Abstract: The development of a student’s professional identity as an engineer is key to understanding education from the student’s perspective, and framing future engineering education research. This paper investigates the idea of a professional engineering identity and puts forward the idea that a student’s engineering education should be focused on them developing an identity as a professional engineer. This identity not only includes the knowledge and skills usually developed in engineering programs, but attitudes and self beliefs toward being able to practice as an engineer. Understanding what influences the development of this identity, both positively and negatively, point to future research in engineering education.

Background & Rationale
In Australia, a recent major review of the engineering education system has identified the need for “systematic and holistic educational design practices with learning experiences and assessment strategies that focus on delivery of designated graduate attributes” (King 2008, p106). Our goal in engineering across Australia and specifically at CQUniversity is to produce engineering graduates both confident and capable of competent practice. We define this competence in terms of a set of graduate attributes that students are to attain by the end of their program. This capability to practise though is not necessarily guaranteed by them taking a set of disparate courses in an engineering program, though this is often the assumption made. The specification of learning outcomes for individual courses that all add to form overarching graduate attributes detail a student’s learning from our perspective.

From their perspective though, their learning involves the complex interaction of many different elements. These include individual courses, the institutional environment, their interactions with other students (their cohort), their disposition, background and lives external to the university, and other meta-influences (Walther & Radcliffe 2006). It is argued that the emergent property of this complex system, their learning environment, is their professional identity as an engineer. It is this professional
identity that enables them to practice. It is argued that a focus on how students develop their professional identity as an engineer:

- Will better prepare our students for practice;
- Improve teaching and learning through curriculum renewal around developing an identity;
- Promote and enhance student learning
- Communicate high expectations to students
- Respect and respond to the diversity of the student body
- Respect diverse talents and ways of learning
- Improve student retention
- Better engage students with their learning

This paper presents the concept of students developing a professional identity as an engineer as a framework for future engineering education research. In this way it is not just about how to improve learning and assessment in a particular class but instead allows more fundamental questions to be asked: What are we trying to educate our students for? How do we know what they need to know and be able to do? What influences their development beyond the very specific learning outcomes in courses? Is the way that we are educating students now best preparing them to practice as engineering professionals?

There is much anecdotal evidence that suggests that students are well aware that a range of professional engineering identities exist in practice. This is opposed to the message that we send to the students through specifying a set of graduate attributes that specify what an engineer is no matter what discipline, program or university they are in.

As an example, the co-op program at CQU uses the CPEng guidelines developed by Engineers Australia as one element, to help students reflect upon their work experiences and document their competencies. One student when delivering a presentation on what he had achieved on his first 6 month work placement commented that while he had enjoyed working at the particular location, and felt that that industry was where he wanted to work on graduation, he could not see how he could become a CPEng working in that industry. Engineers in that industry were not required to do work that would allow him to demonstrate all the required competencies. He still identified himself as an engineer, but now thought that there was a range of engineers who did valuable work, but were not real engineers in the eyes of Engineers Australia, even though they had graduated and could become members. While the class discussion that followed allowed him to see how he would be able to address the required competencies working within that industry, there was still a general feeling within the class that there were a range of roles that real engineers undertook, and so they were defining the identity of a professional, but they felt that the professional requirements were not necessarily in line with what real engineers did.

This research on identity is motivated by a number of factors, including addressing attrition rates, the inclusion of traditionally under-represented groups and an increasing sense of alienation students are feeling in their education (Du 2006; Case 2007). Further, very few professions have a good understanding of how professional identity and mastery of professional capabilities develop. They hold on to older and arguably outdated notions that focus on technical knowledge as the measure of professional capability and fail to recognise the need to incorporate contribution of the learner’s developing sense of professional identity and the role of situated, contextual learning in the workplace to accelerated development of masterful professional practice. How then can an education system keep up with these changes in the profession to adequately equip students to enter that profession? How do you balance having to document what needs to be learnt from learning as a professional (Snowden 20002)?

Research by Aamodt and Havnes (2008) into development of employability (understood not as the ability to get a job but as mastery in employment, the ability of recent graduates to actually perform as professionals) found that ‘attributing employability one-sidedly to characteristics of individuals is problematic’ (p.236). Mastery is the product of a complex system of education affected by the outcomes of the program of study, the work environment and personal factors. Their analysis showed...
that professional mastery three years after graduation developed from complex interaction between learning outcomes achieved as a result of undergraduate studies (particularly practical or generic skills), factors in the workplace (specific in-the-job training, graduate autonomy and co-worker support), and personal commitment to the job. (p. 243). Initiatives such as those in the area of Work Integrated Learning can be seen as attempts to understand and address development of identity and mastery.

In the face of demand for engineers, increasing specialisation and complexity of professional practice, the engineering profession must develop a holistic and robust understanding of the processes that lead to professional mastery and the sense of identity that can accelerate this learning process. However, it is not just the profession that needs to understand the path to mastery, each student need to begin to understand the different ways of being an engineer that the profession offers, to understand her or his personal strengths and weaknesses in relation to these options, and to understand how she or he can use the process of ‘induction’ into professional mastery to ‘construct’ the professional identity that is consistent with personal capabilities and goals. We must make the most of the talent available.

A discussion at ISCAN, Industry Schools and Community Advisory Network, the stakeholder representative committee for undergraduate engineering programs at CQUniversity, illustrated well why students should learn to construct their personal identity. An agenda item was provided at the meeting to present to ISCAN the graduate attributes that Engineers Australia requires each graduate of the program to ‘substantially’ achieve and how the program was designed to support their attainment by students. During the presentation, an industry representative began to explore what the term ‘substantial’ achievement meant in this context. It became clear that within an organization there are different ways of being an engineer, and each requires a different combination of graduate attributes. For example, someone working in technical design needs strong technical capabilities and interests, and while communication skills must be competent the personal desire to communicate, work in teams and interact socially should be constrained to the requirements of technical design. Such a person needs to be happy to spend time behind the design desk. Other engineers in the same organization may be involved in client liaison or project management, and for these people teamwork and communication skills are more important than strong technical skills. They should not ‘hide’ behind their desk, they should enjoy interaction and communication and apply these skills to achieve personal, project, organisational and community objectives. Vinck (2003) provides a detailed social and technical analysis of the different roles played by engineers in design and manufacturing processes in a variety of organisations, and how engineers identify with these roles.

What do we mean by Identity?

Identity and identity development is central to understanding the learning and development of students (Lave & Wenger 1991). For the basis of this paper, identity is understood “not as a relatively stable possession of an individual, but as an ongoing project of construction by a given individual together with the others which whom she comes into contact” (O’Connor et al 2007, p1). Gee argues that someone’s identity is them being recognised as a certain ‘kind of person’ (in our case an engineer) in a given context (Gee 2001). In this way the identity of an individual is both how that individual identifies herself as well as how others actively identify her in the social fields she is active. It is an ongoing process of negotiation taking place in multiple settings and timeframes (Stokes & Wyn 2007). As Gee notes “all people have multiple identities connected not to their ‘internal states’ but to their performances in society” (2001, p99). In the case of engineering students, this multiplicity of identities includes their identity as:

- A student
- A consumer of products offered by the university
- A member of their cohort at CQUniversity (or any other university)
- A member of the cohort of engineering students across universities
- A student member of the engineering profession

as well as many others.
Gee (2001) identifies four ways to view identity:

- nature-identity (a state developed from forces in nature)
- institution-identity (a position authorised by authorities within institutions)
- discourse-identity (an individual trait recognised in the discourse/dialogue of/with ‘rational’ individuals)
- affinity-identity (experiences shared in the practice of ‘affinity groups’)

For example, someone may be tall and blond (nature-identity), an engineering student at a university (institution-identity), a charismatic person (discourse-identity), and being a gear head working on a racing car (affinity-identity). These four perspectives of identity are not separate from each other but instead interact in a complex way. For this research though, they offer “four ways to formulate questions about how identity is functioning for a specific person… in a given context or across a set of different contexts” (Gee 2001, p101). How then can this help us understand the development of our students’ identities as professional engineers? Can this construction of an identity be attained simply by ticking off the ten graduate attributes by the end of the program?

**Research into Professional Identity Development**

The objective of this research is to better understand how engineering students form their professional identity. Particularly, it will identify critical factors that influence this identity development, either positively or negatively. Figure 1 presents an initial attempt at characterising some of influences to developing an identity as an engineer. This will also help us understand how to improve the experience of non-traditional students, including distance students, as they lack some influences but have others (work, family, distance). Using this framework that focuses on identity helps us take the learner centred curriculum to the next level.

![Figure 1: Identity Concept Map](image_url)
The first step is to further develop and test this framework. As the research is focused on the student’s perspective of their learning, it is their experiences of their learning and identity development that will be central to the approach taken. A selection of students across the duration of the engineering program will be interviewed about their experiences in engineering and how they feel they have developed as an engineer. Interviews will be transcribed, de-identified and analysed using a qualitative research method known as phenomenography (Marton & Booth, 1997). This will produce a set of categories describing the qualitatively different ways that students have developed their identities as engineers. This will also identify the factors that have influenced this development, both positive and negative. The major outcome is then to take this understanding and suggest changes to the current engineering curriculum to focus the program more on the development of students’ professional identities as engineers.

Future research can use this framework. For instance, in investigating the influence that staff identity has on developing student identity the following questions could be asked: Is a PhD the best qualification for facilitating the development of professional capabilities? How do engineering educators with no professional industry experience influence students? Often students in co-op programs graduate with more professional industry experience than their lecturers, what effect does this have?

Or for example in investigating the influence learning environments have on identity development. We assume that providing our students access to state of the art learning environments including technology prepares them better for professional practice. But if their workplace is not at this standard, does this impact on their efficacy to perform in professional practice. Are they a lesser engineer if they don’t have access to these tools? If we spend time and capital on developing these ‘ideal’ spaces for the students to use while at university but don’t have them in the workplace, can this undermine their possible performance and development? How do they learn to operate in non-ideal, when things go wrong?

Where to from here?

This paper presents the identity development of students as professional engineers as a framework for future engineering education research. The factors that are identified as a positive influence will be strengthened systematically across engineering programs with the negative influences once identified will be reduced or removed. This focus on an individual’s professional identity development can also help respond to their diverse backgrounds, talents and ways of learning and knowing. On the longer term, the identified influences will be holistically incorporated into engineering programs as a whole. It will also help identify strategies for bringing under-represented groups into engineering and helping reduce attrition rates among engineering students.

If we are to consider identity as an import aspect of student learning, then we must also consider the identity of the university or faculty in which they study. To this end, universities/faculties should be upfront about their educational aims. Their goals must be transparent so that potential students can make informed decisions about where they choose to study. There are many different types of engineering graduates, and all have a place in the profession, but they all develop a different identity, and will require different approaches to developing that identity. If a faculty states that they aim to produce industry ready graduates, then they must be able to demonstrate how they achieve this goal, and justify the methods that they choose. If the aim is to produce research ready graduates, then the faculty should be honest about it, and not give the impression that they are producing industry ready graduates. The type of identity being developed will influence the culture of the faculty, and a disparity between what is espoused and what is delivered will become confusing to the student, and impact upon their identity development.
References


