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Recruiting First Year Engineering Undergraduates

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Abstract
This paper presents findings of three surveys conducted with first year students in the Faculty of Engineering in the Dublin Institute of Technology. It presents evidence on the reasons students study engineering, their sources of information on higher education programmes and the people who influence their decision to do engineering. It shows there are gaps in the students' knowledge of their programmes and also between their expectations and their experience of their course. Some proposed areas of action are identified to increase both recruitment and retention. It is argued that projecting an image of engineering as a creative activity would help in addressing recruitment and retention issues.

Keywords: recruitment, retention, creative engineering

1. INTRODUCTION

The popularity of higher education engineering courses in Ireland is falling. Data released in March 2006 from the Central Applications Office (CAO) showed that secondary school students' first preference applications for engineering were down by 5.5%. This is part of a trend which has seen first preference applications fall by 18% between 2000 and 2005. This has led Engineers Ireland, the professional body representing engineers, to conclude that 'students with honours mathematics are eschewing engineering as a career and opting instead for the more high profile professions of business, law and medicine.' [1].

While the popularity of engineering is in decline the demand for engineers is increasing. A recent report, published jointly by Engineers Ireland and the Irish Academy of Engineering, *Engineering a Knowledge Island 2020*, estimates that there will be a requirement for the number of engineering professionals and technicians to grow by 7% per year if the target of being in the top five economies in the world is to be met. While at present third level institutions are producing 5 100 engineering graduates per year this will have to rise to 14 000 and will require 'a more intensive promotion of engineering and science as a career option'. [2] This desire to increase the number of students taking engineering takes place in the context of a decline in the numbers of secondary students taking the Leaving Certificate (LC), the terminal secondary school examination in Ireland, due to demographic change. Like many others, the report also recommends that more women must be attracted to engineering. One analysis of the 2002 applications for higher education courses showed that for every ten females who accepted an engineering course there were 42.8 males. In mechanical engineering the ratio was 10 to 141.5. This compares to all degree acceptances where the ratio was 10 to 7.7. [3]

The Dublin Institute of Technology (DIT) is the largest engineering educator in the state with approximately 5000 students. The Faculty of Engineering is acutely aware of the need to constantly monitor its recruitment and retention activity in the light of the falling interest in engineering. To that end the faculty has conducted an annual survey of first year full-time students since 2003. The survey seeks to discover why students study engineering and who influences that decision. This paper reports on key findings which identify the motivation for studying engineering and the key influencers on the decision to study engineering. This data makes an important contribution to understanding how to recruit students to engineering and insights into how they might be retained.

The paper will briefly profile the faculty before providing details of the recruitment survey. Findings of the surveys are presented under two main headings: motivation to do engineering and sources of information and influence. The paper concludes by examining key themes that emerge from the research and argues that an emphasis on engineering as a creative activity may be required to increase the numbers of engineering graduates.

2. THE FACULTY OF ENGINEERING AT DIT

The Faculty of Engineering at DIT is a multi-disciplinary faculty involving staff from a wide range of academic backgrounds and interests operating out of two main sites and a number of smaller sites. The current total enrolment in engineering programmes is 5 000 students, with some 2 500 full-time students. The faculty comprises five schools namely:

- School of Civil and Building Services Engineering
- School of Control Systems and Electrical Engineering
- School of Electronic and Communications Engineering
- School of Manufacturing Engineering
- School of Mechanical and Transport Engineering

The faculty currently operates 21 whole-time and 59 part-time programmes. It also runs craft apprenticeship programmes for over 1000 students in any one academic year. The research reported here covers students from 19 different full-time programmes. These programmes are both honours degree programmes, of four years duration, leading to professional qualifications and usually referred to as Bachelors of Engineering (BE), and ordinary degree programmes, of three years duration, leading to technician qualifications and known as Bachelors of Engineering Technology (BEngTech). These latter courses were previously run as certificate and diploma programmes. There is one remaining certificate/diploma programme in electronics and computer systems.

The faculty operates on two main sites, Bolton Street and Kevin Street. In the former a Common First Year (DT 025) is run for those students wishing to take BEs in mechanical, manufacturing, structural or building services engineering. In Kevin Street a common first year for electrical and electronic engineering is operated.

There is a requirement to have achieved honours mathematics in the LC to gain entry to BE programmes. For students who do not get honours mathematics, but who are otherwise qualified, the faculty provides access to the Preliminary Engineering (PE) programme. Students who pass all programme modules at the first attempt gain automatic entry to the BE of their choice. Typically students choose DT 025. The provision of the PE programme is in line with the recommendations of the *Task Force on the Physical Sciences* which recommended the 'provision of bridging and preliminary courses by higher education institutions for poorly prepared students'. [4]

There are two Bachelor of Science programmes in the faculty, in product design and transport management. The former is a relatively new programme which was developed to address concerns raised in relation to deficiencies in engineering design education. This programme was jointly developed with the Faculty of Applied Arts and the Faculty of Business and combines the principles of engineering with design, innovation, business and marketing. The following is the list of programmes covered by the first year survey:

- Common First Year Engineering (Bolton Street)
- BE Electrical and Electronic Engineering
- BE Computer Engineering
- BSc Transport Technology
- BSc Product Design
- BEngTech Engineering Systems Maintenance
- BEngTech Manutronics Automation
- BEngTech Civil Engineering
- BEngTech Building Services Engineering
- BEngTech Mechanical Engineering
- BEngTech Automotive Management and Technology
- BEngTech Electronics and Communications Engineering
- BEngTech Electrical and Control Engineering
- BTech Electrical Services Engineering
- Cert/Diploma Electronic and Computer Systems Engineering
- Preliminary Engineering

Entry to DIT programmes, in common with all higher education institutes in the Republic of Ireland, is through the CAO. Candidates for courses apply to the CAO indicating their preferences both at Level 8, honours degrees, and Level 7, ordinary degree, diplomas and certificates. Places are allocated on the basis of grades achieved in the LC with points being allocated for different grades. Students over 23 years of age can apply as mature entrants and gain a place through direct entry. It is also possible for students to transfer from other higher education courses as direct entrants. There is also a direct entry route for international students.

There are two features of the faculty which should be noted. The first is that programmes are practically oriented, often characterised as 'hands-on'. Students have access to a range of workshops and laboratories that would not be provided in other institutions. The second is the ladder system, which facilitates progression through all course levels. Students who have successfully completed a BEngTech and reached certain grade thresholds may gain entry to the third year of relevant BE programmes. The role of PE in facilitating access to BEs has already been discussed.

3. RECRUITMENT SURVEY

The Faculty commenced collecting data from first year entrants in 2003. This was in the context of a growing concern about recruitment. There was also a concern to evaluate the faculty's recruitment activities which included school visits by staff and a small number of students, the provision of a variety of literature and web based material and participation in the Institute's annual open day. Since 2002 the faculty has had a full time recruitment officer. The survey has been repeated in 2004 and 2005 with modifications being made in each year. This paper relies mainly on the data from 2004 and 2005 as it is most compatible and was analysed using the statistical programme for social sciences (SPSS). Data from 2003 is provided where it is comparable.

The data is collected from students in October and November of the year in which they commence studying at DIT. The students complete an online survey through Web Course Tools (WebCT) the online learning platform used by DIT. As all students take some computing module in first year the survey is completed during one of their early computing classes. Based on mid September acceptances the faculty recruits in the order of 650 students per year although the number of acceptances in 2004 was 747. In each year approximately two thirds of students have completed the survey. In 2003 the proportion was 67% while in 2004 and 2005 it was 64% and 68% respectively. Table 1 provides the details of the programmes for which respondents were registered.

Table 1 shows that each course is represented in the final group of survey respondents. The varying and changing number of respondents from some programmes mainly reflects the numbers registered for each programme.

Programme	*2005*	*2004*	*2003*
Common First Year Engineering (Bolton Street)	93	104	111
BSc Transport Technology	9	17	21
BE Electrical and Electronic Engineering	17	12	10
BE Computer Engineering	7	7	9
BSc Product Design	23	50	21
BEngTech Engineering Systems Maintenance	14	9	13
BEngTech Manutronics Automation	27	22	14
BEngTech Civil Engineering	34	37	37
BEngTech Building Services Engineering	29	34	25
BEngTech Mechanical Engineering	49	26	24
BEngTech Automotive Management and Technology	23	32	13
BEngTech Electronics and Communications Engineering	13	15	24
BEngTech Electrical and Control Engineering	14	23	33
BTech Electrical Services Engineering	19	39	19
Cert/Diploma Electronic and Computer Systems Engineering	24	20	25
Preliminary Engineering	49	31	41
Total	444	478	440

TABLE 1.Survey respondents by programme

The questionnaire asks students for personal details before seeking their responses to questions about sources of information on higher education courses, the reasons for studying engineering and coming to DIT, the key influencers on those decisions and their evaluation of DIT recruitment activity. The majority of questions use standardised lists from which students select responses. The order of these lists is varied from year to year. A small number of questions provide students with the opportunity to provide open-ended responses.

To supplement the survey data, student records are also analysed. Each year the CAO provides DIT with data on all those who accept places. This includes data such as their secondary school address, LC results, their CAO points and their CAO preference of the course for which they are registered.

There are limitations in both data sets which restrict the extent of the analysis. It may also be the case that a tool developed for evaluating recruitment activity may have limitations when it comes to trying to answer more profound research questions. What follows delineates broad trends in the faculty. The responses from year to year have been consistently similar and are sufficiently robust to constitute a serious contribution on the issues surrounding the best strategies for attracting students to engineering. Where appropriate the findings are compared by gender and the level of study (professional engineering or technician courses). Given the small number of women in the faculty comparisons based on gender should be seen as indicative rather than conclusive.

3.1 Respondent Profiles

Respondents for 2003, 2004 and 2005 were predominantly school-leavers and male. The proportion of school leavers was 93% and 85% in 2003 and 2004 and 92% in 2005. The proportion of mature or international students has never exceeded 6%.

The number of women respondents has averaged 9% over the three years. But these women are concentrated in a small number of programmes. In both 2004 and 2005, 53% were in the Common First Year in Bolton Street or the BSc in Product Design. If the numbers in the BEngTech in Civil Engineering and PE are added to these, 72% and 68% of women respondents are accounted for in 2004 and 2005. Women join the faculty either to do civil/structural engineering or product design. Both the Common First Year and PE are routes to the BE Structural Engineering. While students do not decide which discipline they will study on entry to the Common First Year, they do indicate their preferred discipline and in the case of the women in 2005 they all wanted to study structural engineering.

The product design programme has had a significant impact on the number of women in the faculty. Without this course there would only have been 27 women respondents in 2004 . In the first three years of its existence women have constituted 37% of entrants to the programme. The success of the programme in attracting women to the faculty lends support to Beraud's argument for the role of interdisciplinarity in attracting women to engineering.[5] It has been seen above that this course is run jointly with two other faculties. First year students, for example, take a number of modules in these faculties including economics, marketing, creative design practice and design history.

An examination of students records for the full cohort from each year highlights a worrying trend in that the average ability as measured by CAO points is falling. Between 2004 and 2005 the average points in the faculty fell by 13 points. Between 2003 and 2005 average points fell for 9 of the 16 programmes listed in table 1. In some cases the fall is insignificant but in others, particularly in transport and electrical/electronic programmes, especially at technician level, the fall is more substantial.

In summary the faculty is drawing on a very narrow base from which to recruit students: male school leavers. Average ability on entry is in decline. This may be impacting on our capacity to retain students. Data compiled by the DIT retention officers shows that retention rates are lowest for technician programmes.

4. WHY ENGINEERING?

A key aim of the surveys was to determine the reasons why DIT students choose to study engineering. Students were presented with a list of statements. While in 2003 they were asked to rank the statements, in 2004 and 2005 they were requested to rank their top five reasons. Table 2 presents the statements and the percentage of students who gave them a ranking of one or two.

The responses were consistent across the three years. The most popular reason in each year was *'I was always interested in how things work'*. Taking the average across the three years this was followed by '*I am interested in designing things'*, '*Engineering is a good career'* and then by *'I want to build things'*. It is evident that DIT students are primarily attracted to engineering by intrinsic features of engineering and their desire to understand, build and design.

Reason for studying engineering	*Percentage 2005*	*Percentage 2004*	*Percentage 2003*
I was always interested in how things work	38	41	52
I am interested in designing things	34	31	28
Engineering is a good career	28	34	29
I want to build things	25	24	30
Engineers are well paid	19	15	15
I liked engineering at school	15	15	13
I like maths and physics	15	11	14
I like working with computers	10	9	Not Asked
An engineering qualification will allow me to travel	8	8	9
My family is involved in engineering	4	6	8
Other	5	5	5

TABLE 2. Reasons for choosing engineering (Top 2 Choices)

This is in line with findings of research by the American IEEE in which student respondents indicated that their primary reason for doing engineering was that they *'wanted to invent, build or design things'*. There was a significant gap between this response (80%) and the response related to salary, prestige and career opportunities (41%). [6] These kinds of findings reinforce evidence that suggest that 'the single most influential desire' which guides the choice of a career is the desire 'to work in an area that is personally satisfying and fulfilling'. [7] Research in Ireland with higher education applicants shows that 'personal ability' and 'personal interest' are the most important factors influencing the choice of higher education programmes. [8]

Secondly, it can be seen that on average 14% said they did engineering because they liked mathematics and physics, while 16% said they did it because they liked engineering at school. While, according to student records, all of the students who enter the faculty following the LC have studied mathematics and half have studied physics, only a minority of the full cohort of students has studied engineering for the LC. The figures are 21%, 25% and 25% for 2003, 2004 and 2005 respectively. Of these students, who took the survey in 2004 or 2005, two thirds of them ranked the statement *'I liked engineering at school'* first or second. What is notable from an analysis of the LC results is the high levels of achievement of students who take engineering in secondary schools. In 2005, for example, 160 students took engineering, 152 did it at higher level (all LC subjects can be taken at higher or ordinary level) and 146 got an honour (Grade A, B or C). What this suggests is that the experience of doing engineering at secondary school is a positive one and an efficient route in directing students to higher education engineering courses. This is particularly the case for mechanical and transport courses especially at technician level. It is a also a factor for those pursuing professional degree qualifications. One fifth of Common First Year entrants rated this answer as first or second while only one quarter of entrants to this programme had studied engineering.

By way of contrast it can be argued that an interest in mathematics and physics is not a primary motivator in directing students into engineering although it will be seen below that there are differences in relation to this issue between males and females and those studying at different course levels.

Table 3 compares the top two reasons for doing engineering for those taking honours degree programmes and those taking all other programmes in both 2004 and 2005. While both sets of figure display the same general trends as indicated above, some contrasts can be identified. Firstly those not taking honours were slightly more concerned with the career aspects of engineering. Secondly, those on honours programmes were more likely to do engineering because of their desire to *"design things"*. Thirdly, honours degree students were also more likely to say they do engineering because they liked mathematics and physics.

It can also be seen that almost the same proportion in each group do engineering because they liked engineering at school and almost the same proportion in each group said they wanted to '*build things'* or find out '*how things work'*. The answers in table 3 emphasise the strong practical orientation of DIT students at all levels.

Reason for studying engineering	*Hons. Degree %*	*Other Programmes %*
I was always interested in how things work	40	37
I am interested in designing things	36	28
Engineering is a good career	24	28
I want to build things	24	24
I like maths and physics	17	9
Engineers are well paid	16	17
I liked engineering at school	14	15
An engineering qualification will allow me to travel	8	8
I like working with computers	7	12
My family is involved in engineering	4	6
Other	5	5

TABLE 3. Reasons for choosing engineering by course level (Top 2 Choices 2004 and 2005)

This practical orientation is underlined by responses to a question asking why they specifically came to DIT. While the data is not presented here in detail the responses were again consistent across the years. In all years the most popular response was that *'DIT has a good reputation for engineering'*. The answer that scored the second highest number of first and second choices was *'DIT courses are more practical and applied'*. This response received support across the programmes offered at different levels. Indeed in 2005, 57% of the Common First Year students gave this response a first or second preference. This is the highest proportion for any programme. 41% of students on the BE in Electrical and Electronic Engineering gave the same response. In 2004 the degree of support for this response was 39% for the Common First Year and 31% for the BE Electrical and Electronic Engineering.

In relation to the reasons for coming to DIT, it is worth noting that one third of students not taking honours programmes in both 2004 and 2005 gave a first or second preference to the response which stated *'The DIT ladder system will allow me to transfer to a higher course when I finish my current course'*. These students may not have got honours mathematics in the LC and see the ladder system as a route to a career in professional engineering. This response was particularly important to those studying on PE, the BEngTech Civil Engineering and the BEngTech Electrical and Control Engineering.

4.1 Gender Differences

Table 4 contrasts the reasons for doing engineering as provided by males and females for 2004 and 2005 combined. As already stated the number of women in the faculty is small making comparison with males difficult. It is also the case that most women are studying on honours degree programmes particularly the BSc in Product Design. Bearing this in mind some differences between males and females can be noted. While the difference in the emphasis on *'designing things'* can be explained by the nature of the product design programme, it is perhaps indicative of a different emphasis that needs to be placed in promoting engineering to women. It is clear that there is also a significant difference in the proportion of male and females who *'want to build things'*. While it is the case that design is a central engineering activity involving creativity and ingenuity, the message that has not been communicated is that engineering is a creative and disciplined problem-solving process that enhances the quality of life [9][10]. The relationship between engineering and design is poorly understood. The product design course is the only one that includes the word design in its title. Research elsewhere suggests that this title conveys a more artistic impression of the product design process [11]. This may make it more attractive to women. In 2005 one third of the women entrants to the faculty had studied art and design for the LC compared to only 13% of males.

Like other Irish female school leavers the female respondents were less concerned with career and pay issues than males [8]. Their *'like of mathematics and physics'* seems to be more important in directing them towards engineering than it is for males. This is in line with findings elsewhere. [9] [12] Liking engineering at school is less important because of the tiny number of women who did engineering. In 2005, 232 girls took engineering for the LC out of more than 24 000 female LC candidates. In 2004, five of the female survey respondents took engineering, while two did in 2005.

Finally it can be seen that family involvement in engineering was more important for women. This again is in line with evidence elsewhere [9] and will be explored further below.

Reason for studying engineering	*Male %*	*Female %*
I was always interested in how things work	40	42
Engineering is a good career	33	24
I am interested in designing things	31	48
I want to build things	26	17
I liked engineering at school	16	7
Engineers are well paid	15	8
I like maths and physics	12	20
I like working with computers	10	12
An engineering qualification will allow me to travel	8	7
My family is involved in engineering	5	7
Other	4	8

TABLE 4. Reasons for choosing engineering by gender (Top 2 Choices 2004 and 2005)

5. INFORMATION AND INFLUENCERS

The surveys examined the sources of information that students drew on in preparing for higher education. They were also asked about those who influenced their decision to study engineering.

5.1 Sources of Information

Table 5 indicates the main sources of information used to get information on higher education courses.

Source of Information	*Percentage 2005*	*Percentage 2004*	*Percentage 2003*
Career Guidance Counsellor	42	42	48
College Prospectus/literature	38	40	47
College Open Days	26	21	21
Website	24	20	23
Parents	19	22	13
Other Family Members	16	16	10
Friends	12	11	11
Other Teachers	8	11	6
Information Leaflets	8	9	14
Other	5	6	4
Newspapers and Other Magazines	2	2	3
Public Library	0	1	2

TABLE 5. Sources of information on higher education courses (Top 2 choices)

From table 5 it can be seen that the key sources of information were career guidance counsellors (CGCs), colleges prospectuses, open days, websites and parents. If information leaflets and prospectuses are combined the importance of hard copy is confirmed. These findings are in line with those for school leavers in general. [8] There were some minor contrasts between males and females in sourcing information. Women were more likely to give higher rankings to family members, particularly parents. Females also rated prospectuses higher while males give higher rankings to open days and websites

Respondents were also asked about their involvement in, and evaluation of, DIT recruitment activities. Table 6 sets out the average responses for the three surveys. Table 6 shows high levels of satisfaction with DIT recruitment activity. School visits by staff and students were rated very highly. It also shows that these activities have an impact on student decisions to go to DIT. School leavers in general tend to positively evaluate college recruitment activities [8]. The key issue is to increase the numbers who participate in them.

Activity	*Percentage participating*	*Percentage rating the activity good or very good***	*Percentage who were influenced to come to DIT by activity***
DIT Open Day/Information Day	33	79	75
Staff Visit to school	20	90	72
Student visit to school	5	90	67
Read course brochures or booklets	86	80	82
Visited DIT website	68	67	53

***Percentage of total who participated in the activity*

TABLE 6. DIT recruitment activities: average participation and rating 2003-2005

The lowest ratings were for the website again emphasising the importance of hard copy material for prospective students. Respondents made suggestions in relation to the website and promotional activity in general. The key issues that emerged from these text responses is that applicants wanted more detail about programmes, especially the subjects they would be studying when they started. They also wanted the websites to add to the information available in hard copy.

5.2 Key influencers

Respondents were provided with a list of people and asked to indicate the strength of influence each had on their decision to study engineering. Table 7 provides information on those who had a strong positive influence on the decision to do engineering. It can be seen that the key influencers were parents, CGCs, engineers and family members. Current and ex-students and teachers, other than the CGC, had a strong positive influence on substantial minorities. In 2005 14% said a current student had a strong positive influence.

	Percentage 2005	*Percentage 2004*
Parent	38	36
Career Guidance Counsellor	28	23
An Engineer	23	20
Other Family Member	22	21
A Current Student of DIT	14	7
Engineering Teacher	12	14
Maths Teacher	10	10
Science Teacher	10	7
An Ex-student of DIT	9	9
Other Teacher	8	6
A member of Staff at DIT	5	5

TABLE 7. Strong positive influence on decision to study engineering

Those studying for honours degree programmes were more likely than other students to say that teachers, other than the CGC and the engineering teacher, had a positive or strong positive influence on their decision to do engineering. This was particularly the case for the mathematics teacher. 34% of honours degree students attributed a positive influence to their mathematics teacher while only 24% of those doing other courses did so. Honours degree students were also more likely to say that their parents had a positive influence.

Table 8 shows the pattern for males and females for all those who had a positive or very positive influence on the decision to do engineering. Females were more likely to say that parents, family members, science and mathematics teachers had a positive influence. They were also more likely to say this for current and ex-students. Males were more likely to say that their CGC and their engineering teacher had a positive influence. Some points in relation to families, engineers, teachers and students are worth noting.

	Male %	*Female %*
Parent	68	77
Career Guidance Counsellor	51	47
Other Family Member	46	55
An Engineer	38	40
Maths Teacher	27	37
Engineering Teacher	25	13
Science Teacher	21	31
An Ex-student of DIT	22	29
A Current Student of DIT	23	26
Other Teacher	17	18
A member of Staff at DIT	10	16
Other	17	18

TABLE 8. Positive influence on decision to do engineering by gender (2004 and 2005)

In both years over half of respondents said a member of their family, including parents, had a strong positive influence on their decision to do engineering. In 2005 just over one fifth had a relative who studied engineering at DIT. The proportion for males and females were 21% and 25% respectively.

Students in the Common First Year and PE in 2005 were asked to give details about relatives in their extended families who had studied engineering. Bearing in mind the small number of females there is a striking difference between males and females. While 75% of the women said they had a relative who was an engineer only 35% of males did so. In relation to their immediate relatives (mother, father, brother or sister) the proportions were 25% and 12% for females and males respectively. This perhaps explains the higher ranking given by females to family members as sources of information and influence. It may also explain why almost one quarter of respondents said an engineer was a strong positive influence on their decision to do engineering.

But it is the case that only a minority of families have engineers within them. A significant number of respondents said their families were sources of information and/or influence even in the absence of an engineer. If parents are influential then it is important that colleges pay attention to parents understanding of engineering. Engineers Ireland has recently held focus groups with the public and students to discuss their perception of engineering. One of the findings, in common with findings elsewhere [9] was that: ‘The perceptions of most students and parents were negatively influenced by poor knowledge of the breadth of engineering applications and the low contact with engineers’. [1] Engineers Ireland made the summaries of the focus groups available to the author and what is striking is the extent to which parents, in particular, expressed a lack of knowledge about engineering. As one summary said ‘all admitted that they really did not know enough about it (engineering)’.

CGCs are also key information providers and influencers. Respondents were asked if they had had career guidance at school. In 2004, 14% said they had no career guidance while in 2005 the proportion who had none was 8%. Three quarters of respondents in 2005 said that their career guidance counselling involved one to one interviews with their CGC.

The important role of engineering in secondary schools as a gateway to a higher education engineering programme was highlighted earlier. Looking at those who had an engineering teacher, 83% in 2005 and 89% in 2005 said this teacher had a positive influence on the decision to do engineering. In 2004, 60% said they had a strong positive influence while 43% did so in 2005. This underlines the important role this subject plays in directing students to engineering programmes. The small number of females doing this subject has already been noted.

The MRBI national survey with school-leavers, conducted for the Task Force on the Physical Sciences in 2002, showed that 17% of respondents would liked to have studied engineering at school but could not because the subject was not offered in their school or the timetable clashed with other subjects. [8] Department of Education and Science data for 2003/04 shows that only 43% of schools provide the subject. Only one of 156 all girls schools do so. The Task Force Report highlights the lower level of provision of engineering in schools which offer three science subjects (physics, biology and chemistry) [4] making it harder for students who are studying engineering in school to acquire expertise in science. An analysis of the LC subjects taken by the 2004 intake into the Common First Year and PE shows that only 23% (35 of 152) had taken engineering *and* a science subject, mainly physics, for the LC.

Finally there is a cohort of entrants who are influenced by students, ex-students, staff and engineers. What can be suggested is that there are key influencers in the broader engineering community who have an important role in directing young people into engineering. Thus the experience of current and ex-students in studying engineering is important for the type of feedback they give to DIT applicants.

5.3 Are Students Prepared?

Despite the variety of information sources the surveys revealed low levels of understanding of the programmes for which students were registered. Respondents were asked to state whether they *'had a clear understanding of what their course was about before they came to DIT.'* In 2005, 43% said no, with 42% saying no in 2004. While some of this may be attributable to students getting into programmes which were low on their CAO preference list, 80% of entrants to the faculty in 2005 were studying on a programme that was either their first or second preference and therefore they would be expected to have high levels of knowledge about it. The lack of knowledge is worrying in that poor preparation for higher education has been identified as a cause of early withdrawal. [4]

Another factor that that affects retention is the gap between 'students' expectations and their experience on their courses'. [4] Although the surveys were conducted in the very early months of their programmes some evidence emerged that students were having some difficulties. Respondents were asked *'What is the most important thing you need to know before coming to DIT to do engineering'*. While not all students responded, open ended responses were obtained from 459 students in 2004 and 2005 combined. While these responses ranged over a wide number of issues three key themes emerged. First, as already mentioned, students wanted more detail about their programmes before they start. Second, over one fifth made reference to the mathematical and scientific content of their programmes and seemed surprised by the extent of it. The third key set of responses referred to the long class contact hours or the difficulty of the programme.

The second set of responses supports much anecdotal evidence in the faculty that students expect to do more real engineering in first year. Despite the reputation of DIT for having a 'hands on' approach to engineering, most of first year modules focus on the mathematical and scientific foundations of engineering. Indeed research by the DIT Retention Office has shown that LC mathematics score has been the primary factor in determining whether students pass into second year, fail or withdrew from their programme. [13] This may be part of a broader trend whereby 'students expect practicality and find abstraction'. [14]

6. CONCLUSION: LINKING RECRUITMENT AND RETENTION

The evidence presented above has identified the key reasons why students choose to study engineering at DIT, how they obtain information about third level programmes and the key influencers on the decision to do engineering. It has been shown that there were gaps in students' knowledge of their programmes before they start studying and that some were surprised by the mathematical and scientific content and the level of difficulty. It was also seen that DIT is recruiting from a very narrow base and that overall ability levels on entry are falling.

How can this information be used to improve recruitment? Can it help in addressing retention issues? There is a general concern about rates of attrition in engineering programmes particularly among first years. [4] Data from the DIT Retention Office shows attrition rates for first year have fallen from 42% in 2002 to 29% in 2005 but are still higher than for all years of engineering (22%). Attrition rates are highest on programmes not leading to honours degrees. These are the programmes for which entry points have fallen most. Retention rates have been improved due to a number of focused initiatives in the faculty including a peer mentoring programme, the introduction of a diagnostic mathematics test and the establishment of a mathematics learning centre. Focused tutor support on some programmes has also been an important factor. The data presented above suggests that there are other areas which require attention or action.

It is clear that there are gaps in the information students have about DIT courses, and that they are demanding more detail on programmes before they take them. It is also clear that those who take part in recruitment related activities find them useful. Key sources of information and influence have been identified. These are: family members particularly for females; CGCs who have a greater influence on males; other teachers particularly engineering teachers and, for females, mathematics teachers; and engineering networks which include engineers, current and ex-students and academic staff. The experience of studying engineering at secondary school is rated positively and the subject plays a role in directing students to higher education engineering courses. These findings suggest that action in a number of areas offer some potential to improve recruitment and retention:

(i) Students should be given the opportunity to experience engineering in secondary school. It is clear from the data that many students who take engineering in secondary school achieve high grades and say their experience influences their decision to do engineering. It is also clear that more students would take the subject if it was made available to them. In light of this information, there is a need to explore how greater access to engineering could be achieved by, for example, students taking the subject in neighbouring schools.

(ii) There is a perception, given that the majority of CGCs are female and are trained in the humanities, that they are not in a position to advise students about engineering. Further they have to provide all students about the full range of higher and further education programmes and employment opportunities. In this context higher education institutions need to consider how they package information for CGCs and provide with them with effective resources in order that appropriate careers counselling can be undertaken by them. [4] Further, they have to consider how they can help CGCs understand engineering and the role engineers play in society. It is also the case that strategies have to be devised to create an information chain that involves other teachers who have an influence on prospective students.

(iii) Engineering networks could be used more effectively to mobilise interest in engineering. It is clearly important that higher education institutions have an information strategy aimed at their own students and staff, ex-students and engineers. A key element of this strategy is that they are kept up to date with ongoing developments in engineering education. It has been seen that students and staff visits to schools are very effective in recruiting students. The small number of student visits to schools are run as part of a 'key skills' module in one DIT programme. This model could be expanded. It is also important that potential recruits to engineering hear from staff and practicing engineers as 'having access to personal stories is important' [7] particularly for young women.

(iv) But a more substantial issue remains. It has been seen that there are serious gaps in parents' understanding of engineering. In this context concerns have been raised in relation to the public understanding of engineering and the strategies used to convey an understanding of what engineers actually do. Just like students who, as suggested above, are motivated by the desire to have fulfilling careers, parents ,according to Engineers Ireland research, want their children 'to be happy and inspired by the meaningful contribution they are making in life'. [14] This means that the engineering profession and academic institutions need to consider the image of engineering. Are they contributing to an informed public image of engineering which enables parents to understand that this is a career that will allow their children to make a meaningful contribution to society and be fulfilled? And are they giving them adequate and appropriate information to allow them to advise their children? Further, are they generating a public image that young people themselves can understand? This is an issue that needs to be addressed by the entire engineering community and not just by individual, and competing, institutions. As indicated above an emphasis on the creative role of engineering will help in attracting more females to the profession. The idea of creative engineering has been adopted by Engineers Ireland as the basis for projecting a new image for engineering:

> Engineering needs to be perceived as innovative, proactive, and challenging, where the opportunities to use one's creative abilities are manifold. We need to make sure that our target audiences feel excited and inspired by the prospects of working in engineering, and confident that they will be admired and respected for their contribution to societal development [15].

This conception of engineering is useful in that will help to address an overly mathematical and scientific image of engineering [9][12] without suggesting that engineering is just 'hands-on' activity. It will also help in addressing some of the issues raised in the research. Three stand out.

Firstly it has been seen that students, especially females, are motivated by intrinsic features of engineering. Career and pay issues are not the primary motivators. In this context emphasis needs to be placed on the '*other* rewards in advertising engineering as a career'. [7 emphasis in original] Engineering has to be seen as a career that will allow them to build, design and understand how things work and engage with their desire for self-fulfilment.

Secondly, in the context of falling mathematics standards amongst school leavers a focus on engineering as 'doing math and science' excludes a large pool of 'potential engineers who have not yet being motivated to develop their math and science skills, and who don't realise that they have abilities that make them well suited to be engineers'. [12] It has been seen that recruitment to DIT is narrowly based on school leavers. For our professional programmes they must have higher level mathematics in the LC. Yet the survey findings show that an interest in mathematics and science is not a primary motivator in choosing engineering and that many students value the ladder system in DIT which allows them to enter at technician level or onto PE and progress to professional programmes when they have attained the requisite standard in mathematics and science. An emphasis on attributes other then proficiency in mathematics may make some believe that engineering is for them.

Thirdly, an emphasis on engineering as a creative activity may force institutions to consider 'how can the creative challenge that is seen to be an important element of engineering be retained in the training of engineers'. [7] Edward has criticised the overly mathematical approach to the early education of engineers which makes engineering appear 'unexciting, abstract and frankly, tediously arduous'. He argues for an approach that would introduce more innovative work early in courses and 'engage and excite students'. [14] He echoes Wulfs's call 'to make the creative part of engineering more evident early on'. There is no reason, Wulf says, 'to deny engineering students the opportunity to tackle some creative problem solving until they have survived the initiation of two years of math and science.' [16] Such an approach would engage with the main reasons why DIT students do engineering and help bridge the gap between their expectations and their programme of study which undoubtedly contributes to retention problems in the faculty.

References

[1] G. Fitzgerald, "Engineering perceptions – raising the profile of 'the invisible profession'" The Engineers Journal, Vol. 59, Issue 8, October 2005.
[2] "Greater number of engineers required to win Ireland a place among world's richest", The Engineers Journal, Vol. 59, Issue 9, November 2005.
[3] S. Mc Donagh , "Some 'gaps' in education", Institute of Engineers Ireland 'The Gender Gap in Engineering Conference', Dublin 22 November 2002.
[4] Task Force on the Physical Sciences, "Report and Recommendations", Dublin.
[5] A. Beraud , "Potentials of Interdisciplinary Courses in Engineering, Information Technology, Natural and Socio-Economic Sciences in a Changing Society", European Journal of Engineering Education, Vol. 28, No. 4, December 2003.
[6] IEEE Spectrum and IEEE-USA, "Professional Image Study" December 2003.
[7] N. Smith and M. Monk, "Attracting tomorrow's engineers: an evaluation of a scheme to enhance recruitment into engineering" European Journal of Engineering Education, Vol. 30, No. 2, May 2005.
[8] MRBI, "Factors influencing CAO choices", Presentation to Forfas, Dublin, 2 October 2002.
[9] S. Beder "The New Engineer", Sydney, Macmillan, 1998.
[10] S.F. Johnston , J.P. Gostelow, and W.J. King, "Engineering and Society", New Jersey, Prentice Hall, 2000.
[11] P. Scallan and S. Gallagher, "What's in a name (stakeholders perceptions of engineering programmes)" International Conference on Engineering Education, Manchester, April 18-21, 2002.
[12] B. Isaacs, "Mystery of the missing woman engineers: A solution", Journal of Professional Issues In Engineering Education and Practice, April 2001.
[13] M. Russell "Academic success, failure and withdrawal amongst 1st year engineering students: was prior mathematical knowledge a critical factor? ", DIT Retention Office, Dublin.
[14] N.S. Edward, "Preaching to the converted", International Journal of Electrical Engineering Education, 39/3, 2002.
[15] G. Fitzgerald "Inspiring creativity: the key to marketing the profession" The Engineers Journal, Vol. 59, Issue 9, November 2005.
[16] W.A. Wulf, "The image of engineering", Issues in Science and Technology, Winter 1998 [Online] Available: http://www.issues.org/issues/15.2/wulf.htm

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