Canterbury Earthquakes Royal Commission
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Submission re; Training and Organisation of the Engineering Profession

This submission relating to the training and availability of Technicians / Technologists, and the part they play in the Engineering Profession, is made by the Design Association of NZ.

Design Association of NZ inc - DANZ was founded in 1946 to represent persons working primarily in the preparation of design documentation. In early times most of the work was to do with public infrastructure, road, rail, defence, electricity, mining, telecommunications, land division and mapping, and state housing. In 1961 DANZ joined with other technological associations to support the enactment of the Engineering Associates Registration Act. Being mentioned in statute distinguishes DANZ from other technologist practitioner organisations.

With the change arising from privatization of the hitherto largely public owned design and documentation business, DANZ membership changed from being a professional support facility, for a relatively few large design offices, to a large number of small practices with many sole practitioners. DANZ has responded to these challenges by insisting its membership gain and maintain a high standard of ethical practice, and reinforces this with education programmes, disputes avoidance and resolution schemes, and risk management programmes supported by a high quality professional indemnity insurance facility.

DANZ fully supports the aims of its peer groups such as professional Engineers and Architects, Standards New Zealand, the Building and Construction Industry Training Organization, the polytechnics, universities, etc.
For more information please visit www.danz.co.nz

1. Submission Summary

1.1 Much has / is being said about Professional Engineers in these post-earthquake hearings, however it is our view that they are but part of an industry team comprising University Educated Engineers, Engineering Technicians / Technologists, and Trades; that might be working in the design or construction sectors. For the team to function at its best there needs to be an overall ratio something in the order of 1 Engineer to 4 Technicians / Technologists, to 16 Tradespeople. Further, for each group there needs to be adequate training and occupational regulatory systems.

1.2 In New-Zealand the current arrangements are far from being what they should be.
University education has been maintained, although entry criteria relaxed, with excessive social belief that university education is a must have, to the detriment of both Technician / Technologist and Trades groups.
Technician / Technologist education and training was decimated with the abolition of NZ Certificate qualifications, and trades similarly treated with the abolition of apprenticeships until more latterly when modern apprenticeships were introduced. Only some of the NZ Certificate qualifications have been replaced, although generally with something of lesser demand and standing, and general consensus is that the modern apprenticeships are likewise of lesser standing.

Whilst we have no numbers for the trades areas, in 2006 we had then for every University educated engineer, 0.96 technician / technologists, 1:0.96. That is, instead of 1:4 we had 4:1 and this result confirms the continuing decline in technician / technologist numbers.
Even more disturbing though, are the results of engineering qualifications completed in 2008 which show the replacement ratio at 1:0.43, ie 2.3 engineers per technician / technologist instead of 4 technician / technologists per engineer. As a consequence of this, University educated engineers are being used in technician / technologist roles for which they have received no training.

1.3 In terms of Occupational Regulation, we have in a generic form: Chartered status for various University educated, Registration for the technician / technologist group (however only for Engineering) and Licencing for many trades (although only after systemic failure surfaced through the leaky-home issue).

1.4 The industry make-up is in our opinion currently unbalanced and extremely weaker than it should be, with an incomplete regulatory structure, and consequences will continue to be suffered until these deficiencies are rectified.

1.5 What we need from this Commission, are recommendations for Government to review;

a) the Engineering, Building and Construction Industry structure with respect the numbers involved in each group,
b) TEC funding distribution of tertiary education funds on a qualification and ratio basis commensurate with recognised employment structure ratios,
c) education fundamentals for the building and construction industry across all groups and disciplines,
d) the establishment of an education and training organisation for levels 6 and 7,
e) an occupational regulatory structure supporting the three group employment structure across broadened work-force descriptors with consistency of credential form,
f) the introduction of work-force planning that drives education and training funding, and,
g) specific training and qualification for careers advisors with industry experience to become a pre-requisite.

These reviews need to be conducted by, and driven by, researchers with economic and management experience and independent of the engineering groups, academia, and organisations that are the subject of the review, but using these various groups and bodies to assist where appropriate.

2. The Engineering Team

2.1 The university educated professional brings a high level of academic learning that enables development of concepts from first principles, and the introduction of research based innovation; the trades bring the practical skills that create the final product, be they routine or highly technical; the technicians / technologists are the linkage between them, the glue between their colleagues in the team.
It is the Technicians / Technologists with an understanding of both the professionals and the trades needs that are the all-important link. The existence of Technicians / Technologists supports the need that has been / is necessary to bridge the crevice between the theoretical and the practical,

"a crevice that is becoming a crevasse,"

as technology advances and the gap widens. This need is not new, but has evolved over centuries as a result of market force needs. It is worth reflecting on the fact that all three groups have evolved from a single artisan group centuries ago.

2.2 In a very generalist manner it has often been said that:

"The university educated are so theoretically focused as to be practically useless",
and "The trades so practically focused as to be theoretically useless".

2.3 As the rate of change increases ever more rapidly, and the degree of specialisation increases, so the need for the middle group becomes more significant, but instead of allowing continuation of this evolutionary process to meet changing market needs, New-Zealand has fostered its deconstruction. New-Zealand has destabilised that employment structure through a lack of understanding of the importance of the technician / technologist role, and by;
- academics building and supporting academic empires,
- the denigration of those without university degrees,
- a reduction in the standing of qualifications for technician / technologists,
- the lack of a national body (ITO) tasked with responsibility of education and training of technician / technologists. Currently ITO coverage only extends to level 5, however the funding model at level 5 is not conducive financially for ITO's to the extent that it is not in general taken up.
- the absence of occupational regulation acknowledging their part in the team, and the need to involve them in protecting the public interest. Occupational Regulation that ensures the right people are used for the right job.

3. Technicians and Technologists Title and Credentials

3.1 It has been said that; *"Technicians are handicapped by the lack of uniform titles and credentials which clearly identify their educational background" (Smith and Lipsett).*

3.2 We agree, and in New-Zealand's case it can be traced back to the uninformed restructuring of trades and technician qualifications.
Over many centuries, across many cultures and creeds, the building and construction work-force has evolved into what worked best for industry and Nations alike. That structure consisted in general terms of: University Educated, Technician Qualified, and Trades Trained. NZ had such structure once.

3.3 The Universities had and still have a well established structure with substantial independence from government intervention, however technicians and trades did / do not. c1950's, the Trades Certification Board (TCB) was established in 1949 under the Apprentices Act of 1948, and the Technicians Certification Authority (TCA) in 1960 under the Technicians Certification Act of 1958, the latter replacing the NZCE Controlling Authority which had been established at the time of the introduction of NZCE in 1955. Such was the success of NZ Certificate qualifications that by 1990 there were 16 courses, with Engineering facilitating specialisation in the last stage to cover 14 disciplines, and Science 6 disciplines.

3.4 With the passage of time and various Government reforms, these two Certification organisations previously under the auspices of the Department of Labour were combined first into the AAVA (Authority for Advanced Vocational Awards), more latterly renamed NZQA (NZ Qualification Authority). The role of the Department of Labour was removed to a new crown agency ETSA (Education and Training Support Agency) which became "Skill New-Zealand" which became TEC (Tertiary Education Commission). With each change came reduced recognition of technicians / technologists as their numbers were less. However what was overlooked was that less in number did not translate to less needed. They failed to understand the industry ratios applicable.

Change may have been necessary at the trades level, but as a lesser numerical participant the technicians / technologists were a casualty of the reforms.

3.5 The loss of distinction between the two groups, and with it formal loss of the use of the terms Technician and Trade, has led to more liberal use of the terms to the extent that the general understanding of each has become blurred and mis-understood. The understanding behind the different needs of each was lost on the reformists and finance keepers. This combined with the

lesser number of technicians / technologists by industry ratio, when compared with the trades, has led the general public too, to become increasingly less aware of this group as it became less visible.

3.6 Add to this the confusion created within the qualification sector, where once the public at large understood that Degrees for professionals came from Universities, Diplomas were for technicians / technologists, and certificates were for trades. Simple yet clear distinction of each group that supported the employment structure.

3.7 This confusion, lack of clarity and understanding of our employment structure is demonstrated by the considerably less student / parent interest in such qualifications, and with many careers advisors not even understanding that this structure even existed, let alone what technician / technologists roles were required. To most it was / is promotion of universities as the starting point for a career, and the rest cast-off to the trades as failures. The lack of respect for the technicians / technologists, and trades groups in NZ is both offensive and destructive.

4. Loss in Industry Team Balance

4.1 In the late 80's, many of those government departments who employed and trained the majority of the technicians / technologists, were dis-established, privatized, and restructured, and many of the time proven practices developed to build our nation were seen (wrongly in our opinion) as no longer being necessary. University education was available to the masses, Engineers more plentiful, graduate engineers readily available, so the practice adopted was, – why use a technician when so many engineers were available. The higher societal cost of educating university engineers for technician roles failed, and continues to fail to attract attention. As this trend continued, so the requirement for technicians / technologists has diminished, despite many of those engineers lacking the all-important practical component in their education so beneficial to be able to transfer information successfully to the trades.

4.2 In many European societies where entrance to university is more controlled to match the needs of society from a more pragmatic perspective, the numbers available and keen to aspire to technician / technologist level, and the number of technicians / technologists required by industry, are greater. And with this, respect of the group is more widely held of the place they play in the team. This to us is intelligent tertiary education.

4.3 The government departments that previously encouraged and fostered clear progression and career paths for technicians / technologists, that recognized the need for the group, that set the example for the rest of society, were restructured in a manner that saw these practices lost to the Nation. There is no doubt that some changes were necessary, but throwing out the baby with the bath-water has led to an unbalanced industry employment structure.

4.4 Added to this was the failure of the private sector to take on the mantel for training, in its widest context, that the public sector had previously filled and the private sector enjoyed. This has led to a severe gap in the demographic profile of technicians / technologists now existing.

4.5 Following the reformation of the government departments, Territorial Authorities then became the subject of amalgamation, and with that restructuring, similar consequences as they too reduced their in-house engineering capability.

4.6 As if this wasn't enough, Technician Qualifications at a national level were abolished in the 90's and replaced with a plethora of lesser ones from various providers, with little if any experiential component. And with this phase of restructuring, control of various qualifications was passed over to ITO's (Industry Training Organisations), note the use of the word training as it relates to the

vocational training of trade qualifications, however their responsibility was limited essentially to trades levels only and left technician / technologist education / training without voice, a point some ITO's have recognized and provided some assistance toward.

"Australian Engineering Associates and Technicians have ... been given a bad deal in terms of the educational expenditure on their courses, industry standing and remuneration. Little recognition is given to their high level of expertise, which is a combination of TAFE based education and experience. Perhaps some of the problems of Australian Industry are the result of the failure to create a confident, capable, well remunerated and well educated Technician engineering workforce of adequate size".
(Paper by MC Clark February 1989 to the World Conference on Engineering Education for Advancing Technology, "Technician Engineering Education; The Neglected Step in Engineering Education").

There needs to be an education and training organisation for Levels 6 and 7 in New-Zealand to extract our Nation from on-going similar consequences.

4.7 Technicians / technologists have always been marginalized as the work of W H Evan in particular and others have shown. Sandwiched between University Engineers and Indentured Trades, neither one nor the other, never as a valued member of the team, instead being considered either inferior to one or a threat to the other.
This combined with the diverse nature of their work, the multiplicity of role titles, the limitation of their specific education and training compared with the other groups, has led to their own ambivalence reflecting the general levels of ambivalence towards technicians / technologists in wider society.
This ambivalence however is quite contrary to the reality of a needs driven and innovative economy as the industry's evolution had demonstrated. With increased marginalization, the over-reliance on trades personnel masquerading as technicians, and the under-utilisation of university educated graduates as technicians / technologists, and the development of new tools such as CAD (computer aided draughting) has led to technicians / technologists being side-lined. However what has not been recognized is that it is only the tools that have changed, not the skills that utilised the tools, and that neither of the other groups has those skills necessary in a balanced mix.

4.8 The need now in many respects, is in fact greater than in the past due to the increasing separation between; the higher levels of academic theory associated with greater understanding and knowledge, and trade skills. It is this gap that technicians / technologists fill.

4.9 The Technicians / Technologists are betwixt and between, in no-mans land, the invisible group, so much so that for many of the few, now, being a Technician or Technologist is no longer a career, and is seen merely as a stepping stone to becoming an engineer or scientist, a pathway that avoids the glass ceiling for the individual, but leaves a void in the team structure.
What is needed is government led example that recognizes technicians / technologists, and facilitates industry reform toward both a more economically sustainable and more accountable model in the interests of public safety.

5. **Industry Ratios**

5.1 For a strong and competent industry structure, it is important to have a balanced team of suitably qualified personnel where each is challenged to maximize use of their education / training, and this applies in many fields. Remember the saying;

"too many chiefs and not enough indians".

5.2 Given that much of our organisational management history and theory is evolutionary and of military origin, it is noteworthy that for every 1 in command there are typically 4 sub-ordinates at almost all levels in all forces. At junior ranks (equating to the trades:labourers relationship) a ratio of 1:3 is more general.

5.3 In medicine, the ratio for Doctors to Nurses is also typically 1:4. In New-Zealand it is 1:4.4. Nursing and its place in medicine is an example where we have got it right, and provides a particularly good model to replicate. In Pharmacy there is typically 1 Pharmacist to 3 pharmacy technicians.

5.4 In software development likewise, a ratio of 1:4 *(J Frain Jan 2008)*.

5.5 In Engineering across India*(http://education.nic.in/cd50years/g/T/W/0T0W0L02.htm)*, Australia *(MC Clark – "The neglected step in Engineering Education"),* and the United States *(William Evans – MIT, and Michael L Skolnik),* they have been advocating improvement of the ratio of Engineers with technicians since the mid-1960's, recognising the disparity that existed with the ratios in other countries which were operating more efficiently. Examples provided include Great Britain at 1:4.2, West Germany 1:2.5, France 1:2.4, Australia 1:1.9, Soviet Union 1:1.7, India 1:1.4, Canada 1:0.9, and the United States 1:0.3.

"In India, many graduate engineers are in fact doing what should be regarded as technician type work. This is wasteful of their skills and an unnecessary charge on training costs."
(Report of the Education Commission prepared for the Indian Government June 1966).

In India they have, over 40 years, corrected this deficiency to 1:4, although the standard of qualification is seen by some as still needing to be lifted further. What should also be noted is that by recent statistics, India's rate of increase in productivity is now second only to China.

More recent data from North America *(Engineering Employment Characteristics Report)* shows the USA had improved their ratio to 1:0.8 by 1980, and anecdotally it is understood that Canada currently has a ratio to approx. 1:2.

5.6 But what of NZ *(IPENZ Engineering Dimension December 2008)*; in 1991 it was 1:1.64, and in 2006 1:0.96. We now have more engineers than technicians, and instead of a ratio of 1:4 we have 4:1. In terms of replacements coming through, the number of engineering qualification completions in 2008 *(IPENZ Neep Report October 2010)* was 1:0.43, ie 2.3 engineers for every technician / technologist instead of 4 technician / technologists per engineer.

6. Education

6.1 As has been described in 4.6 above, the standard of education available for technicians / technologists has been diminished, although more recent developments have seen the introduction of BEngTech and NZDE which are more comparable with the old NZCE. However the entry criteria for these is such as to limit applications when compared with university entry criteria for the BE Intermediate year which have been relaxed over recent decades. Lost on enrolees is the drop-off rate (40-50%) between Intermediate (Canterbury University) and First-pro years, but the consequence is that when they fail to make entry to First-pro they are lost to engineering as they migrate to other degree courses within the university or have a gap year, an OE, and fail to return to engineering. These students (300 – 350 / an Canterbury University) who by their enrolment in engineering have demonstrated an interest in engineering, should be transferred to engineering technician / technologist qualifications offered through Polytechnics, not encouraged into other university courses because it suits the university funding model.

6.2 Combined with this is the number of engineering related technician / technologist qualifications across a diminishing number of applicants despite the need. From the days of essentially a single national qualification being NZCE, we now have BEngTech and NZDE, plus a number of provider based courses of variable standing throughout NZ. For a small country this is not sustainable and confusing for employers, students and parents alike. The stability that the Universities and the degree name have maintained across generations has been their strength, however for the trades and technician / technologist groups their education and training has been a political football to their demise, and resulted in a loss of balance in our industry employment structure.

6.3 For the trades and technician / technologist groups, combined with these changes has been the change to unit standard based papers which are of silo form and not contextualised as previously had been the case. Whilst this may be beneficial for training, it is not so we believe for education, especially for technicians / technologists where the requirement is a combination of education and training.

6.4 Concurrent with the above, we have seen the watering down of some papers to enable new material to be incorporated, and the content of some papers almost disappear. This is on the surface appears easy to justify, however in the process, what has been lost is that technician / technologist qualifications should be more about "education" than the bias towards training as currently exists. It's about understanding the basics, so that training in practice has a broad foundation from which to build, and a wider knowledge base from which to draw in any particular situation. From diversity of knowledge comes greater understanding and innovation. It is interesting to note for ITO's, the "T" is for training, yet they are overseen by the TEC (Tertiary "**E**ducation" Commission).
Training pertains to "how to complete a task", and requires little understanding / education about the task. Education on the other hand teaches about the task, and concentrates on understanding how and why it needs to be done.
The education requirement of a robust qualification does not change at the same rate as a qualification based on training, yet it is the education component that is being lost that will serve society best in the long term.
Our technician / technologist qualifications have been hijacked by training.

6.5 Entry criteria was discussed above in the context of universities, but a further issue is the failing of the high-school NCEA system to produce students sufficiently skilled in english, maths and sciences, to the extent that universities and polytechnics have to run additional courses to raise skill levels to an acceptable but still minimal level. NCEA results indicate increasing numbers with higher levels of achievement to the delight of the MoE, but the market sees decreasing competence and understanding. Technical Drawing, which was a subject which introduced many to technician engineering and gave them an understanding on how to read drawings, is now almost a thing of the past having been dropped or supposedly encompassed within what is now broadly known as technology. But with the content of technology being so broad and generic, and hijacked by so-called design, the original constituents that paved the way for this new subject have essentially been lost.

6.6 Combined with this, the number of students studying english, maths and sciences is declining in favour of softer options, where similar credit achievement is less demanding. Although it is estimated that 37% of all students leaving high-school with level 3 NCEA have the subjects necessary to embark on engineering based qualifications, only 11.4% (approx. 966/an for the whole of NZ) might be expected to pursue engineering at BE / BEngTech / NZDE level *(P Glen Feb 2012 for Weltec).* If the ratio was 1:4, this would mean 773 technician / technologist students nationally, and

at the current ratio of 1:0.43, a mere 290. These numbers do not bode well for what needs to be an increasingly progressive industry, when the Neep report of 2010 (prior to the earthquakes) is predicting a national need for 1350 technician / technologist graduates each year. Note graduates, enrolments will need to be higher than this to account for the approx. 20% who fail to complete, and international students who leave on completion.

6.7 *"A significant number of new engineering technicians (NZDE) are needed to alleviate the severe shortages on infrastructure projects that industry has experienced in recent years. In relative terms, more of the new degree-holding engineers should be engineering technologists (BEngTech) rather than professional engineers".*

We agree with that statement from the Neep report, however what is also interesting to note from that report though, is the prediction for University educated Engineers (BE) at 1400, ie a ratio of 1:0.96, in other words maintenance of 2006 ratios. In reality we believe if the total of 2750 is reasonable, and using a ratio of 1:4, the numbers would be 550 University Engineers to 2200 technician / technologists. Thus the extent of the shortage would be more accurately reflected by comparing the current 290 with a requirement of 2200 per annum. However if the OECD average were used it would be 2900, 10 times current numbers.

6.8 To correct immediately the ratio of current graduates coming through would solve replacement levels, but does nothing to rectify the severe gap in the current demographic profile. The real impact of this gap has yet to bite, the experience shortage not peak until 2020, and then last for at least 25 years assuming the ratio was corrected right now. Remember that with a highly concentrated government led effort, India took over 40 years to get the ratio of graduates right and go from 1:1.4 to 1:4, New-Zealand is coming from 1:0.43 at best. Our Polytechs do not have either the physical or teaching resources to cope with such a change at present, and as in India would need to be developed with intensity as a government led initiative.

6.9 What makes it worse, is that these numbers do not reflect the increased numbers required to resource rebuilding after a disaster such as has occurred in Canterbury.

6.10 There are industry "training" reviews in progress for the trades, but nothing on a national basis for the technician / technologist group which is in dire straits as a national resource, and at levels that when the rebuild is able to begin proper, will be the obstacle that will slow it down significantly. Just meeting business as usual without the Canterbury earthquakes it was an extreme bottle-neck.

7. Consequences

7.1 As a result of the above influences, we have witnessed the general lowering of qualification standards and calibre of graduates, plus engineers doing technician / technologists work for which they have neither been educated nor trained. In the case of engineering drawings for example, many are being done by University graduates to a standard that is less than satisfactory, whilst others are being led by Engineers and completed off-shore with similarly poor completion standards, with the risk of ambiguity and error.

7.2 From Lund Construction Insight Newsletter 2008, Mika Rairi – reinforcement steel-placer;

"In the old days detailers knew how to draw plans. Now they draw plans in all sorts of different ways, and I have to try and figure out what they want".

7.3 Combine this with NZ's culture of taking the cheapest path at the expense of quality, and we have other disasters waiting to happen. To compete against competitors successfully at either design or construction stages, and have the cheapest price, necessitates cutting costs somewhere in

detail and/or quality, for at the end of the day the same deliverable is expected and the number of new innovative opportunities to reduce costs are limited. For example, many drawings are now represented in stick form to reduce drawing time, but the concept of a picture is worth a thousand words is lost, at what level of risk. Further, we are seeing more and more work being left undetailed for the contractor to attend to, but the manner in which this is to be done is left unclear. These sort of approaches do save on design detailing time by the consultant, who has only hours to sell with little if any opportunity to absorb any within margins.

7.4 Good work practice as we used to know it is being reduced partly by lesser education standards, partly by a cost driven society, and eventually because the parties no longer recognise what good practice is.

7.5 All of these reducing factors have seen the rising need for more formal Quality Assurance systems to counteract the increase in risk, however this is the ambulance at the bottom of the cliff. What has evolved is a "form culture" rather than a "quality culture", with personnel signing off documentation without checking first due to time pressures created by our cost driven model, where cost comes first. Employers won't and generally don't condone corner cutting and poor performance, but they create a work environment where this becomes inevitable. Because most designs are seldom exposed to their worst case design scenario, the personnel are generally long-gone if and when this does occur, so it often goes un-noticed until the next disaster strikes.

End of submission.