
AC 2012-3585: IMPROVING ENGINEERING RECRUITMENT

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“Get Those Geeks” an Innovative Recruitment Strategy for a New Engineering Provider

Abstract

Victoria University of Wellington (VUW) is a new provider of Engineering in New Zealand and faces numerous challenges. These include a general ignorance of engineering amongst our secondary school students and very strong competition from established providers. Traditional marketing strategies have been unsuccessful in achieving the level of growth our programme requires. In collaboration with the regional polytechnic, Wellington Institute of Technology (WelTec), VUW undertook a major exercise to identify issues relevant to recruitment and retention in the “digital” engineering specializations. This paper considers the recruitment aspect of this project. Demographic studies indicate that our target audience strongly identify with being “geeks”, something that no New Zealand tertiary training institute incorporates into its marketing strategy. In response, a novel website, hard-copy “geek hero” publication and clothing range was created. The publications have been extremely well received by secondary school students, teachers and career advisors. Informative and promotional posters have also been created for display in secondary school laboratories and classrooms. Whilst final enrolment numbers are not at this stage known, one indicator of the success of our initiatives can be seen in the unprecedented increase in pre-enrolment numbers.

Overview

The New Zealand Government acknowledges that the country does not produce sufficient numbers of engineering graduates. As a result, Victoria University of Wellington (VUW) accepted its first students into a new Bachelor of Engineering degree in 2007. VUW has chosen to specialize in what we will generically label “digital” engineering. Specifically VUW offers Electronics and Computer Systems Engineering (a programme that includes several mechatronics courses), Network Engineering and Software Engineering. This “digital” label is not an accurate one, but will serve in this instance to differentiate these forms of engineering from (say) Civil, Mechanical or Chemical engineering.

VUW is now the primary university provider of engineering in Wellington, New Zealand. It faces challenges in attracting engineering students given the specialized nature of its engineering offering (and poor student understanding of these specializations) and extremely strong competition from New Zealand’s two most established engineering universities, The University of Auckland and Canterbury University. Indeed, local secondary school engineering students have many decades of tradition of leaving the city, primarily for Canterbury in order to pursue their studies. This tradition is firmly in the mindset of parents, secondary school teachers and careers advisors.

To help retain engineering students in the Wellington region, a partnership has been formed between VUW and the Wellington Institute of Technology (WelTec), the primary polytechnic engineering provider in the region. This partnership is non-competitive in that VUW offers a Bachelor of Engineering (BE) (a four year degree awarded with honors), Masters of Engineering (ME) and PhD degrees whilst WelTec offer a two year Diploma and a three year Bachelor of Engineering Technology (BEngTech) degree – both more trade-orientated and hands-on than the various VUW offerings.

WelTec currently offer three majors for their BEngTech degree, Electrical (with a specific specialization in Mechatronics), Civil and Mechanical. The partnership between the institutions concentrates on the overlap of course offerings in the “digital” engineering areas, although there are also overlaps between VUW’s mechatronics offerings and WelTec’s mechanical engineering degree. No attempt was made to partner in the area of Civil engineering since no near equivalent is provided by VUW. When possible, these institutions seek to cooperate in the recruitment areas of increasing student awareness of “digital” engineering and encouraging them to engage in tertiary (university or polytechnic level) engineering study in the Wellington region.

This paper primarily discusses the new recruitments efforts undertaken by VUW in these digital engineering areas and includes our WelTec partners when the initiatives would benefit from a multi-institutional approach. Space restrictions have prevented a discussion on our very successful outreach activities that form a significant component of our recruitment strategy. A very brief summary is presented towards the end of this paper.

Specific Challenges (The Environment)

There is a severe shortage of qualified professional engineers in New Zealand¹. The New Zealand Institute of Professional Engineers (IPENZ) indicates that, depending upon how the demand is analyzed, New Zealand needs to grow its Dublin Accord accredited Engineering Technicians graduates by up to 178%, its Engineering Technologists (Sydney Accord) graduates by as much as 233% and its full Professional Engineers (Washington Accord) graduates by up to 83%². These figures cover all of the engineering fields, but it would be reasonable to expect that in a growing knowledge economy that the demand for the digital engineers could be even higher than these figures. Conversations between the authors and engineers from some of our major engineering employers state that the inability to recruit sufficient numbers of appropriately trained engineers is, in some instances, the major limitation to their company’s growth.

Figure 1 illustrates the poor ranking of New Zealand amongst its OECD trading partners. The OECD average indicates that approximately 13% of all tertiary graduates can be classified as an engineer of some form. New Zealand scores below half of this average at 5.7%².

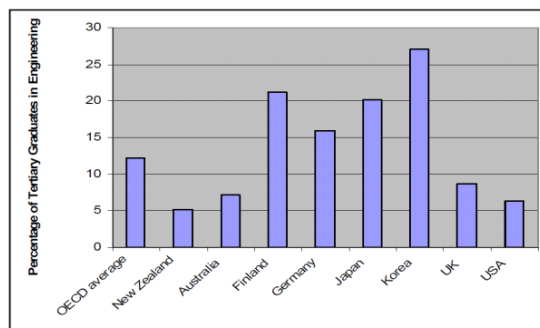


Figure 1. Comparison of percentage of engineering graduates across 8 OECD countries.

This shortage directly relates to a low uptake of tertiary engineering study by students and high attrition rates in tertiary engineering study, a phenomenon occurring worldwide^{3,4}. The lack of supply has important consequences for the future development of New Zealand’s industry and economy, and was the motivation for establishing a new engineering programme at VUW in 2007.

Recent New Zealand research by the IPENZ identified a number of issues that contribute to student recruitment in tertiary engineering. They determined that the three main factors that contribute to a student's decision of secondary school subject choice are their interest in the subject, their academic ability and the perceived career opportunities. However, additional significant influencers in this subject selection decision include the opinions of their peers, parents, teachers and careers advisors⁴.

These findings are very important given that engineering is not specifically covered in our secondary school curricula. Students are able to participate in science (physics, chemistry, biology) and technology (materials, computer applications, etc.) classes, but are generally unaware of how engineering is a distinct discipline. So given that one of the primary motivations of students is subject interest, the absence of engineering options at secondary school level significantly impacts on the number who choose to pursue tertiary level engineering. Interestingly 86% of the secondary school science teachers we surveyed did NOT believe that students are sufficiently aware of engineering or applied science careers in New Zealand.

To compound this, our research (based on focus groups and student and teacher surveys), also found that many of the students' influencers, specifically their secondary school teachers and careers advisors are themselves often unaware of engineering as a distinct discipline and especially the variety of new careers that engineers are now entering into⁵. Many still think that engineering is only about building bridges and tall sky-scrapers.

With a lack of knowledge of engineering options, engineering capable students often abandon the enabling subjects of calculus and physics as they struggle to see the relevance of these courses in their future studies. IPENZ have recognized that intervention is necessary to improve this situation. Their published opinion is that students need to be targeted at secondary school and that, "While some students may go to university and only later decide on a career, tertiary education is too late to foster interest in engineering; career choice needs to be made before leaving school, and indeed before subject choices are irrevocably decided"⁶. Additionally, it is well known that it is more difficult to up-skill in mathematics later in life especially if the foundation skills were not obtained during secondary school.

To address some of these issues the New Zealand Government in association with IPENZ created an organization called Futureintech. Futureintech uses student ambassadors and graduates to promote an awareness of science and engineering in schools across the country for all age groups. They have an active campaign but are non-institutionally specific in their approach and as such cannot be directly involved in promoting any institution in a given area. They are also more oriented towards the traditional areas of engineering rather than our offerings in the "digital" area.

In order to address the findings of this research and to avoid repeating or replicating the work of Futureintech, we developed solutions that focus on being both discipline instructional and institutionally promotional. These solutions were undertaken in association with WelTec when possible. The following section details a somewhat traditional marketing approach undertaken in 2010 that resulted in an average success rate. Subsequent sections detail a more innovative approach undertaken in 2011 that appears to have contributed to a substantial enrolment increase.

2010 Marketing

At the beginning of our 2011 academic year (March), a survey of first year VUW engineering students was undertaken to determine what factors influenced their decision to enroll in engineering at VUW. The survey had a return rate of 88 respondents out of a total of 105 surveyed first year students. One question from this survey asked the students to “Please advise us how you found out about Engineering at Victoria University”. The students were allowed to enter as many options as were relevant. The survey results are presented in Table 1. The “other” category allowed students to enter any options not explicitly listed. Responses to this field included ex-girlfriends, an “IT guy at work”, the Ministry of High Education in Saudi Arabia, and School/University Career Exhibition.

Some explanation of these fields is required to place them in an appropriate context. The television advertising was very limited. New Zealand has six easily available free-to-air television channels (although more are available with an appropriate digital decoder). One channel was targeted specifically for younger viewers, from approximate ages of 13 through to 25. VUW as an institution chose to advertise there and profiled four areas in separate advertisements, engineering being one of them. Budget restrictions meant that frequency of play was low compared to many other television marketed products.

TABLE I. Summary of student responses to advising on how they found out about VUW’s Engineering Degree.

Activity Description	Number of students selecting this option	Percentage of students selecting this option
Attending Open Day	47	53
Friends	46	52
School Careers Advisors	33	37
Website	27	30
Parents	22	25
Secondary School Teachers	23	26
School Visits by Eng. Staff	19	21
Attending Eng. Outreach Activity	9	10
Publicity Posters	6	7
Engineering Facebook Page	4	4
Television Advertising	5	6
Eng. Sponsorship of Events	2	2
Newspaper Advertisements	2	2
Sponsored Television Interview	1	1
In-Game Advertising	1	1
Other	14	16

VUW Central Marketing also paid for two interviews by a popular television presenter. These interviews each featured a selected fourth year VUW Engineering student who profiled their project and discussed the innovative and modern engineering degree at VUW. These interviews were only aired once, but can be viewed at <http://www.engineering.geek.nz/cool-stuff/cool-videos>.

Engineering also sponsored “Armageddon” which is a form of comic-convention that attracts a considerable number of students in our target range. Information on Armageddon can be

found at <http://armageddonexpo.com/nz/>. This sponsorship allowed us to insert promotional material into the give-away bags. We provided a one page advertorial for VUW Engineering and an entry form to enter into a competition to win a Mac laptop simply by registering at our website.

Our most innovative marketing feature was to insert a dedicated advertisement into the most popular on-line games available through “Massive” The advert featured the VUW logo, and the caption “Don’t just play it. Create it”. We were charged by the number of 10 second cumulative views of the advertisement and consequently we believed that this would be a cost effective method of directly targeting our prime audience.

A final point of interest, is that for students who only ticked a single information source box, that box was most likely to be one of; Friends, Open-Day, or Website. No student was prepared to enroll based solely on their parents’ advice, but a substantial number did seem make their decision based only on their friends’ opinions. Similarly a large number of students claim to have found out about our engineering offering solely through attending our open-day (normally arriving as part of a secondary school coordinated group), or else via our website.

We knew that the sponsorship of Armageddon had gone poorly due to a very low number of responses to our ‘win a computer competition’ and so we were not surprised at the low number of responses in the survey. The In-Game advertising results produced unexpectedly poor results. Our expectation was that this would be a very targeted and cost effective strategy. As a result of these responses, we have discontinued both these forms of marketing.

Newspaper advertisements are targeted primarily at the students’ influencers, particularly the parents. We are not surprised at the very low student response rate to this category but have continued it since parental advice is still a significant contributor.

Students entering our outreach programme were also surveyed and asked “if they previously knew about engineering at VUW then where did they get that information from?”. Our expectation was that the results of this survey would be different to those presented in Table 1 since these students have not yet decided to engage in tertiary engineering. Out of 82 surveyed students 54 answered this question. The highest response, at 35% was for school teachers being their information source. This is not surprising since they were at VUW as part of a school trip. The next highest responses were careers advisors 28%, web site 24%, parents 17%, television 17% and friends 15%. Interestingly 4% indicated radio even though we do not do any radio advertising!

The overall effect of our 2010 marketing was a rise of 6% in our first year engineering enrolment numbers. This was a disappointing result for a growing program and new initiatives were required.

Our solutions were to:

- better understand the target student culture and be innovative in our marketing towards them
- increase and refine our outreach activities
- more fully engage secondary school teachers and careers advisors

These solutions are presented in the following sections.

Understanding “The Geek”

A demographic study of students was undertaken that spanned both genders, a variety of socio-economic backgrounds and several ethnicities. This study indicated that students with an interest in, and ability to perform in these “digital” areas of engineering, strongly identified with being “geeks”⁷. Rather than this being a negative connotation, the target secondary school students embraced this label.

To our best knowledge, this geek culture had not before been used as a significant marketing campaign. However, as detailed in the previous sections, even with innovative interpretations of traditional marketing approaches (such as the in-game advertorials) we were not making an impression on our target demographic. Given that we are a new provider of engineering and had to break decades of an established practice of engineering students moving out of region, we decided to embark on a somewhat radical departure from the traditional university recruitment strategies.

Print and online material was subsequently developed to relate with this identified culture – a major departure from the traditional university and polytechnic marketing campaigns. A new website was developed, and a dedicated “geek-hero” advertorial booklet was developed.

The “geek-hero” publication was considered controversial when presented to the marketing department, but was enthusiastically accepted by the university’s student recruitment team. To partially illustrate the geek concept, the front and rear cover of this publication is illustrated below.



Figure 1. Covers of Geek Engineering promotional booklet

Internally the first page of the publication explains how engineers can change people’s lives – a concept our research has shown to be of particular interest to female students. The differences between study at a university and a polytechnic are detailed and reinforced by a series of relevant student profiles and projects. The theme is a fun, geek-orientated style. The geek concept is further promoted with identifiers such as “DigiGeek”, “GeekGirl”, “Hands-On Geek” describing particular students. These students are interviewed and asked about their school experiences, what engineering at university (or polytechnic) is like, what projects they are doing, what they do for fun and any advice they might have for new students. A sample of this is provided in Figure 2.

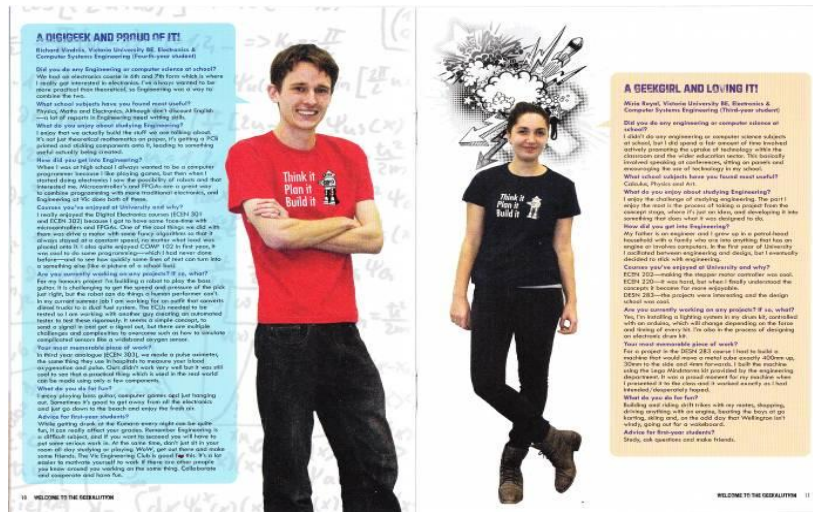


Figure 2. Inner pages of the Geek booklet profiling two students.

Note also in Figure 2, the students are wearing an identically designed engineering tee-shirt. The caption, next to a retro-looking robot, states “Think it, Plan it, Build it”. Developed primarily for retention purposes to assist in the development of an engineering identity for VUW and WelTec students, these shirts are also distributed as part of our regional efforts to increase engineering awareness. As an aside, the adoption of these shirts (which includes a hooded sweatshirt option) by both staff and students at VUW has been very enthusiastic. It is common to see both staff and students wearing them, perhaps in an analogous manner to a sports uniform.

Our initial printing of 2500 booklets was exhausted within a few months – substantially faster than the formal university prospectus. Anecdotal evidence from the students, teachers and careers advisors has been overwhelmingly in favor of this novel approach. We have subsequently reprinted 4000 copies.

As well as the printed booklet, a new website was developed (also in partnership WelTec) in a similar “geek-orientated” style. This is available at www.engineering.geek.nz, and like the geek hero booklet, primarily represents “digital” engineering at a regional rather than at an institutional level. The landing page is intended to initially engage students and then facilitate their accessing of relevant information. Topics include regional providers of tertiary engineering study (primarily VUW and WelTec), cool features of digital engineering, career advice, interviews with students and the profiling of interesting projects. For secondary school students and teachers, there is a page delivering advice and suggestions on the operation of VUW’s Arduino outreach boards³ and a ‘Scratch’ programming page with the trial programs that can operate on these boards. A sample page from this geek-oriented web site is illustrated in Figure 3. The left image is of a page where the user can click and run a video of a variety of student projects, and the right image is of a resource page to support the use of Scratch.

Informational Posters

In New Zealand terms, VUW is an old University (established in 1897) and has a significant reputation as being a quality provider of law, government studies and commerce degrees. Whilst the successes of its science schools have been numerous and substantial, it has been difficult to alter the perception of students, teachers and parents who continue to view VUW as a conservative institution that still focuses on the business, legal and politics arenas.

As discussed previously, our recruitment strategy targets two student groups; those who wish to pursue engineering and are considering the institution best suited to their interests; and those students who are engineering capable but are ignorant of engineering opportunities and hence are headed to a science or medicine course of study.



Figure 3. Sample pages from the geek-orientated promotional website.

To influence the first group, one of our key strategies is to train secondary school students to associate the term “engineering” with VUW (and not the Universities of Auckland or Canterbury). This is important as whilst outreach and school visits can attract students into the engineering domain, we need to attract them to our institution rather than losing them to these more established providers. It is also a difficult challenge given that Auckland and Canterbury offer the full range of engineering subjects and so their student intake, numbers of graduates and industry involvement are an order of magnitude greater than VUW’s.

One mechanism to begin this association of VUW with engineering has been to create, in collaboration with our WelTec partners, a series of eight promotional posters to be inserted inside secondary school science and technology laboratories, mathematics class rooms and careers advisors’ offices. These posters need to be informative and professional in appearance so that teachers will want to host them, but they must also strongly identify VUW with an area of “digital” engineering. We are not concerned that WelTec will also feature on these posters since (as discussed) VUW attracts a different student cohort.

In the absence of dedicated engineering laboratories, we targeted physics and computer science labs since there are many overlaps between our digital engineering specializations and these two secondary school curricula. Specifically we designed posters to cover:

- Ohm’s law: Current, voltage, power and series and parallel resistive circuits
- Battle of the Currents: The advantages of AC versus DC, the battle between Tesla and Edison, step-up and step-down transformers
- Conductors and Superconductors: Transmission power loss, metallic conductivities, superconductors and applications
- Building Blocks: Resistors, capacitors, diodes, transistors

For computer laboratories there are posters covering:

- The Amazing Self Healing Internet: How the internet works, its history and the development of “hot-potato routing”
- Facebook: How Facebook works, databases and caching
- Digital Difference: Digital data storage, binary numbers, digital music and image representation

Figure 4 illustrates examples of these posters (selected for this publication because they resolve reasonably well when miniaturized). The rest can be viewed at: <http://www.engineering.geek.nz/help/help-for-teachers>.

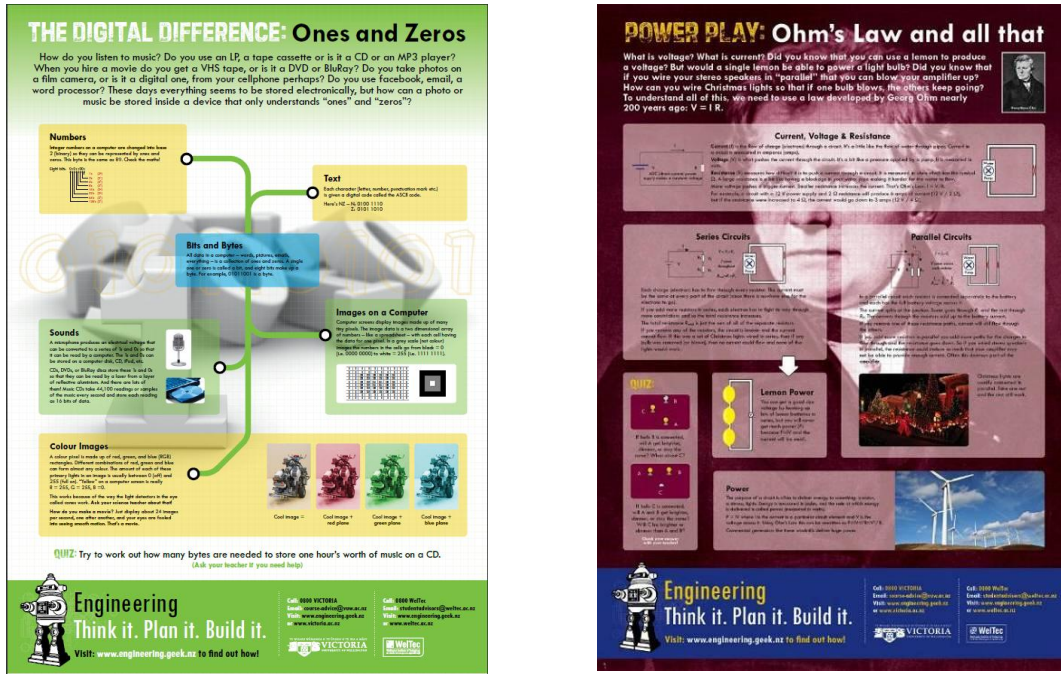


Figure 4: The “Digital Difference” and the “Ohm’s Law” informational posters

Note that both the posters presented in Figure 4, and indeed all of our informational posters, have the same form of engineering caption and contact information at the bottom. They also all include an introduction that is intended to be relevant to the student, and a related quiz question that the students may have to ask their teachers about.

We have also created a special non-informative but visually striking poster for the careers advisors. Whereas the posters inserted in laboratories and classrooms can be text and information rich since the students will see them every day and have the time to read the content, the purpose of this poster is to immediately grab the student’s attention and then to associate VUW with modern engineering. Our solution is illustrated in Figure 5.

The uptake on these posters has been extremely pleasing. Although we cannot yet state that this has influenced our target school students, schools have been requesting additional copies to post in their labs – to the extent that we have distributed double the number we originally anticipated. Given this success, from 2012 we will be extending the distribution of these posters nationally – in the first instance to the higher performing schools.

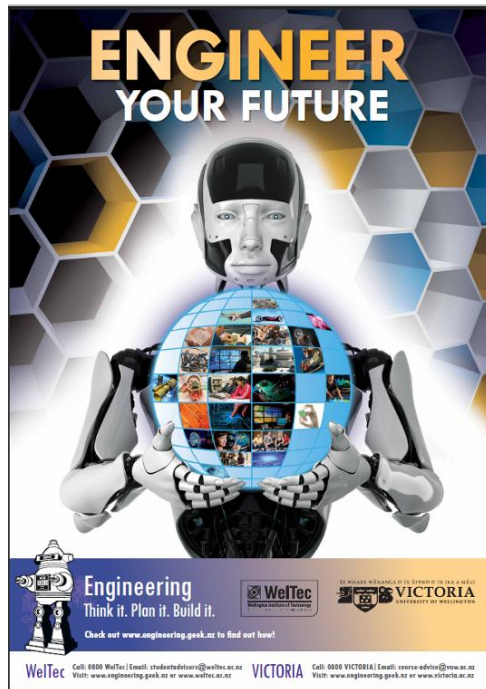


Figure 5: Poster for careers advisors office

Conclusion

VUW is a new provider of engineering. Our primary challenges in recruiting include an absence of engineering curricula amongst our secondary schools (and hence a general student ignorance concerning engineering), a history of a poor uptake of university/polytechnic engineering study, the fact that we only offer a very restrictive set of “digital” engineering, and that engineering interested students have a long history of going to one of the two traditional engineering providers that are out of region.

We lack the funds and the resources to increase our recruitment through traditional means of comprehensive television, radio and newsprint advertising. Attempts at this form of traditional advertising – even with some innovative approaches in 2010, proved to be largely ineffective. We have therefore had to seek cost-effective and even more innovative alternatives.

Student surveys indicate the importance of teachers, careers advisors, friends, web site, open days and outreach activities. Not discussed in this paper are retention initiatives that we have undertaken that addresses the “friends” influences since a positive engineering experience at VUW will be communicated to siblings, and school friends.

However, to engage the students, their teachers and careers advisors we have:

- Created an engaging, informative and flexible outreach programme that now concentrates on senior secondary school students
- Created a series of informative posters for display in secondary school laboratories, offices and classrooms
- Identified the “geek” subculture of our target students and created a booklet, clothing and web pages that embrace this concept.

- Reinforced the outreach events with a student orientated web site that additionally contains useful material for teachers who wish to extend these activities in the classroom.

As mentioned in the introduction, outreach activities have formed a significant component of our recruitment strategies. In very brief summary, the students are given an incomplete Arduino-based circuit board that they must populate and programme. The board can play games and has a variety of add-on shields (daughter boards) so that its functionality can be customized. Initially the student programming of these boards was undertaken using C but with most of the difficulties and intricacies abstracted away. Dissatisfaction with this language, especially when it served as a first programming experience for many of the students, led us to adopt Scratch instead. A summary of the status of these outreach activities is presented in [8], using a PIC microcontroller and before the implementation of Scratch. Recent student survey responses from these activities have been exceptionally positive and comparable with those expressed in [8].

Our pre-enrolment numbers continue to track approximately 40% above those for the same date last year. Indicatively, As at 21 November 2011, when student first indicate their intention to enroll, there was a 40% increase in the number of applications received compared to those received at the same date in 2010 (200 vs. 143). The most recent figures, released 12 February 2012 (with only three weeks to go until lectures begin), indicated that enrolments are tracking 36% above last year's figures. This is exceptionally encouraging (almost unbelievably so) however, the final number of students that actually turn up will not be known until the second week of March.

Whilst the definitive indicator of the success of our initiatives will be the final, confirmed enrolments numbers, we do have the exceptionally positive results from our outreach surveys, the disbursement of nearly double the number of geek booklets compared to the traditional university material, the repeated requests from schools for additional posters, an encouraging number of hits on our website and of course the ~40% increase in pre-enrolment numbers.

We will resurvey our new first year students at the beginning of our next academic year (March) to gauge the effectiveness of these initiatives, particularly our geek-orientated approach. Although the results will not be available in time for the written version of this paper, they will be presented during the conference paper presentation.

We believe that we can justifiably claim to have provided a number of innovative and cost effective solutions to increase recruitment for a new engineering provider operating within a restrictive range of engineering.

Bibliography

1. Earle, D., Advanced trade, technical and professional qualifications – trends in supply, Ministry of Education, Wellington, 2009.
2. IPENZ, 2009. *The Demand for and Supply of Engineers*. http://www.ipenz.org.nz/ipenz/Education_Career/Final_Statement_on_Demand_and_Supply.pdf
3. UNESCO Report, Engineering: Issues Challenges and Opportunities for Development. UNESCO Publishing, Fontenoy, France, 2010. www.unesco.org
4. House of Commons, Innovation, Universities, Science and Skills Committee, 'Engineering: turning ideas into reality', Fourth Report of Session 2008–2009, Volume I, Ordered by the House of Commons to be printed 18 March 2009, <http://www.publications.parliament.uk/pa/cm200809/cmselect/cmduis/50/50i.pdf>
5. Watterson, C. and Carnegie, D.A. Increasing Student Retention and Success: Survey Results and the Success of Initiatives to Create an Engineering Community.. IEEE Engineering Education Conference, pp 191 – 200, Amman, Jordan, 2011.

6. Schagen, Sandie and Hodgen, Edith. 'Why engineering, technology, or science? The views of first-year tertiary students', Report prepared for IPENZ, New Zealand Council for Educational Research, 2009, pp.34-35.
7. Colin Phillips, Unpublished, 'Transcripts of Bachelor of Engineering Student Interviews 2010' Base Two Ltd, Wellington, New Zealand.
8. Carnegie, D.A., Exley, T., Edwards, J. and Watterson, C. Increasing Engineering Awareness Through Targeted Outreach. IEEE Engineering Education Conference, pp 128 – 135, Amman, Jordan, 2011.