses to promote greater investment in R&D and innovative projects to help the Australian food industry be more competitive and profitable.

Russell Reichelt heads Barrier Reef authority

Dr Russell Reichelt FTSE has been appointed Chairman of the Great Barrier Reef Marine Park Authority and will take up his appointment in November. He has been the managing director of the Reef and Rainforest Research Centre since 2006. Previously, he was also the CEO of the CRC Reef Research Centre and CEO of the Australian Institute of Marine Science. He is also a former chairman of Seafood Services Australia Ltd, the Fisheries Research and Development Corporation, the Great Barrier Reef Consultative Committee and the National Oceans Advisory Group.


Russell Reichelt

Doug Rathbone on CSIRO Board

Mr Douglas Rathbone AM FTSE has been appointed as a member of the Board of CSIRO. Mr Rathbone has led Nufarm Ltd, one of the world's leading manufacturers of crop-protection chemicals, for more than two decades. Dr John Stocker AO FTSE is Chairman of the CSIRO Board.

John Keniry joins Innovation Board

Dr John Keniry AM FTSE, chairman of the CRC for Sheep Industry Innovation, has been appointed to the Board of Innovation Australia, formed by the merger of the IR&D Board and Venture Capital Registration Board. Dr Keniry has served has served as chairman or director of numerous agribusiness and mining ventures in Australia and New Zealand, and on the boards of government organisations at state and federal level, including the Pig Research and Development Corporation and the Pork CRC.

Peter Farrell joins education body

Dr Peter Farrell AM FTSE, founder, chair and CEO of ResMed Inc., 2007 ATSE Clunies Ross Award winner and current member of the Board of Trustees at the University of California, San Diego, has been appointed to the advisory board for the $6 billion Higher Education Endowment Fund. Australia's Chief Scientist, Dr Jim Peacock AC FRS FAA FTSE, has also been appointed (ex-officio).