Sustainable Design Practitioners: Why they must be at the Centre of Discussions on Sustainable Design Education

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Abstract

Sustainable design education is vital for engineering students. This is to allow them to meet the challenges both engineering and the wider community will face in the future. This need has not only been mandated by Engineers Australia's graduate attributes from an Australian perspective, but more widely the issue of sustainability is one of the greatest challenges humanity has ever faced. Engineers need to be at the forefront of this challenge, because we can not only do the greatest good, but have the potential to cause the greatest harm[1]. The biggest question with respect to the education of engineers about sustainable design is what do engineers need to know, and how best to enable this learning. This paper argues that since the entire phenomenon of sustainable design is constantly growing and changing, it is only by looking at practitioners currently trying design sustainably, and their ways of experiencing sustainable design, can we hope to articulate what it is, and therefore what and how we need to teach engineering students. It also argues that to accommodate sustainable design within engineering, we need to go further and transform the engineering profession to enable it to meet the challenges that sustainability presents.

Introduction

The introduction of Engineers Australia's graduate attributes has mandated that engineering programs develop within their students "an understanding of sustainable design and development" in order to be accredited[2]. It is even more vital that these future engineers be educated about sustainable design, considering that they will be the generation who are able to bring about the most change[3]. As some argue that sustainability can only be achieved through design[4], this presents further challenges for the current engineering education system for how best to instil within engineering students this understanding. Different universities throughout Australia though have adopted different approaches to teaching their students about sustainable design, alluding to the fact that there are different understandings among academics of what sustainable design is[5].

This paper introduces a study that aims to address this issue. It develops the concept of 'Sustainable Design Practitioners' and argues that we need to turn to them to develop a clearer picture of the phenomenon of sustainable design; what it is, how it is experienced, and how it is operationalised. Sustainable design practitioners encompass traditional engineers, architects, town planners, community liaison groups, researchers into sustainable design and many other groups. The study will attempt to look across these groups, and determine what

learning across boundaries is necessary for these groups to move toward their common goal of sustainability. By analysing the variations in the practitioners' ways of experiencing sustainable design, we can better inform discussions on sustainable design, and more importantly, we can determine how we should educate future engineers.

This has further significance for the future of engineering education, in line with the current transformation of the profession of engineering as we know it[1]. Engineering is facing a wide range of challenges to maintain its relevance and to meet its social expectations[6]. These challenges are in effect blurring the edges of where engineering stops and other disciplines and professions begin. These other disciplines can contribute greatly to discussions on the nature of sustainable design, and variations in ways of experiencing it, and hence contribute to the development of what sustainable design is from an engineering perspective. In order to learn and interact across these boundaries, a new understanding of working across disciplines needs to be developed if engineers are going to take a central role in meeting the challenges of sustainable design and interact with these other disciplines.

Sustainable Design

Sustainability, and in particular sustainable design, have become central to engineering practice, both at the professional level and consequently at the educational level also. The changing roles of engineers in industry and the focus on sustainable development, rather than simply development, have meant that engineering decisions need to be made with a number of different stakeholders in mind. Consequently the terms sustainable development and sustainable design have come to mean a lot of different things to a lot of different people on a professional as well as personal level. Hence, since the decisions that need to be made are value laden and emotionally charged[6], much more so than traditional engineering decisions, it becomes harder to understand what sustainable design is.

One reason for this is that "people are trying to articulate a movement that is still in its adolescence"[3]. Sustainable Design is a phenomenon that is being defined and developed as it is used every day, including its principles, components and philosophy[3]. But as different disciplines, industries and professions struggle to understand and apply sustainable design to their own domains and to their own unique problems, their ways of experiencing the phenomenon vary and diversify. Yet, each of these groups' ways of experiencing and viewing sustainable design are valid, and add to the ongoing evolution of the phenomenon of sustainable design. The problem is not that different groups vary in the way they experience sustainable design, but that there has been very little effort to recognise these varied understandings between disciplines and to determine what implications these have for the future of engineering.

To illustrate this variation, Table 1 presents examples of sustainable design principles from three engineering disciplines, namely product design, plant design, and green design. Some similarities exist, such as the focus on human health and well-being, and preventing the release of toxic by-products. However, there are a lot of variations, as each focuses on aspects prevalent to their own discipline. These include the focus on renewable energy for product design, the focus on costs, operability and maintainability for plant design, and not being limited by current or dominant technologies for green design. All of these are valid ways of experiencing sustainable design.

Table 1: Sustainable Product Design, Sustainable Plant Design and Green Design

Sustainable Product Design[4]	Sustainable Plant Design[7]	Green Design[8]
1. Cyclic: Made from compostable organic materials or from minerals that are continuously cycled. 2. Solar: Their manufacture and use consumes only renewable energy that is cyclic and safe. 3. Safe: All releases to air, water, land or space are non-toxic. 4. Efficient: Most efficient use of energy required over life cycle. 5. Social: The products manufacture and use supports basic human rights and natural justice.	1. Ensure the health and safety of workers and the community; 2. Maximise resource productivity; Maximise energy efficiency; 3. Prevent dispersion of toxic or harmful materials to the environment; 4. Keep the plant as simple as possible; 5. Enhance constructability, operability and maintainability; 6. Reduce life cycle costs.	1. Engineer processes and products holistically using systems thinking, and environmental impact assessment tools. 2. Conserve and improve ecosystems and human health and well-being. 3. Use life cycle thinking in all engineering activities. 4. Ensure that all material and energy inputs and outputs are as inherently safe and benign as possible. 5. Minimize depletion of natural resources. 6. Strive to prevent waste. 7. Develop and apply engineering solutions, being cognizant of local geography, aspirations and cultures. 8. Do not be limited by current or dominant technologies; seek fundamental and incremental change. 9. Create awareness in and engage communities and stakeholders.

While the variations in Table 1 represent examples from engineering, the variations are even greater between professions. This is due to the different paradigmatic orientations that exist between the disciplines or communities of practice. In Figure 1, disciplines are represented as lines, which have different orientations depending on the predominant paradigm within that discipline toward sustainability and sustainable design. The crosses represent individuals from each discipline.

The variations within individual disciplines' ways of experiencing sustainable design (the dot-dot-dash oval) result in less overall variation in ways of experiencing sustainable design than when all of the disciplines' variations are considered (the area within the dashed lines). Thus, since the study is interested in maximising the diversity of experiences, while still maintaining the focus on engineering activities, it is vital that disciplines other than engineering are included. This will in turn expand and add to the current understandings of sustainable design within engineering.

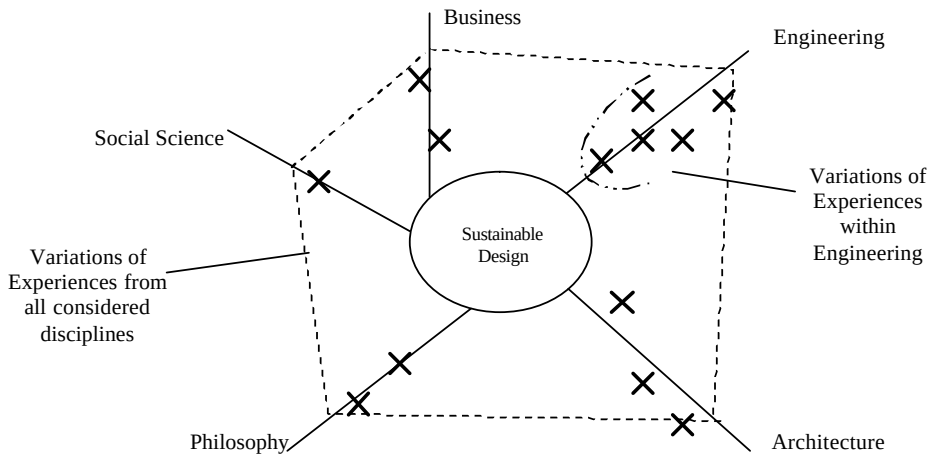

Figure 1: Outcome Space - Variation among Disciplines

How to Educate for Sustainable Design

A recent report from the National Academy of Engineering in the US into visions of what an engineer would be in the year 2020 stated that

> *"[E]ngineers will continue to be leaders in the movement toward use of wise, informed, and economical sustainable development. This should begin in our educational institutions and be founded in the basic tenets of the engineering profession and its actions"*[9]

Currently, academics are largely responsible for determining what engineering students learn about sustainable design at university[5]. Generally, the way in which academics experience or have experienced sustainable design is not enough to form the basis of what to teach students, as many academics are out of touch with current sustainable design practices in industry. Generally, in Australia, academic ties to industry are not as tight as in other countries. Also, it is harder for academics to gain insight into current practices because design practice requires a much longer periods of *in situ* work than in more technical work.

To enable future engineers to have "an understanding of sustainable design"[2], the variations among different groups involved in sustainable design need to be examined to develop a picture of what sustainable design is and how to foster this understanding within engineering students. As mentioned before, the phenomenon of sustainable design is constantly being developed and defined as it is used, and is changing much faster than education, both higher education and professional development, and government approaches are. In order to find out what and how we should educate tomorrow's engineers about sustainable design, it is to the practitioners that have to deal with sustainable design every day that we need to turn. These practitioners are constantly working with sustainable design practices and concepts and are usually at the forefront of changes that are occurring.

A study is currently underway at the University of Queensland investigating the experiences of these sustainable design practitioners. It is using a phenomenographic research approach, which empirically investigates and articulates qualitatively different ways of experie ncing a

phenomenon[10]. One of the major premises of phenomenography is that "whatever phenomenon or situation people encounter, we can identify a limited number of qualitatively different and logically interrelated ways in which the phenomenon or the situation is experienced or understood" [11]. Twenty sustainable design practitioners are being interviewed about their experiences using sustainable design. Participants were primarily selected based on the diversity of their experiences, proximity to design activities, and their ease of access for the collection of data. They were then selected based upon a set of diversity indicators to attempt to get the maximum diversity among the sustainable design practitioners identified.

The indicators used were:

1. Project Scale
2. Project Definition
3. Location
4. Scale
5. Client
6. Stakeholder groups involved
7. Professional discipline
8. Years of design experience
9. Formal training of sustainable design
10. Gender

The results of this study will be a set of categories of description, that represent the limited number of distinctive ways sustainable design is understood by the set of participants at that time[12, 13]. Specifically, these categories of description will give a clearer picture of what sustainable design is and how we can educate this to engineering students.

Sustainable Design Practitioners

In developing and planning the above mentioned study, the notion of a sustainable design practitioner was developed and investigated. Initially the study was to look at engineers experiences, but as possible candidates were investigated, it was realised that these engineers we no longer just engineers, that they had moved beyond the traditional boundaries of engineering. This lead to the consideration of what exactly was a sustainable design practitioner, and why they represent what engineers need to become for the profession to be able to deal with sustainable design.

While many sustainable design practitioners may start within specific disciplines, such as engineering or architecture, they soon develop their abilities beyond their traditional disciplinary boundaries. They will become interdisciplinary practitioners, and while usually grounded in their original discipline, will have developed skills that are akin to other disciplines. For example, sustainable design practitioners grounded in engineering require a much larger set of abilities, such as[14]:

1. Experience at working with businesses, governments, the community, professional groups and educational groups
2. Have a working knowledge of sustainability, social systems, the environment, economics and stakeholder engagement

3. Have an understanding of systems thinking, project management, marketing and training

These attributes go beyond those of engineering, and are more in line with other disciplines, including business, economics, ecology, anthropology, political science, social work and law.

While there are no sustainable design practitioners at the moment to the author's knowledge, that can claim to have all of the abilities mentioned above, there is a growing group of people that are moving toward this ideal. Figure 2 represents these people moving from their own disciplines toward being sustainable design practitioners. Individuals are again represented by crosses with the distance from their original discipline (the arrows) representing the paradigm shifts they have already made become sustainable design practitioners. These shifts represent some of the skills and attributes these practitioners have developed through practical experiences and professional development.

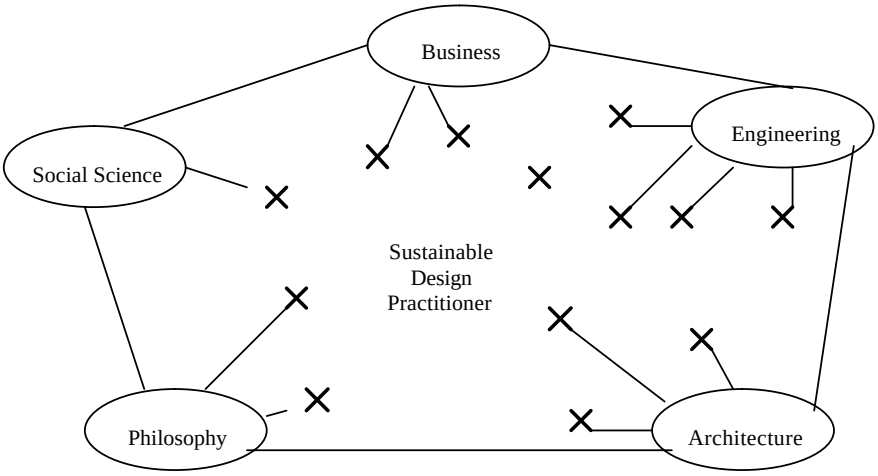

Figure 2: Variation among Professions

Transformation of Engineering

The attributes listed above describe activities and skills are not within the traditional discipline of engineering. Yet in order to deal with the scope of sustainable design, future engineers will need to have some or all of the above attributes. The fact that these are currently outside traditional engineering confirms that sustainable design has operated for a long time outside the mainstream of the disciplines, so for many within different disciplines, a shift towards sustainable design represents a "total shift in how their profession is viewed"[3]. For engineering as a discipline with design as a major part, this represents a shift of the core of the profession itself. "What is disappearing is engineering as a coherent and independent profession that is defined by well-understood relationships with industrial and other social organisations"[1].

In particular for sustainable design, the variations in ways of experiencing the phenomenon need to be embraced. This will lead to a new concept of interdisciplinary within engineering. Engineers can not face and solve the challenges of sustainability alone[1], nor can they just get

an expert in to deal with the "non-technical stuff". The engineering profession needs to transform, to produce sustainable design practitioners able to deal with the challenges faced by sustainability and sustainable design.

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Biographical Information

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