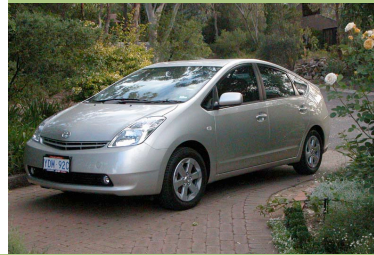


Sustainability in Engineering Education and Knowledge



ENGINEERS AUSTRALIA

SEEK 1 - February 2005, Volume 1, No 1

Newsletter for Engineering Educators from EA's College of Environmental Engineers

Industry Still Seeking Better Grasp of Sustainability from Graduates

In his Keynote address to the 1999 A²E² National Conference, Chancellor of the University of South Australia, David Klingberg, lamented the lack of understanding of environmental matters that engineering graduates displayed at the time. Klingberg had been CEO of Kinhill Engineers, a company that in the 80s was moving rapidly into the environmental engineering arena (Kinhill was acquired by Brown & Root in 1997, now Kellogg Brown & Root). Klingberg called on engineering educators to lift their game, particularly pointing to the need for engineers to be better equipped with regard to Triple Bottom Line reporting. In this inaugural issue of SEEK we ask "Has anything changed since then?" and we look at what is being done.



Editorial

Welcome to the first edition of **SEEK - Sustainability in Engineering Education and Knowledge**, the newsletter of Engineers Australia's College of Environmental Engineers. The College has been concerned for some time that environmental engineering education has languished around Australia's engineering faculties over the past ten years. Echoing Klingberg's words from the 1999 A²E² Conference, College Chairman Tim Macoun stressed the need for all graduate engineers to have a far better understanding of sustainability at the Environmental College Workshop held during the 2004 A²E² Conference in Toowoomba last September. Macoun's comments reflect then EA National President Doug Jones' call for

sustainability to pervade all aspects of engineering education and practice. Following his call for action, EA Council has endorsed a proposal to establish a new Sustainability Board with a wide responsibility, including the making of recommendations to ensure that engineers, and particularly members of our Chartered Engineering team deliver more sustainable outcomes for society. The Chairmen of both the College and the Environmental Engineering Society will play a key role in the development of this new Board, particularly briefing the Board on achievements to date, and barriers yet to be overcome.

Education obviously plays a significant part in the process of inculcating sustainability into the engineering practice culture. Talk of graduate engineers knowing less about the environmental impact of their work and sustainability generally than when they left high school (as I heard from a well known and recently retired educator at UNSW) is simply horrifying.

So, the College has embarked on a multi-pronged program to support Council's initiative. Essentially, the College is concerned that **all** engineers have a thorough grasp of the principles of sustainability in the context of triple bottom line impacts, AND that Environmental Engineering education equips graduates with appropriate deep knowledge and understanding in specific environmental engineering fields. As re-

ported elsewhere in this newsletter, to address the first issue we have reached agreements with a number of universities for the trialing of the first year critical literacy in sustainability module (Engineering Sustainable Solutions Program or ESSP Module 1).

The Chairman in his column talks of the planning behind this education initiative, and discusses a list of the things we'd like to achieve.

Elsewhere we hear from those facing the issues in getting sustainability into their curricula. Margaret Rossiter is trialing ESSP 1 at ANU, and talks with us about current student attitudes and reactions to sustainability. Answering our question, Paul Bannister notes that he is not really happy with the engineering graduates that he seeks for his business.

The College hopes to bring SEEK to you at least twice per year. In the next issue we look at the accreditation process and Environmental Engineering courses, report on Engineers Australia's initiatives in sustainability, and look further at what industry wants from engineering graduates. Your contributions are also welcome - please contact me on 02 6258 7161 to discuss. We look forward to your input.

David Hood FIEAust CPEng MASCE

Deputy Chairman, College of Environmental Engineers

(The views expressed herein are those of the authors, and do not necessarily represent the views, or imply policy of the College of Environmental Engineers or of Engineers Australia). Credit all images David Hood except as noted.

The Natural Edge Project (TNEP)

Cheryl Paten

The Australian Engineering Code of Ethics contains a direct imperative for engineers to include sustainability considerations in their daily work. Tenet 6 says, "Members shall, where relevant, take reasonable steps to inform themselves, their clients and employers, of the social, environmental, economic and other possible consequences which may arise from their actions" (EA, 2000).

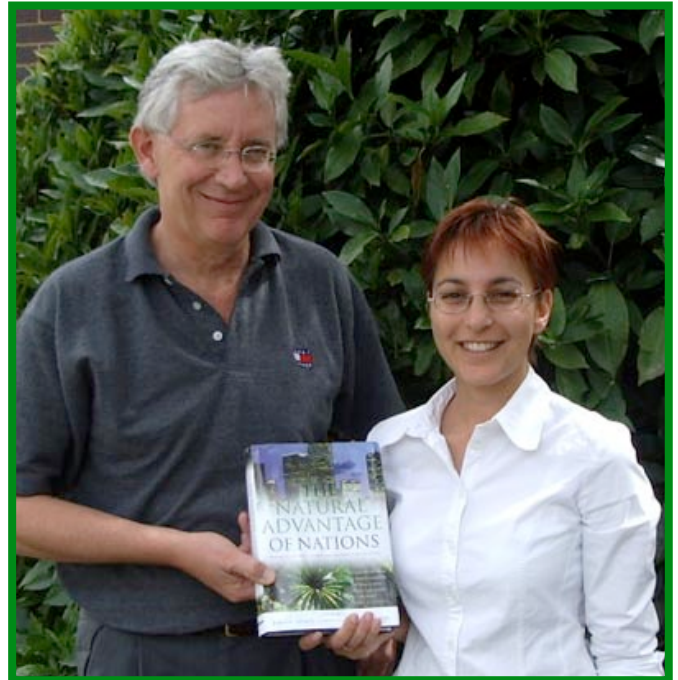
EA's 2004 national president, Doug Jones, is clear about the need to move forward on education for engineers in sustainability: "It is up to engineers to consider sustainability in every project they design and construct & every product that is made. Sustainability is now a fundamental responsibility that all engineers must carry every day." (Jones, 2004).

Those of you who attended the A²E² workshop in September will know that in 2004 the College of Environmental Engineers provided a grant to develop an introductory module on sustainability, suitable for entry level engineering students across disciplines and initially environmental engineering. The Natural Edge Project (TNEP) prepared the module, which also forms part of a larger program under development between TNEP, UNESCO and Engineers Australia called the "Engineering Sustainable Solutions Program - Critical Literacy for Engineers Portfolio" or "ESSP-CL".

TNEP (represented by Cheryl Paten) presented a paper on the module development at the 2004 Interna-

tional Conference on Engineering Education in Sustainable Development (EESD04) in Barcelona. The paper described the module as a current initiative supported by Engineers Australia that is seeking to address the 'critical literacy' dilemma in our country.

We are excited to announce that the paper has since been accepted for publication in a special edition of the International Journal for Sustainability in Higher Education (IJSHE), which is great news for TNEP, Engineers Australia and the College. Indeed, from the conference it appears that Australia is leading the way on initiating nationally coordinated and peer-reviewed sustainability content for teaching across engineering disciplines.



College Chairman Tim Macoun receiving his copy of *The Natural Advantage of Nations* from Cheryl Paten (order your copy at end of Newsletter)

Having a single entity representing all engineering disciplines (ie Engineers Australia) appears to provide a degree of leverage and opportunity that is highly regarded internationally (a situation shared by Australia and only a handful of other countries). Indeed, given the commitment to sustainability shown by Engineers Australia and the College, there is no excuse for Australian higher education and vocational centres not to 'show the way' in working to embed sustainability in all engineering curricula nationally.

As a 'snapshot' summary, ESSP-CL Module 1 comprises 6 one-hour lecture equivalent units and a trainers guide. All 6 units may be taught as the full module, or 1 or more of the units may be selected according to the needs of the students. The module has been developed to be as flexible as possible, so the presentation is simple and concise.

The College and TNEP are currently conducting a 'trial phase' of the introductory module, among a number of universities nationally (at no cost). If you or your faculty would like to join the trial by providing a desk-top review of the material, or trialing part of the mod-

ule within existing courses, please contact Cheryl on 0422 994 143 (cheryl@naturaledgeproject.net).

All those participating in the trial will be recognised in future work associated with the module. Once the trial is complete, the College proposes to seek to recover some of the costs in developing this program through nominal purchase/licensing arrangements.



Cheryl Paten is a lecturer in the School of Environmental Engineering, Griffith University. The Natural Edge Project (TNEP) is an ongoing, not-for-profit partnership driven by a group of young engineers and scientists based in Australia (www.tnep.net). TNEP is hosted by Engineers Australia. The project is focused on assisting nations, through a whole of society approach, to achieve sustainable genuine-progress.

Chairman's Message



It is very exciting to pen this introduction to our SEEK newsletter. This is the start of a process that I believe will see profound change over time in the quality of education of our environmental engineers. AND, through their experiences and the standards they set in the workforce, I also believe we'll see changes to all

engineering programs, in all academic institutions across Australia. The embedding of sustainability in a meaningful and fully integrated way will open up a future for engineering brighter than anything I've experienced in my 38 year career to date.

Dr Bannister (see 'Sustainability and Engineering Education', in this issue) is 'spot on' in his criticisms of our current engineering education standards in this country. A colleague reported to me on a recent research project on the extent that our engineering programs engender critical thinking. She surveyed widely, optimistic as to what she might find, but there was a poor response perhaps because most academics don't really understand what the term means.

Engineers Australia's experience in the accreditation of environmental engineering (EE) programs over the last few years has found that most of our so called EE programs are nothing more than 'green' civil or

chemical engineering programs. They are only marginally removed from their original programs and taught largely by the same academics that taught those original programs some years before. So what has changed?

A lot, theoretically. The Institution has espoused a Changing Culture in Engineering Education. There is a changing accreditation system with new Stage 1 competency standards required of graduates. There is ample encouragement and indeed a requirement for change. However, over that same period a continuing decline in entrant numbers. Program architects and Heads of School are nervous of too much change in an uncertain environment.

Environmental engineering issues must also be seen in the larger context of Engineering as a profession - at a time when engineering student numbers and membership of professional associations are declining. Sustainability has perhaps provided the vehicle to begin a 'culture change' to an engineering profession now looking at 'whole system design', 'contextually sensitive development' and 'serving society' in a new light. It will be important for Environmental Engineering educators to examine their role in this emerging cultural transition - potentially increasing services to other engineering disciplines (ie on sustainability critical literacy skills), as well as focusing environmental engineering students on the bountiful niche opportunities that are presented in such a transition.

The College will continue to develop teaching modules for both undergraduate use and the continuing professional development of practising engineers. Our primary focus will be on the profession of Environmental Engineering but we will support the other EA Colleges in the "greening" of all engineers and encouraging changes to their undergraduate programs. Fundamentally we see EE providing the leadership in the workplace and the universities and being the 'standard setters' - and, we see the signs of change emerging. That is why this initiative is so important.'

Tim Macoun FIEAust CPEng

Chairman, College of Environmental Engineers

Whole-System Engineering begins with a Focus on Sustainability

Dr Barry Newell & Dr Margaret Rossiter

Modern engineering is multi-disciplinary. Technical expertise is no longer sufficient. Engineers must be able to evaluate and defend their technical analysis and design within the broader social, environmental and business systems. The systems and software engineering programs at the Australian National University (ANU) are uniquely placed to meet this increased demand. These degrees build upon a strong technical foundation to explore a diversity of systems, always within a professional framework that empha-

sises social, business and environmental issues. Maintaining this approach to whole-system engineering education demands ongoing teaching innovation with a focus on sustainability.

As evidence for anthropogenic changes to the Earth system accumulates it is becoming clear that we are approaching, and in some arenas have exceeded, the carrying capacity of the biosphere. Simultaneously, we are close to exhausting vital stocks of unrenovable physical resources such as oil and groundwater. Attempts to confront these issues commonly focus on the use of "technology" to tackle specific ecological problems (such as soil degradation, pollution, the greenhouse effect and global warming) and to extend the availability of basic resources (agricultural land, energy, water, materials). For this reason, there is a growing recognition, throughout the developed world, that "sustainability" is a primary challenge for engineers.

While there is considerable confusion about just what constitutes "sustainability", many interpret this term to mean that the engineer's role is to find "solutions" that will permit continued growth of the global economy. But such "business as usual" approaches are short-sighted. Duncan Brown's *Sixth Law of Ecological Bloodymindedness* states that:

The long-term survival of any species of organism requires that all processes essential for the viability of that species function at rates that are compatible with the overall functioning of the ecosystem of which that species is a part.

In many areas of the world human-driven processes already run at rates that significantly exceed the biosphere's ability to cope. Excesses include exceedingly wasteful use of resources and the related production of ecology-destroying levels of pollution. Furthermore, given the feedback delays inherent in the overall sociobiophysical system, there is a real risk of dynamical "overshoot and collapse".

There is an urgent need for us to reduce our impact on the planet and it is here that engineers can play a vital role. In particular, there needs to be a strong focus on radical resource productivity, closed-loop processes, and waste reduction. We must come to terms with the way that we interact with each other, and with the natural world, in our attempts to gather in the "necessities of life", and then design and develop new ways to meet the present-day needs of the world's people without irreparably damaging the resource base and the opportunities for future generations to prosper.

Engineering at the ANU attempts to provide undergraduate engineering students with an introduction to these issues and to establish the foundations of a whole-system approach that can help them to contribute powerfully to the redesign and improvement of human activity systems at all levels.

Dr Barry Newell & Dr Margaret Rossiter are Senior Lecturers in the Department of Engineering, Faculty of Engineering and Information Technology, Australian National University, Canberra, ACT 0200, Australia. Email: margaret.rossiter@anu.edu.au

Sustainability and Engineering Education – An Industry Perspective

Dr Paul Bannister

One of the ways to view the role of sustainability in engineering is to think of it as being the difference between something working and something working optimally. It's certainly true in the area I work in – energy efficiency and sustainability in the built environment.

As a general vocation, engineering is concerned with producing things that work. And work. And work. You build a bridge, you don't want it to fall down. You build an air-conditioning system, you don't want complaints. These are reasonable expectations. However, the overriding prerogative of "it must work" produces a culture of conservatism and risk aversion that has a definite impact on sustainability. Put in a consulting context, nobody wants to face a Professional Indemnity claim, so it's better to overdesign than to risk getting it wrong.

The problem is, from a sustainability perspective, overdesign is public enemy number one, shortly followed by most other forms of conservatism. Sustainable design – almost by definition, given that we don't have it now as mainstream design – is not what we do today. It has to do the job, efficiently. This requires an openness to innovation and the ability to understand and work along the fine edge of getting things just right – using the right size of hammer rather than smashing the problem with a hammer five times too large because you know that will always work.

So what does this mean for engineering education? More than anything it means it has to be that – education. An educated engineer understands not just what to do but why it works, what the options are to make it more sustainable. He or she can develop theories about how it could be made to work better based on a critical review of the problems involved, a solid analytical approach and synthesis, leading to the optimal solution. This then opens the way to innovation and sustainability.

Sadly, that's not what the average engineering graduate gets. Most engineering graduates seem to come out of university without having being taught to think – that is to say they have been trained, not educated. Perhaps this is what Joe Average employer wants, but is certainly isn't what I want or what

sustainability needs. These poor souls arrive in their first job and are trained –not educated - in their discipline. The result is that they are force-fed the mistakes of their forebears which, having not learnt to think, they swallow unquestioningly. By the time they have creative control of projects they are well and truly cogs in the machine of “business as-usual”.

So from my perspective based on the experience of interviewing many recent graduates, this has two consequences for engineering education. Firstly, we need to have a far stronger focus on educating engineers to give them a solid analytical understanding of their field so that when they reach the workplace they can cast a critical perspective across the engineering norms of their early workplaces. There are some courses that do this, but they are definitely the minority. Secondly, we need to provide effective support to graduates – and indeed the more experienced - in learning their speciality field using knowledge that is based on the forefront of best practice rather than the once bitten-twice-shy conservatism that drives many workplaces.

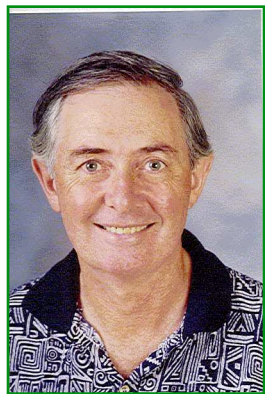
Ultimately, we have to recognize that sustainability requires a change of culture. One of the key planks in changing culture is for new blood to be permitted to enter the profession and change the workplace with a flow of great new ideas. We should be educating to achieve this goal.



Dr Bannister, Managing Director Exergy Australia Pty Ltd, educated in the UK and New Zealand is one of Australia’s leading Building scientists. He prepared the Australia Building Greenhouse Rating (ABGR) Scheme for the NSW Government and his company employes a number of engineers.

Dr Bannister is constantly on the lookout for graduates with the right competencies to grow his sustainability focus business. (Image - Exergy Pty Ltd)

Professor Ian Lowe confirmed as Keynote Speaker - EES2005.



Ian Lowe joins Peter Newman at the National Environmental Engineering and Sustainability Conference 2005, organised by the Environmental Engineering Society, and supported by Engineers Australia’s College of Environmental Engineers.

The theme of the conference is "Creating Sustainable Engineering Solutions". This reflects a view that sustainability applies to every aspect of engineering projects, from planning, design, construction or manufacture, through to operation and decommissioning. **The Conference Program features outstanding national and international speakers, concurrent sessions in themes such as Land Rehabilitation, Sustainable Solutions, Water & Wastewater, Infrastructure, Transportation, Engineering Education, and plenty more.** Note the dates: **July 17 to July 19, 2005.**

The Conference will attract researchers and practitioners from all around Australia and the Asia Pacific and provide a wonderful opportunity to meet and extend your contacts.

The venue for the Conference is the Powerhouse Museum, Sydney, superbly situated in the Darling Harbour precinct of Sydney. This was selected as the venue for the EES 2005 National Conference to highlight the advances and diversity in engineering.

For more information about the conference or to register please visit www.iceaustralia.com/ees2005
(Ian Lowe Image Griffith University)



Creating Sustainable Engineering Solutions

Mon 18 - Tues 19 July 2005

Powerhouse Museum
Sydney, Australia

THE NATURAL ADVANTAGE OF NATIONS

Business Opportunities, Innovation and Governance in the 21st Century

Edited by Karlson 'Charlie' Hargroves and Michael H. Smith

DESCRIPTION

This collection of inspiring work, based on solid academic and practical rigour, is an overview of the 21st-century business case for sustainable development. It incorporates innovative technical, structural and social advances, and explores the role governance can play in both leading and underpinning business and communities in the shift towards a sustainable future.

The team from The Natural Edge Project (TNEP) have studied and incorporated key works from over 30 of the world's leaders in sustainability. The book is also supported by an extensive companion website. This work takes the lessons of competitive advantage theory and practice and combines them with the sustainability paradigm, in light of important developments in economics, innovation, business and governance over the last 30-50 years.

Far from being in conflict with economics and business practices, this book demonstrates how we can improve the well being of society and the environment while driving innovation in an increasingly competitive world. The book and its companion web site are a significant resource and contain something for everyone.



TNEP would like to thank our Sponsors for their ongoing support and faith in our project, in particular our Foundation Partners (<http://www.naturaledgeproject.net/TNEPSupporters.aspx>)

EDITORS INFORMATION

Charlie Hargroves a civil engineer and Michael Smith a scientist, are part of a team of young Australians known as The Natural Edge Project (TNEP) hosted by Engineers Australia. The team formed to respond to the need for professional development in the area of sustainability. As a not-for-profit partnership TNEP commits all royalties and revenue to further develop the project's initiatives and programs.

TNEP is focused on assisting nations to achieve a natural advantage through a whole-of-society approach to sustainability.

The project team receives mentoring and support from a range of professionals, public servants, business leaders and academics internationally (www.naturaledgeproject.net developed by Izilla).



"The focus of this initiative is not only potentially a seminal book, a truly world changing book, it has become more than that. As part of the process of pulling together the people whose ideas they wanted in the book, they have brought together government, business, activists, academics - all of the parties who need to be part of this conversation. This project should not stop when the book is published - the publication of the book should only be the beginning. The Natural Advantage of Nations is much much more than just a book, and TNEP is a very important project."

Hunter Lovins, Time Magazine, Hero of the Planet 2000



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