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Case studies in professional-oriented education: engaging with sustainability and complexity

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Abstract

Case studies have been used in management teaching for nearly a century, and have deeper roots in the teaching of other professions, including law and medicine. Cases have considerable value as a teaching method but there has been increasing criticism of the limitations of many of the case studies currently available. There are challenges that are particularly relevant to today's professional students who are often working at the complex interface between technical and social issues. First, many cases have a clear disciplinary label and do not embrace multi-disciplinarity. Second, most cases are focused on organising and analysing issues and arrive at a decision, usually placing primacy on the outcomes for a single company, and do not capture the complexity created by social and environmental considerations. This is problematic when it comes to considering how to address issues associated with sustainability and resilience in the built environment. This paper reports on a revised, piloted case study model that addresses the shortcomings of existing typical cases, focusing on exploring problems rather than making specific decisions. The pilot case, on engineering decisions in disaster recovery, was based on insights developed through a research project. Similar to other case teaching, the lecturer becomes a facilitator to help participants through the case, rather than specifically teach material. This proved to be a successful way of exploring a complex problem space where there is no right answer, only lessons that can be drawn from the tensions presented. Drawing on this experience, this paper outlines what this means for the roles of teachers and post-graduate training in advancing professional-oriented education in engineering and the built environment.

1 Introduction

One of the challenges of engineering education for sustainable development (EESD) is that students need to look beyond technical problems to the broader social and environmental context of professional engineering decisions. As technology improves to automate more technical problem-solving, the role of engineering professionals is evolving to involve deeper levels of stakeholder engagement. Practitioners find themselves dealing with intractable problems of working with groups who have very different perspectives on the needs for sustainable communities and resilient infrastructure. However, there is a noticeable shortage of teaching materials suitable for students to engage in this type of problem solving. While case studies show considerable potential as a way of exploring unstructured, complex problems, there is not an established library of materials designed for engineering students. In this paper, we address this gap by first

examining the way case studies can be used in EESD, and then showing an example developed from our own research and teaching practice.

In responding to the University of Cambridge's mission to contribute to society through the pursuit of education, learning and research, an opportunity was identified to bring relevant research to life through a revised case study teaching format. Our initial focus is on creating case studies that are suitable for teaching experienced professionals. This is partly because of the increased emphasis on life-long learning. It is also partly because these people are in the 'front line' of the fulfilment of the Sustainable Development Goals, and other related elements of the United Nations agenda such as the Sendai Framework for Action (on disaster risk reduction). The basis for this approach emerged from two observations made in our understanding of teaching experienced engineering professionals. Firstly, setting journal papers as pre-reading only goes some-way towards engaging students with learning material – where they may come ready to class to engage in the concepts, rather than just be introduced to them in class. Secondly, case studies take theory and turns it into more of a narrative that *require* student participation in class. Cases are structured specifically with the lesson in mind. However, case study teaching is not typically applied to the engineering profession, so coverage of issues encountered by engineering professionals (beyond those encountered generally when running a business) in existing cases are limited.

To address this gap, we present how we developed an approach to developing case studies for EESD for experienced professionals. In this paper we look at coverage of "natural disasters" as a focused topic within the wider scope of sustainable development concerns. This is primarily due to circumstances that presented an opportunity to create and trial a case study based on a research project on post-disaster reconstruction. However, we believe that the essential principles of building for resilience to natural disasters are applicable in other sustainability-related contexts, and that the case allows students to develop problem-solving skills to manage other complex, multi-stakeholder situations.

This paper is organised as follows. First, we introduce the key features of case study teaching. Then, we critically review the existing case studies on natural disasters, and demonstrate the gap in the teaching materials that we sought to address. The paper then introduces the approach we took to developing, piloting and teaching the case study, before concluding with some observations about the implications of this work for research and practice.

2 A brief review of case study teaching

Cases have been used in management teaching for nearly a century, and have deeper roots in the teaching of other professions. Rippin et al. (2002) provide a helpful history of the development of case study teaching in management training, highlighting the earlier roots in law and medicine. Harvard Business School (HBS) academics were pioneers of the method at the start of the twentieth century; HBS still dominates the market for business school case studies. HBS define the method briefly as "a discussion of real-life situations that business executives have faced". The intent is to develop "wisdom" among participants in a shorter period than they might achieve through their own professional experience. Freeman Herreid (2011) reviews the case study teaching method in its variety of forms. Essentially, his paper summarises the different ways to engage with the case method, from a didactic approach where the teacher acts as a storyteller (similar to the traditional lecture method) through to small group discussions where students teach each other (the approach more commonly adopted via the HBS method). Drawing on established teaching theory Freeman

Herreid emphasises that increasing the levels of discussion with students, and between students, increases level of retention of information.

The case study essentially presents a summarised real experience. It allows students to engage with content based on real situations, without providing a "right" answer. Cases material may be formed via mixed media, although historically have been in written form,1 to 50 pages in length. *The case study handbook* (Ellet, 2018) advises that a case must have four characteristics:

1. A significant business issue or issues (to provide the basis for learning).
2. Sufficient information on which to base conclusions about the issues (to allow engagement and debate of the issue presented, based on evidence).
3. No objective conclusion, in other words: no explicit or implied right answer (real life involves different opinions and perspectives).
4. Organised in a nonlinear way (evidence is not always presented neatly, students need to apply their own critical thinking and extract relevant information).

Interpretation of point 1 above is expanding. Rippin et al. (2002) observed that there is a change in application of the traditional case method to use it as a means to explore complexity and ambiguity. By "traditional approach" they are referring to what they have termed a *mode 1* case, which places emphasis on problem-solving and decision-making. This is in contrast to *mode 2* cases, which focus on developing critical thinking skills to manage ambiguity and complexity. They suggest that *mode 1* has been the dominant basis for decades of case study teaching in management, but with *mode 2* emerging as a concept in the 21st Century. There are other supporters of *mode 2*. While Akrivou and Bradbury-Huang (2015) do not directly adopt the *mode 1/mode 2* terminology, their paper implicitly supports the need for greater emphasis on *mode 2* teaching. They call for business schools to be "custodians of society", teaching people to serve long-term prosperity of humanity, rather than serving the interests of specific organisations.

Experts in EESD have long called for the need to place greater emphasis on the wider context of technical engineering decisions (see, for example Fenner et al., 2006; Allenby et al., 2009; Byrne and Mullally, 2014;Mulder, 2017). However, specific teaching resources remain somewhat limited. Given the desire to develop engineering professionals to engage with complexity and to recognise the wider social impacts of their decisions, *mode 2* case study teaching presents as a potentially useful approach. We therefore decided to review existing HBS case studies on "natural disasters" – a topic which has clear relevance for EESD to assess whether suitable materials for postgraduate EESD would be available.

3 Reviewing the current state of case studies

To demonstrate the observed gap and opportunity in case study teaching, we present a brief review of a sub-set of cases available through the current Harvard Business Publishing catalogue (https://hbsp.harvard.edu/). A key word search of "natural disasters" returns 41 cases (with a further 16 supporting cases). Sixteen of the main cases are published via the Harvard Business School, eight through the Harvard Kennedy School and others across a number of management/business schools. This is a small sub-set of hundreds of cases in this catalogue, but demonstrative in reinforcing key points made in the above review of case study teaching.

Within the 41 case set, the database indicates predominant key topics of general management (31 cases), corporate social responsibility (20 cases), business and government relations (15 cases) and operations and processes (14 cases). Unsurprisingly, given the emphasis of business school teaching, these cases are either oriented on an issue for a specific business, or a broader focus on the operation of markets. Where the case is oriented on a specific company, the subject focus predominantly covers supply chain management and various forms of business strategy. This small set of cases helps to reinforce two critical points:

(A) *Mode 1* cases dominate the list, where there is a traditional business school focus on decisions made in business that have the potential to have a critical impact on business performance.

(B) Where focus is expanding in these cases, for example in exploring themes oriented on social issues, sustainability and ethics, the case remains generally focused on the continuity of business.

The disasters referenced in these cases include, among others, Hurricane Katrina (from 2005), the 2010 Haiti Earthquake and the Great East Japan Earthquake of 2011. These all hit global headlines given the significant physical and social impacts of these events. However, these existing cases are typically focused rather narrowly on business and finance. Only one case considers an infrastructure design-related issue. The Harvard Kennedy School cases tend to be broader in focus, exploring a wider governance and government relations issues. The examples presented in Table 1 represent two of the few cases that have a clear connection to infrastructure in the significant issue at the core of the case. The discipline area and key words are those supplied with the cases.

Table 1: Example cases covering a "natural disaster" theme

Source	Harvard Business School	Harvard Kennedy School
Title	The Big Easy, Not So Easy	Rebuilding Aceh: Indonesia's BRR spearheads post-tsunami recovery
Discipline	Finance	Business & government relations
Subject key words	Emerging markets, Cross functional management, Project management, Risk management, Community development, Natural disasters, Reputations, Risk mitigation	International Development, Disaster recovery, Natural disasters
Industry key words	Real estate, rental & leasing, Residential construction	Not provided
Case summary	Oriented on the rebuilding housing projects in New Orleans following Hurricane Katrina. The case explores the environmental, contractual, reputational, and legal risks in rebuilding, and whether the group at the core of the case, Enterprise Community Partners, is to lead the rebuilding, what changes might be involved.	This case focuses on how the recovery agency (known as BRR) in Indonesia coordinated reconstruction efforts following the 2004 tsunami. It explores the challenges of setting up the agency and coordination of the recovery process, covering thousands of reconstruction projects.

There are challenges that are particularly relevant to today's professional students who are often working at the complex interface between technical and social issues. First, many cases have a clear disciplinary label and do not embrace multi-disciplinarity. Second, most cases are focused on organising and analysing issues and arrive at a decision, usually placing primacy on the economic outcomes for a single company. That is, they often do not capture the complexity created by social and environmental considerations, particularly in the context of engineering and infrastructure. While cases are broadening out to explore issues such as climate change, our observations are that "business" remains the centre of the narrative.[1] We therefore set out to create and teach a new case study that would address these concerns directly.

4 Developing a case study for EESD teaching

Our approach had three phases. First, we set some criteria for case development, building on our analysis of EESD requirements, and identified a body of research that we could use for creating the case. Then, we prepared the case materials and pedagogical design. Finally, we ran a pilot teaching session so that we could ensure that the materials met our teaching aims before we introduced the case to the curriculum.

Step 1: Setting the teaching goals and identifying the research

Our aim was to help students engage with a complex system of actors and how the tensions between different people or concepts can shape behaviour – sometimes resulting in unintended outcomes. To do this, we set about creating a case study on the post-earthquake recovery of the city of Christchurch, New Zealand, as a trial for the revised case study concept, expanding the framing of the problem that a case addresses. The Christchurch context was chosen as a starting point to allow us to draw on material from a research project that had previously been led by one of the authors of this paper. The existing material (a PhD and associated published papers) informed a two-part case study, which is described below.[2] The objective of this pair of associated cases is about how people respond in a complex situation that cannot be anticipated in detail. It features the problems of operating in a multi-stakeholder landscape under pressure of time and cost, where the engineers have to respond to a range of pressures. The narrative is based around the role of SCIRT, an engineering and construction alliance that was convened to rebuild the city's roads, water, sewerage and land drainage systems.

Step 2: Developing the case design

The process of converting this material to teaching material involved four key steps. First, we needed to clarify our learning objectives. While our aim was a large one, we needed to clarify the specific goals of the teaching session and design materials that would deliver these. Second, we needed to reduce the very extensive research material to a much shorter format. This involved simplifying the context and narrative of the existing material, and emphasising the points that could support discussion focused on the learning objectives. With the core material developed, we then developed the lesson structure (step three) and a

[1] As demonstrated in this short video from HBS, published in Sept 2019 (https://www.hbs.edu/about/video.aspx?v=1_h3k7ye6p).

[2] For example background material see (MacAskill and Guthrie, 2015, 2017, 2018; MacAskill, 2019). The case study itself is not currently publicly available - please contact the authors directly.

teaching note (step four) to guide the instructors through the session, recognising that the focus for the teachers would be on facilitating discussion rather than presenting information.

The case is designed in two parts, set in the aftermath of the series of earthquakes that affected Christchurch in 2010/11. Case A is the main case and can be delivered as a stand-alone case. It describes the problems of 'building back better' in Christchurch. While the infrastructure rebuild programme was initiated with good intentions to improve resilience in the city's infrastructure, there were a series of problems that inhibited this. The case allows the students to explore the way that tensions between the different stakeholders created a difficult environment requiring design compromises. This case helps students develop the following skills:

- Defining and scoping a complex problem
- Stakeholder identification and management
- Understanding the way organisations may improvise in order to respond to changing conditions
- Challenges of building back better and design for resilience
- Explore the role of engineers in shaping cities, within the wider context of other actors

Part B is a supporting case, focusing more specifically on an issue that emerged during the recovery. Specifically, this explores the design choices made by engineers in a part of the infrastructure system that – while technically sound – proved controversial with the community they served. It is intended to help students with the following skills:

- Understanding the critical relationship between technical and social problems and solutions
- Developing stakeholder engagement strategies
- Identifying and addressing the trade-offs involved in design decisions in difficult conditions

In order to test the teaching materials (including our lesson plan), we held a pilot session before introducing this case to the curriculum.

Step 3: Pilot and delivery

We held a pilot trial with post-graduate engineering students (master's and PhD level) and staff (research associates and course leaders) at the University of Cambridge. There were twelve participants. The participants were required to read Part A before the session, and were given time to read Part B part-way through the session. The session lasted three hours in total. While some traditional lecture slides were used to reinforce key theories engaged with, the session emphasised group discussion.

Every participant provided feedback at the end of this session. Helpful pointers were provided regarding the structure of the session, which were mostly related to the newness of the case and experimentation of the lecturers as to how to best engage with the students with the material.

The respondents were unanimous that they thought the case study was effective, and that by exploring the case first and then applying theory they learned more. The students were a diverse group, and although they were almost all engineers, they came from different disciplines and brought different perspectives to the session. The basic rhythm (do something new every 20 minutes or so) and variety was effective. The students particularly appreciated the activity when they broke into different stakeholder groups, because this actively promotes a greater level of engagement (which was generally very good). People were also

interested in the 'end' of the story, seeking an update on how Christchurch is recovering after the earthquake. This would help make sure that people feel that the session is concluded. Although, in adding such content we suggest care must be taken to emphasize that this does not necessarily present the "right" solution, merely the one that ultimately emerged from the tensions presented in the case. This positive and constructive feedback led us to make some small changes to the teaching delivery (for example, including more photographs to help the students to 'situate' themselves in the case), and the case study has now been incorporated into our teaching practice.

5 Conclusion

This paper makes the following contributions. First, it shows the potential for developing case studies as a teaching method for helping students explore complex problems. Second, it outlines the shortcomings of the current cannon of case studies on exploring engineering-oriented problems and in enabling students to take a broad and holistic view of problems. Third, it illustrates an approach to developing new cases as a way to introduce students to the more complex, multi-faceted problems that are involved in building communities.

The work has implications for further research and for practice. The case described in this paper was developed using the material from a large-scale research project as its starting point. There is considerable potential to use certain types of research project – for example, those involving research with multiple stakeholder groups – as a basis for case development. By doing this, it is possible to increase the potential impact of the research. One implication for researchers is that they could bear this possible application in mind as they design their research programmes. The case study approach also has implications for teaching: the role of the teacher in this method is more facilitative than instructional, and this makes new demands on teaching staff. Despite these challenges, research-led cases show great potential for advancing professional-oriented education and preparing engineers and professionals in the built environment for the challenges of building sustainable and resilient communities.

We see a real opportunity for engineering education to advance with this model – exploring the context of decision making that ultimately shapes the boundaries of the project within which technical engineering decisions are made. While technical-oriented decisions (such as sizing of components such as pipes) can have sustainability implications, the wider political and institutional context often has a substantive influence in shaping sustainability considerations. Engineers will need to be able to understand and navigate these complex contexts in order to create resilient and flourishing communities.

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