ENGINEERING
EDUCATION TO EMPLOYMENT

THE ENGINEERING E2E PROJECT IS A RESPONSE TO THE NZ GOVERNMENT GOAL OF INCREASING ENGINEERING GRADUATES TO 500+ PER ANNUM FROM 2017

Engineering E2E Talking with Employers

Tuesday 9 June 2015, Wellington

Workshop Report

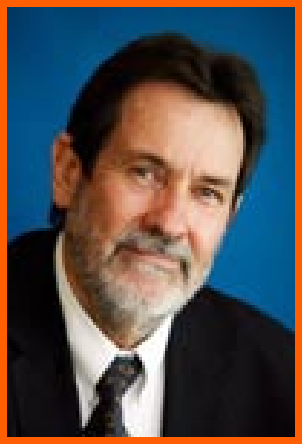
Initiatives undertaken through the Engineering E2E programme contribute directly to the achievement of the Government's Business Growth Agenda priority of building a more productive and competitive economy

ENGINEERING E2E TALKING WITH EMPLOYERS Workshop Report

The Tertiary Education Commission-organised 'Engineering E2E Talking with Employers' workshop, held in Wellington on Tuesday 9 June 2015, brought employers together to discuss the skills and capabilities needed by current and future engineering graduates as they enter the workforce.

In attendance were 30 chief executives and senior managers from a wide range of engineering disciplines, including those involved with tertiary industry advisory groups, as well as representatives of engineering education providers and IPENZ.

Professor Geoff Scott facilitated the meeting which critically tested the usefulness of his professional capability and competency framework for engaging employers to improve the sector's understanding of employers' needs with regard to engineering graduates and their qualifications.



SCOTT'S PROFESSIONAL AND GRADUATE CAPABILITY FRAMEWORK

Geoff Scott, Emeritus Professor of Higher Education and Sustainability at the University of Western Sydney, has developed a professional capability framework used to identify, validate, and cluster programme-level learning outcomes deemed relevant in each degree or diploma.

The framework is based on Professor Scott's research over the past decade which looks at high-achieving graduates three to five years out of university to determine what makes them successful. Informed by extensive peer review, Professor Scott's work has been used to improve teaching and learning and substantiated by studies of successful graduates as well as educational leaders across secondary and tertiary sectors in Australia.

Key outcomes of the workshop

IDEAL CAPABILITIES AND CHARACTERISTICS OF ENGINEERING GRADUATES AS IDENTIFIED BY PARTICIPANTS

Successful engineering graduates were seen by participants as having to be not only work ready for today but work ready plus for tomorrow. This requires them not only to have key competencies (skills and knowledge) but the range of broader capabilities necessary for them to know when and how to apply these skills to unique contexts and situations and how to continuously update them.

The key capabilities and competencies identified by participants were:

PERSONAL CAPABILITIES

- **Self-awareness and regulation:** humility; knows strengths and weaknesses; high levels of self-awareness and self-management; willing to learn from errors; leads a balanced life.
- **Decisiveness:** willing to go for sensible approximation; tolerates ambiguity; willing to take sensible risks.
- **Commitment:** energy, passion; commitment; takes responsibility for allocated jobs.

INTERPERSONAL CAPABILITIES

- **Influencing:** team player; able to work with diversity; good at influencing teams; community engaged.
- **Empathising:** a people person; empathises.

COGNITIVE CAPABILITIES

- **Diagnosis:** able to 'read' situations and 'match' the right combination of skills and knowledge to address this (multiple ticks); good at determining what is 'fit for purpose'; able to draw out the core issue from a mass of information; able to ask the right questions.
- **Strategy:** capable of lateral thinking; good at strategy and implementation.
- **Flexibility and responsiveness:** Able to learn from experience; adaptable.

KEY COMPETENCIES (skills & knowledge)

- A high level of technical skill and knowledge (including strong coding and calculus skills)
- The specific skills and knowledge to perform competently in the engineering area concerned
- Commercial astuteness, including the ability to manage risk and liability in a complex regulatory environment
- Knowledge of how to bring a competitive edge to an organisations) along with a range of basic, generic skills and knowledge (including strong written skills, computing skills and understanding, knowledge of how to project manage, work productively with clients from diverse backgrounds etc) .

A high level of competence is necessary but not sufficient for effective professional performance.

RECOMMENDATIONS

Five recommendations came through strongly for consideration by the Engineering E2E Steering Group:

- Change the curriculum to incorporate the graduate capability framework and opportunities for experience across engineering disciplines as well as entrepreneurial experience.
- Improve stair-casing opportunities for current and prospective students and also those in employment.
- An engineering graduate study based on the framework should be replicated in the New Zealand context.
- Follow up with participants on ideas for contributions to a public awareness campaign.
- Form a reference group to act as a conduit for ongoing advice and guidance from workshop participants.

Twelve key themes and observations

1 'WORK-READY PLUS' GRADUATES AND THE CAPABILITIES EMPLOYERS VALUE MOST – WHAT DOES THE IDEAL ENGINEERING GRADUATE LOOK LIKE?

Increased business productivity and intelligent business operations come about when successful graduates enter work. Ideally, these are 'work-ready plus' graduates who have strong foundational skills in engineering as well as the interpersonal capabilities to thrive when confronted with complex problems in the workplace. By way of example, Professor Scott drew attention to the strong focus on developing graduates' sustainability and cultural competencies in the University of Waikato's Faculty of Science and Engineering.

Participants agreed that different levels of competence are required of graduates depending on their role and discipline. Skills and knowledge are necessary but not sufficient.

Asked to consider Professor Scott's framework and rank their top three capabilities of engineering graduates, all participants ranked 'commitment' and 'energy and passion' highly. Amongst most participants' top three capabilities were 'ability to get along with people from all walks of life' and self-awareness, including 'learning from experience' and an ability to 'diagnose what didn't work'. Employers also value graduates who 'know how to ask the right questions'. This aligns with Professor Scott's view that engineering graduates should be trained to question tacit assumptions such as 'growth as good' and 'diversity creates adaptability'.

It is critical that students have the learning capacity to quickly develop new technical skills. Employers want to establish strong teams supported by a diverse workforce which contributes a mixture of skills to the company. They further stated the importance they place on graduates:

- with developed intercultural and linguistic skills
- with a strong social conscience and an interest in cultural and environmental sustainability
- who can understand risk and liability in a complex regulatory environment.

Participants highlighted the need to support a pipeline with a stronger flow of engineering technicians capable of meeting the practical, hands-on challenges of engineering companies in a range of sectors. For Professor Scott, there needs to be a systematic way to get employer buy-in to do this.

» *Consideration needs to be given to how we support and leverage education-employer partnerships*

» *Are current assessment, resources, and teaching practice fit-for-purpose?*

2 SUPPORTING ENGINEERING CAREER PATHWAYS WITHIN THE SECTOR AND INTO CAREERS

Employers strongly emphasised the need to support a range of pathways into engineering careers, with a lack of transition and educational pathway opportunities observed over the last 15 years.

They highlighted the importance of more clearly defining two-way pathways from a). ITP study to university study and employment, and b). from a trade to ITP study, work and university level study.

Internships were flagged as a means of supporting stronger connections between universities and engineering companies. One participant highlighted the success of the Summer Scholars Memorandum of Understanding which gives students from Victoria University of Wellington opportunities to work on a range of STEM-related projects in the Wellington City Council research team.

Clear articulation of pathways in the engineering industry would enable students to plan their careers and also allow for up-skilling opportunities once graduates reach the workforce, including career development for keeping up with technological change in their industry. Participants further stressed the need to support ongoing education of engineers already in the workforce through study in a range of onsite and online educational environments, including MOOCs.

3 THE VALUE OF ITP GRADUATES

Employers were challenged to discuss the perceptions of the quality and value of the Bachelor of Engineering (BE) degree, as compared with the Diploma in Engineering and New Zealand Certificate in Engineering (NZCE) offered by ITPs.

Most employers placed a high premium value on ITP sector graduates in New Zealand. They noted that these graduates bring a 'unique toolbox of skills' to the workforce, along with strong interpersonal, practical and problem-solving skills. Some noted that NZCE graduates are the most commercially astute of their intake, and are capable of understanding profit and risk. Consensus was that ITP graduates have a better range of emotional intelligence capabilities and are more 'work-ready' than their university-qualified peers.

» *Consideration needs to be given to emphasising how ITPs and universities can complement each other, with the former focusing on producing technicians, the latter fostering inventors and enterprise growth enablers.*

4 RECALIBRATING THE ENGINEERING CURRICULUM TO BE RESPONSIVE TO INDUSTRY NEED AND TECHNOLOGICAL CHANGE

Employers want to play a stronger role in the recalibration of the engineering curriculum to ensure that it addresses the perceived 'disconnect between theory and practice' so that graduates are equipped with the competencies and capabilities required by industry.

With the speed of technological change placing the engineering curriculum at risk of obsolescence, flexibility is essential to allow students to develop the skills to adapt to rapid changes in engineering technology. The tertiary education system will also need to place stronger emphasis on fostering inventiveness and creativity in graduates.

To make sure that the curriculum is more relevant and responsive to industry need, participants suggested a stronger feedback loop between employers, tertiary education organisations and regulatory bodies.
Further suggestions for a curriculum update included:

- Skills required by industry influencing curriculum redesign, including factors such as course duration and point value
- Moving away from a model of 'regurgitation' to one that supports creative thinking
- Greater specialisation in the Bachelor of Engineering Honours year, with graduates potentially working in the field in their fifth year of BE study
- More students involved in product development initiatives during their training
- Incorporating elements of the Aichi-Nagoya Declaration on Education for Sustainable Development into the New Zealand engineering curriculum
- Tertiary education organisations assessing more than just skills and knowledge – new methods of online learning will require graduates to develop a unique set of digital skills
- Integrating dilemma-based assessment asking students to tackle real-life problems they would encounter, and have to solve, under pressure in the workforce – these scenarios test students against technical as well as emotional challenges which valuably assist in strengthening their broader interpersonal skills and resilience.

Accepting that they have to teach graduates the skills specific to their business and industry, many employers seek to hire graduates with a broad range of 'soft skills', in addition to the learning capacity to quickly develop new technical competencies. Employers particularly seek graduates with effective self-directed learning techniques and social resilience.

5 UP-SKILLING GRADUATE EMPLOYEES FOR GREATER BUSINESS EFFICIENCY AND REDUCED LIABILITY

Employers expressed concern about the low number of engineers with sign-off authority for engineering projects. This creates issues with project efficiency and can severely limit the productivity of their business.

Providing graduates with opportunities to pursue further tailored study and qualifications while in the workforce would assist companies to address particular skills gaps and deficiencies such as these, and help absolve them from potential liability.

Employers further called for long-term mentoring to help develop graduates' skills in the workforce.

6 BACKWARD MAPPING FROM STUDIES OF SUCCESSFUL EARLY CAREER GRADUATES

In his introduction to the workshop, Sir Neville Jordan shed light on the value of 'backward mapping' – identifying successful graduates three to five years into their careers and interviewing them to find out which components of their studies were most helpful, in order to develop these skills in future graduates (e.g. through more fit-for-purpose resources and teaching practices).

Professor Scott advised that backward mapping can also strengthen companies' graduate recruitment processes and help managers assess the key competencies/capabilities of their graduates.

7 INTERNATIONAL GOOD PRACTICE AND EXEMPLARS

Professor Scott advised that engineering courses which embed innovation through programme design can help graduates to face the challenges of grappling with new and emerging forms of technology once they enter the industry. He drew attention to a number of overseas models which might guide practice in New Zealand.

- The Stanford Innovation Centre fosters engineering students' entrepreneur skills by providing them with resources and opportunities to transform engineering projects into start-ups through substantial venture capital funding.
- The University of Western Sydney's 'living laboratory' aims to incorporate a focus on sustainability in its core business activities through its curriculum, research outputs, and industry engagement.
- The United Nations Regional Centres of Expertise (RCEs), Rochester Institute of Technology, the Stanford Design Lab, and the Worcester Polytechnic Institute in the United States offer work-ready assessment models which have helped their graduates to excel when they reach the workforce.

Questions were raised around how tertiary education organisations' curriculum frameworks align with international engineering accords. An ongoing conversation is needed around this alignment.

8 THE FUTURE OF ENGINEERING, INCLUDING GREEN TECHNOLOGY AND BLUE ECONOMY INVESTMENTS

Participants discussed the vast opportunities from new technological advances in their field, such as robotics, PV cells, geodesic domes [in disaster areas], electric cars, 3D printing and changes in materials for vehicle manufacturing. They also raised the issue of densification of urban living and how this impacts engineering infrastructure.

Huge economic opportunities for industry lie in green technology (to address high carbon emissions and protein shortages) as well as blue economy research and development (with benefits from smart investment in low-carbon technologies seen through the likes of initiatives to make money out of waste and help ease environmental pressures).

Employers also raised the impact of high electricity demand on the engineering industry, with one participant highlighting the work her graduate is doing to analyse how to reduce the load on the grid in the face of increased energy consumption. Another participant flagged a boiler engineering project in Darfield and highlighted the project's success in pulling the community together.

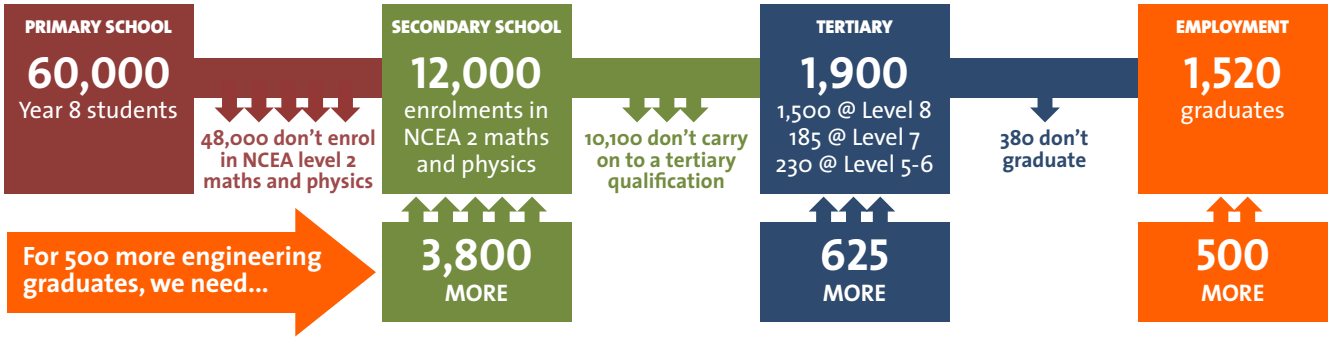
Participants enjoyed discussing the opportunities and challenges of new disruptive technology, variously asking:

- What role does legislation have to play in regulating new and emerging forms of technology?
- Does current legislation adequately address the risks and benefits associated with disruptive technology?
- Are the laws regulating the engineering industry in New Zealand well conceived and fit-for-purpose?
- What kinds of infrastructure will engineers need to service in 10 years' time?
- How can the New Zealand engineering industry compete with low-cost overseas labour?

9 INCREASING THE NUMBER OF ENGINEERING GRADUATES TO 500 PER ANNUM FROM 2017

Employers were particularly interested in the breakdown of what was needed to meet Government's goal of creating 500 engineering graduates every year from 2017:

ENGINEERING EDUCATION PIPELINE – FROM SCHOOL TO GRADUATION



Participants commented on the difficulties of reaching this target and asked whether the education system has the capacity to absorb this number of graduates. They also stressed the need for a strategy to encourage more engineering graduates to remain in New Zealand after their studies.

10 AWARENESS CAMPAIGN CHAMPIONING ENGINEERING AS A CAREER, WITH MORE WOMEN, MĀORI, AND PASIFIKA PRACTITIONERS

Many participants stressed the need to champion engineering as a profession with strong earning potential, exciting career opportunities, and positive social and environmental outcomes. This is especially important in working towards producing 500+ engineers per annum from 2017.

It was mooted that an awareness campaign aimed at secondary school students, careers advisors and parents as well as science and maths teachers be made across the whole sector, not just at degree level in universities. Participants identified the need to encourage more women to take up STEM subjects at tertiary level.

Nurturing a pipeline of more Māori and Pasifika into engineering careers was also identified as an important step for improving socio-economic outcomes. This involves strengthening the interface between iwi and tertiary education organisations to help the latter better understand the needs of Māori students and their communities. Employers further suggested a strategy mapping pathways for Māori and Pasifika to become leaders in STEM industries.

Professor Scott suggested a video campaign as an engaging way to raise awareness about engineering career pathways. Short clips could shine the spotlight on a successful graduate or 'fellow traveller' to inspire students into exciting engineering career pathways. Many employers were keen to help produce such videos, and suggested showcasing New Zealand engineering roles which influence positive social change on both a national and international scale. FrameCAD, for example, has designed machines for defence and international humanitarian aid operations.

11 NEXT STEPS – KEEPING THE CONVERSATION GOING WITH GREATER COLLABORATION

Employers were keen to stay in contact after the workshop to share knowledge and best practice for mentoring graduates and transforming them into successful engineers, with Professor Scott further encouraging them to share 'cunning plans'.

Professor Scott also invited participants to consider the following questions:

- How could they implement the capability framework into their respective organisations?
- What role do ITPs and universities play in promoting engineering as a career? What are they doing well, and not so well?
- Would ITPs and universities be interested to participate in the proposed replication of the successful early career Engineers project
- How can more business-savvy engineering graduates be developed?
- Who understand concepts around NZ Inc?
- How can investment in STEM at tertiary create new sources of economic income?

12 WORKSHOP FEEDBACK FROM PARTICIPANTS

Q. What was the most interesting aspect of the workshop?

For many, the graduate capability framework was the most interesting aspect of the workshop in that it very usefully articulated the skills they are looking for in engineers. Some participants said they would integrate the framework into their recruitment processes (customising it with more specific wording and embedding a cultural competency).

Many also took away the need for providers of engineering qualifications to strengthen linkages with overseas organisations to share knowledge, resources, and best practice.

Q. What is one area you would like to see followed up?

Participants expressed willingness to work on joint initiatives, especially in raising awareness of the opportunities which open up for students (including women, Māori, and Pasifika) through pursuing engineering as a career. A large number of attendees noted the need for more real-life problem solving opportunities during study and for dilemma-based assessment in the curriculum.

Find out more

- For more about industry involvement in the Engineering E2E Programme: **engineeringe2e.org.nz/Employers**
- For the latest progress on Engineering E2E initiatives: **engineeringe2e.org.nz/Progress**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