

Engineering change

**ENGINEERING EDUCATION TO EMPLOYMENT
STRATEGIC UPDATE**

(as at MARCH 2015)

Engineering change



Engineering fulfils some of the most important functions of a nation – vital both economically and in terms of the well-being of its society.

Yet New Zealand faces critical shortages of engineers across all levels.

The world's global transformation is no more clearly evident than in the two inextricably interrelated growth areas of education and engineering.

If New Zealand is serious about advancing its place among the developed nations, then our education pathways to careers in engineering must be well articulated, funded, promoted and supported at all levels.

The Government has recognised this, through additional funding and by its goal of increasing the number of engineering graduates by 500 each year, by 2017. To coordinate the engineering sector's response to that goal, the Engineering Education to Employment (E2E) Programme was set up in June 2014.

Engineering E2E's initial research has confirmed that the issues behind the shortages in engineers are complex and multifaceted. To make up the shortfall will require a wholesale change in the perception and understanding of the activities, learning areas and professions that engineering encompasses. It will require the active engagement, the commitment, the resources, and the collaboration of all sectors: government, schools, tertiary education organisations and industry. And part of this focus must be on identifying strategies that engage in engineering studies the seriously under-represented groups of Māori, Pasifika and women.

The past nine months of the Engineering E2E Programme have been highly encouraging. Our consultation with sector groups has shown a genuine recognition of, and concern over, the issues. In the tertiary sector, particularly amongst the ITPs, there appears a genuine willingness to seek solutions to the challenges ahead. We have identified successful initiatives already in place that deserve greater support. And we are finding successful overseas initiatives that could well be adapted for the New Zealand environment.

The message is clear: the task is tough. But there is a growing recognition throughout the engineering sectors that this is a task not only worth doing, but one that simply *must* be done, and with all urgency.

SIR NEVILLE JORDAN BE DEng(hc) DistFIPENZ
Chair, Engineering E2E Steering Group

A focus on levels 6 and 7

New Zealand’s shortage of engineers is across all levels, but is particularly critical in our numbers of engineering graduates with qualifications at levels 6 and 7 on the NZQF.

Research from the Institution of Professional Engineers New Zealand (IPENZ), highlights the shortfall in detail. In 2010 IPENZ convened the National Engineering Education Plan (NEEP) Project Governing Group to provide estimates of the demand for and supply of engineers (2010-2015) in New Zealand.

The NEEP Project Governing Group used four sources of data – from the Department of Labour, the Ministry of Education, the OECD and feedback from industry – to reach estimates of the likely future demand for engineering graduates. Two scenarios were selected; “business as usual”, based on historic patterns, and the “innovation-led economy”. The table below shows the estimates for each scenario and the percentage growth required to achieve these figures.

DEMAND ESTIMATES FROM THE NEEP PROJECT GOVERNING GROUP (NEEP, 2010)				
QUALIFICATION TYPE	QUALIFICATION COMPLETIONS IN 2008	ESTIMATED ANNUAL NEEDS BUSINESS AS USUAL	ESTIMATED ANNUAL NEEDS INNOVATION LED ECONOMY	GROWTH REQUIRED
Level 6 Engineering Technicians	270	500	750	85% to 178%
Level 7 Engineering Technologists	180	400	600	120% to 233%
Level 8 Professional Engineers	1,050	1,100	1,400	5% to 33%
TOTAL	1,500	2,000	2,750	33% to 83%

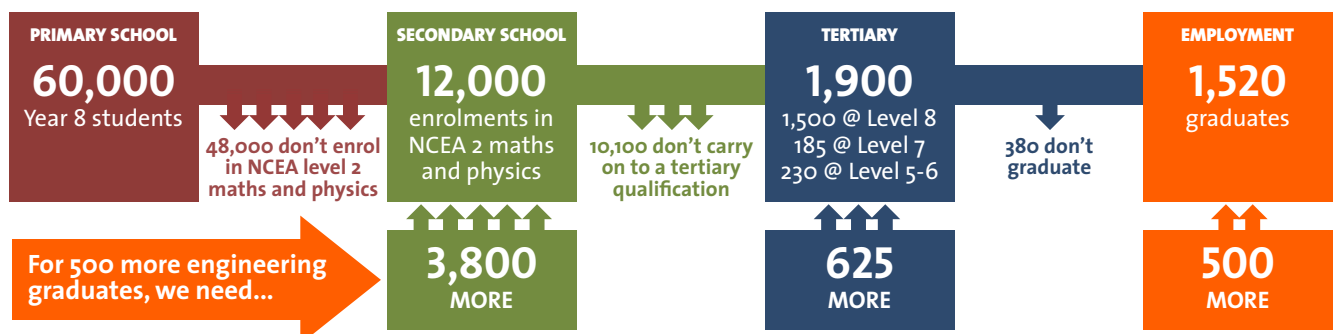
The number of engineers pursuing level 8 qualifications as professional engineers is almost enough to meet the industry’s business as usual needs but 33% short of what we need to become an innovation-led economy.

At levels 6 and 7 qualifications, we are currently able to meet less than half the demand for business as usual engineering. We need to increase the number of graduates by 150%-200% in each case if we are to have the resources to become an innovation-led economy.

If the current rates remain unchanged, we will at best hold even in some areas while we fall behind in many others. This has a direct effect on our economy and our ability to compete internationally as a nation.

Engineering education pipeline – from school to graduation

To achieve 500 more engineering graduates, we need 3,800 more students doing maths and physics at NCEA 2, and then 625 more students enrolling in tertiary engineering qualifications:



Research, dialogue and defining actions

The Engineering E2E Programme represents a partnership between the TEC, the institutes of technology and polytechnics (ITPs), Business NZ, IPENZ and a number of organisations that employ engineers or benefit from their services.

The Engineering E2E Programme has undertaken significant consultation across the sector to get agreement about the issues, underlying causes, and potential solutions.

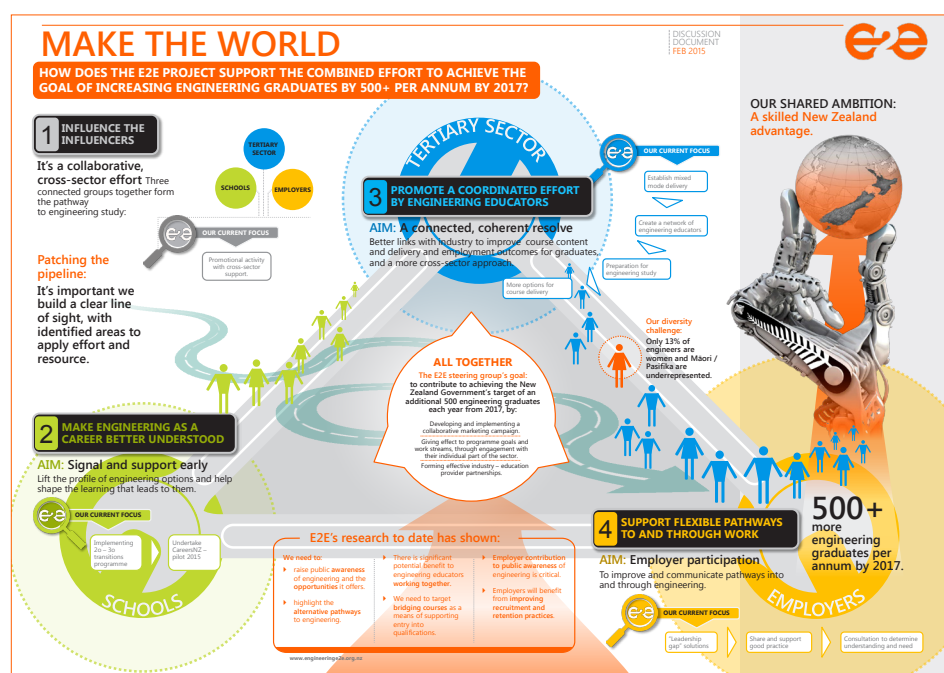
To help define the issues, the Engineering E2E Programme commissioned two research works:

- *Engineering Barriers and Responses*, Research First (October 2014)
- *Improving Pathways to Engineering Education*, Ako Aotearoa (December 2014)

In November 2014, Engineering E2E convened the two-day Alternative Engineering Pathways Professional Forum, in which engineering education providers met to discuss existing pathways, identify the gaps, and explore practical and innovative solutions related to pathways and entry requirements for the BEngTech and NZDE. That month, Engineering E2E also re-convened the NEEP Reference Group, which revalidated the figures in the original 2010 Plan (see page 4).

A key component of the Engineering E2E project has been informing and consulting with stakeholder groups, including engineering educators at ITPs, engineering-related professional bodies, industry organisations and government agencies. Information is shared via the Engineering E2E website which showcases good practice by employers and educators and the project's progress, and each month a newsletter is distributed to a wide range of interested parties. Meetings have been held with organisations such as Association of Consulting Engineers New Zealand, Electricity Engineers Association, New Zealand Board of Engineering Diplomas and government agencies including Ministry for Women, Callaghan Innovation and Ministry for Pacific Island Affairs, all of which have expressed their enthusiasm for the work and willingness to support the achievement of the project goals. Hearing the views of stakeholders and inviting their contribution is a vital to inform the Engineering E2E Steering Group's recommendations and any resulting actions. Engineering E2E will take the opportunity to leverage and link with the work of these agencies such as the Vocational Pathways initiative and a Nation of Curious Minds.

This consultation and research has led to consolidation of agreement among stakeholders about the underlying issues and challenges. This is particularly apparent in the ITP sector, where there is a demonstrable willingness to collaborate with both schools and industry.



The 'Make the World' infographic, developed in January 2015, aims to define the sectors and their roles, and to summarise the issues, activities and possible future direction of the Engineering E2E initiative.

Issues, needs and recommendations

The problems in the engineering pipeline from education to employment are numerous and complex. There are significant issues at all levels of the engineering supply chain resulting in an under-supply of engineering graduates.

Rates of students entering into and completing engineering qualifications in New Zealand are well below the OECD average. Tuition subsidy rate increases from Budgets 2012 and 2013 have not resulted in significant increases in the number of EFTS or qualification completions in engineering priority areas, especially in ITPs at levels 6 and 7.

Barriers pertain to different sectors of society and occur at different stages along the engineering pipeline, and can be grouped in four key themes/sectors: Public awareness; School; Tertiary Sector; and Employers.

PUBLIC AWARENESS

The New Zealand public lacks awareness about what an engineer is and what value an engineering qualification has. Sometimes, engineering is thought of as boring, physical and/or dirty.

This means that children – especially Māori, Pasifika and female – are not encouraged into engineering as a study option as much as they could be, particularly by influencers such as parents, whanau, teachers and careers advisors. In addition, issues of prestige cause some students to prefer to enrol in universities rather than ITPs. This preference is particularly driven by parents, who are primarily the most significant sources of influence regarding decisions about where and what their children study.

RECOMMENDED ACTION	DESCRIPTION	EXPECTED OUTCOMES	KEY PARTNERS	DURATION
Develop and deliver a nation-wide awareness campaign	A campaign which celebrates engineers and their achievements over a broad range of engineering disciplines, clarifies levels 6, 7 and 8 in terms of content and outcomes, and profiles Māori, Pasifika and women in the profession	Improved awareness by the general public of engineering and its contribution to the social and economic well-being of New Zealanders	Employers Professional bodies Government agencies including Ministry for Women, Ministry of Pacific Island Affairs TEC	2 years

Issues, needs and recommendations

EDUCATIONAL DELIVERY – SCHOOLS

- Teaching of the STEM subjects in schools needs to be better supported to stimulate more interest, as they are a critical foundation to ensure more students take up studies/careers in science, technology and engineering.
- Pathways between secondary school study and engineering qualifications must be more clear, so students gain the right prerequisites for engineering study. Careers information should be consistent and promote the three pathways to the engineering profession – the NZDE, the BEngTech and the BE(Hons).
- The approach taken to teaching prerequisite subjects must more adequately prepare students for higher-level study in engineering; more Māori, Pasifika and females must be encouraged to consider engineering.
- We have a good technology curriculum, but it must be more widely and better taught in secondary schools.

RECOMMENDED ACTIONS	DESCRIPTION	EXPECTED OUTCOMES	KEY PARTNERS	DURATION
Teacher education*	Identify and implement a range of strategies to improve the focus and relevance of science maths and technology teaching in primary and secondary schools	More students studying science, maths and technology at all levels of the compulsory sector	Ministry of Education Providers of teacher pre-service and in-service professional development Teachers TEC	5-10 years
Student achievement*	Identify and implement strategies to increase student achievement in science, maths and technology at all levels of primary and secondary schools	Improved levels of achievement in science, maths and technology at all levels of the compulsory sector More students choosing to study engineering and technology-related subjects at tertiary level	Ministry of Education School communities	5-10 years
Secondary-tertiary transitions	Work with secondary schools and TEOs (particularly ITPs) to develop practically-based engineering-related programmes in secondary schools (mostly Level 3), co-delivered by tertiary educators, to enable students to gain engineering prerequisite achievement standard	More students transitioning easily to appropriate engineering education pathways at tertiary level	Ministry of Education ITPs Physics, maths and technology teachers	2 -3 years
Develop engineering preparation courses	Provide support for engineering educators to work proactively with industry, secondary schools and government agencies to develop a common set of flexible, multipurpose, mixed mode engineering-specific preparation courses or modules for secondary and tertiary students, able to be used for preparation for engineering study while in school, as bridging programmes, and just-in-time refreshers/ preparation for current students	Increased numbers of appropriately prepared students entering and graduating from engineering study	Engineering educators Schools NZQA TEC	2 years

*The Government is already investing \$359m over four years and \$155m per annum thereafter as part of its Investing in Educational Success initiative. This involves raising teaching quality to raise student achievement and should contain a focus on science, technology and mathematics.

Issues, needs and recommendations

EDUCATIONAL DELIVERY – TERTIARY

- There must clear school-tertiary-employment pathways to the engineering profession that ensure best-fit with students' interests and aptitudes.
- Access is improved for students when it is easy for them to switch pathways and to retain the credit value of previous study, and to transfer credits between qualifications and providers.
- When enrolments are consistently low, regional ITPs should be encouraged to look to collaborate to combine courses, rather than cancel programmes.
- Good quality bridging programmes must be readily available for students who have not achieved prerequisites at school, available. TEOs need clarity on whether the TEC can fund these programmes.
- It is important that courses provide graduates with the skills and experience relevant to work in their chosen field.
- Tertiary providers must have the capability to respond to the demand for places, particularly when this increases in the near future.

RECOMMENDED ACTIONS	DESCRIPTION	EXPECTED OUTCOMES	KEY PARTNERS	DURATION
Create a network of engineering educators	Provide a forum across all institutions that offer the NZDE, BEngTech and BE(Hons) to improve teaching and learning and share good practice	An effective professional learning network which supports ongoing improvement in the quality of engineering education	Current education engineering groups Employer groups IPENZ	6 months – ongoing
Establish a mixed-mode course initiative	A research programme to determine best practice in mixed-mode (online and classroom) delivery, and to facilitate the development of new courses using methods recommended by this research	Engineering courses delivered effectively via mixed mode	Research group ITPs TEC	1 year
Demonstrate clear pathways	Collaboration between tertiary providers and careers information providers to demonstrate clear pathways from school to study and on to employment	Consistent, clear and simple messages about the pathways to engineering careers.	Tertiary providers Careers NZ Futureintech	1 year

Issues, needs and recommendations

EMPLOYER ENGAGEMENT

- Strengthen links between TEOs and industry to improve understanding each other's role.
- Raise employer awareness of the value and purpose of levels 6 and 7 engineering qualifications, so that both graduates and their employers will benefit from their being placed in an appropriate role for their qualification.
- Employers will gain from actively providing opportunities for students to get experience that will help them to be work-ready and skilled.
- The industry is male-dominated – it is difficult for women to see a place for them in the industry to aspire to.
- Major engineering employers are now experiencing the after-effects of a ten-year period of under-investment in engineering training (particularly at the certificate and diploma levels), which means they do not have the professional leaders available to support new graduates entering the workforce.

RECOMMENDED ACTIONS	DESCRIPTION	EXPECTED OUTCOMES	KEY PARTNERS	DURATION
Re-convene the NEEP Reference Group	Consideration of the engineering employment targets based on the results of consultation	A set of reliable employment targets	IPENZ TEC	1 year
Employer consultation	Implement actions resulting from employer consultation	A set of reliable employment targets Increased awareness of the role of employers in profiling engineering and engineering education	Employers Professional bodies Employers	1-5 years
Promote recruitment and retention strategies to ensure diversity in the engineering workforce	Use the Engineering E2E website and other means to share case studies and research of good practice.	More Māori, Pasifika and women enter and stay in the engineering workforce	TEC Employers	10 years

Engineering E2E past, present and future

	COMPLETED ACTIVITIES (to Feb 2015)	CURRENT + ONGOING ACTIONS	RECOMMENDED ACTIONS
PROMOTION	<p>ENGINEERING E2E FORMAL LAUNCH EVENTS (<i>July/August 2014</i>) Held in Auckland Hamilton and Wellington</p> <p>ENGINEERING E2E WEBSITE LAUNCHED (<i>August 2014</i>) and developed over its first six months</p> <p>ENGINEERING E2E MONTHLY NEWSLETTER ESTABLISHED (<i>First issue August 2014</i>)</p> <p>RESEARCH FIRST REPORT: ENGINEERING BARRIERS AND RESPONSES (<i>October 2014</i>) Research on barriers to the uptake of engineering study in New Zealand: Barriers in secondary education; Barriers in industry; Barriers in the tertiary space; Perceptions of engineering among students, parents, teachers and the public</p> <p>MAKE THE WORLD: A discussion document for stakeholders that aims to distil the aspirations and future focus of the Engineering E2E project</p>	<p>WORKING WITH CAREERS INFORMATION PROVIDERS, such as CareersNZ and Futureintech, to ensure alignment</p> <p>ENGINEERING E2E WEBSITE: Continues to be developed as a resource for all stakeholders</p> <p>ENGINEERING E2E MONTHLY NEWSLETTER: The newsletter has gained considerable traction, with good uptake by stakeholders</p>	<p>DEVELOP AND DELIVER A NATION-WIDE AWARENESS CAMPAIGN: A campaign which celebrates engineers and their achievements over a broad range of engineering disciplines, clarifies levels 6, 7 and 8 in terms of content and outcomes, and profiles Māori, Pasifika and women in the profession</p>
EDUCATIONAL DELIVERY	<p>EXTENSIVE CONSULTATION WITH STAKEHOLDERS, including conference/forum attendance and Education Advisory Group meetings, to develop an understanding of activity in the sector, especially ITP actions and initiatives</p> <p>NATIONAL ENGINEERING EDUCATION PLAN (NEEP) REFERENCE GROUP MEETING (19 November 2014): The first review of the NEEP (IPENZ 2010) by a reference group of employers, tertiary education and professional body representatives, which provided recommendations to help inform future engineering education funding decisions</p> <p>AKO AOTEAROA REPORT: IMPROVING PATHWAYS TO ENGINEERING TECHNOLOGY EDUCATION: Based on the Alternative Engineering Pathways Professional Forum (Nov 2014), interviews with students and other research, this report provides recommendations on how to improve pathways from school to tertiary to industry (particularly secondary-tertiary bridging and foundation courses) and how to address broader challenges to raising the profile of engineering in New Zealand.</p> <p>CASE STUDIES OF GOOD PRACTICE IN ENGINEERING EDUCATION: Gathering and dissemination via the Engineering E2E website of good practice with regard education/industry links</p>	<p>CONTINUED CONSULTATION WITH STAKEHOLDERS</p> <p>CASE STUDIES OF GOOD PRACTICE IN ENGINEERING EDUCATION: Continued gathering and dissemination via the Engineering E2E website of good practice with regard education/industry links</p>	<p>TEACHER EDUCATION: Identify and implement a range of strategies to improve the focus and relevance of science maths and technology teaching in primary and secondary schools</p> <p>STUDENT ACHIEVEMENT: Identify and implement strategies to increase student achievement in science, maths and technology at all levels of primary and secondary schools</p> <p>CREATE A NETWORK OF ENGINEERING EDUCATORS: Provide a forum across all institutions that offer the NZDE, BEngTech and BE(Hons) to improve teaching and learning and share good practice</p> <p>SECONDARY-TERTIARY TRANSITIONS: Work with secondary schools and TEOs (particularly ITPs) to develop practically-based engineering-related programmes in secondary schools (mostly Level 3), co-delivered by tertiary educators, to enable students to gain engineering prerequisite achievement standard</p> <p>DEVELOP ENGINEERING PREPARATION COURSES: Provide support for engineering educators to work proactively with industry, secondary schools and government agencies to develop a common set of flexible, multipurpose, mixed mode engineering-specific preparation courses or modules for secondary and tertiary students, able to be used for preparation for engineering study while in school, as bridging programmes, and just-in-time refreshers/preparation for current students</p> <p>ESTABLISH A MIXED-MODE COURSE INITIATIVE: A research programme to determine best practice in mixed-mode (online and classroom) delivery, and to facilitate the development of new courses using methods recommended by this research</p> <p>DEMONSTRATE CLEAR PATHWAYS: Collaboration between tertiary providers and careers information providers to demonstrate clear pathways from school to study and on to employment</p>
EMPLOYER ENGAGEMENT	<p>EXTENSIVE CONSULTATION WITH STAKEHOLDERS, including conference/forum attendance and meetings with professional group representatives and employers</p> <p>CASE STUDIES OF GOOD PRACTICE IN THE ENGINEERING EMPLOYMENT SECTOR: Gathering and dissemination via the Engineering E2E website of good practice with regard to education/industry links</p>	<p>EMPLOYER CONSULTATION WORKSHOPS: Pilot workshop to be held in Wellington in June</p> <p>CASE STUDIES OF GOOD PRACTICE IN THE ENGINEERING EMPLOYMENT SECTOR: Continued development</p>	<p>RE-CONVENE THE NEEP REFERENCE GROUP: Consideration of the engineering employment targets based on the results of consultation</p> <p>EMPLOYER CONSULTATION: Implement actions resulting from employer consultation</p> <p>PROMOTE RECRUITMENT AND RETENTION STRATEGIES TO ENSURE DIVERSITY IN THE ENGINEERING WORKFORCE: Use the Engineering E2E website and other means to share case studies and research of good practice.</p>
OPERATIONS + POLICY	<p>MONTHLY STEERING GROUP MEETINGS to provide governance and oversight</p> <p>EARLY ENGAGEMENT WITH THE MINISTER</p>	<p>MONTHLY STEERING GROUP MEETINGS</p> <p>ENGINEERING CHANGE – STRATEGIC UPDATE (<i>March 2015</i>)</p> <p>USING ENGINEERING E2E KNOWLEDGE TO INFORM MINISTERS OF POTENTIAL ACTIONS</p>	

Engineering E2E Programme Steering Group

The Steering Group members represent key stakeholder groups from the engineering sector including education and employment in a wide range of disciplines. Members are a crucial link to the wider sector and play an important role in gathering and disseminating information.

The Steering Group's purpose is to guide and oversee the programme. It is made up of a broad range of business, education and professional representatives committed to the cause.

The group's goal is to contribute to achieving the New Zealand Government's target of an additional 500 engineering graduates each year from 2017, by: developing and implementing a collaborative marketing campaign; giving effect to programme goals and work streams, particularly through engagement with their individual sectors; and forming effective industry/education provider partnerships.

STEERING GROUP MEMBERS

- Sir Neville Jordan (*Steering Group Chair*)
- Grady Cameron, CE, Delta Utilities
- Lindsay Crossen, Chairman, Board of Engineering Diplomas
- Dr Rick Ede, CE, Unitec
- Mark Flowers, CE, Wintec
- Kay Giles, CE, CPIT
- Tony Gray, CE, NMIT
- Professor Margaret Hyland, Deputy Dean of Engineering, University of Auckland
- Murray Johnson, Manager, Strategy, TEC
- Max Kerr, Metro CE Group Coordinator
- Richard Muggleston, Senior Bid Manager, Construction, Fletchers (*IPENZ representative*)
- Carrie Murdoch, Manager, Education Skills and Trade, Business NZ
- Kevin Palfreyman, External Relationships Liaison Manager, Research, Science, Technology & Development, Fonterra
- Michael Pervan, General Manager, Altitude Aerospace
- Craig Price, Regional Manager, Beca Christchurch



ENGINEERING
EDUCATION **TO** EMPLOYMENT