

# Power of Engineering: Changing the perceptions of year 9 and 10 female school students towards an engineering career

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## BACKGROUND

The engineering profession in Australia has failed to attract young women for the last decade or so despite all the effort that have gone into promoting engineering as a preferred career choice for girls. It is a missed opportunity for the profession to flourish as a heterogeneous team. Many traditional initiatives and programs have failed to make much impact or at best incremental improvement into attracting and retaining more women in the profession. The reasons why girls and young women in most parts of the world show little interest in engineering haven't changed, despite all the efforts to address them, the issue proposed here in this paper is with the perceptions of engineering in the community and the confidence to pursue it. This gender imbalance is detrimental for the engineering profession, and hence an action-based intervention strategy was devised by the Women in Engineering Qld Chapter of Engineers Australia in 2012 to change the perceptions of school girls by redesigning the engagement strategy and key messages. As a result, the "Power of Engineering Inc" (PoE) was established as a not-for-profit organisation, and is a collaborative effort between government, schools, universities, and industry. This paper examines a case study in changing the perceptions of year 9 and 10 school girls towards an engineering career.

## PURPOSE

To evaluate and determine the effectiveness of an intervention in changing the perceptions of year 9 and 10 school girls about engineering career options, but specifically, "What were their perceptions of engineering before today and have those perceptions changed?"

## DESIGN/METHOD

The inaugural Power of Engineering (PoE) event was held on International Women's Day, Thursday 8 March 2012 and was attended by 131 high school female students (year 9 and 10) and their teachers. The key message of the day was "engineering gives you the power to change the world". A questionnaire was conducted with the participating high school female students, collecting both quantitative and qualitative data. The survey instrument has not been validated.

## RESULTS

The key to the success of the event was as a result of collaboration between all participants involved and the connection created between government, schools, universities and industry. Of the returned surveys (109 of 131), 91% of girls would now consider a career in engineering and 57% who had not considered engineering before the day would now consider a career in engineering. Data collected found significant numbers of negative and varying perceptions about engineering careers prior to the intervention.

## CONCLUSIONS

The evidence in this research suggests that the intervention assisted in changing the perceptions of year 9 and 10 female school students towards engineering as a career option. Whether this intervention translates into actual career selection and study enrolment is to be determined. In saying this, the evidence suggests that there is a critical and urgent need for earlier interventions prior to students selecting their subjects for year 11 and 12. This intervention could also play its part in increasing the overall pool of students engaged in STEM education.

## KEYWORDS

Women in Engineering; Girls in Engineering; Perceptions of Engineering; Engineering Careers.

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## Introduction

Engineering has remained one of the most male dominated professions around the world with male bias in undergraduate engineering student cohorts still evidenced (UN 2010). In contrast more girls are completing year 12 than boys (Kaspura 2011). Engineers Australia suggests that women make up only 16% of commencing undergraduate students in engineering, and 9.5% of those with tertiary qualifications in engineering or related occupations (Engineers Australia 2008a). Of these statistics, over half of the 9.5% are under 30 years of age and just 15% of women engineers over 40 remain in the engineering profession. While women's involvement in engineering has increased somewhat over the past three decades, beginning from an extraordinarily low base, female participation remains very low compared to overall female workforce participation rates (Engineers Australia 2008b). This gender imbalance presents a missed opportunity if we are serious about addressing the engineering skills shortage. Systematic intervention into the education system and graduate supply is required.

Perceptions, cultural and workplace flexibility issues have caused the exodus of women from the profession. Though addressing systemic workplace and cultural issues in the engineering profession is of urgency, the profession needs to consider strategies to improve the pipeline supplying female engineering graduates. Hence the K-12 sector is critical to successful participation.

Although women make up roughly half the workforce, far fewer women than men reach senior management and leadership positions. While the business case for gender diversity at all levels is compelling, progress has been slow. The ILM report, *Ambition and Gender at work* (2011), suggests women's managerial career aspirations lag behind men's at every stage of their working lives and that they have less clarity over traditional career direction than men. The engineering profession needs to nurture the talent of their best female employees; it needs to start challenging some of the unwritten rules of what senior engineering management roles look like. From this research, there is still a fundamental perception and confidence issue about what women think they will be able to do. One can argue that this perception and confidence issue initiates at the primary education level. Up to 40% of first year undergraduate students first consider university in primary schools, and another 23% at lower secondary schools; with 79% (of those surveyed) decided to study an area of interest (Hare 2010). The finding, as part of a large-scale survey of 55,000 students in 55 institutions, has given universities quantitative evidence for the first time that young students are highly receptive to the notion of attending university. Prof Trevor Gale, director of the National Centre for Student Equity in Higher Education, said "For some children it is a given that they will attend university. They never consider otherwise. It's part of who they are" (Hare 2010).

The evidence suggests initiatives that influence and setting career expectations in female students are not currently been successfully exploited. In the absence of inspiration, directions and role models, this perception and confidence issue becomes endemic at the primary and secondary education levels, where growing minds form and adjust their expectations for future career paths, and they become self-limiting. Even if they persist through this doubt and progress to graduation at the tertiary level, female engineers may be acculturated with this self-limiting mentality. The Power of Engineering's team seeks to address this fundamental problem of perceptions and confidence. This is achieved by changing the discourse describing the engineering profession, having engaging engineering activities, and having role models to inspire high school girls about a career in engineering.

## Power of Engineering Inc

The Power of Engineering Inc. (PoE) is a not-for-profit membership-driven organisation co-founded in 2012 by Felicity Briody, a water resources engineer at Aecom and Jillian Kenny, a

PhD candidate at QUT. PoE seeks to inspire young people, particularly females, to consider a diverse and creative career in engineering; to quash the perception that a career in engineering is all numbers; to prove that engineers have the power to shape the world they live in; and to show that innovation and creativity are imperative to creating solutions and ultimately changing the world. Further information is contained in Table 1 which describes the key objectives, messages and strategies of PoE.

**Table 1: Key objectives, messages and strategic directions of PoE**

Objectives	<ul style="list-style-type: none"> <li>• Show high school students that engineering gives you the power to change the world;</li> <li>• Create new perceptions about the engineering profession;</li> <li>• Establish a strong connection between school students, teachers, parents, communities and universities and the engineering profession;</li> <li>• Link engineering projects to and engage the local community in these projects;</li> <li>• Offer an opportunity for university students to develop their professional skills and networks;</li> <li>• Provide professional development for teachers about engineering;</li> <li>• Enable and mentor engineering ambassadors;</li> <li>• Creatively present engineering to the community through various media;</li> <li>• Be a leader in the industry for the coordination of the 400+ existing programs;</li> <li>• Develop sustainable PoE programs for Australia and around the world.</li> </ul>
Messages	<p>Engineering is about:</p> <ul style="list-style-type: none"> <li>• People (working with people, creativity and innovation, saving lives)</li> <li>• Choice and Opportunity (diverse career pathways, opportunities for travel, good salary)</li> <li>• Influence (Opportunity to make a difference, contribute to society, turning dreams into reality)</li> <li>• Key descriptors of engineers and engineering: <ul style="list-style-type: none"> <li>- Engineers make a world of difference.</li> <li>- Engineers are creative problem-solvers.</li> <li>- Engineers help shape the future.</li> <li>- Engineering is essential to our health, happiness and safety.</li> </ul> </li> </ul>
Strategic directions	<ul style="list-style-type: none"> <li>• Deliver Power of Engineering events which comprise hands-on workshops, real-life stories from prominent engineers, hands-on activities and site tours;</li> <li>• Deliver a regional workshop series during Engineers Australia's 'Year of the Regional Engineering Team 2012' to at least 5 regional locations by end of 2012;</li> <li>• Engage with industry, universities, schools, kindred organisations and local communities to enable the sustainable delivery of an extensive program of events across Australia for 2013 and beyond;</li> <li>• Create a website to house the existing programs with a calendar of events and resources;</li> <li>• Team the Power of Engineering incorporated association with a full time employee to provide administrative support for program delivery;</li> <li>• Empower young engineers (graduates and undergraduates) to be project managers for Power of Engineering events;</li> <li>• Provide professional development workshops for teachers about engineering;</li> <li>• Empower ambassadors for engineering to prepare and train them with presentation and communication skills, awareness of audience and consistent key messages;</li> <li>• Develop a communications strategy where non-traditional media, including public art, will be utilised to share the Power of Engineering's messages.</li> </ul>

## Previous Initiatives

There have been many initiatives from the engineering profession and engineering faculties in addressing the supply of quality engineering graduates (King 2008). There have been a number of ALTC projects within the engineering and related disciplines (ALTC n.a.) as well as current and forthcoming ANET reports (ANET n.a.). Southwell & Morgan (2009) provides

a comprehensive literature review of the leadership topic for the K-12 as well as the tertiary sectors, where Goh (2011) argued for leadership in engineering education from K-12 to university as key to improving diversity in the engineering profession. Frid (2010) aimed to enhance the primary teacher education students' capacities as mathematics teachers to cater for the diverse achievements and learning needs of primary school students.

Other literature have suggested Women-in-Engineering conferences, equity and outreach programs exclusively catering for female students may increase the career aspirations of girls (Fahey & Missingham 2009; Holland 2007; Cater-Steel & McDonald 2011). However, these programs would only seek to partly address some very fundamental problems in the lack of recognition of the engineering profession within the community and the perceived masculine-oriented workplace culture (Mills et al 2007; Roberts & Ayre 2002; Darby et al 2003).

Other research alluded to the need to address the perceptions of engineering profession as a career option in female students (Oware et al. 2007; Jolly 2007; Hebbani et al 2010; English et al. 2011; Darby et al. 2003). In addition, Lyons & Quinn (2011) suggested that even though students who enjoyed science education at primary and middle school did not select science in year 11, reinforcing the need to change perceptions rather than just improving engagement in the classroom. Other major overseas research has been undertaken to address the question of perceptions (Marshall et al. 2007; Intel 2011; EngineeringUK 2011; NAE 2008), and it is evidenced this fundamental problem needs addressing in Australia and around the world where there is gender imbalance in the engineering profession.

## Event/Survey

The inaugural PoE event was held on International Women's Day, Thursday 8 March 2012 and was attended by 131 high school female students from year 9 and 10 and their teachers (Lebihan 2012). The Office for Women hosted the event that included partners Engineers Australia (EA), Women in Engineering Queensland (WiEQ), National Association of Women in Construction (NAWIC), and Queensland Resources Council (QRC). "The Power of Engineering Event" that day comprised four parts:

- Breakfast for teachers, educators and key influencers of high school students
- Workshop for students in QUT engineering labs with four activities and a tour of the facilities
- Networking lunch with high school students, QUT engineering students and industry representatives
- Site tours for high school students to four different locations

The key message of the day was "engineering gives you the power to change the world".

The objectives of the event are to:

- Inspire female high school students and teachers about the power of engineering;
- Attract females into the engineering profession;
- Inform teachers of the resources and programs available to educate high schools students about engineering;
- Ensure school students have fun and learn about a variety of engineering disciplines;
- Convey the key message "engineering gives you the power to change the world";
- Create a community connecting high school teachers, high school students, university students and the engineering industry which will contribute to a long term strategy of increasing the number of female engineers.

A post intervention survey collecting both quantitative and qualitative data was administered to evaluate and determine the effectiveness in changing the perceptions of year 9 and 10 girl's view of engineering career options, but more specifically, "What were their perceptions of engineering before the event and have those perceptions changed?" The girls (n=131)

were year 9 and 10 students attending both private and public school systems in the Brisbane area. The selection of the students was determined by the schools and specifically their teachers. They responded to statements about “considering a career in engineering” and “had their perception changed about what is involved in engineering”. The survey instrument has not been validated; for the purpose of this research, the emphasis is on the qualitative data collected triangulated by the quantitative data.

## Results

The summarised results of the inaugural PoE event can be summarised as:

- The key to the success of the event was as a result of collaboration between all participants involved and the connection created between government, schools, universities and industry;
- Of the returned surveys (109 of 131), 91% of girls would consider a career in engineering and 57% who had not considered engineering before the day would now consider a career in engineering;
- Student registration for the event was so popular that bookings for the event were full in just over two days;
- There are currently more than 100 students on a waiting list for the next event;
- The day had a very positive impact on the students and teachers based on feedback obtained;
- Students wanted more information about different disciplines of engineering;
- Site tours could be run on a separate day so students can choose the discipline type;
- There were significant numbers of varying but mostly negative perceptions about engineering prior to the intervention.

Table 2 indicates that 57% of participants did not consider a career in engineering before the event. Of these 91% responded positively to considering a career in engineering as a result of the event. This confirms with some qualification that the messages and strategy implemented have been successful in changing their perceptions of a career in engineering.

**Table 2: Career in Engineering**

Before today, had you considered a career in engineering?		
Yes	40	37%
No	62	57%
No (including “May be”)	69	63%
After today, would you considered a career in engineering?		
Yes	99	91%
No	10	9%

Table 3 indicates that participants were very interested to observe and get involved in the engineering activities as part of the workshops at the QUT at 73%, and secondary to that, the site visits were also popular with the participants at 31%. The guest talks were ranked behind “hands-on” activities which indicate traditional seminar/lecture approaches may not be very effective in communicating across the desired messages.

**Table 3: Engagement in Event activities**

Did you enjoy today?		
Yes	75	69%
No	3	3%
If so, what were the best parts?*		
Workshops at QUT laboratories	80	73%
Guest speaker at lunch	12	11%

Hearing from Young Engineer of the year, Emma Charlton	20	18%
Site visit	34	31%

Table 4 indicates that participants were interested to find out more about the day-to-day role of the female engineers (mentors on the day) as role models, but also information relevant to their own future action regarding subject selections for year 11-12. Also of note, information on the OP score for entry into engineering programs and the details of engineering disciplines were sought.

**Table 4: Further information for engagement**

Going away from today, what would you like to learn more / get more information about?		
Where can I study engineering	23	21%
What OP do I need to get into engineering?	46	42%
What subjects should I study at school?	59	54%
What's the difference between civil, mechanical, electrical and environmental engineering?	46	42%
What do engineers do in their day to day job?	67	61%

One of the survey questions asked "What were your perceptions of engineering before today and have those perceptions changed?" This question had fascinating responses and some are detailed, in no particular order below in Table 5 below. The "no and yes" after the statements refers to if before the day they had considered a career in engineering and if they would now consider a career in engineering.

**Table 5: Perceptions of Engineering Student comments**

<i>That only girls who did very well at science opted for engineering careers [perception before]</i>
<i>Men building bridges [perception before changed from No to Yes]</i>
<i>My original perceptions were that engineering was mostly mechanically based, I have since been further educated</i>
<i>Lots of electronics. A wide variety of technological opportunities [perception after]</i>
<i>My perception on engineering has changed I never realised how many different types of engineering</i>
<i>My perceptions of engineering were that it was just related in terms of buildings and bridges and now I've learnt that there are many types of engineering like medical and others</i>
<i>Now I realise that engineering is part of everyday life</i>
<i>Before today, engineering was just another career path that I wasn't very interested in. However, my perception has changed after today as I have learned how engineering can help to change the world</i>

## Conclusions

The engineering profession within Australia has failed to attract young women for the last decade despite all the effort that have gone into promoting engineering as a preferred career choice for girls. It is a missed opportunity for the profession to flourish as a heterogeneous team. Many traditional initiatives and programs have failed to make much impact or at best incremental improvement into attracting and retaining more women.

The reasons why girls and young women in most parts of the world show little interest in engineering haven't changed, despite all the efforts to address them, the issue is with the

perceptions of engineering in the community and the confidence to pursue it. The Power of Engineering's team seeks to address this fundamental problem of perceptions and confidence.

The argument made in this paper is that perceptions of the engineering (traditionally masculine) must be changed in order for successful engagement with female students. And that changing perception can be achieved by changing the discourse used for describing engineering careers (as part of the intervention strategies described in this paper).

The evidence in this research suggests that the intervention assisted in changing the perceptions of year 9 and 10 female school students towards engineering as a career option. The students were eager to find out more on subject selections to have the opportunity to consider a career in engineering and the diverse choices in disciplines and industries that engineers participate in. Whether this intervention (and resultant eagerness) translates into actual career selection and study enrolment is to be determined.

In saying that, the evidence suggests that there is a critical and urgent need for earlier interventions such as PoE (and a repeated focus) before the students select their subjects for year 11 and 12. This intervention could also play its part in increasing the overall pool of students engaged in STEM education.

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