

## Grounded by values: An emergent engineering practice

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**SESSION** C4: The role and impact of engineers and the engineering profession in the wider community

**CONTEXT** A transformational change in engineering education culture is required to address ongoing issues such as declining interest and a lack of diversity in the student cohorts and profession. This change must go beyond transforming educational pedagogies; organisational cultural change is necessary to shape perceptions about engineering and engineering in society. The creation of the Engineering Practice Academy at Swinburne University of Technology provides the opportunity to intentionally construct a culture guided by a set of espoused values that can be used to define and guide the emergent culture, and inform decisions made in the development of the Engineering Practice Academy.

**PURPOSE** This paper describes the development process of co-constructing espoused values within the Engineering Practice Academy.

**APPROACH** Espoused values were co-constructed by project stakeholders through a facilitated workshop. The workshops included individual tasks, reflections and sharing, and collective discussion used to facilitate the construction of the values.

**RESULTS** The five espoused values co-constructed by project stakeholders were: collaboration with empathy, honesty through transparency, equity and diversity, sustainability through practice and, excellence – individually and collectively. The espoused values are being used in all aspects of the Academy's creation such as evaluating and selecting potential initiatives, generating an ethical partnership policy to guide the selection of external partners and creating a culture to attract and support a diverse staff and student cohort.

**CONCLUSION** Values-based decision making has been shown to empower individuals from all levels of an organisation to make decisions as well as being useful in the recruitment and retention of staff and students. Values present a novel resource for informing collaboration between Universities, industries, and community.

**KEYWORDS** Values integrated practice, Engineering Practice, Being and becoming an engineer.

## Introduction

The Bachelor of Engineering Practice (Honours) degree at Swinburne University of Technology, Melbourne, Australia was designed and developed to equip future engineers with the capabilities and attributes crucial for a twenty-first-century engineering career. The development of the program challenged the Engineering Practice Academy (Academy) at Swinburne to re-conceptualise engineering education. The Academy provides the social, cultural, political, technological, economic and ecological contexts in which the Bachelor degree operates within and delivers engineering education entirely through industry and service learning projects and other professional development activities. The Academy operates as an engineering practice being both a professional service provider and a higher education institution.

This paper reports on the process undertaken by the Academy to construct a practice culture guided by a set of espoused values. Values are details that assist a practice in moving towards a desired future state by directing the emergent now and the course of daily work processes (Dolan & Garcia, 2002). Values can, therefore, in the case of the Academy be used to define and guide a new culture, and inform decisions made in regards to the development of the Academy processes. Culture is the inescapable by-product of repeated human interaction. Schein (1983, p. 14) defines organisational culture as:

*the pattern of basic assumptions that a given group has invented, discovered, or developed in learning to cope with its problems of external adaptation and internal integration*

While practice cultures are often left to grow organically and develop of their own accord as a result of how members of the practice think and interact, a practice culture can also be intentionally constructed or invented, to some extent, through conscious effort (Schein, 2010). The intentional development of a practice's culture is most likely to occur, at the very beginning of a practice's life, and as such, reflect the values and behaviours of the founding group. Schein (2010) model for organisational culture presents three levels of culture thus being: artefacts, espoused beliefs and values and, underlying assumptions. Of these three, the most important, regarding the influence of a practice's culture are the underlying assumptions about the "problems of external adaptation and internal integration" (Schein, 2010, p.18) that each member of a practice holds. Underlying assumptions are however unique to each member of the team and can be quite divergent, especially in the early days of the development of culture.

In the case of the Academy, five espoused values were co-constructed by eight Academy stakeholders (university decision-makers, Academy employees and, engineering educators) in a facilitated workshop. Schein's (2010) model of organisational culture structured the workshop activities and the established espoused values were used to guide the creation of the practice's strategic objectives. The Academy intentionally created the espoused values early in the development of the Academy because the timing was believed to be crucial in ensuring that the adopted values underpinned the emerging culture and vision of the Academy. Furthermore, it was anticipated that early adoption of the values would empower the Academy staff to make decisions that aligned with the direction of the underlying strategy of the Academy.

## Influence of values and culture in education

The Academy and its associated Bachelor degree were co-created with stakeholders which included industry representatives, university decision-makers, Academy employees and, engineering educators. Academy stakeholders were challenged to be responsive to the existing social, historical, technical and economic barriers that prohibit individuals engaging in engineering education. Furthermore, Academy stakeholders were asked to recognise

systemic limitations that current and future engineering students encounter because of the current culture within engineering education.

For Australia to be a leader in engineering, a change in the culture of engineering and engineering education is needed, from one that is mostly exclusionary to one that is both inclusive and diverse. The idea of culture and cultural change has entered the mainstream of the discourse on engineering education only recently (Godfrey, 2009). Investigations into aspects of engineering education culture have included Cech's (2013) study that showed engineering students' commitments to and concerns about public welfare declines over the course of their training. This phenomenon was described as a culture of disengagement, and an ideology of depoliticisation presents the:

*belief that engineering work can and should be disconnected from 'social' and 'political' concerns because such considerations may bias otherwise 'pure' engineering practice (Cech, 2013, p.7).*

The perception of engineering being a profession whereby the social and the technical cannot and should not be separated in practice and especially in engineering education has begun to occur (see, Pawley, 2009; Riley, 2008) thus changing the landscape of engineering education programs. Furthermore, engineering education programs are beginning to facilitate the development of the self with self-efficacy in engineering another aspect of educating future engineers examined recently (see, Mamaril, Usher, Li, Economy &, Kennedy, 2016). In the context of engineering education, self-efficacy concerns individual's confidence and knowledge about their aptitude to perform engineering tasks (Bandura, 1982; Ponton, Edmister, Ukeiley, & Seiner, 2001). For students in an academic environment, self-efficacy and self-perception influence individual's cognitive engagement in studies, working with others in a team and their persistence in understanding and applying engineering knowledge in practice (Pajares & Miller, 1994).

Engineering education provides a nexus of opportunities and experiences in which students become to identify themselves as an engineer. Furthermore, the rhetoric of engineering presented by a university influences an individual interpretation of being an engineer and engineering as a profession. The:

*activities, historically salient understandings about engineers and engineering, and routines for recognition as engineers - all of which frame how students navigate educational opportunities and, for some, become engineers thought to belong (Tonso, 2014, p.277).*

Changes in academic environments, curriculum strategies, and technology approaches are an ongoing process in the development of engineering education. It is a university's responsibility to prepare graduates to be industry ready whereby they are required to solve problems that address social and environmental impacts, be self-responsive and behave professionally, develop consumer relations and understand business acumen. Besides curriculum changes, cultural change in engineering education is a crucial aspect because an individual's interpretation and identity as an engineer are "held between person and campus culture" (Tonso, 2006, p. 301). The culture of the university in which a person studies engineering and the activities and rituals the person is exposed to concerning engineering as a profession informs their identity as an engineer. Meaning, universities develop students standing as an engineer and the values, underlying beliefs and assumptions they hold in regards to engineering as a profession (Godfrey, 2009). However, exposure to a university's engineering degree is not the only avenue in which an individual's identity as an engineer manifests, as identity as an engineer is also an outcome of sociocultural and socio-temporal contexts both within and external to the degree being undertaken by a student. However, this paper is explicitly addressing how the Academy, one engineering university program, constructed espoused values to acknowledge the responsibility the Academy has to students identifying as being-and-becoming an engineer.

The activities and rituals in conjunction with the technical skills delivered by the Academy will inform students' identity as an engineer. Furthermore, the shared-values the Academy holds

as a working and learning practice will influence students' perception of belonging within the field of engineering. Shared-values are the manifestation of deep-seated patterns of team beliefs, supportive morals and social/peer responsibilities (Schein, 2010). Behaviour is an enacted aspect of culture (Godfrey, 2009) and behavioural values are performed through both direct and indirect verbal and non-verbal forms of communication. For example, the behaviour of staff working in an academic environment can be perceived either directly or indirectly by a student cohort as being a reflection of the value system of the university. Furthermore, the language used by staff in regards to the representation of who an engineer is, verbally communicates to students who constitute being an engineer in the eyes of the university program.

The culture of a practice can be positioned as a mechanism to "shape who is included and who is excluded" (Faulkner, 2009, p. 5) and typically it is the dominant cultural group who determines who is accepted. In the engineering workforce, men outnumber women by a factor of over two for those in the top pay-bracket (\$104 k + per year), and conversely, women are over-represented in the lowest pay bracket (Office of the Chief Scientist, 2016). The disparity between woman and men connected to the discipline of engineering is associated with high-school to university pathways into engineering education being considered biased against women and is compounded by declining numbers of women undertaking traditional prerequisite subjects including advanced mathematics and physics in high school (Australian Council of Engineering Deans Inc, 2017). Unconscious bias against girls in STEM emerges in primary school (Sarkar, Tytler, & Palmer, 2014) also contributes to the lack of gender diversity within the discipline of engineering.

The lack of diversity in the discipline of engineering extends beyond gender. Diversity can be considered as a measure of heterogeneity across a given population; whether that be gender, sexuality, culture, or socio-economic status (Hunt, Layton, & Prince, 2015). Diversity can be encouraged by promoting equality of opportunities. Within the engineering discipline, this needs to operate across the educational system and subsequently in the workplace. Within the educational system, young people from a low socio-economic status backgrounds are less likely to study STEM disciplines (Lamb, Jackson, Walstab, & Huo, 2015), while Aboriginal and Torres Strait Islander participation in engineering degrees has limited enrollments (Department of Education and Training, 2016). When studying engineering at university, lesbian, gay, and bisexual students often engage in tactics to navigate a predominantly heterosexual culture, which places additional academic and emotional labour on these students (Cech & Waidzunus, 2011).

From a practice perspective, benefits from increased diversity can include improvements in innovation (Østergaard, Timmermans, & Kristinsson, 2011), financial performance, ability to attract and retain staff, and organisational reputation (Workplace Gender Equality Agency, 2016). Culture and the shared-values of a practice should:

*recognise and affirm woman's as well as men's competence and commitment, so that all, not just the numerically dominant group, find the work enjoyable and personally fulfilling in an inclusive and supportive workplace (Ayre, Mills & Gill, 2013, pp. 230-231).*

The Academy as a new practice that traverses both a professional service provider and a higher education institution acknowledged its responsibility to address systemic limitations that current and future engineering students encounter in entering an engineering degree and continuing to becoming a practicing engineer. The development of the Academy's espoused values aim to empower Academy staff to make decisions that align with the espoused values and culture of the Academy as a practice.

## **Project scope**

The culture of a practice emerges over time and is influenced by the individuals who were formative in the development of the practice. The developmental phase of a team is critical as it is the time when the agenda, values, expectations and shared direction of the practice

are negotiated and assigned. The development of shared direction is a “blend of what the leader brings and what the macro context of the group affords as it grows” (Schein, 2010, p. 71). Meaning, the development of a practice and its culture is an outcome of the leader's assumptions of and for the practice and its members in conjunction with the construction of shared assumptions between team members.

In the case of the Academy, the development of an espoused culture and values were positioned and treated as being emergent. The Academy openly acknowledged that the advocated culture of the Academy would develop over time and as the practice evolved from three individuals to fifteen, the supported culture would continue to emerge as new members engaged with the existing practice culture and challenged it. Academy members openly discussed the evolution of its practice culture within structured team meetings and project management workshops. The development of the practice culture external to the formal culture and values building workshop discussed in this paper was necessary to ensure Academy members were empowered to employ a values-based decision-making system. As the Academy continues to develop the values-based decision-making system will continue to be researched; however, this paper discusses how and why the Academy established the initial espoused values that are being applied within a values-based decision-making system.

Understanding culture as being established across three levels being (1) artifacts, (2) espoused values, and (3) tacit assumptions grant the opportunity to recognise that culture is both individual and collective (Schein, 2010). The correlation between overt behaviours and espoused values of a practice is complicated; this is because espoused values, tacit assumptions and the immediate now can cause divergence from what a group wishes the ideal outcome to be (Schein, 2010). The urgent now can present situations, which because of time or resources, constrains the idealistic approach that aligns with the practices espoused values. In the case of the Academy mitigation of espoused values, tacit assumptions and the immediate now was brokered through various processes, which were themselves emergent and reactive processes. This paper does not address the processes that the Academy employed to address how espoused values, tacit assumptions and the immediate now was brokered. However, it is important to note that the Academy team were aware that the development of culture is impacted by the circumstances of the immediate now.

## **Creation of the values: Method**

The development of the Academy's espoused values was structured around Schein's understanding of culture. Members of the Academy participated in a total of four workshops designed to develop, expand and refine the creation of the values. This paper discusses explicitly workshop number three which was designed to unpack and expand on the five espoused values established in workshop number two. Workshop number three was titled *an open discussion on values* and focused on refining the selection of values and generating a shared understanding of each value.

Reflection-in-action as a theory and method was used to position the development of the espoused values and informed the design of the workshop. Reflection-in-action acknowledges that individuals are “agents” (Schön, 1995, p.328) within a group and it is through an individual's agency they shape and are shaped by the social system of the team. Through this understanding, the Academy members who participated in the workshop would both inform and be informed by their peer's participation.

The workshop was structured to allow for tasks to be completed individually, followed by reflection and sharing than collective discussion. The outcomes of the workshop were synthesised by the workshop facilitators and shared back to the participants after the completion of the workshop which provided the opportunity for participants to reflect upon the findings and implement them in their daily practice. The implementation and reflection of ideas or insights is an essential element of a reflection-in-action process. Insights are

acquired from research is application and inform the next iterations of activities thus creating a cycle of reflection and implementation.

The workshop was positioned as an open discussion on values with values being expressed as how we want to approach everything we do and what values we will embed in everything we do. The workshop comprised of four activities with activity one being a visioning task where all members of the Academy were asked to individually reflect on and then collectively share their motivations for joining the Academy and what they hoped to achieve as being a member of the Academy. This task was designed to open up a conversation around intrinsic motivations and their connection to values and goals. Activity two presented the values statements of four different organisations that spanned the Australian public, private and not-for-profit sector. This task was designed to demonstrate the variants in the articulation of values. Participants in activity three were then required to individually generate five potential values for the Academy expressing what the values mean for them. Participants then paired and discussed their values to create shared understanding and document the common elements. Two pairs then came together and repeated the process until the whole team was back together, see Figure 1 for the outcome of this task. Following this task, participants collectively prioritized the values being of low importance to high. Through this process, participants started to group interdependent values. At the completion of the workshop, the participants had generated five working espoused values and had begun to produce a shared understanding of each value, see Figure 2. The five value sets created within the workshop were:

- Collaboration with empathy
- Honesty through transparency
- Equity and diversity
- Sustainability through practice
- Excellence – individually and collectively

**Engineering  
Practice  
Academy**

Workshop three: An open discussion on values  
Generation and explanation of potential Academy values

**PARTNERSHIP:**  
Achieve more together

**CONSTRUCTIVE:**  
Say yes, positive attitude and approach

**EVIDENCE-BASED:**  
Grounding our solutions and our operations in the best available evidence.

**HUMILITY:**  
Letting our work and our efforts speak for themselves

**POSITIVE:**  
Approaching our work and our interactions with positivity

**FEARLESSNESS:**  
Not letting our egos stop us from attempting the impossible.

**RESPECT:**  
For others  
For people and culture  
For the land

**ADVENTURE:**  
Agile and ready for a challenge

**SAFETY:**  
Of others and the community

**ENERGY:**  
Throw yourself into things and encourage others to do so

**CONSCIOUS:**  
Being mindful of our impact on each other, our clients and the whole world.

**OPEN-MINDEDNESS:**  
I will always consider alternate points of view

**SERVICE:**  
To our team  
To our clients  
To the community

**COMMUNITY:**  
Create a sense of support, friendship, care and fun

**SELFLESS:**  
Other above yourself

**INTEGRITY:**  
As people and as a practice

**SERVICE OF AGENCY:**  
people are free to make their own choices

**CONTINUOUS LEARNING:**  
Everything is a learning opportunity, failure is an opportunity to learn.

**AUTHENTICITY:**  
Be real to yourself and others

**Figure 1: Outcome of workshop activity three: Generation and shared understanding of potential Engineering Practice Academy values.**

**Engineering  
Practice  
Academy**

Workshop three: *An open discussion on values*

**COLLABORATION WITH EMPATHY**

- We no better together and we enjoy it
- Work together with others
- Communicate frequently and clearly
- Share success/failure
- Enjoy working with others
- Seek new opportunities
- Work together for mutual benefit creating shared value
- Consider others points of view
- Respect others circumstances recognising you may no know what they know.
- Willingness to think of another's circumstance

**HONESTY THROUGH TRANSPARENCY**

- Showing the why , how and what in all we do.
- Releasing our work into the world to assist and inspire others

**EQUITY AND DIVERSITY**

- Everyone has equal value
- Work sensitively with people from all backgrounds
- Understand others may have different perspectives
- Celebrate differences
- Of thought
- Of people
- Of solutions

**SUSTAINABILITY THROUGH PRACTICE**

- To our team
- To our clients
- To the community
- Striving to leave things as they are or better
- Social, environmental and economic

**EXCELLENCE – INDIVIDUALLY AND COLLECTIVELY**

- Be the best we can be, individually and collectively
- Striving to be good people and good engineers who care.

**Figure 2: Outcome of workshop activity four: The espoused Engineering Practice Academy values and the shared understanding of the values.**

## Results: Acting and reflecting on values

The creation of a practice's culture is emergent, and changes as the practice grows and develops new knowledge and perspective. The espoused values generated by the Academy was positioned as working values because they will inevitably be modified as the culture of the Academy develops and the values continue to be implemented into decision-making processes. At the completion of the workshop and once the outcomes were distributed the participants came back together and reflected on the generated values and the evolution of the values from workshop one to the result of workshop three. Within this meeting, the team acknowledged that equity and diversity should become diversity and inclusion. The process of generating shared values requires participants to be advocates for the organisation and to recognise the value of different opinions. It was through a process of reflection and collaboration that Academy members began to negotiate their perspectives and begin to form shared values for the Academy.

The espoused values co-created by the Academy are being used in all aspects of the Academy creation such as evaluating and selecting potential initiatives, generating an ethical partnership policy to guide the selection of external partners and creating a culture to attract and support a diverse staff and student cohort. Since the creation of the espoused values Academy representatives have participated in a vision setting workshop where participants created the strategic objectives to achieve each of the value elements. Workshops were then held with all Academy members to align and priorities their projects to contribute to these objectives in a manner that maximized the impact across all generated vision elements. Throughout this process, the espoused values were used as a lens to inform the decision-making processes.

## Discussion

An explicit statement of the culture of the Academy expressed through the five espoused values described in this paper provided at least four tangible benefits to the operation of the

practice as both a professional services provider and a higher education institution. At a strategic level, the values provide a test against which potential initiatives can be judged and thus provide clear direction to the practice. Operationally, the values are a powerful tool to guide decision-making; decisions that are inconsistent with the values are not desirable and are thus avoided, and other options considered. Within the context of the practice reported in this paper, the values have already been effectively used to guide decision-making around the types of industry partners that the Academy chooses to engage with, and indeed, to guide decisions on the level of engagement with specific companies.

Values-based decision-making systems, when used effectively, can be implemented across practices to devolve decision-making down through hierarchies by empowering individuals, not just managers, to make decisions, yet ensuring that such decisions are not detrimental to the practice as a whole. Further, clear values are an effective tool for recruitment and retention of, in this context, both academic and professional staff, and students. Explicitly-stated values attract individuals that share those values and increases their commitment to the practice when they experience their beliefs and assumptions reflected in their work (Sullivan, Sullivan, & Buffton, 2002).

Employing values as a framework to construct decision making is not uncommon in engineering practice, as Catalano (2012, p. 118) states “engineering is a value-laden profession with a strong ethical foundation”. The true test of the values created by the Academy will lie in the communication, implementation, and ownership of the values by staff, students and supporters of Academy who were not present in the construction of the values.

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