Engineering students and International Exchanges: Why so few?

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Abstract
Student exchange – the experience of a lifetime! Surveys and attendance at promotion fairs suggest that engineering students hear this message, but statistics, not only from New Zealand but also from Australia and the United States suggest that engineering students are consistently under-represented in student exchange programmes.

In seeking for causes of this under representation, this paper investigates the situation at a large New Zealand university. Evidence of trends and patterns in choice of destination, the engineering discipline of exchangees and academic success is provided. Survey data combined with individual feedback, identifies perceived barriers and strengths of the current exchange programmes and their administration. The complexity experienced in matching institutions and courses that would enable degree completion without time delay, was found to be more important than foreign language proficiency, previously identified as an obstacle to participation, or even lack of funding.

The results presented in this paper, are relevant not only to New Zealand but to the institutions and countries to which our students go, and from which inbound students come. The conclusions and recommendations emanating from the data collected will assist in building better pathways for engineering students wishing to pursue international study experiences.

Introduction

Technological development has resulted in an increasingly complex and highly interdependent world, where multinational companies are the rule not the exception, call centers operate across national boundaries, telecommuting and distance education are realities. The comment that US engineering graduates can confidently expect to work with overseas partners or on off shore postings for their own companies[1] applies equally well to engineering graduates from Australia and New Zealand. Engineering educators have recognized that the importance of education for an international career has never been greater [2]. Conferences such as the ASEE Global Colloquia, current world wide accreditation reforms, and emerging agreements to enhance international mobility of engineers are all evidence of a wave of interest in the impact of globalization on engineering education.

It has been suggested that international experience should be part of the fundamental education of the 21st century engineer[1] and International student exchange programs, often known as Study Abroad, are an effective means of providing this experience. US engineering student participation in study abroad programs does not adequately reflect this new reality[3]. In reflecting on this under-representation Lohmann[4] cites data which suggest that on 2000-2001 only 10.7% of US college graduates took part in study abroad experience, of those

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engineering represented 2.7% and that 2.7 % represented only 4% of all US engineering graduates. Open Door statistics[5] suggest that although actual numbers have increased in 2002/3 the overall percentage remains static. The Opendoors website also identified that 6.6% of US Study Abroad students in 2002/3 went to Australia and 1.1% went to NZ.

The situation for New Zealand engineering students is very similar. Outbound student numbers in approved exchange programs from the University of Auckland increased in 2003/2004 from 67 to 81 across the university with approved placements for 2005 already at 119. Engineering students were13% of those students, but the proportion of outbound engineering students relative to the appropriate engineering student cohort was closer to 2%.

In response to the School's goal of raising the proportion of engineering students studying overseas to 10%, there is an evident need for analysis of the situation. This paper takes an initial, scoping study of the current participation in International exchange programs by both outgoing and incoming engineering students at the University of Auckland.

The University of Auckland is a research led university, the only New Zealand member of the Universitas21 group of international universities, a member of the Association of Pacific Rim Universities, and internationally, the highest ranked New Zealand university[6]. It is therefore academically well placed to promote itself as a venue for inbound exchange students and as a strong academic source of outbound exchange students. The School of Engineering with 2200 undergraduate students is the largest of seven engineering degree granting institutions in New Zealand.

New Zealand is world reknowned for engineering excellence and innovation in several areas such as yacht design, biomedical modelling, earthquake engineering. Probably not well known except where alumni are on faculty. Its non-nuclear stance, temperate climate, and promotion of its "clean and green" image make it an attractive destination.

The University of Auckland's School of Engineering provides nine engineering specialisations, all accredited by the local professional body, IPENZ, which is a signatory to the Washington Accord. The graduate profile, and accreditation processed monitored by IPENZ have been developed in consultation with other Washington Accord signatories, suggesting the likelihood of similarities in academic programmes and commonalities in the curricula, particularly of the traditional engineering disciplines. It would be expected therefore that course matching for exchange students in the traditional disciplines such as Civil, Mechanical and Electrical Engineering should be relatively easy, whereas for the disciplines of Biomedical Engineering or Engineering Science, course matching might be more difficult or reduce number of appropriate exchange institutions.

The University of Auckland participates in two types of exchanges. The Study Abroad programme, are inbound students predominantly from the USA and Scandinavia, who pay New Zealand International fees. The "360° Auckland abroad" program, provides student exchanges with universities who have signed explicit exchange agreements with the University of Auckland. Because the exchanging students pay the fees due to their home institution this program is limited by attempts to make inbound equal outbound students, although this equivalence is by institution rather than academic discipline. Consequently there is no attempt to control the number of inbound engineering students incoming, relative to the

number of outbound engineering students. Funding assistance is provided to outgoing students, with a subsidy of $3000NZ given to those placed at a Universitas 21 partner institution, and $1200NZ to another approved university. Although New Zealand students only pay their local tuition fees, the greater majority of student exchanges carry with them increased living costs, not nly because of currency exchange rates but also because the majority of Auckland students live at home.

Some Statistics

Study Abroad data for the university in Table 1 reveal a trend of rapid growth. All these students are inbound and bring revenue into the university in the form of International fees

Country of origin	Semester 1 2003	Semester 1 2004	Semester 1 2005
Canada	0	2	5
Denmark	5	5	8
Germany	15	43	54
Norway	16	34	22
Sweden	17	12	4
UK	0	2	0
USA	95	157	206
TOTAL	148	258	**311**

Table 1. Study Abroad data 2003 – 2005

Of the 311 Study Abroad students currently in Auckland, only 23 are enrolled in one or more engineering courses. Whilst growth is evident, there are fluctuations in the source of these students which lie out of our control and ability to forecast such as the changes in government sponsoring policies which have seen Scandinavian numbers markedly decrease.

360^{o} Auckland abroad (Official exchange) data also demonstrate growth, Table 2, although numbers are still small for a university with over 27,000 students..

INBOUND	2002	2003	2004	2005
Engineering		9	17	
Total across University	70	93	131	101
OUTBOUND				
Engineering	3	9	11	4
Total across University	41	67	81	119

Table 2; Auckland abroad (Official exchange data) 2002 – 2005.
Note that 2005 data are placed or approved by June 2005 only and could increase,.

Although dealing with small numbers, trends can be noticed in the countries chosen by Engineering students for their exchanges as evidenced by the data in Table 3 for 2004

Country	Inbound 2004	Outbound 2004
Australia		1
Canada	2	1
Chile	1	
Denmark	1	
Germany	4	
Israel		1
Japan	1	
Korea		2
Norway	1	
Singapore	3	
Sweden	2	1
UK	1	2
USA	1	2

Table 3: Country of origin and destination for Auckland Abroad exchange engineering students

The majority of New Zealand students aimed for English speaking countries, with those going to Korea, Germany and Israel having family connections or previous experience as school students.

Academic success

Auckland students wishing to go on an official exchange are required to have a B grade average or better. Combining this with the entry level to the Auckland Engineering degree, which is as high, if not higher, than most Australian universities and the majority of our UK and USA Universitas 21 partners, it is not surprising that Auckland engineering students going on exchange can be expected to be academically able. They have been uniformly successful to date in their overseas studies, consistently achieving a B average or better.

With the variety of backgrounds and institutions, attempting to quantify or statistically analyse academic performance would be unsound, but experience over a period of five years has shown that inbound students, have been variable in their level of academic success. Those from the background of a traditional engineering discipline, where credit transfer was quite explicit and course matching was more successful, have been, as might be expected, academically successful. Whilst the Auckland engineering degree places a high emphasis on Design and project based learning, it is also relatively rigorous in the level of mathematics

incorporated in most technical courses. Those exchange students from more flexible engineering - related degrees, particularly those with a lower level of mathematical content, have experienced difficulty in some engineering courses despite considering themselves able students. In the initial years of Study Abroad programs there was concern that some students appeared to treat the time away as a holiday with consequent poor academic performance. Increasingly it has been found that students expect to receive credit from their home institution for the work done overseas and are motivated to carefully match up their courses and achieve academically.

Survey results

The Auckland abroad program surveyed 738 first year students across the university in early 2005. The objectives of this survey included:

- Determining the success of activities promoting student exchanges
- Determining the relativity of benefits to participating in an exchange
- Determining the perceived barriers to participating in a student exchange
- Determining the popularity of regions

This survey identified some trends but had not included engineering students. For the purposes of this research, Engineering students in their third year were given the same survey. The choice to survey third year students was based on the awareness that exchanges for engineering students were recommended to take place in the second semester of their third year. They had therefore been provided with a variety of promotional activities in their second year, including talks in lectures, promotional brochures and a one day "fair" in which students who had done exchanges combined with inbound students to provide information and encouragement. It was to be expected that these third year students would have reflected on the benefits and barriers of participating in an exchange. Some initial results from the engineering student responses are provided, pending a complete analysis forthcoming.

One of the first questions asked was whether students had considered going on an exchange and of the 335 responses, 190 answered yes.

The students were then asked to rank the following choices in order of importance to them as benefits of an exchange programme,:

- Experience a different culture
- Make new friends
- Enhance my CV and career prospects
- Move out of my comfort zone/experience a challenge
- Enhance my degree
- Sightseeing/ travelling
- Experience a different learning environment

Of the 190 students who had considered an exchange, Figure 1 illustrates the distribution of the two highest priorities they saw as benefits for an international exchange.

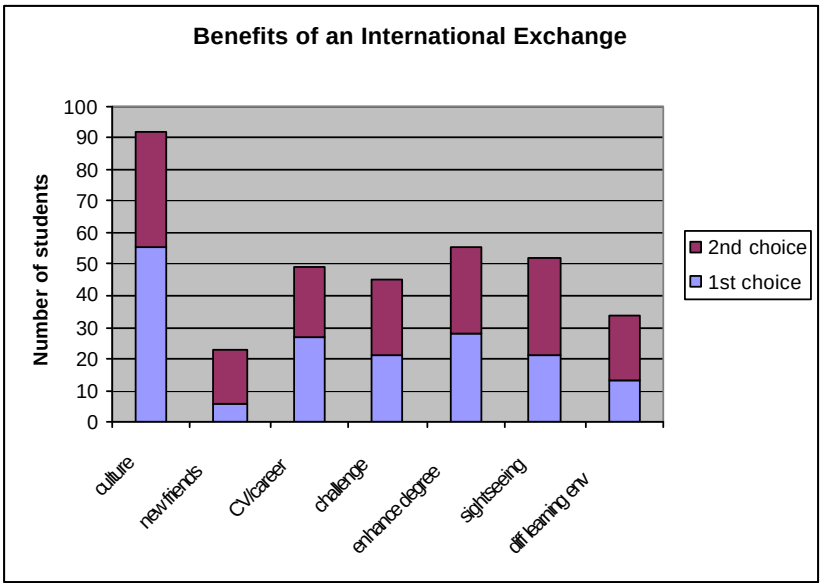

Figure 1. The Relative Importance of different benefits of International Exchange

Considering that a mere handful of applications have been processed in 2005 from this cohort it is evident that the majority the 190 students who had considered an exchange had not followed through with an application. The survey then asked them to prioritise their perceived barriers to an international exchange from the following list:

- Cost
- Would miss my friends
- Too much to organise
- Would be out of my comfort zone
- My parents would not let me
- Exchange does not appeal
- Other

For consistency with students from other faculties, the decision was made not to alter the original survey, but it was noted that lack of foreign language proficiency was not listed as a barrier. Listed under "Other" were the following reasons: slow down study in Engineering/class group (7), courses not compatible (8), miss vital papers (4), grade level too low (4), relationship (4) language barrier (3) sports training (2)

Although cost clearly was a perceived as a major deterrent, when the comments under Other were taken into account, the difficulty in organising, matching courses and the desire not to delay program completion were almost equal in weight.

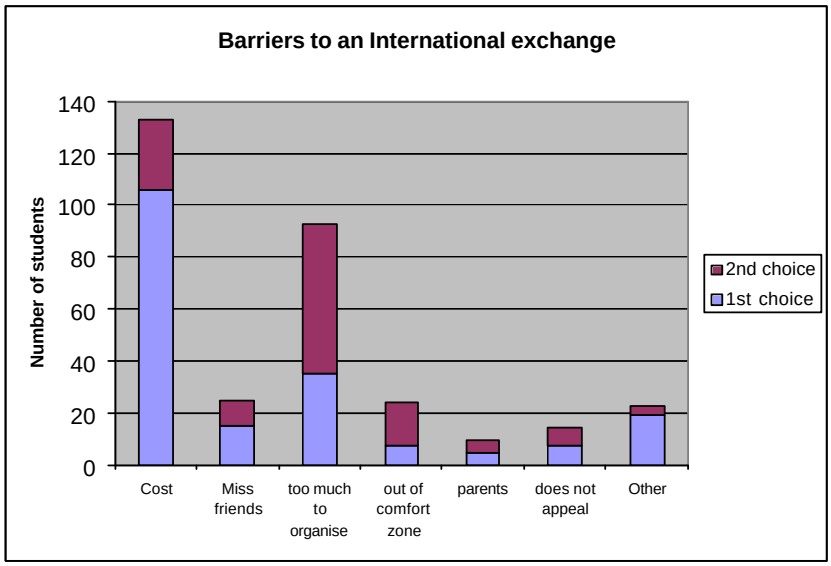

Figure 2. Relative importance of perceived barriers to an International Exchange.

Feedback from Exchange students

For the purposes of this paper, email contact, followed up by face to face contact was made with 7 inbound exchange students (US, Denmark, UK, Norway, Germany) and 4 Auckland students who had taken part in exchanges (US, Canada, Germany, Korea). As the staff member who assisted Engineering students, both inbound and outbound in organising appropriate courses to ensure credit transfer, several years experience were also added to the information provided.

The motivation for inbound students in coming to Auckland, was focussed around

- The need for an English speaking program with high academic credibility so that credit transfer would be approved
- The climate (from Scandinavia and northern Europe!)
- The lifestyle and scenery
- The chance to study courses that were not available "back home"

The barriers identified by Lohmann[4] resonated with the feedback from these discussions.

Costs and lack of Funding

The perception of New Zealand students that costs would be prohibitive was refuted or at least minimised by those students who had gone on exchange. With the appropriate travel subsidy, the availability of student loans, part time work and assistance from some overseas universities, assisted by the currently helpful exchange rate, they had found the costs much less prohibitive than envisaged. The perception prevailed however, as the survey data clearly demonstrated. One university in Germany, for example, provided students with a scholarship that covered living costs, and another provided a summer internship to assist with expenses. It was noted that several of the Scandinavian students received Government funding for their

semester abroad, but the majority of inbound students were self funded which appeared to confirm Lohmann's[4] perception that students from lower socio-economic backgrounds would be disadvantaged.

Academic difficulties

For Auckland students, in common with many engineering programs internationally, the engineering degree is relatively inflexible, with prescribed courses often needing to be done sequentially to ensure pre-requisite knowledge. Many students whose interest may have been stimulated in an exchange program found the process of choosing an institution, trying to understand their degree structure, primarily from information on the internet, and then trying to match course content, clearly quite daunting. Even those who had returned from an exchange described this as the most difficult part of the whole experience. Increasing improvements in university website material is assisting as students attempt to locate matching courses, but the majority of course descriptions do not provide the detail required for the prior approval that students require from their home institution. The choice of appropriate courses is further complicated by differing degree structures and rarely articulated differences in teaching approach.

The Auckland degree for example assumes its entrants have a strong background in calculus and physics, and first year courses are not general science but in-house engineering courses across a wide spectrum of engineering science fundamentals. As a consequence, students coming from a much broader science or liberal first and second year do not have the depth of exposure of the corresponding Auckland students. They often initially choose courses with appropriate sounding titles but without realizing the level of mathematics or pre-requisite knowledge required.

Because of the different timing of the academic year, which starts in late February for Australia and New Zealand, students from the northern hemisphere, from the US or UK for example, are looking to take courses out of sequence. A 5th semester (Fall) student from the USA, for example, would be arriving in July which would be 4th or 6th semester in Auckland program. Auckland courses are only taught in one of the two semesters. The same difficulty is experienced in reverse by Auckland students travelling to the Northern hemisphere.

The very structured Auckland engineering programs, where each discipline has its own timetable and few overlapping courses, cause problems for overseas studens from more flexible or less traditional engineering specialisations. One current student is enrolled in courses crossing three departments of mechanical engineering, electrical Engineering and engineering Science with the consequent hazards of negotiating three timetables.

Recommendations

There is a sense that this initial investigation is only the tip of the iceberg in analysing the current situation, as a guide to improving engineering student participation, but it has already highlighted some areas of possible improvement. The following recommendations are made as a path forward:

1. A database of exchange partners and previously cross credited courses should be compiled and maintained. This information is not currently maintained in a retrievable

location although it has been kept on individual student files and by some departmental advisers. A good role model is outlined by Gerhardt, Blumenthal and Spodek[1] in their discussion of the operation of the Global Engineering Education Exchange (Global E^3) which operates as a consortium arranging exchanges between America, Europe and now Asia, Latin America and Australia. One of the strengths of this consortium is the databank of courses previously approved for credit, available for reference from the internet.

Although a local database would be the first step, it would be advantageous to liaise with Auckland exchange partners in seeking resources to form and maintain this information.

2. In further attempts to simplify academic pathways, it would be advantageous to identify institutions where programmes are close in curriculum and structure. This may require different institutions for different disciplines. By identifying the most popular or most suitable countries/institutions, establishing a first point of contact with academic Associate Deans or departmental advisers, and the exchange officers, and then strengthening those ties with one-to-one, preferably face to face contact, would facilitate effective and speedy information transfer for students and staff.

3. Issues around funding must be made more transparent to prospective exchange students. Clearly, there is a cost, but perception does not appear to match reality. Any opportunities for external funding need to be promoted, and the initiative of providing funded internships to subsidise other expenses could be explored.

4. Further assessment of outcomes has been recommended The majority of exchange students bring back glowing descriptions, with warm fuzzies and superlatives abounding but the need to go beyond to assessing the effect on intercultural competencies and learning outcomes has also been recognised[7]. The research conducted by the Institute of International Education using alumni of the Global E^3 program has shown that participants identify that study abroad clearly offers excellent training in soft skills but Spodek et al[3] suggested it was less clear how engineers evaluated the strength of the "hard" or technical skills they studied abroad, other than to identify that they were given opportunities, such as research projects, not available at their home institution.

Lohmann[4] has suggested that internationalizaton or globalization is the next major wave of change that will wash over engineering education worldwide", although he also comments that "there appears to be no consensus on what is a globally prepared engineer" - what is multi cultural appreciation?".

For us in Auckland, there is a sense that despite, or perhaps because of, our geographical isolation many of our students are increasingly globally aware and already have a high level of multicultural appreciation. Although 88% of undergraduate students are NZ citizens or permanent residents, approximately half of them were not born in New Zealand and, of those, a high proportion have lived in New Zealand for less than ten years. This group came to New Zealand with families who value education and the career opportunities that New Zealand could offer their children, but many do not have a strong allegiance to staying and working in New Zealand and will be part of a globally mobile engineering workforce.

The curriculum at Auckland contains material, at several levels of the degree, on the necessity for cultural awareness. This is focussed strongly on the bicultural nature of New Zealand society and engineer's responsibility to be aware of the need, and indeed legal requirement, to take account of Maori (indigenous people of New Zealand) cultural values by reason of the Treaty of Waitangi. Consideration of Maori issues heightens awareness amongst students of other cultural diversities, particularly in a compulsory fourth year course which includes modules on Globalisation and Culture.

Although the IPENZ accreditation criteria do not contain the equivalent of the ABET criteria 3h[8], which requires engineering programs to demonstrate that their graduates have ..."(h) the broad education necessary to understand the impact of engineering solutions in a global and societal context", the University of Auckland is motivated and committed to ensuring our graduates are equipped with the skills that will enable them to move confidently and competently into the international engineering environment.

This paper is but the first step in our investigation and analysis of the strengths and barriers of international engineering student exchanges, as they apply to the students at the Unviersity of Auckland.

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Elizabeth Godfrey PhD is currently the Associate Dean Undergraduate at the School of Engineering at the University of Auckland after a career that has included university lecturing, teaching and 10 years as an advocate for Women in Science and Engineering. Several years of hands-on advising on International exchanges for engineering students complements her research interest into the Culture of Engineering Education which includes both how that culture is manifested in our teaching and learning practices, but also how that knowledge can be used to effect improved learning outcomes.