

Engineering a future



Engineering students at Victoria University, home to New Zealand's newest professional engineering degree. But did this country really need another engineering school?

The new tertiary education funding system is supposedly geared to ensure skill needs are better met and tertiary education providers are collaborating.

JOHN GERRITSEN considers the challenges for a discipline at the sharp end of both those issues – engineering

ENGINEERING, they say, runs in families. Where there's an uncle or a grandfather who was an engineer in the profession's male-dominated past, the chances are you'll find a young person following in his footsteps today.

That tendency toward lineage apparently stems not so much from natural aptitude for engineering so much as understanding just what engineering entails. Where a young person in a non-engineering family might discount engineering as a future of oil stains and blue overalls, those with engineering relatives know the reality is a career as a problem-solver who will tackle problems ranging from roading and electricity to large-scale computer systems and environmental issues.

But where an understanding of the profession might run in the genes of Kiwi engineers, prolific breeding apparently does not. For while the rest of the OECD sees about 13 per cent of their degree and post-graduate students graduating with qualifications in engineering, manufacturing and construction, New Zealand's figure is less than half that – just 5.7 per cent.

That figure makes our degree graduation rates for engineering (and manufacturing and construction) further from OECD norms than any other discipline. Life sciences? We're just below average. Physical sciences? Above the average. Maths and stats? Average.

The picture is even worse at diploma and certificate level. The OECD norm for such graduates in engineering, manufacturing and construction is 16.3 per cent. New Zealand's figure is just 3.9 per cent. And again, no other area of study in this country is so far from the average for the developed world.

Of course, it could be that none of this matters. New Zealand does not have the industrial base of some of engineering's big hitters like Germany, Korea, Finland, and Sweden, so do we really need a higher proportion of engineering graduates?

The answer from Institute of Professional Engineers (IPENZ) chief executive Andrew Cleland is a clear "yes".

In fact says Cleland, New Zealand needs about twice as many engineering graduates each year as it currently produces.

To prove his point, he produces Department of Labour figures that show just how tough it is to hire an engineer in New Zealand. Those figures show that the fill rates for engineering positions were significantly below the average of 61 per cent last year. Chemical engineers appeared to be easiest to find, with 53 per cent of such jobs filled within 10 weeks, but anybody seeking a structural engineer was facing an uphill battle with none of the 19 positions considered by the Department of Labour's survey filled within 10 weeks. The category of "other

civil engineer" was not far behind with a fill rate of just 13 per cent for 60 jobs covered by the survey, while electronic and telecommunications engineering positions had a fill rate of 25 per cent.

And that situation is only going to get worse, Cleland predicts. Worldwide, there is a shortage of engineers and New Zealand will itself need more with major challenges ranging from Auckland's roading to sustainable energy supply – challenges exacerbated by New Zealand's long, skinny and mountainous geography.

University of Auckland acting dean of engineering David Ryan agrees. "These are not science problems," he says of the big projects and issues facing this country, "most of these are engineering and business problems. We are in a position where we do need to increase our engineering output."

In particular, New Zealand needs more civil or heavy infrastructural engineers, though there is also demand for engineers in other specialties, notably mechanical and electrical engineering.

It might be useful then for the nation's engineers of breeding age to, ahem, 'get busy', but the real need for more engineers is right now. Clearly New Zealand needs to look beyond engineer fertility if it wants to address its shortage.



The engineering school's annual bridge building (and breaking) competition at the University of Canterbury neatly encapsulates the challenges of engineering. Students must build a bridge that will hold two of them, but collapse when a third steps onto it. Pictured are Liam Duff (centre) with team mates, Damian Philippen and Neville Wilson at last year's event.

The obvious answer is to increase the intake of students to New Zealand's engineering schools.

Massey University dean of engineering and chair of the Council of Engineering Deans, Bob Hodgson, says an informal survey last year concluded that the seven schools then offering four-year degrees could increase their intake by 50 per cent with little capital investment.

"There is capacity in the system," he says, but adds that finding appropriately-qualified staff is likely to be a big problem.

The pro vice-chancellor of the University of Canterbury's college of engineering, Peter Jackson, is cautious about expansion, or at least large-scale expansion.

While he recognises the need to provide more graduates – "We get berated every month by the consulting industry for not increasing our intake of civil engineers" – he warns that there are shortages in all areas of engineering and that not so long ago (about eight years) there was actually a downturn in demand for civil engineers and graduates had trouble finding work.

In addition, Jackson says there are practical barriers to expansion.

"We can't double the output, which is what the current demand requires. We'd have to make quite significant investment and that's risky for us because the investment has got to last 50 years and we need to be careful that demand will last."

The subtext is that someone else – the government – would have to come to the party with extra funding so that Canterbury's school could expand.

The University of Auckland is home to the only other New Zealand engineering school to offer civil engineering. David Ryan, who was acting dean at the time this interview took place, says Auckland's engineering school is looking to increase its annual intake above the current limit of 550.

He says that limit was self-imposed and Auckland has the toughest entry requirements of any engineering school in Australasia. "If we benchmarked our entry standards on New South Wales and Melbourne, then we would get a higher number of students."

Unlike Canterbury's Jackson, Ryan says the increased income from student subsidies and fees should be enough to cover the costs of such expansion, but it appears the sort of increase he is considering is a lot less than doubling the annual intake.

But engineering schools cannot simply increase their intakes. Until this year, modest increases in student numbers were funded at public institutions, but from the start of next year the new tertiary education funding system will only fund enrolment increases if they have been pre-approved by the Tertiary Education Commission (TEC). To get that approval, tertiary institutions must prove to the commission that there is demand that warrants expansion of a particular programme or the introduction of a new one. In addition, the new system will enable providers to put their hands up for extra funding to make marginal courses viable or for new areas of investment – such as the expansion of an engineering school.

IPENZ has already written to the Tertiary Education Commission (and the

Vic versus Massey

With a shortage of engineers afflicting the country, one would expect celebration in engineering circles at the creation of a new professional engineering programme at Victoria University this year. And one would be wrong.

Victoria's move into engineering was greeted with dismay by Massey (which had recently introduced a four-year engineering degree to its Wellington campus), prompted IPENZ to warn very clearly that Wellington was not big enough for two professional engineering schools, and appeared to expose serious shortcomings in the Tertiary Education Commission's powers.

The main problem identified was the issue of critical mass. As mentioned in the main article, IPENZ is of the view that professional engineering schools need to graduate 100-150 students a year from related engineering specialties in order to be viable – and that is per campus, a multi-campus institution like Massey cannot count its graduates from all campuses in that total. IPENZ was also of the view that there would not be sufficient students for two viable professional engineering schools in the capital.

Despite those concerns and despite its role in steering a tertiary education system that should have less competition and more collaboration, the TEC appeared unable to stop Victoria's foray into engineering. Instead, it warned Victoria in no uncertain terms not to expand its engineering programmes without TEC's approval and stated that it "expects that VUW and Massey University will develop a collaborative approach to the provision of engineering in Wellington".

Asked to explain its failure to prevent Victoria entering the engineering world, the commission indicated that Victoria's programme, which concentrates on software and electronic engineering, was not necessarily direct competition for Massey. But *Education Review* understands TEC's ability to veto the course was very much a legal grey area, and one which stands to be rectified before the end of the year with an education amendment bill.

So will Massey and Victoria collaborate as instructed by the TEC?

Massey's Bob Hodgson indicates it might take time. "Just at the moment there needs to be some diplomacy. The go ahead for Victoria was against expectations."

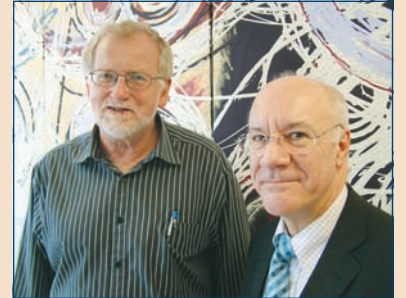
The view from Victoria is similarly cautious. Pro vice-chancellor for information technology Warwick Clegg says Victoria "would certainly look with an open mind at any suggestions for collaboration if it was sensible", but also says that Victoria has no intention of moving into other areas of engineering so TEC's requirements are not seen as a constraint.

But just how similar are the Massey and Victoria degrees?

Victoria essentially altered its three-year Bachelor of Information Technology to become a four-year Bachelor of Engineering with specialties in electronics, computer systems, software, and networks. (A move Massey's Hodgson derisively compares to rebadging a Lada as a BMW.)



Massey University dean of engineering Bob Hodgson. "We know the people at Victoria... there aren't fist fights in the street when we meet."



Victoria University's engineering bosses – professor of computing science John Hine (left) and pro vice-chancellor for information technology Warwick Clegg. Confident Victoria's engineering programme will gain a critical mass of students.

And Massey's offerings? The four-year degree it introduced last year has two main strengths – mechatronics and multi-media systems engineering.

"The distinctions are not huge," says Hodgson.

But Victoria's pro vice-chancellor for information technology Warwick Clegg says the differences between the two universities' engineering programmes are such that "we didn't feel we were really bringing ourselves into competition with them [Massey]".

Clegg says the specialties in Victoria's degree were chosen because they matched the university's existing research and teaching base and addressed an area of skill shortage that was expected to worsen.

So Victoria wasn't being bloody-minded by introducing its engineering degree?

"We looked at Auckland and found that there were three universities and Manukau Institute of Technology offering engineering in that area and we really felt that the bottom of the North Island and the South Island could support three... Canterbury, Massey and ourselves.

"Wellington has got a big catchment area... our offerings were not duplicating what Massey was offering and there was really quite spectacular need for more graduates."

And would Victoria's action have been more difficult had it not got in before the introduction of a new tertiary education funding system next year?

"The way TEC is moving is to a very much more managed environment and constrained EFTS. I think any programme next year is going to be subject to scrutiny," Clegg says.

Whether student numbers will be an issue remains to be seen. Victoria's first intake for its BEng this year is 100 students, while Massey last year had about 42 students in its four-year degree.

Clegg says 100 students was more than expected and while he does not expect all 100 to continue to graduation, he would like to "build up a little bit" from 100 new enrolments per year.

He is also confident that Victoria will reach the critical mass recommended by IPENZ.

CONTINUES FROM PAGE 7



University of Waikato associate dean of engineering and chair of the department of engineering, Janis Swan. "My wish actually would be that somehow we could fund students coming into engineering. I don't think funding the schools as such would get us that much further along."



Institute of Professional Engineers (IPENZ) chief executive Andrew Cleland. New Zealand needs more engineers.

Ministry of Education and Qualifications Authority), putting the case for an increase in the number of engineering graduates, but quite what should happen next is not clear.

Cleland says: "Our hope is the TEC will recognise what is the appropriate level of investment for engineering in New Zealand at all levels, from trades to PhDs."

The IPENZ paper suggested that there should be just four to seven campuses providing professional (four-year or longer) engineering programmes and only two or possibly three should cover large-scale infrastructural or civil engineering. Together those schools should produce 1500-2500 graduates per year. In addition, there should be four to seven providers of Bachelor of Engineering Technology degrees – a three-year qualification – and a network of polytechnic provision of engineering diplomas, with 500-1000 graduates per year from each type of qualification.

The number of graduates suggested in the IPENZ paper is roughly double the current output and would align New Zealand with OECD norms.

But the issue is not as simple as building or expanding engineering schools. The IPENZ paper also notes that each professional school (those offering four-year Bachelor of Engineering degrees) should produce at least 100-150 graduates per year from a range of inter-related engineering disciplines – any fewer and they are unlikely to have the critical mass required to meet the institute's accreditation requirements.

In addition, the country needs a truly national network of provision among the nation's polytechnics for engineering diplomas, Cleland says. There is a substantial shortage of engineering technicians, he says. "We've survived the last few years by importing engineering technicians from South Africa. We're only now starting to rebuild national qualifications for these people."

But this is a niche area of provision, which means a sensible solution would be for several polytechnics to offer base courses with just one provider offering the final papers in each area of specialisation, Cleland says. It's exactly the sort of solution the new tertiary education system is designed to provide, but it's anyone's guess when or if such a solution will in fact be arrived at.

It seems that the TEC will be left to weigh up possibly competing bids for increased intakes at some engineering schools and possibly also bids for capital investment to enable those increases. It will also need to consider the fact that where IPENZ recommended there be a maximum of seven schools offering professional engineering degrees there are now eight.

The commission's job might be made easier in one respect – the question of whether New Zealand needs a third civil engineering school. Auckland and

Canterbury's spokespeople agree that their schools should be able to provide the increased number of civil engineering graduates required, though Canterbury's Jackson admits that if demand holds up it might be in the country's interests to develop a third. However, the heads of the Waikato, Massey and Victoria schools all told *Education Review* they were not interested.

In the meantime, the commission has indicated it is ready to engage with the engineering world on the issue of increased student numbers.

TEC deputy chief executive Colin Webb says: "Where there is capacity in current engineering schools to deliver more engineering student places and there are students seeking to enrol, the TEC will discuss with the universities concerned how increased provision might fit in the context of institutional plans.

"Funding will take into consideration the wider network of engineering provision bearing in mind that funding for all tertiary sub-sectors, including universities, is controlled."

Webb says the commission will also work with the engineering profession and other key stakeholders to identify ways the numbers of students seeking to enrol in engineering programmes can be increased.

This raises an important issue for engineering schools – even if they were given the green light to take more students, it is debatable whether many more would actually enrol.

Bob Hodgson candidly admits that a lack of potential students is a significant issue: "In general it's not a shortage of places, it's a shortage of students who are sufficiently qualified."

"We do most of our recruiting at a higher level in high school, but the [subject] decisions are made rather early – I think we should be talking to 12 year olds."

Auckland's David Ryan concurs, saying that the preparation of secondary school students for engineering study is perhaps a bigger issue than expansion of engineering schools.

Prospective engineering students need to have studied maths with calculus and physics. IPENZ has been aware of this issue and developed programmes to ensure young people are aware of engineering at an earlier age and will, hopefully, make the right subject choices while at secondary school. The IPENZ programmes include the Neighbourhood Engineers scheme which gets school children working alongside engineers; Futureintech – a government-funded programme aimed at raising the profile of engineering among school students and their teachers and career advisors; and Techlink, a website that provides support for school teaching of technology.

But more is needed, says Massey's Bob Hodgson.

"What we need is the Prime Minister and captains of industry talking up those technological careers."

Canterbury's Peter Jackson says one issue is the low visibility of schools of engineering other than Auckland and Canterbury.

Those who don't get into engineering at Auckland or Canterbury tend to choose another discipline at one of those universities instead of pursuing engineering at another university, such as Massey or Waikato. That needs to change, he says.

"Auckland and Canterbury are both pretty much full – students know they are the two places to try to get into. At the same time, most of the other places offering engineering are not full. So there is a problem in diverting those who can't get in."

University of Waikato associate dean of engineering and chair of the department of engineering, Janis Swan admits there is an issue with awareness, at least for Waikato's relatively young engineering department.

The university still encounters surprise from potential students who are not aware that it offers a four-year professional engineering degree, she says.

The programme produced its first six graduates in 2002 and Waikato now has 47 students in its fourth-year cohort.

Swan agrees that increasing engineering school intakes would help meet the demand for more engineers, but she notes that Waikato does not have a cap on its intake and that increased intakes can only go so far before staff and resources are too stretched.

In terms of attracting more students to engineering, Swan says she would like to see more money go to the students rather than the engineering schools.

"My wish actually would be that somehow we could fund students coming into engineering. I don't think funding the schools as such would get us that much further along."

That money, she says, could be used to subsidise students' fees, creating an incentive for people to study engineering.

IPENZ executive director Andrew Celand is optimistic that enrolments can be increased. He believes labour markets work, albeit with a time lag, and if capacity at the engineering schools is expanded, the students will follow – so long as there is the demand in the job market.

How well the new tertiary education system, and the TEC in particular, responds to the challenges posed by the engineering schools will be of interest to tertiary education observers up and down the country. After all, engineering has the key elements that the new system was supposed to address – skill shortages, capacity issues at education providers, the potential for wasteful competition, and a need for national network of provision.

And now? Let's just wait and see what happens.

What is engineering?

"The difference between engineering and science," says the chair of the Council of Engineering Deans, Bob Hodgson, "is that engineering has to work."

After all, there's not a lot of use for bridges that test interesting principles, but can't be driven on. Or electricity grids that black out.

University of Waikato engineering head Janis Swan also has a science-engineering comparison. "A scientist is like a triangle – you start with a base and become very knowledgeable about a specific area. Engineers are more like a box – you throw in

elements of management, social awareness, looking at costs..."

Swan says engineers need to be able to work in multi-disciplinary teams and are taught to look at clients' needs, to weigh up options including cost and risk factors, and complete designs.

Engineers think in different ways, and we need more of them, she says – and not just in engineering.

Institute of Professional Engineers executive director Andrew Cleland agrees. Overseas experience indicates that businesses are

stronger if engineers are involved in their management and governance.

Engineering is divided into two broad types – infrastructural or "civil" engineering and wealth creation. The former is concerned with the systems on which modern society depends such as roading, and the latter with new products or systems, such as in IT. The specialisations of New Zealand's accredited professional engineering degrees include civil, manufacturing, biotechnology and computer systems engineering. There are also degrees in electrical and electronic engineering, and mining, agricultural and forestry engineering.