The current culture of engineering education often assumes that this education begins at university; that the ‘best’ performers in maths and science at school will be those who choose to enrol in engineering courses. The major flaw with this assumption is that unless school students and their teachers have direct contact with an engineer through family or friends, they may never have even articulated the word ‘engineering’ until they are expected to make or support students in their career choices. This then affects the student diversity and intake attributes of students in engineering courses, as well as the overall community perception of the engineering profession.

Engineers have a social responsibility to develop community awareness about engineering and the role of engineers in society. Such an awareness will not only develop a more informed community, but will also pave the way for more young people to consider engineering as a career option.

The Engineering Links program that I founded and now run at the University of Technology Sydney (UTS) attempts to broaden the focus and scope of engineering education to target younger ages, all abilities and a greater variety of community groups to change perceptions of both the engineering profession and engineering in our lives. I take care not to reinforce old perceptions by promoting engineering in terms of engineers of the past, but in terms of the new breed of engineers needed in the 21st century. I focus on the interests and needs of the audience rather than the needs of engineers to tell their story. I have been involved in the discipline of science communication for over 30 years as science teacher, museum educator and member of Australian Science Communicators. The intellectual rigour of this area has underpinned my task to model good practice in both engineering communication and social responsibility.

What is Engineering Links?

Engineering Links is the outreach program I have developed and run for the UTS Faculty of Engineering for over 5 years. It includes both community service elements by staff and students, and academic components (e.g. Professional Service Project, a project-based elective for undergraduate engineering students). The program demonstrates my skill, persistence and effectiveness in overcoming barriers to cultural change in engineering education. It addresses the issues of diversity, inclusivity, sustainability, social responsibility and development of a more holistic view of engineering. It has reshaped the boundaries of engineering education and has required creativity and initiative to design, implement and evaluate such a program.

With many years experience in education at the school level, I have seen a lack of understanding in school students and teachers of the role of engineering in society. Engineering is often called ‘the invisible profession’. Unlike many other subject areas in the school curriculum, engineers do not usually teach in schools and teachers rarely know about engineering. Engineering Links encourages school students and teachers to articulate the word ‘engineering’ by working with them in their classrooms and community groups. Naming of a concept and thus becoming familiar with it are the first steps to developing an understanding of that concept. Engineering Links aims to ‘get people talking about engineering’ by ‘making engineering visible’.

Publications that outline the history and operational structure of the program include:
Running the program actively engages a broad range of both staff and students. In creating Engineering Links I have provided a scaffold, framework or system on which UTS engineering students and staff can form effective and positive links with school and community groups. These links have a number of outcomes:

- development of communication skills in undergraduate engineers
- development of an understanding (in young engineers) of the needs of community and school groups and their perceptions of engineering
- enhancement of the perceptions of engineering in community and school groups.

I have set up a structure that encourages undergraduate engineering students to become involved on a voluntary basis at anytime throughout their course. “Professional Service Points” for their work are accrued. When and if they choose to enrol in the elective subject, they must then:

- achieve the required number of points
- attend formal workshops/lectures on communication skills for targeted audience(s)
- research and practice oral, graphic and written communication skills specific to their audience(s)
- prepare written, oral, graphic materials and/or artefacts required for their contact with their client

- present written, oral and graphic reports demonstrating what they have done, their academic learning achieved and reflecting on the process and how it has helped towards achieving both required graduate attributes and certification as a practising engineer.

By being embedded in an elective subject (Professional Service Project) students can gain academic merit for their development in engineering communication, an attribute highly valued by the engineering profession. This learning is supported by lectures and workshops in the communication skills required for working with this special audience. Because of this link with the subject, the cost to the faculty of running such an outreach program is minimised.

Using my experience in the school and science communication environment I have developed a structure for the program that is open-ended and negotiable for our clients but in which our undergraduate students have support. Students develop activities to meet the needs of clients that ‘get people talking about engineering’ by ‘making engineering visible’. These activities fall into one or more of the following time frames:

- short activities from 5-20 min duration
- 1 hour activities
- 5 x 1 hour activities with a common theme that can either run over one day or for 1 hour each week for 5 weeks
- written teacher’s resources.

A 3-hour or whole-day event can be created by combining appropriate activities as an Engineering Expo or Special Event. A longer activity running for 3-5 consecutive days as a summer school for Year 6-10 students and work experience opportunities for Year 10-11 is currently being developed. Each activity developed is also pitched at one class level from Years 5/6, Years 7-10, Years 11/12.

The activities all have a common theme, they answer the question “What do engineers do?” rather than the more usual “What is engineering?” Some of the answers (activities) developed so far include: Engineers -

- design (artefacts, for safety, for efficiency)
• measure or analyse (forces, electric currents, radio frequencies, fluid flow)
• test and evaluate (structures, software)
• use (tools, skills)
• work in teams (biomedical, environmental, mechatronics, aeronautical, telecommunications)
• model and simulate (artefacts, structures, to scale, software, systems)
• work with others (biologists, ecologists, physicists, chemists, geologists, astronomers)

There is ample scope for expansion and many engineering principles can be incorporated.

To ensure the development of a library of resources I have required that all resources produced by the UTS students form an integrated unit within the program so templates are supplied for all printed materials. When used together these materials form a cohesive unit. Students are expected to develop at least some of the following items:

• **poster** – 2xA3 posters that illustrates and gives brief background information about the topic to answer the question “What do engineers do?”

• **laminated activity sheets** – A4 sheets that outline what participants should do, each one pitched at one level and one time frame from the choices listed above

• **storage unit** – to hold the activity for ease of transport and storage. This unit contains lists of materials required and things that must be checked for use or damage before and after the activity runs

• **place mat** – an A2 hand-drawn layout of equipment needed for the activity. This placemat is folded and stored with the posters. This allows the facilitator and participants to monitor resources required

• **instructions for the facilitator** of the activity

• **background notes** for teachers and/or facilitators

• **take-home page** – an A4 worksheet for school students to take home that includes some notes, illustrations, questions to investigate and workspace

• **virtual site visit or case study** based on a real engineering workplace of the same theme as the activity.

The overall aims of all activities and resources developed are to:
1. answer the question “What do engineers do?” thus ‘making engineering visible’
2. encourage the users to articulate the word ‘engineering’ i.e. ‘get people talking about engineering’ and ‘engineers’
3. promote engineering as a career option
4. promote UTS Engineering courses.

I have incorporated monitoring of all engineering students to ensure that changes in attitude are detectable, quantifiable and comparable. Although increased intake of a more diverse range of students into engineering courses may be one outcome that justifies the program, an equally worthwhile and socially responsible outcome is a community that is more aware of engineering and its impacts. Many of the participants in Engineering Links are quite young so one outcome will be the creation of a more informed community, rather than just convincing students to do engineering at UTS. One positive outcome that is certainly quantifiable is the increase in interest in our engineering courses and the subsequent increase in the UAI cut-offs of our recent intakes.

Evaluation and reflection by all our clients is encouraged while our undergraduate students must submit written reflections as part of their compulsory assessment tasks. In both cases these evaluations and reflections are positive. It is interesting to note that the program has so excited some of our own students that they ask to stay on our volunteer list long after graduation and continue to pass on helpful information as they find it and spread the word encouraging schools and community groups like Guides and Scouts to become involved in the program.
My research with NSW school students (Jacobs and Scanlon 2002) shows that these students rarely have sufficient understanding of engineering to make informed decisions about what careers in engineering - if any - are compatible with their personality, academic ability, intelligence, communication style, learning style and values. From this research and other literature it becomes apparent that problems with student diversity and decreasing enrolments in engineering in Australia can be attributed to:

- **negative and outdated perceptions of engineering** in students, teachers and parents, that leads to
- **exclusion of engineering as a career option at an early age**, before informed perceptions are developed at senior school level through careers education or university promotional activities. Research shows that children form attitudes **before age nine** that affect choices made in high school and as adults. However, universities still focus on Years 11 and 12 to inform, influence and change perceptions of engineering.

**Universities** actively promote engineering as a career option. They spend large sums promoting to Year 11 and 12 school students. However, in the current economic climate, it is seen as more immediately cost-effective for faculties of engineering to encourage ‘brand-switching’ from customers who already want to purchase the product (engineering). To change overall perceptions of potential students and families and encourage them to ‘buy’ a product for the first time and so choose engineering is more difficult and thus more expensive. **The UTS Engineering Links program takes the socially responsible direction of also focussing on a younger audience to ‘get people talking about engineering’ and open the way to ‘buying’ a new product.**

**Teachers** have the opportunity to relate their subjects to real-life engineering examples but many are not familiar with the profession so are unable to make such links. **The UTS Engineering Links program addresses the problem by working directly with teachers.**

**Engineers** themselves (individually as well as collectively through professional associations) have an important role to play in changing community perceptions. The ability of engineers to articulate effectively what they do, and how they do it, in an audience-focussed manner, is essential. **The UTS Engineering Links program develops the ability in our undergraduate engineers to be effective engineering communicators.**

Although there is no doubt that the role of engineers is changing, the profession is struggling to communicate these changes to school students, their teachers and parents. Faced with this same issue, scientists realised a need for **science communicators** - people trained in science and communication skills, with an understanding of audience needs, who could promote science in interesting and exciting ways both as a profession and an important aspect in our lives. From this developed the Education Centres at many museums, science shows and expos, and even Dr Karl of ABC radio fame. University science faculties have joined this effort by offering Science Communication as a course within a degree structure. Engineering lingers in the minds of the masses as the invisible cousin of the sciences. **Through Engineering Links I have developed a new approach to supporting a broader role for engineering communication.**

The UTS Faculty of Engineering supports the Engineering Links project at both strategic and operational levels. Through the program it taps into the learning and experience of its undergraduate engineering students based on a flexible and negotiated student-centred pedagogy. The program is flexible and outcomes are negotiated with each educator and undergraduate student involved. Presenting engineering as a young and vital career option that supports diversity and inclusivity can only help to develop this reality further.