



Māori and Pasifika in Engineering

Disparities, Reasons and Solutions

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Definitions

Aotearoa	The “land of the long white cloud”, named so for its vast appearance on the horizon when journeying from Hawaiki. The etymology of this word is apparently that it was originally used to refer to the North Island (which is also known as Te Ika a Maui). These days, the term has evolved to refer to New Zealand as a whole.
Atua	Supernatural being with dominion over a certain domain e.g. Tangaroa, the atua of the sea. Usually translated as “god”, although the two concepts do not perfectly align. Atua are revered and respected more than they are worshiped.
Hapu	Sub-tribe. The hapu is traditionally the major economic unit for Māori, and the level at which most decision-making is done.
Hawaiki/Havaiki	The ancestral Polynesian home of Māori and other Polynesian peoples. Because Māori came in a series of migrations from various places for various reasons, Hawaiki is more a concept than a fixed and singular geographic location.
Iwi	Tribe. Collective of many hapū. Traditionally, hapū would come together as an iwi when there was a need greater than they could face alone (for example, war). Post colonisation, iwi is the level at which government generally engages (although local government often works with hapū).
Kaitiakitanga	Guardianship. Iwi and hapū in particular may have kaitiakitanga over an area or a resource. The reciprocal relationship with the atua and the environment places a great responsibility on kaitiaki (guardians) to look after resources, so that they continue to exist and be available for the nourishment of future generations.
Kaupapa	Guiding principle or policy.
Mana	Best translated as “prestige”, but has elements of “power” or “influence”.
Māori	Defined as “commonplace”. This was a term coined after contact with Europeans, in order to distinguish the ordinary inhabitants of Aotearoa from the newly-arrived ones.
NCEA	National Certificate of Educational Achievement. New Zealand high school level qualification.
Pasifika	Term currently used to describe Pacific peoples. In reality this is a large number of distinct cultures and groups of cultures. It includes Polynesian, Melanesian and Micronesian cultures, and many different ethnic groups.

RMA	Resource Management Act, 1991.
STEM	Science, Technology, Engineering and Mathematics.
Tagata Pasifika	Pasifika people.
Te Ao Māori	The world of the Māori, most commonly in terms of the Māori worldview. In other words, the Māori viewpoint of the world (and beyond).
Te Reo Māori	The language of the Māori peoples of New Zealand. Māori from certain parts of Aotearoa insist that there are different languages. Certainly, there are different dialects. Native speakers in various regions insist that the commonly spoken Māori of our modern times is very different from their own languages. For conveniences' sake, Te Reo Māori is here (and in many places) used to denote either and both of the common language, or the collection of languages.
Turangawaewae	“Place to stand”. In Te Ao Māori, The place where one is from, in the deepest sense of the word. The place where one has connection, whakapapa and a sense of belonging.
Whakapapa	Lineage or descent. Can be used as a verb as well as a noun.

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1. Te Mihi

Tihei mauri ora!

Ko Te Arawa te waka

Ko Tongariro te maunga

Ko Tongariro te awa

Ko Taupō-nui-a-Tia te moana

Ko Ngāti Tūwharetoa te iwi

Ko Te Heu Heu te tangata

Ko David Rei Miller ahau

My ancestors arrived in Aotearoa on the Te Arawa and Takitimu waka some 1,000 years ago. They left from Polynesia, sailing against the trade winds. This was not a voyage made by accident, or one for which success was based on luck. My other ancestors arrived from England less than 200 years ago, and originally settled in the area that now bears their name, Johnsonville. New Zealand is founded on great voyages from across the globe. We are pioneers, and we are diverse.

Engineering has underpinned the success of New Zealand, as it has for all societies throughout the globe, and throughout time. New Zealand has produced remarkable examples of engineering, in everything from the Raurimu Spiral to the Britten motorbike. But something is wrong. The proportion of our engineers who identify as Māori or Pasifika is significantly lower than their representation in the population.

This research paper has been commissioned by Engineers Without Borders New Zealand (EWB). This is a non-profit, humanitarian engineering organisation which works primarily in New Zealand and the Pacific. There have been phenomenal advances in engineering, particularly over the past 300 years, that have greatly enhanced the standard of living of humanity as a whole. These advantages have, however, not been conferred equally upon all. It is the mission of EWB to redress this balance, and to ensure that no one must go without the benefit of these advances. Similarly, EWB seeks to ensure that no one is excluded from pursuing a career in engineering.

The research question at hand is essentially:

What can be done to improve Māori and Pasifika representation in engineering, and what can Engineers Without Borders do to help?

My personal feeling is that we should not seek to make people do engineering. But I strongly believe that we should give everyone, equally, the opportunity to become an engineer if that is where they will be most suited, and happiest. Currently, this is not the case. This paper seeks to ask “why not?” and “what can we do?”. The next Sir Paul Callaghan, the next Gerry Te Kapa Coates, and the next Michelle Dickinson are out there waiting to be found. They could be any gender, any ethnicity, any background. It is our duty as a profession to ensure that no matter what their history is, they can help build the better world of tomorrow.

I must state in delivering this research that my understanding comes from someone of Māori ancestry who is, like many of us, rediscovering their culture. Colonisation has taken a grand toll on our people. Some of us have felt it at a personal level, and some at a whānau level. For some, like my family, our culture was lost to an extent, and only several generations later have we been able to make inroads back. So, my understanding of Te Ao Māori is similar to someone waking from a lengthy coma, and coming to terms again with who they are. My understanding of the many and diverse Pasifika cultures is even more limited, save for the fact that as Māori I am also Polynesian.

I do not consider myself an expert in these matters. I consider myself someone who has been lucky. I have been fortunate enough, largely due to my family, that I have had the freedom and the means to pursue a career in something deeply meaningful to me, engineering. I have also been fortunate enough to receive assistance in the form of scholarships to ensure that I had a chance to succeed. Part of repaying these gifts is giving back to our people, as well as to the industry, in what little way I can. Over my career and my life, I have met some incredible people. My interviews with some of these people through the course of this research are an attempt to pull together various strands surrounding this issue, and weave them into a narrative which can continue the conversation for EWB and add to the pool of knowledge already in existence.

It should also be stated that due to time and practicality constraints, the research is largely limited to organisations working within New Zealand. There is doubtless a great deal of emphasis in the Pacific Islands on educating and retaining engineers, but details largely cannot be brought into the current paper, unfortunately.

1.1 Te Ao Māori

In order to answer the research question, it is essential to know the subject, or rather the subjects. One of the key failings I have seen throughout my career when non-Māori engage with Māori is not realising that one is engaging with another culture. New Zealanders are renowned for being world travellers. For going all over the globe, and making a difference. Whether that is through personal encounters with other travellers or the inhabitants of the countries they travel to; through their hard work and positive attitude in whatever pursuits they choose; or through the considerable amount of development work in which they engage. It is an uncomfortable fact that New Zealanders are considerably better at accepting cultures overseas than in their own country. This is a generalisation, of course. There are many people who embrace the Māori culture, or at least make an effort to. To really make inroads, though, into cultural acceptance and to better engagement, the shape of this engagement needs to change. This can only come about first of all through an acceptance that the Māori and Western points of view are at

many points at complete opposites with one another. And secondly that people of Māori descent have different values, cultural norms, and expectations to those of European descent.

Many of us are familiar with at least some Māori myths and legends. But the role that these play is often misunderstood, and underestimated. They are far from being just entertaining stories. Marsden and Henare (1992) state:

Myth and legend are an integral part of the corpus of fundamental knowledge held by the philosophers and seers of the Māori and indeed of the Polynesian peoples of the Pacific from ancient times. Indeed, there are remarkable parallels and similarities between the extant myths and legends held by the various Polynesian groups who have been separated from each other for time spans ranging from eight hundred to two thousand five hundred years.

For instance, Maui as a myth hero, Tangaroa as the god of the sea, Tane, Rangi, Papa and the stories that revolve around them have a common thread or theme running through them. The concepts which underlie the various legends also exhibit a common motif and focus. Modern man has summarily dismissed these so-called myths and legends as the superstitions and quaint imaginings of primitive, pre-literate societies. That assumption could not be further from the truth.

Myth and legend in the Māori cultural context are neither fables embodying primitive faith in the supernatural, nor marvellous fireside stories of ancient times. They were deliberate constructs employed by the ancient seers and sages to encapsulate and condense into easily assimilable forms their view of the world of ultimate reality and the relationship between the creator, the universe and man.

As with all societies, among the most powerful myths and legends is the creation story. To understand the relationship of Māori to the environment, one must appreciate that we are not separate from the environment. We are part of it, and more than this, we are formed from it. One of the reasons that Māori whakapapa back to an area of land and a body of water is to identify where exactly we are from, for the information of other people. But another reason is that physically, we were formed from these things. Consider for a moment that we are all made from atoms which have existed since our galaxy was formed. Consider also that “you are what you eat”, and also what you drink. Māori recognise that as we drink from the water, and eat of the bounty of the land, we are one with them.

To think of a piece of land as something that can be carved up, delineated, bought and sold is anathema to Māori. It would be very much like doing the same to one’s own mother. To think of a river as a convenient place to dump our waste is anathema to Māori. This would be like injecting poison into the veins of one’s mother. Only on understanding these things can one begin to understand the worldview of Māori, and to begin dialogue about the concerns that tangata whenua have regarding the land and waters over which they are kaitiaki.

Another key concept to be aware of is that for Māori, the physical and the spiritual cannot be separated. They are, by the very nature of the universe, intertwined. To split off one from the other is not done.

This manifests itself in the attitude towards water. Whereas Western capitalism can quite easily see the purest water as a resource to be obtained, exploited and profited from, Mātauranga Māori cannot shut its eyes to the fact that this water is sacred, and must be treated as such. It is tempting to over-analyse this, and concoct the opinion that this is adaptive. That placing a high value on pure water was a necessary cultural adaptation to ensure the survival of individuals and groups. It would be a mistake to do this, because again it is looking at the topic through a very different cultural lens. The fact of the matter is that, for Māori, water has as a fundamental property wairua, or spirit.

1.2 Tagata Pasifika

This research attempts to answer the same questions for Pasifika peoples as it does for Māori. In some ways, it makes sense to do so. In another sense, this widens the scope considerably. “Pasifika” is not one particular culture, or one particular group of people. The term is used to describe all of the cultures that originated in the Pacific Ocean. This covers not only a large number of distinct cultures, but it covers several different groups of cultures.

The table below provides a snapshot into some of the many Pacific peoples. This list is not exhaustive.

Table 1: Examples of Pasifika Cultures

Polynesians		Melanesians	Micronesians
Western Polynesian-Melanesians	Northeast & South Polynesians		
Samoans	Hawaiians	'Are'are people	Marshallese
Fijians Lauan Group	Māori	Kanak people	Palauans
Rotumans	Tahitians	Kwaio people	Carolinians
Uveans	Tuamotuans	Motuan people	Chamorros
Futunans	Tubuai	Ni-Vanuatu	Chuukese
Tokelauans	Rapans	Fijians	Yapese
Tongans	Marquesans	'Are'are people	Kosraens
Tuvaluans	Gambier Islanders		Pohnpeians
Niueans	Cook Islanders		Nauruans
	Rapanui		

From this, it can hopefully be seen that to speak about Pasifika is to generalise. While this is done as far as reasonable in this research, it must be remembered that these are distinct cultures, with distinct languages, customs, genes and beliefs. To draw a comparison, the term “Asian” is now well-recognised as representing many separate cultures from across a wide area, most of whom speak different languages. Similarly, the word “European” covers many different cultures, a lot of whom do not speak the same language, and many of whom have been at war with each other at some point in the past.

2. The Current Situation

This section examines the current data around Māori and Pasifika participation in engineering. It attempts to posit answers about the reasons for the disparities that exist. In order to answer the question with respect to engineering, it is necessary to take several steps back and look at where people come from before they choose to do, or not to do, engineering.

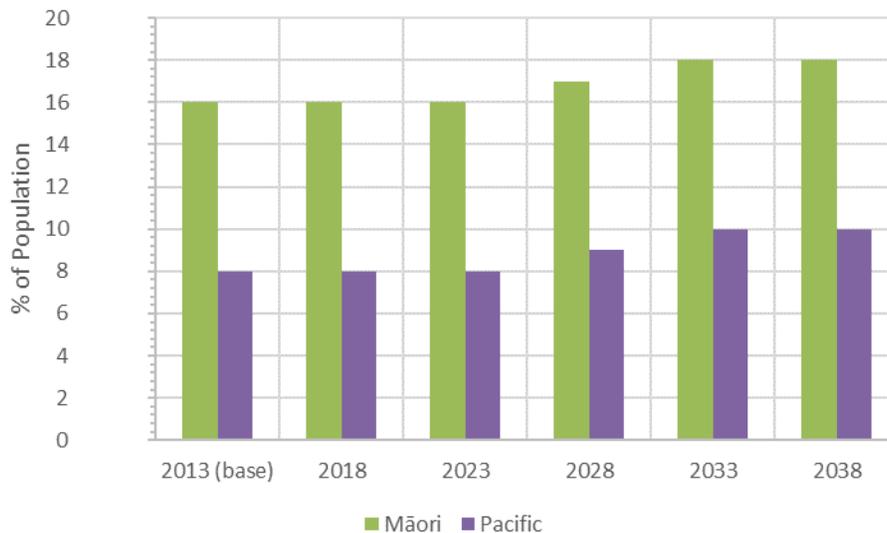
2.1 Demographics

The research question is framed within the context of the makeup of our society. The reason for a perceived disparity in the numbers of Māori and Pasifika engineers is that Māori and Pasifika make up significant numbers of our population. Data around this are presented below. Figure 1 shows that for the base year of 2013, Māori made up 16% of the population of New Zealand, with Pasifika at 8%.

One thing to be aware of when interpreting data on ethnicity is that people may identify with more than one ethnic group. Statistics NZ indicate that according to their projections for 2021, 17% of the population will identify as Māori, 9% as Polynesian, 15% as Asian and 70% as European. The more astute will notice that's 111%. This is because many people, including myself, cannot be boxed into only one ethnicity.

Bearing this in mind, Figure 1 shows that by 2038, it is anticipated that 18% of the population will identify as Māori, and 10% as Pasifika.

Figure 1: Projected Ethnic Share of Population (Statistics NZ)



The projections indicate that the baseline population of 690,000 Māori and 340,000 Pasifika could increase to 1,160,000 Māori and 650,000 Pasifika. By comparison, the European population could be expected to rise from 3,310,000 to 3,970,000.

With a baseline population of more than a million even five years ago, it is clear that Māori and Pasifika are a significant part of the population of New Zealand.

2.2 Primary School

Although the education of a child begins (ideally) before school, the first step on their educational journey towards becoming an engineer begins at primary school. A child with a good grounding in maths and science stands a far better chance of enjoying and excelling at these subjects at secondary school and beyond.

It is a fact that in New Zealand, Māori and Pasifika children are disproportionately represented in low socioeconomic circumstances. Our current Decile rating¹ of schools (about to be overhauled) means that Māori and Pasifika students are more likely to attend schools with low Decile ratings (e.g. the lowest, Decile 1). While this means that their school has more government funding available, it also attaches a stigma. This stigma extends not only to the parents and the students, but importantly to teachers.

The realities of teaching in Decile 1 schools are harsh. A tragically high proportion of students come from unstable family situations. These situations can involve violence, gangs, poverty, drugs and other substance abuse. Schooling can be difficult for any child. But when a child faces such circumstances, when they come to school hungry, without lunch, and in some cases with physical and mental health issues, it is extremely difficult for them to learn. It is a sad state of affairs that any child has to live with this. Demographically, it is more often Māori (in particular) and Pasifika children who are in these situations. That is why this is relevant to the current discussion. It is another potential set of hurdles that must be overcome.

Through my interviews, it became apparent that a major barrier to Māori and Pasifika primary students doing well in maths and science is the nature of the curriculum, and the scarcity of qualified teachers in these areas. The primary school curriculum varies, naturally, from secondary school. The environment is different, and the types of teachers attracted to it are different. In primary school, although all subjects must be taught, there is a greater freedom around what proportion of each subject can be taught. Schools, or individual teachers, may decide to spend more time on subjects such as reading or social studies, and less on science or maths. This is often the case when teachers are not confident in teaching maths or science. These are specialised areas, and the number of primary teachers who are qualified to teach them is relatively low.

It is also a reality of the education system that many of these teachers will be dissuaded from choosing roles at low-decile schools. As well as the stigma mentioned above, there are very real behavioural issues. Violence at home can transfer to violence at school. There are often mental health issues as mentioned above, and these can include conditions such as foetal alcohol syndrome. Dealing with behaviour can occupy as much as 70% of the time for a teacher in a school where these issues are widespread. There are dedicated teachers out there who are committed to making a difference in environments such as this. But it is not everyone's cup of tea, and the pool of qualified maths and science teachers in low-decile schools reduces accordingly.

¹ For a brief explanation of the system, see for example <https://parents.education.govt.nz/primary-school/schooling-in-nz/ministry-funding-deciles/>

Having said this, there are certainly cases where teachers with a passion for maths or science teach in primary schools with high proportions of Māori or Pasifika students. Having good teachers certainly nourishes any innate tendencies towards these subjects which children may have. And this gives them a good grounding to go on to study and enjoy these subjects at secondary school.

2.3 Secondary School

It is the subject choices students make at secondary school which determine their ability or willingness to study engineering at tertiary level. Factors affecting subject choices are many and varied. Personal desire, family background, peer pressure, and role models (or lack thereof) may each play a part.

Whether or not the foundation has been laid at primary school, in junior high school (Years 9 and 10) students may become interested in STEM subjects, or alternatively decide they want to veer away from them as quickly as possible. Some students, especially Māori and Pasifika, may come to believe for whatever reason that STEM subjects are not for them.

Qualifications begin at NCEA Level 1, generally taken at Year 11. Following this is NCEA Level 2, and finally NCEA Level 3, which for most students is the highest qualification they will receive at high school. Achievement at NCEA Level 3 has to be built on previous achievement at Level 1. It is possible to pick up STEM subjects at Levels 2 or 3 without having studied them previously, but this is a much more difficult path, and the chances of failing are much higher without the groundwork having been completed.

This means that choices about subjects which students will leave high school qualified in need to be considered early. Students need counselling from their family and their school. This needs to be done at least at Level 2, but preferably at Level 1. This means that when students are choosing Level 1 subjects, they should be considering the career options they may wish to pursue. This occurs when students are in Year 10 i.e. when they are around 14 years old.

This may seem like a young age at which to be deciding one's future. But the reality is that it's at this age that students will decide whether or not to continue with subjects like science. And this will ultimately decide whether they can continue on to study engineering, or will be unable to because they lack the prerequisites or the foundational knowledge. Making these subject choices does not mean that students must choose a career (e.g. website developer). But it does mean they should think about the range of career options they want to leave open (e.g. Information Technology).

A student who thinks in Year 13 that they would like to study engineering cannot go back in time to reverse Year 11 subject choices.

One of the other challenges facing students when choosing subjects is that some are perceived (rightly or wrongly) as being easier to gain credits in than others. Students may take, or have recommended to them, certain courses that are easier. I have personally had this happen. A teacher at my son's high school recommended that he study PE and Health, because it would be "easy credits". Marketing courses in this way may tempt students into taking courses that are not right for them. The focus should be more on the skills that a subject will teach someone. But now, because of the system we have, the metric could tend to influence the subject choice.

There is still a lack of understanding about what engineering is, and what engineers do. Not just for secondary students, but also the general population. People think they have a vague idea of what engineers do. But to many people, engineering can sound “opaque and uncool”. Furthermore, there is a low number of role models for Māori or Pasifika engineers (see Section 2.5). If Māori and Pasifika do not, in general, see themselves as technologists, engineers, scientists and innovators, they will be less inclined to become these things. People can tend to gravitate to professions where they see others like themselves. Historically, for Māori and Pasifika, this was not normally in professional roles. More recently, pathways such as health and law have become more well-travelled. There have been drives from universities in particular around this, and also the needs are well-known. In the era of Treaty settlements, Māori have needed lawyers to get the best deal for their people. Traditionally, among groups that are marginalised and over-criminalised, there has also been a need for lawyers. Nelson Mandela and Mahatma Gandhi both started out as lawyers. Regarding health, it has been understood for some time that a) Māori and Pasifika are suffering disproportionately, and b) they respond better to health professionals and health approaches that are themselves Māori or Pasifika. This same focus on the development of the profession is now needed for STEM subjects. Engineering can offer huge benefits to iwi, and to Pacific nations. Having qualified engineers with Māori or Pasifika backgrounds should be seen as a huge asset for our nation and our region, and a base which we want to develop further.

There is currently an ethnic disparity in educational achievement at high school. The following figures show that Māori and Pasifika students, in general, are performing less well than Europeans, who in turn are performing less well than Asians.

Figure 2: Year 11 Students Achieving NCEA Level 1 (NCEA Annual Report 2016; Roll-based)

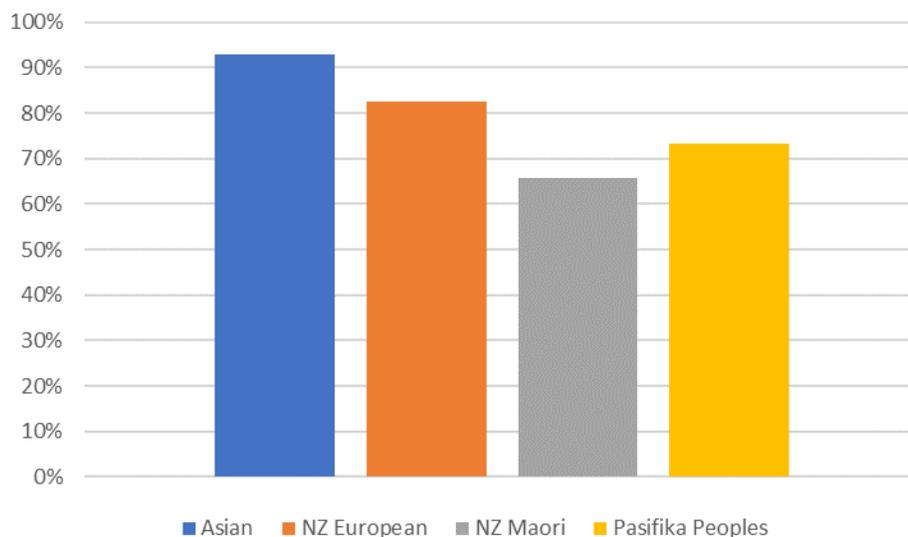


Figure 3: Year 12 Students Achieving NCEA Level 2 (NCEA Annual Report 2016; Roll-based)

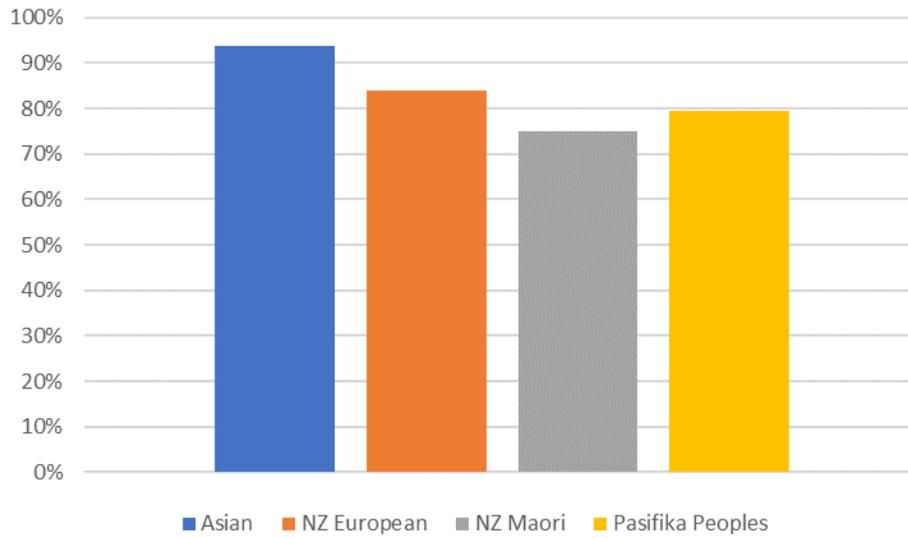


Figure 4: Year 13 Students Achieving NCEA Level 3 (NCEA Annual Report 2016; Roll-based)

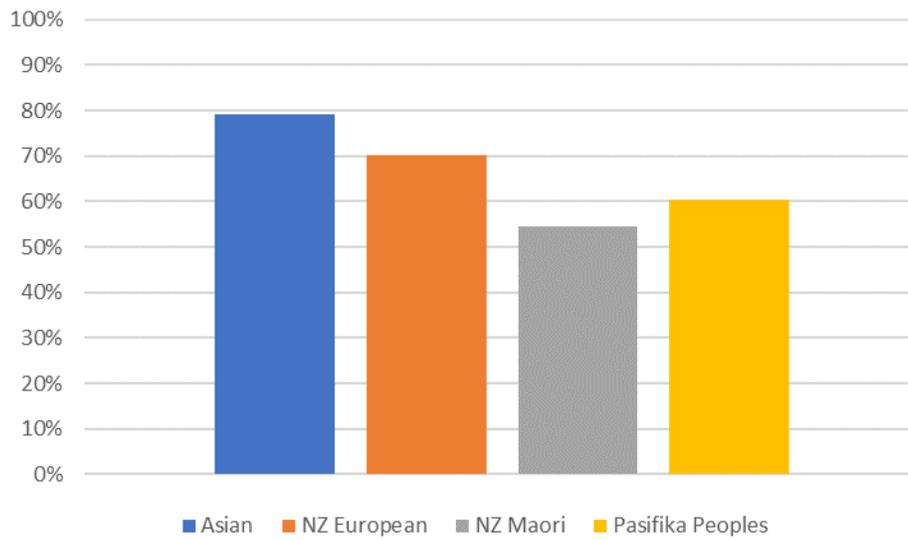
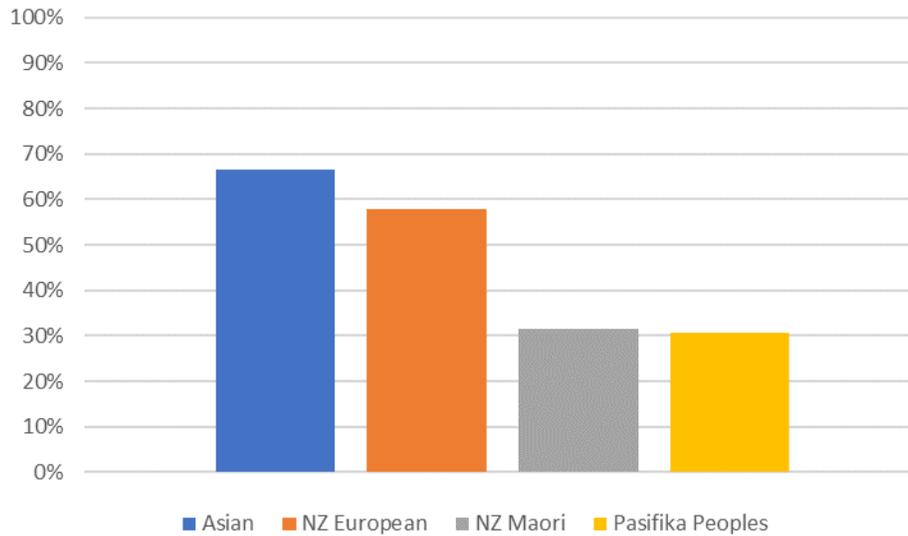


Figure 5: Year 13 Students Achieving University Entrance (NCEA Annual Report 2016; Roll-based)



The significance of these data will be seen in the next section.

2.4 Tertiary Training

In order to become a professional engineer, university level tertiary training is required. There are, of course, other university courses that students may take instead. There are also other methods by which tertiary training can be delivered. Some students choose to attend these other institutions rather than university, for various reasons. This section examines Māori and Pasifika participation in universities as opposed to other institutions, with a focus on engineering courses.

First, an extension of the previous section is necessary, and an examination (no pun intended) of entry criteria for engineering study.

University Entrance Rank Scores are used by universities as a basis on which to accept applicants. The Guaranteed Entry Score (GES) is the level at which a student would gain automatic entry to a programme (providing they fulfil any other requirements). This is calculated from the best of a student's 80 credits at NCEA Level 3 or higher, over a maximum of five approved subjects. Contributing scores for each credit are 4 for Excellence, 3 for Merit, 2 for Achieved. The maximum possible is 320 credits (80 credits, all Excellence).

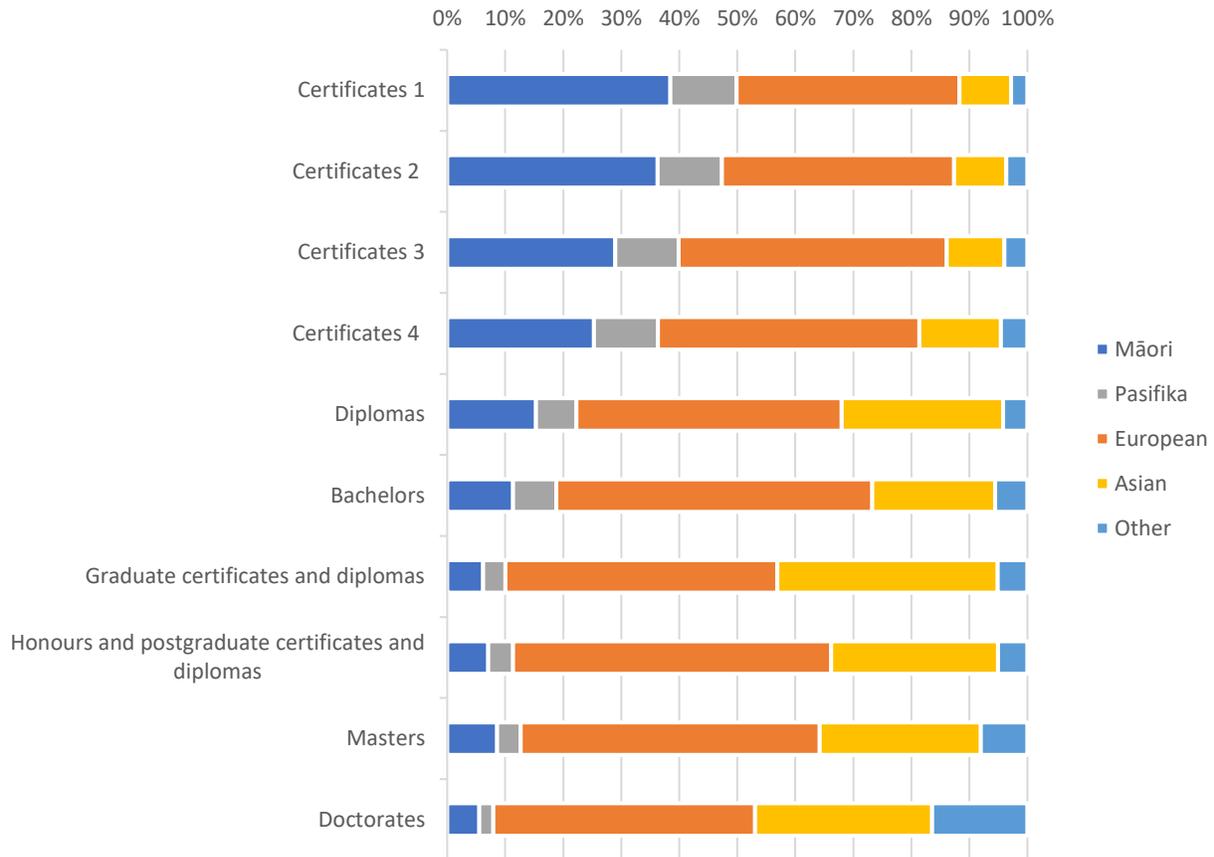
As a comparison, the GES for a Bachelor of Arts degree at Auckland University is 150, while the GES for Engineering is 260. So, while the bar is high for university, the bar for engineering is considerably higher. Not only does this reduce the number of students who can apply for engineering, it potentially leads to competition between programmes, as a student may be tempted to aim for a programme with a lower bar.

There are very good reasons why the bar needs to be high for engineering. It is a competitive field, and the consequences of producing unqualified engineers can be measured in hundreds, if not thousands, of lives. Every Māori and Pasifika engineer has had to pass the same rigorous testing applied to all

engineering students. But the difficulty of entering this field of study should be considered a hurdle that some students may require additional assistance to approach, and to vault over.

Figure 6, following, shows the proportion of students by ethnicity at each level of Tertiary training.

Figure 6: Enrolment in Tertiary Study (2015)



It can be seen that Māori, and to a lesser extent Pasifika, are over-represented in Certificate level courses, and under-represented in university level courses. This is in line with feedback from interviews, where a perception was voiced that Māori and Pasifika choose to do lower-level qualifications, even though some of these are at the same level as secondary training they had prior completed.

Figure 7 shows first-year University student attrition rates. In 2015, 26% of Māori first-years did not return the following year to a course at the same, or higher, level. This attrition rate was 19% for Pasifika, but only 16% for Europeans and 11% for Asians.

Figure 7: First-Year Attrition Rates – Bachelor’s Degrees (2015)

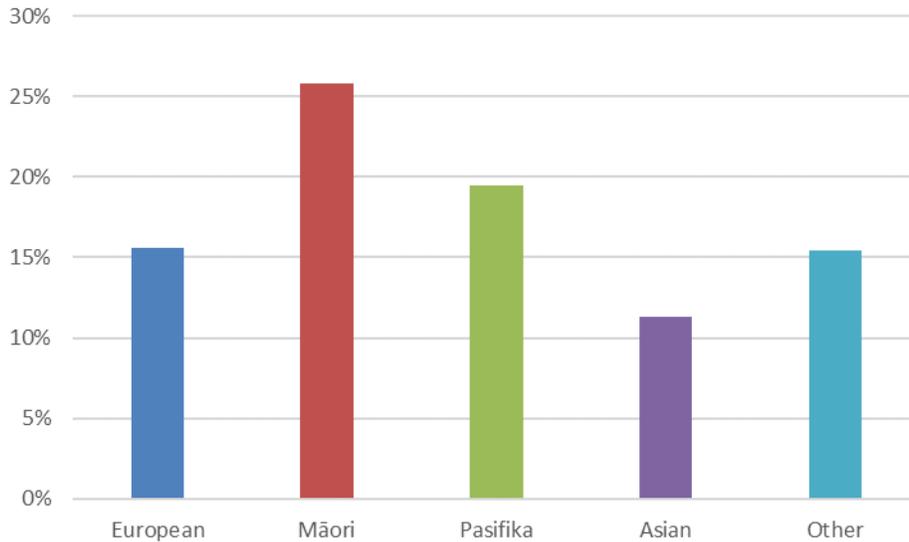
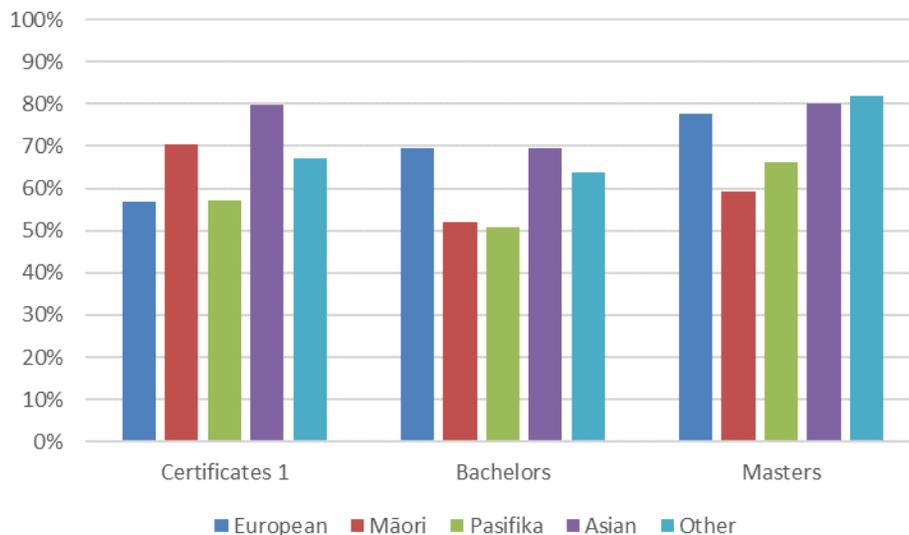


Figure 8 shows that while Māori and Pasifika fare relatively well in completion of Certificate level courses, completion of Bachelors or Masters degrees is at a much lower rate than other ethnicities.

Figure 8: Eight-Year Qualification Completion Rates (2016)



These data support the learnings from interviews carried out, and the potential seen in my own experience. If Māori and Pasifika University students are not supported and encouraged, there is a far higher likelihood that they will not complete their training. Studying engineering at university can be overwhelming for Māori or Pasifika students. With only small proportions in these courses, it can be very easy to feel out of place, and to miss out on a sense of belonging. University can be difficult, academically and in other ways. If students do not feel as though they fit in, and do not have strong support networks, it can be very easy for them to perform poorly or discontinue their studies.

Mentoring is crucial. Section 3 of this report notes where universities have specific mentoring programmes in place. Mentors can be formal and appointed through the university or other means, or they can be informal. They can be friends who have also studied engineering, as was the case for one of my interviewees. University is difficult, and engineering is difficult. Māori and Pasifika students finding themselves in these courses can have additional difficulties, as they may feel outnumbered and alone. There are so many other temptations that can draw a student away from their engineering studies. It is crucial that students are supported and assisted, so that if the right thing for them is to finish their engineering studies, they are able to do so.

Financial cost can be a burden, as well. On top of the cost of fees, there are day to day living costs. One of the strongest temptations for an engineering student is the fact that they are not earning money, but could do so by leaving their studies and taking up full-time employment. Some Māori and Pasifika students (and indeed students of any ethnicity) may be studying at the same time they are raising a family. This adds additional work and stress, in particular for women, who still do the bulk of childcare. Being a student who is also a parent can make it even harder to fit in, as predominantly students in New Zealand are young, unmarried and without children. Raising a family also means that there is less time available for bonding with student peers.

2.5 Māori and Pasifika Engineers

Māori and Pasifika are innovators. Defining “waka” as “canoe” is patently inaccurate. Ocean-going waka were being used by Polynesians to cross vast tracts of the Pacific more than a thousand years ago. They did this without technology such as sextants or timepieces. Rather than making our ancestors less gifted, this makes them more so. Their voyages were made with knowledge of the stars, ocean currents and birds. Science is not restricted to the Western world. Observation and experiment are known the world over.

When the British arrived in New Zealand, they found heavily fortified pā. The impression these fortifications made on them has been documented (e.g. Knight, 2009). It was not an easy task, even for a seemingly better-resourced and better-equipped Colonial party, to take these pā by force. The most common narrative that comes down from these times is that Māori were fierce warriors. This is true, but it is not the full extent of the story. Māori adapted quickly to firearms – not only in the use of them, but in adapting tactics to suit. Even aside from this, the fortifications in existence were cunningly designed, and had stood the test of inter-tribal warfare. In the end, it was artillery that decided the outcome of colonisation. Māori fortifications were unprepared for such weaponry, and this became decisive. But the fact remains that Māori were skilled military engineers, and that engineering is not new to Māori.

Engineering is crucial to Māori and to Pasifika. For Māori, it underpins the key aspiration of kaitiakitanga. There is an interface between mātauranga Māori and Western sustainability science. Many of the principles that have been developed over the past 200 years, for example inter-generational equity, are inherent in the Māori worldview, which predates them by ages. There is great opportunity for Māori to exercise cultural values as well as environmental ones by training in science or engineering. Amenities and facilities are required in the built environment at marae. Marae must also comply with fire codes, which can require specialist knowledge. It is important to Māori that the next generations are well-

versed in all they need to know to prosper in the world of today, and the world of tomorrow. Māori have excelled in recent years in putting students through medicine and law as well as the arts. For engineering, the leap has yet to be made. Engineering underpins economic growth. In fields as diverse as mineral processing or software, engineers are behind not only the development of new ideas, but their implementation and ongoing use.

A lot of the narrative around Māori and engineering, still, is one of indignation. That engineers, in particular wastewater, water or roading, are responsible for implementing so much that is offensive to tikanga. Discharge of sewage (treated or untreated) into water bodies; routing roads through or near wāhi tapu; taking large amounts of water from significant awa and using it to grow sheep or wash down trucks. The offense and agitation around these culturally offensive actions has, particularly through the RMA, engendered change. Many local authorities are now making use of either partial or full discharge of treated wastewater to land, as an example. This has come about to a large extent by Māori lobbying Pākehā engineers and decision-makers. Imagine if the narrative could be changed, though, to Māori engineers developing solutions that are culturally acceptable, as well as technologically and politically. As has been discussed in this section, there are already some highly capable Māori and Pasifika engineers. But there need to be more, either working directly for their communities, influencing those in authority, or being the decision-makers themselves.

For Pasifika, expertise is needed in the Pacific Islands. There are Pasifika engineers, and many Pacific nations have programmes to enable students to study overseas, some of which include a requirement to come home and work for a period of years. But a lot of engineering in the Pacific Islands is imported from other countries, for example New Zealand and Australia². These engineers have to learn how to operate in cultures and environments that are foreign to them. The results are good, but imagine if this onboarding did not have to take place. If the nations of Fiji, Tuvalu, Tokelau, Samoa, the Cook Islands, to name a few, had more Pasifika engineers, trained at world-class universities, bringing their skills home.

The Census contains information on occupation by ethnicity. However, since Statistics NZ do not release this information free of charge, it was not uplifted for the current study. The best source of information available other than this is the membership of Engineering NZ (Section 3.9). Engineering NZ has a membership of some 20,000 engineers across the country. 1.9% of this group identify as Māori, and 2.6% as Pasifika. Compare this with the numbers given in Figure 1, with a 2013 baseline of our population being 16.0% Māori and 8.0% Pasifika. For each of these groups, the proportions of engineers having membership in Engineering NZ is drastically low. There are undoubtedly Māori or Pasifika engineers who are not members of Engineering NZ. But in the absence of other data, the figures reported can be taken as an indication of the extent of Māori and Pasifika in the profession here in New Zealand.

Several Māori and Pasifika engineers were interviewed for this research paper. As could be expected, their stories are all unique. But there emerged some key themes underpinning their success:

1. Supportive family.
2. A mentor or role model who inspired them.

² Carys Everett, pers. comm., 8/11/2017.

In some of these cases, financial assistance played a big part as well.

One of the strengths that Māori and Pasifika bring to engineering is the importance of familial ties, and of responsibility to the wider group. Family in Polynesian society is different to family in Western society. Western society has evolved into nuclear families. While the wider family is important, most planning and decision-making is based around the nuclear family. In Māori and Pasifika cultures, the family group is wider and more connected, and entails more responsibility to members outside the nuclear family. Added to this are obligations to the society and culture as a whole. We are constantly reminded that we are not simply an individual. We are part of a larger whole, with roles and responsibilities that come along with this. Engineering in New Zealand in the 21st century is much better at recognising the importance of the social, environmental and cultural dimensions to the work we undertake. Māori and Pasifika have a head start on this, as these considerations are part of our cultures, our makeup, and who we are.

Role models are important for students at any age. The concept of giving back to the society and the culture means that it should be possible to draw on the resource of existing Māori and Pasifika engineers, encouraging them to work with students, inspiring them to become engineers. There are already some excellent examples of people doing this kind of work across New Zealand. But undoubtedly there could be more emphasis, more structure and more coordination. Māori do not live solely in the moment. Our mindset focuses on the past, the present and the future. As such, the passing on of knowledge and experience is an important consideration, as is the wellbeing and prosperity of future generations. Engineering is a mechanism by which lives are improved, on a public as well as a personal scale. When asked what one thing would improve the numbers of Māori and Pasifika engineers, one interviewee clearly stated that it was role models. Someone to say:

“it’s going to be hard, but you can do it.”

When analysing performance, it pays to look at not only why did failures occur, but why did successes occur. These very simple findings from interviews of successful Māori and Pasifika engineers made clear at least some of the conditions for success.

3. Relevant Organisations

This section contains information on support provided to Māori and Pasifika at each university which teaches engineering, and through to professional organisations. It also mentions programmes which work in schools with younger students. There are undoubtedly other organisations contributing in this area, so this should not be considered a complete list.

3.1 The MacDiarmid Institute

The MacDiarmid Institute is an organisation working in advanced materials and nanotechnology. They run an event every year known as Discovery Camp, or Te Tohu Huraina. Leonie Hayden of The Spinoff calls this:

“a fun, hands-on programme designed for Year 12 or 13 Māori and Pasifika secondary pupils with an interest in science.”

Students come from across the country, and are given a chance to attend this programme based at a university over a week in summer. For the 2018 programme, students will have a choice of attending at either the University of Auckland or Victoria University.

As well as experience in high-quality teaching labs, students get a glimpse of what university life is like. This kind of experience can be useful in either helping secondary students realise that university is a potential pathway for them, or solidifying the idea they already had, and making university attendance a certainty for them.

3.2 Puhoro Academy

Puhoro Academy is a programme organised by Massey University in Palmerston North. It is run at various secondary schools, including Palmerston North Boys' High School, Awatapu College, Palmerston North Girls' High School, Feilding High School, Manukura, and other schools outside the Manawatū.

The programme is essentially high-performance tutoring in the sciences for Māori students. Massey provides tutors, and activities aligned with the internal and external achievement standards in which students are enrolled. This happens on a weekly basis at school. Every term, students also go to Massey, where they attend mini-labs and lectures which expose them to the university environment, and potential careers in science beyond that.

The programme's intent is to expose young Māori to opportunities in science, and foster the development of a community of young Māori which is connected through science. It is delivered in a way that includes cultural and whānau values. Its primary goal is improving Māori leadership and capability in a world needing more scientists.

Janine Rankin of the Manawatū Standard reported on the phenomenal success of this programme, which began in 2016. In the first year there were 97 students. Not only were the NCEA Level 1 results of this group better than other Māori students; they achieved better than non-Māori as well in physics,

chemistry and biology. The results were most marked in chemistry, where 87% of Puhoro students passed ahead of other Māori on 62% and non-Māori on 67%.

There were 107 students on the 2017 programme, and Palmerston North Boys' High School alone already has 45 students signed up for 2018.

Massey University is investing \$300,000 a year in the academy, which is also supported by the Ministry for Business, Innovation and Employment; Te Tumu Paeroa; the Palmerston North City Council; the New Zealand Qualifications Authority; and a range of employers and industries.

3.3 University of Auckland

Auckland is the First City of the Pacific. At the 2013 Census, 66% of New Zealand's Pasifika population resided in the Auckland region, along with 24% of our Māori population. Walking around the University of Auckland, the high proportion of Pasifika students is clear. Accordingly, the University has good support structures in place, for both Māori and Pasifika.

The breakdown of programmes available in each faculty can be seen [here](#).

The Tuākana mentoring and tutorial programme is available across the university, but has a specific programme tailored to engineering students.

One of the main ways in which Māori and Pasifika engineering students can find support and belonging is through SPIES, South Pacific Indigenous Engineering Students. SPIES is a student body specifically for Māori and Pasifika. According to the University of Auckland website, since 1993, SPIES have supported their fellow students by providing social, cultural and sporting activities as well as tutoring services. SPIES has a study and recreation space within the Faculty of Engineering.

[Waipapa Marae](#) is the marae of the University of Auckland. For Pasifika students, there is also a [Fale Pasifika](#). These buildings provide focal points for the expression of culture, and also a very strong indicator that the University sees this cultural support as highly important.

Students can find information on scholarships which are available through a tool on the university website [here](#).

3.4 Auckland University of Technology

Auckland University of Technology (AUT) provides specific support for Māori students. There are whānau spaces on campus, and learning mentors are available. There is a level of support for Pasifika students as well, but with support provided through the same channel as for general students, the Student Hub.

There are [scholarships](#) for Māori and Pasifika available through AUT. Although the amount specific to engineering is small, there are a number that could help students studying engineering.

AUT has a marae on site, Ngā Wai o Horotiu.

3.5 University of Canterbury

As well as support networks, the University of Canterbury (UC) provides free tutoring for Māori and Pasifika students. Engineering students are the greatest users of this facility. There is usually no limit to the amount of tutoring that can be taken up, but the preference of the University is that it be no more than 2 hours per week per course.

The support networks have included social gatherings in the past. Belongingness is seen as a strong indicator of success.

Canterbury University offers [scholarships](#) for Māori and Pasifika students. There are specific scholarships for first-year Māori engineering students, and first-year Pasifika engineering students.

UC has a whare, Te Whare Ākonga o Te Akatoki. This is not used for noho marae (overnight stays).

3.6 Massey University

Massey University has had good support networks in place for Māori and Pasifika students for some time. When I completed my studies there in 2003 and 2004, there was already a tutoring programme in place, and support people. There was a real sense of community at Massey for Māori and Pasifika students. It was seen as a university that was friendly and supportive, and a good option.

This success has been built on. The previous Assistant Vice-Chancellor Māori, Sir Mason Durie, was a strong advocate for Māori “walking in both worlds”. In other words, remaining Māori but being able to navigate the modern, English-speaking, global world. The current Assistant Vice-Chancellor Māori and Pasifika, Dr Charlotte Severne, is a geologist and former chief scientist for oceans and Māori development at NIWA.

There are support staff for Māori and Pasifika students, and specific scholarships which can be found [here](#).

Te Kupenga o te Mātauranga is the name of the marae at the Hokowhitu Campus of Massey University, in Palmerston North. Opened in 1980, the name of this marae refers to the net bringing in seekers of knowledge from across this central part of the North Island.

3.7 Victoria University

Victoria University has a group, Te Rōpū Āwhina, dedicated to supporting Māori and Pasifika engineering students. The kaupapa of this group is to provide a culturally-relevant learning environment for students.

There are whānau spaces on campus, and mentoring services are available.

There are some specific [scholarships](#) available for Māori and Pasifika engineering students, as well as those for Māori and Pasifika students in general.

Victoria also has a marae on site, Te Herenga Waka.

3.8 University of Waikato

Each faculty and school at the University of Waikato has a Māori mentoring unit. There is also one based in Tauranga, primarily to serve extramural students.

The university has a Pacific space, called The Conch, located in the Student Centre.

Although there are no specific [scholarships](#) available for Māori and Pasifika engineering students, there are others for Māori and Pasifika which engineering students could benefit from.

The University of Waikato marae is named Te Kohinga Mārama.

3.9 Engineering NZ

Engineering NZ, formerly known as IPENZ, is the professional institution for engineers in New Zealand. Although there are other professional organisations that are more specialised (e.g. IPWEA for local government, or IEEE for electrical and electronic engineers), Engineering NZ is by default the membership organisation for most engineers in New Zealand.

Numbers on Māori and Pasifika membership in Engineering NZ were given in Section 2.5. Engineering NZ recognise the discrepancy. As an organisation focused on its members, they are aware that they must act to redress this imbalance, and that there are things they can do which will help. The main issue Engineering NZ is currently facing in this space, however, is the low proportion of female engineers (across all ethnicities). Having a wide remit and a relatively scarce pool of resources, Engineering NZ can only focus on one of these issues at a time.

As stressed throughout this paper, the lack of Māori and Pasifika is a systemic issue, and the solution cannot be restricted to only one sector or organisation. It is to be hoped however that in the near future, Engineering NZ will be able to help redress the imbalance.

3.10 SPPEEx

SPPEEx stands for South Pacific Engineering Excellence. It is a group which was formed in 2004 to support Māori and Pasifika professional engineers. Although it is New Zealand-based, the group provides a forum for engineers from across the Pacific to network, collaborate and promote the profession.

The stated objectives of SPPEEx are:

- Promoting professional engineering to target the needs of communities through projects and research;
- Identifying and encouraging potential Māori and Pacific engineering students;
- Facilitating the establishment of scholarships for Māori and Pacific engineering students;
- Providing career mentoring to engineering students and recent graduates;

- Through research and seminars expose, develop and promote indigenous technologies and practice;
- Develop networks amongst indigenous engineers of the Pacific and further abroad e.g. Native American engineers; and
- Represent the position of indigenous engineers to Engineering NZ and the Tertiary Education Commission.

Te Whakapapa me ngā taonga tukuiho...Kia mau tonu ki nga whakapapa, ki o tatou whenua, me ngā taonga tukuiho.

Hold fast to our lands, our treasures and our identity.

SPPEEx is largely quartered in Auckland. They work closely with SPIES, the South Pacific Indigenous Engineering Students group, which was mentioned in Section 3.3 above.

3.11 South Pacific Engineers' Association

The South Pacific Engineers' Association (SPEA) is an association of the bodies which represent engineers within countries in the Pacific Island Forum geographical region. In some countries, there is a formal body, and that body is regarded as the national chapter of SPEA. In other countries there are too few engineers to form a formal body, so the national chapter is informally constituted. Each national chapter has a representative on the Council of SPEA, and the Council elects a President of the Association. The Council meets at least twice per year. The costs of doing so are met by national chapter subscriptions. At each meeting of the Council a forward-looking work programme is developed.³

The SPEA mostly works outside of New Zealand, with national chapters in Fiji, Papua New Guinea, Samoa, Tonga, Vanuatu and the Cook Islands. Because of this, further examination of the work that SPEA does is currently outside the scope of this research.

3.12 Engineers Without Borders

Engineers Without Borders (EWB) NZ is a non-profit humanitarian organisation. Its core principle is that all people should have access to the advantages which society has obtained through engineering. EWB NZ works primarily in New Zealand and throughout the Pacific. There are similar organisations elsewhere throughout the world.

EWBs values are consistent with the idea that anyone should have the opportunity to become an engineer, regardless of ethnicity, nationality, gender, sexual orientation or any other potentially discriminating factor.

³ <http://www.spengineer.org/default.cfm>, accessed 23/11/2017.

EWB commissioned this research to look into the issue of Māori and Pasifika representation in engineering. This was with a view to understanding the problem, and seeing what EWB could itself do to assist. This is in a sense the start of EWB taking a more active role in addressing this shortfall, within its means.

Aside from this, and already in place, are two programmes in particular. One, the Odyssey Design Challenge, and two, the In Schools programme.

The Odyssey Design Challenge is an annual design competition for university students. Students work, generally, on solutions to real-world design challenges. EWB prioritises selection of projects which will have a direct benefit to communities. Recent Odyssey projects have included work with youth in Christchurch, social enterprise in Tongan schools, and emergency management for three hapū of Te Whānau-a-Apanui in the Bay of Plenty.

The In Schools programme involves EWB representatives going in to schools, to teach students about engineering and technology. This is done in the context of using these skills to address global challenge. The In Schools programme is a core part of the work that EWB NZ do, and a key focus area. It is a way in which EWB can directly influence Māori, Pasifika, and other students into taking up engineering and using it for the betterment of society.

More on these programmes, and EWB NZ in general, can be found at <http://www.ewb.org.nz/>.

4. Funding

This paper is by no means the first recognition of the disparity currently under discussion. While most of the work in getting Māori and Pasifika access to engineering still needs to be done, there has been decades of work on improving enrolment at university in general. This section contains details of what is known regarding funding that may be taken up to help address the imbalance of Māori and Pasifika in engineering.

4.1 Scholarships

The financial cost of attending university can be a major consideration. Scholarships can ease the financial burden and the stress. They can free up time for study that may have been spent on part-time employment. And they can make it more likely that a school leaver pursues a university education.

Links have been provided above to the websites of each university, where information can be found on scholarships. Some of these are specific to each university, but the bulk of them are available across the country. Further to the information provided above, the [Māori Education Trust \(Toitū Kaupapa Māori Mātauranga\)](#) is a useful resource. The Māori Education Trust website also has information on scholarships for secondary schooling. Although in theory secondary education is free, the reality is far from this. Secondary scholarships can help to ease financial stress, and make it easier for students to get the best education available.

There are some scholarships that specifically target Māori and Pasifika engineering students. They are few in number, however. There are more scholarships that target Māori and Pasifika students in general. Engineering students can apply for these, but they must compete with a wider pool of applicants. There are scholarships that target Māori and Pasifika undertaking other studies, for example health. For students with a number of study options open to them, but with financial constraints, these could foreseeably draw students away from engineering. There are also scholarships that are open to either engineering students in general, or all students. Again, Māori and Pasifika engineering students could apply for these, but would have to compete against a wide pool of applicants.

One of the examples where indirect assistance can be obtained is through TeachNZ, which offers scholarships specifically for students to become science, technology or maths teachers. This is not an insignificant programme by any means. Each is for full course fees plus \$10,000 for the first year. There are 100 scholarships available for 2018 (40 for science, 20 for technology and 40 for maths).

Making available a greater number of targeted scholarships for Māori and Pasifika engineering students would contribute to a higher number of Māori and Pasifika engineers. Unfortunately, this is an area in which EWB is unlikely to be able to help.

4.2 New Zealand Government

The New Zealand Government provides targeted assistance to Māori and Pasifika students, as well as the assistance it provides to students in general. www.education.govt.nz contains several links to either internal government pages, or external resources, which are helpful.

The New Zealand Aid Scholarships provide substantial assistance to recipients from the Pacific Islands. Included in the scholarships are full payment of tuition fees, a living allowance, and travel to and from home at the commencement and conclusion of the scholarship. More details on these scholarships can be found on the website for the Ministry of Foreign Affairs and Trade (MFAT)⁴. The NZ Aid scholarships are coveted, and are referred to as a “two shoestring” scholarship, in that they provide for both fees and living costs (as opposed to “one shoestring” scholarships, providing fees only).

4.3 Pacific Governments

As mentioned previously, assistance from outside of New Zealand is not within the scope of the current research. Further research would no doubt reveal that at least some Pacific nations have internal scholarships available to support students studying at home or abroad.

4.4 Iwi Organisations

As well as funding available nationally and mentioned above, many iwi or hapū will make funds available to Māori students connected to them by whakapapa. Funding for these grants or scholarships has historically come from income on lands or from settlement claims, in either case administered by trusts.

As well as financial assistance, there is a certain amount of mana that comes from being recognised as worthy of investment. Education is seen as hugely important and highly critical by those planning for the future of their iwi or hapu. While there is generally no form of bonding associated with this funding, there is usually an expectation that students will work in some way for the betterment of their people. This can apply equally to the nationwide scholarships mentioned above.

Students should contact their iwi or hapū to see whether additional funds are available. Generally, information will be available on the internet, or by phoning the relevant office.

There are so many iwi and hapū in Aotearoa that no attempt is made here to list them all, lest any be unintentionally left out.

4.5 Community Groups

Service organisations such as Rotary International or Lions Clubs may also offer scholarships. This is generally managed at a club level, with recipients being locally based. For this reason, it is problematic to provide further information on what is available. However, it is worth noting for students that these organisations do exist, may offer assistance, and can be approached.

⁴ <https://www.mfat.govt.nz/en/aid-and-development/scholarships/what-you-get-with-a-new-zealand-scholarship/>

5. Conclusions

Representation of Māori and Pasifika in engineering is low. Pasifika make up 8.0% of the population of New Zealand⁵, but only 2.6% of the membership of Engineering NZ. Māori make up 16.0% of the population, and only 1.9% of Engineering NZ membership.

There are many reasons, and complex factors, contributing to this under-representation. Entry to engineering courses requires a high level of academic achievement. In general, Māori and Pasifika are not performing as well as other ethnicities at NCEA level. They are also more likely to choose certificate-level courses rather than university courses.

Māori and Pasifika students who do make it to university are more likely to drop out in the first year than other ethnicities. University can be an overwhelming place, particularly if you are one of a small cohort of people from your background in a given course of study.

Engineering underpins the aspirations of Māori and Pasifika societies. Polynesians are no strangers to science and engineering. From celestial navigation to defensive fortifications, there is a long history of sound scientific and engineering practice throughout these islands.

There are fine examples of Māori and Pasifika engineers who have been successful in finding meaningful careers. It is crucial that they are joined by higher numbers of qualified engineering professionals.

A multitude of organisations are doing work in this area, either directly or indirectly. Organisations such as the Puhoro Academy and the MacDiarmid Institute target secondary students, inspiring and encouraging a love of science. Universities now offer more support than ever to Māori and Pasifika students. This support covers a range from financial assistance to peer support and socialising to tutoring. SPPEEx and SPEA provide networking opportunities for Māori and Pasifika engineering professionals.

The next section follows on from the findings of this research to give recommendations for action, with a particular focus on what EWB can do.

⁵ Base year 2013, Statistics NZ projections.

6. Recommendations

The previous section summarised some of the key findings of this work, and the areas in which there are hurdles that Māori and Pasifika must overcome in order to be successful engineers. In line with these findings, the following recommendations are made for how these hurdles can be lowered. Those marked in **bold** are ones in which EWB can practically take part.

1. Encourage more maths and science graduates into teaching, at both primary and secondary.
2. **Foster a love of science and maths in primary school students.**
3. **Promote STEM subjects to junior high school students (Years 9 and 10).**
4. Provide additional resources to help students with STEM subjects at NCEA level.
5. **Promote university level engineering courses as tertiary study options for Year 13 students.**
6. Increase availability of financial support for Māori and Pasifika engineering students, especially those with dependents.
7. **Provide mentoring, support and tutoring to Māori and Pasifika engineering students, with a particular focus on the first year.**
8. Ensure that being Māori or Pasifika is not a barrier to advancement in engineering careers.
9. **Encourage Māori and Pasifika engineers to contribute time to speak to students as role models.**
10. **Promote engineering as a career in general, emphasising the role of engineers in society.**

EWB should be able to influence the picture through focusing on the recommendations in **bold** above, by using, expanding and directing its existing programmes. In particular, the two programmes that can have the most immediate impact with the least additional outlay are:

- **Learning and Change.**
- **Student Chapters.**

6.1 Learning and Change

Through Learning and Change, EWB already has access to impressionable young minds eager to learn about the fascinating world of science and engineering. In order to prioritise increasing Māori and Pasifika representation in engineering, EWB could:

11. **Target schools with high proportions of Māori and Pasifika students.**
12. **Encourage members from Māori and Pasifika backgrounds to give their time to assisting with Learning and Change programmes.**

13. Recruit more Māori and Pasifika members to facilitate the above⁶.

6.2 Student Chapters

In Section 3, it was indicated that universities have programmes and networks in place specifically for Māori and/or Pasifika students. With student chapters in several major universities across the country, EWB is well placed to tap into these networks. To take advantage of this opportunity, EWB could:

14. Encourage student chapters to form relationships with Māori and Pasifika organisations at universities (e.g. SPIES at Auckland University).

15. Encourage student chapters to co-host events with these organisations.

16. Encourage other chapters in university towns (e.g. Palmerston North) to do likewise.

As an added bonus to these activities, EWB as an organisation would be able to increase its profile amongst Māori and Pasifika students.

6.3 Working with Communities

Finally, another way for EWB to promote engineering to Māori and Pasifika is to be involved in work that matters to young Māori and Pasifika people. This could mean marae-based initiatives here in New Zealand, or work that connects young engineers to their turangawaewae and/or their country of origin.

⁶ As this is an indirect recommendation, not included in the scope of the research, it is not discussed in further detail.

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