HOW PEOPLE ENACT ENVIRONMENTAL STRATEGY WITHIN ORGANISATIONS

A thesis submitted in fulfillment of the requirements for the degree of Doctor of Philosophy

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July, 2018
DECLARATION

I certify that except where due acknowledgement has been made, the work is that of the author alone; the work has not been submitted previously, in whole or in part, to qualify for any other academic award; the content of the thesis is the result of work which has been carried out since the official commencement date of the approved research program; any editorial work, paid or unpaid, carried out by a third party is acknowledged; and, ethics procedures and guidelines have been followed. I acknowledge the support I have received for my research through the provision of an Australian Government Research Training Program Scholarship.

Simon Lockrey 25th March, 2019
Completing a PhD requires plenty of encouragement along the way. My PhD required the development of a series of research artefacts, four journal articles and an edited book chapter, as well as supporting chapters that completed the research. I would like to thank the people who provided support throughout my candidature to complete this body of work.

Firstly, I would like to thank my supervisors Professor Linda Brennan, Associate Professor Karli Verghese, Dr Tim Butcher and Dr Warren Staples. Your academic guidance, and moral support were paramount to my growing as a researcher, and, on occasion, as a person.

Linda, as senior supervisor I want to thank you for your encouragement, tireless attention to detail, timely reviews, and honest feedback throughout my candidature. I am sure you would agree that it was worth it, evidenced by the way in which I have developed.

Karli, my long time research collaborator and friend, thank you for motivating me to succeed in contributing an important piece of reflection on our research work from the last decade. Here is to many more years solving sustainability issues together.

To Dr Tim Butcher, who served as my supervisor for a short period of time. I appreciate your help navigating a new paradigm in my tackling organisational research, a role that Warren then stepped into. Warren, your guidance at the end of my PhD work was crucial as you transitioned to the role of co-senior supervisor with Linda. Thank you for your persistence and expertise, as well as appreciation of fine coffee establishments.

My editor Judy Gregory was also an important academic mentor as I pieced together my thesis. Thank you for your patience and advice Judy, throughout the writing process.

I must acknowledge my RMIT academic colleagues, students and research partners for their understanding as I focussed on completing my PhD. Particular thanks must go to my research partners United AgeWell, MicroHeat, Swinburne University, Kambrook, and Southcorp
Appliances, for allowing me to conduct research about them. Thank you to RMIT School of Management and School of Graduate Research for providing funding to present my research abroad in Japan and the US during my candidature. To the reviewers of my papers presented at the 2016 and 2017 Academy of Management Meetings. Your guidance was invaluable in refining the focus of my research. A special mention should also go to RMIT School of Design Industrial Design Program Managers Dr Liam Fennessy and Simon Curlis, and Deputy Dean of Research Dr Marcelo Stamm. Thank you for offering me time throughout my candidature to focus on PhD, along with my other academic duties.

A number of co-authors collaborated with me on four of the research artefacts included in my thesis. I would like to thank my co-authors other than my supervisors Kate Bissett-Johnson, Dr Stephen Clune, Alan Pears, Paul Taylor, Dr Liam Fennessy, and Dr Wayne Binney, for assisting in completing those research artefacts. I wish to formally acknowledge their contributions as per Appendix 2.

I sincerely thank my examiners Professor Jonatan Pinske and Associate Professor Annette Bos for their expert points on improving my manuscript through the examination process.

I would like to thank my family, for whom unconditional support was ongoing. A “How are you going?”, “Are you ok?”, and subsequent discussions tempered my anxieties on occasion.

Finally, I would like to thank my partner, Clare Shewan. Your love, humour, intellectual input, and encouragement provide me constant motivation to be better, and soak up life. For my PhD, this was no different. Even in difficult times, your empathy and level headedness were critical to me taking stock, and then getting it done. I love you, we are a terrific team!

Now complete, there is more work to be done following this PhD. Efforts are needed to bind humanity to a common goal to secure the future of our planet. We need to take further action for the prosperity of generations to come.
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ABSTRACT

This PhD project consists of a thesis with publications and focuses on how people enact environmental strategy within organisations. For organisations, the goal of an environmental strategy is to decrease environmental impacts of their activities. Although organisational action for the environment is growing, their efforts often fall short. Moreover, little is known about the actions of individual managers who are tasked to enact environmental strategy. Understanding why organisational goals and individual actions do not always align is important if the planet is to be maintained sustainably.

Research has explored the resources managers use; rules and norms they abide by; and stakeholders they deal with enacting environmental strategy. Researchers have also attempted to understand the cognitive frames people use in decisions aimed addressing at the environment. However how individuals’ apply agency, being their ability to make judgments and actions, is yet to be articulated for when environmental strategy is implemented. Nor is how social structures that people encounter, being rules, resources, norms and information, affect how they apply agency. Without knowing if people can apply agency, or not, organisations will continue to struggle in addressing the environment. Subsequently, throughout my PhD I address the research question;

*How do people within organisations enact environmental strategy?*

The research explores people, their agency, and the social structures they encounter in relation to enacting environmental strategy. I adopt an interpretivist philosophy, and an inductive approach. Case studies from tertiary education, aged care and new product development provide contexts where data about people enacting environmental strategy are available. Building on structuration theory I draw on qualitative primary data in the form of
observations, interviews, field notes, correspondence, and secondary data in the form of newsletters, reports and literature. Those data, were analysed systematically and generated insights about how people plan, implement, review or refine environmental strategy. Collectively I developed a series of research artefacts, four journal articles and an edited book chapter, with supporting chapters.

My research findings demonstrate that social structures both enable and constrain people when enacting environmental strategy within organisations. Resources such as life cycle assessment and design tools assist individuals to apply their agency through both old routines and new practices that enable environmental impacts to be reduced. Alternatively rules, such as mandated project briefs, and norms redefined by new situations and information that becomes available, guide people as to what needs to be achieved, or limit problematic behaviour.

Social structures are also shown to interact to increase how much power some individuals have when enacting environmental strategy. Collaboration; new information; cross functional expertise; and redefined policies afford people power beyond resources they apply, through the process of environmental strategy. Further, it was found that social structures also interact, as agency and social structures do. Such interactions empower people to take action that benefits the environment in some circumstances.

Finally, some managers are shown to be able to modify organisational contexts when actions for environmental strategy are too difficult. They do so if they are given the time and space for reflection, through processes designed for review; policies mandating change; and resources to use to modify their situations. They can then better support their employees to implement environmental savings by better thinking through the decisions they make.
My PhD provides a nuanced account of environmental strategy, by showing how social structures can be designed to support people enacting them. The mix of rules, norms, resources and practices summarised above enable people to achieve environmental impact reductions. This contribution extends knowledge about stakeholder groups and resources organisations engage with, by demonstrating how individuals interact with them; institutions followed, by showing how they influence people and their agency when environmental strategy takes place; and enriches research about cognitive frames managers use for decision about the environment, by focusing on subsequent actions. Subsequently organisations can now be more confident that environmental strategies they deploy support people and their actions throughout the process, contributing to the future sustainability of the planet.
CHAPTER 1: INTRODUCTION
1.0 INTRODUCTION

This research focusses on understanding how people enact environmental strategy (ES) within organisations. Organisations use a variety of strategies to achieve goals they set. Strategies implemented can relate to a range of organisational functions such as sales, supply chain, or marketing. ES is one such strategy, designed to decrease environmental impacts of activities of organisations. Individuals within organisations play a role when they enact ES, enactment being when they take action on environmental issues. Whether employees at work, students studying, policy makers legislating, or in another role, people within organisational situations are involved. My research explores how individual people enact ES within a range of organisational context. A focus on people is underexplored, yet pertinent as organisations implement ES whilst their environmental impacts and risks go on largely unabated. Understanding the gap between organisational goals and individual actions is both urgent and important if the planet is to be sustainable. Subsequently, for my PhD I ask the research question;

*How do people within organisations enact environmental strategy?*

Chapter 1 (Sections 1.1 to 1.5) provides an introduction to the research I conducted aimed at answering this question. Firstly, relevant literature covering how ES has been implemented and researched that led to my research problem is briefly summarised in Section 1.1. My contributions are articulated in Section 1.2. The research methodology adopted is noted in Section 1.3. Finally, Section 1.4 summarises the structure of my PhD project. In the following section I introduce research problem regarding organisations implementing ES.

1.1 RESEARCH PROBLEM

Increasingly, the Earth’s ecological environment faces damage from human induced impacts (Barnosky et al., 2011, Carpenter et al., 2011). Impacts include issues such as climate change
(O'Neill et al., 2017, Poloczanska et al., 2013), pollution (Brauer et al., 2016, Wan et al., 2016, Landrigan et al., 2017), and natural resource depletion (Klinglmair et al., 2014). Increased greenhouse gas emissions leads to climate change, that consists of increasingly extreme and dangerous natural events (Cai et al., 2014, Pal and Eltahir, 2016, Cazenave et al., 2014). Pollution consists of substances, such as heavy metals and toxics materials, released into the environment which can have harmful human effects (Kim et al., 2015, Yan et al., 2016, Li et al., 2014). Natural resource depletion reduces finite materials like oil and metal ores, and facilitates environmental degradation to land, water and air in the process (Venier et al., 2014). Consequently, environmental impacts damage people and the planet. People, and organisations they work for, face adverse consequences when impacts are unabated.

As environmental impacts grow, so do associated risks to organisations. Risks are threats to organisational operations stemming from environmental impacts they are exposed to. Threats from environmental impacts are now considered a major management risk to be dealt with (Coombs, 2010). Illustrating this, business organisations will have to manage increased natural disasters from climate change to ensure their ongoing survival (Howard-Grenville et al., 2014). Organisations increasingly mobilise their business activities to address risks from environmental impacts. However if they do not have an environmental strategy, ongoing operations may be in peril from associated risks.

ES is a subset of organisational strategies formulated to address environmental impacts to achieve organisational goals. Organisational strategies are typically characterised as processes set to achieve organisational goals (Porter, 1996). A number of goals are used by organisations when considering ES. Some use ES as a vehicle for compliance to rules pertaining to environmental issues (Benn et al., 2006). Others look to be legitimised by their stakeholders by implementing ES in being seeing to be responsible on environmental
concerns (Bansal and Roth, 2000). Yet others are concerned with using ES for competitive
advantage (Simpson et al., 2004, Nakao et al., 2004), for instance by becoming more efficient
(Benn et al., 2006). Primarily though ES includes a processes to decrease environmental
impacts from organisational activities (Papagiannakis et al., 2014). As such it is the focus of
this thesis, whilst the other goals for ES are also acknowledged throughout when appropriate.

As environmental issues have grown in public prominence, visibility of organisations
implementing ES has increased. Instances of Fortune 250 organisations reporting on
sustainability activities increased from 39% to 93% between 1999 and 2010 (Kolk, 2008,
Junior et al., 2014), yet very little improvement in addressing environmental damage has
resulted (Wittneben et al., 2012, Lyneis and Sterman, 2016). For instance Jones and Levy
(2007) found that close to 300 large multi-national organisations were not adequately
addressing climate change at the time of their study. Organisational commitments, actions
and political initiatives were not sufficient for greenhouse gas reductions required. Problems
occurred even when the organisations communicated externally about their processes and
management efforts focussed on improved environmental practices. Impacts continue
unabated as organisations resist transition to low emission technologies that would assist
(Jones and Levy, 2007, Wright and Nyberg, 2016). Hence a key problem is that damage to
the environment and associated risks persist even as ES is implemented. More consideration
is needed as to why impact reductions are elusive. If not, the difference between what is
proposed for ES, and achieved, will continue. Organisations will also remain exposed to
environmental impact risks.

People within organisations play a crucial part of when ES is implemented. For example,
managers, engineers, marketers and a whole range of functional disciplines take part in tasks
aimed at slowing climate change (Wright et al., 2012). Associated activities that people
participate in include policy development and efficiency programs aimed at reducing greenhouse gases (Wittneben et al., 2012). Thus people are given the responsibility of managing tasks for ES, yet how they enact it is not well known (Montiel and Delgado-Ceballos, 2014, Touboulic and Walker, 2015, Clifton and Amran, 2011). Clifton and Amran (2011) showed that organisations often default to satisfying narrow stakeholder interests, by focusing on the influence of a few powerful groups when implementing ES. In a review of how ES applied to supply chain management, individuals within organisations were afforded little attention (Touboulic and Walker, 2015). Consequently, it is not clear how people can be supported when enacting ES, which is problematic for organisations who continue to damage the environment. An overarching question then is;

*How do people within organisations enact environmental strategy?*

One underexplored aspect is the agency of people who enact ES. In particular it is unclear who has the power to act or apply agency when ES is implemented. Agency involves the interplay between a set purpose; judgments made in light of that purpose; and routines used by people as they take action to achieve a set purpose (Emirbayer and Mische, 1998). The purpose of an ES is primarily aimed at reducing the environmental impacts of organisational activities (Papagiannakis et al., 2014). Judgements that people make enacting tasks within organisations then interplay with the purpose of an ES. Giddens (1984) describes routines as repetitive actions that people enact, that may be aimed at set goals. In regards to ES, routines can result in people taking ongoing actions that benefit the environment (Naranjo-Gil, 2016). For instance, continuous improvement tasks can aim at increasing energy efficiency for organisational operations (Wittneben et al., 2012). If continuous improvement becomes routine, the pursuit of greenhouse gases reductions on an ongoing basis are achievable with energy efficiency gains. Alternatively, people and their routines can run counter to what ES
requires. This was the case with engineers in multiple oil sands projects in Canada, where routines of engineering excellence in oil exploration trumped focus on environmental impact reduction (Gond et al., 2015). Agency can block what an ES is set out to achieve. Therefore agency can define how people enact ES, either inhibiting or enabling their participation.

Resources, such as tools, data, people, infrastructure, or knowledge, provide a means with which agency is applied within organisations (Giddens, 1984). Resource based theory (RBT) proposes that organisations use such resources to gain competitive advantages (Peteraf, 1993). For ES, Krause et al. (2009) proposed the internal process, purchasing management, as able to deliver both economic and environmental outcomes when integrated with ES. Purchasing management is a central organisational process used to optimise profit, quality and supply. When combined with ES, purchasing provides established resources to use to achieve environmental goals. RBT can also be used to explain how some resources inhibit the goals organisations look to achieve. As an example, economic and supply chain priorities caused problems for 32 US food organisations realigning existing resources to implement ES (Pullman et al., 2009). Processes were subsequently prioritised to achieve cost minimisation and retain food quality. The same processes were to be deployed to reduce environmental impacts, and only local issues, such as land management, were addressed due to the competing cost and supply priorities. Despite useful insights, RBT research of ES has provided little insight about how resources are used by people (Aragón-Correa and Sharma, 2003), however, this is an important consideration. Tools such as life cycle assessment (LCA) have been shown to assist people to identify environmental implications of decisions they face (Hellweg and Canals, 2014). When LCA data is incorporated into decision making processes, impact reduction options become viable as they are incorporated into routines of people enacting ES (Rio et al., 2013). Hence by investigating how people apply resources
such as LCA, it may be established if they contribute to successful ES implementation, or otherwise.

There are also significant existing institutional influences on decisions that people make (or not) as they enact ES. Institutions are accepted conventions, such as established rules and norms, that guide the practices of people and organisations (DiMaggio and Powell, 2000). One prominent strand of institutional theory suggests organisations seek legitimacy by applying institutions that align to relevant stakeholder interests (Suchman, 1995). Rules are formal expectations, such as legislation and regulation set by governments, which organisations have abided by as they implement ES (Wittneben et al., 2012). Rules can be problematic when organisations implement ES. Legislation has demonstrated this in the US, when it blocks organisational action on climate change due to vested interests in the fossil fuels industry (Falke, 2011, Wittneben et al., 2012). Yet the influence of rules on people tasked to enact ES within organisations is not well understood. More clarity is required about what rules help guide people to achieve environmental savings, or limit actions needed for ES to be implemented.

Norms are less formal institutional expectations than rules, shaped by pressures from institutional entities such as markets, professions and society (Scott, 1987). They guide organisational behaviour through prescribed expectations. ES may become legitimised when tied to expectations defined by norms. For example financial expectations exerted by markets, such as maximising revenue, influence organisations. Carbon pricing, a common ES adopted by organisations that involves revenue generation, demonstrates that normalised expectations can shift the focus from the environment (Böhm et al., 2012). Moreover norms and their effect on people are not sufficiently understood when ES is implemented. An individual’s ability to contend with influential norms whilst still delivering environmental
savings is not apparent. Understanding how people apply agency will help ascertain how problematic norms, such as financial expectations, are dealt with when ES is enacted.

Finally, a key consideration for organisations implementing ES is that of stakeholders. Various stakeholders have an interest in how organisations operate, and are generally defined as groups (Freeman, 1984). Stakeholder theory research considers stakeholder expectations that influence how organisations implement ES (Kassinis and Vafeas, 2006). Neubaum and Zahra (2006) demonstrated financially minded stakeholders, such as banks or investors, can dictate economic drivers for Fortune 500 organisations, including for ES. Profit motives then compete with environmental impact reduction, and influence how ES is implemented. However if stakeholders take a longer term view of strategy, their influence was shown as positive for ES. In another study Mayes et al. (2014) showed that for Australian miner BHP Billiton, aligning to community interests enabled action for the environment that held legitimacy. When establishing a new mine, BHP balanced their profit motives with ideas deemed environmentally acceptable to community stakeholder groups. The consultation BHP initiated demonstrated how stakeholder concerns can help shape the implementation of ES. Stakeholder research largely focuses on the influence of external groups, ignoring internal individuals as part of that process (Touboulic and Walker, 2015, Clifton and Amran, 2011). This was the case during the BHP consultation, where groups were the focus rather than individual stakeholders (Mayes et al., 2014). Nevertheless, people influence negotiations with stakeholders when enacting ES. More attention is needed about how individuals manage stakeholder expectations that align, or at odds with, goals they set out to achieve.

In conclusion, resource based, institutional and stakeholder theory research has primarily considered social structures affecting how ES is implemented by organisations. Social structures consist of rules, resources and norms (Giddens, 1984). RBT research has identified
the resources organisations use for activities when ES is implemented. Institutional theory has revealed the rules and norms that have guided such activities. Stakeholder theory has defined influential groups that determine what resources and rules organisations apply when delivering environmental impact reductions. Despite these understandings, organisations continue struggle whilst implementing ES (Wittneben et al., 2012, Lyneis and Sterman, 2016). One way to further understand why organisations have had such trouble delivering environmental impact reductions is to explore ‘all aspects and levels of sustainability, especially the social/ human aspects and micro behavioural level’ (Touboulic and Walker, 2015 p. 34). Focusing on people and their agency provides a way to determine if past problems organisations experience stem from their employees’ behaviour.

Therefore, my research problem is to understand how people enact ES. This problem derives from organisational implementation problems leading to issues achieving environmental impact reduction. To investigate how individuals enact ES, my research is framed around how people apply agency. Agency remains an underexplored dimension of how people engage with the ES process. Such investigations are important if organisations are to rectify the issues they have experienced when implementing ES. A series of sub research questions were developed to address my research problem. Those questions are summarised in Table 1.

Table 1 – Sub-research questions framing my PhD

<table>
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<th>Question</th>
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<td>What resources assist people to enact ES within organisations?</td>
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<td>What rules assist people to enact ES within organisations?</td>
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<tr>
<td>Who within organisations is needed to enact ES?</td>
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<tr>
<td>Why are structure and agency important when people enact ES?</td>
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As the questions suggest, they were designed to investigate people; resources they use; rules they apply; and norms they reference to apply agency whilst enacting ES. For instance, I observed students at a university implementing and reviewing eco-design projects with a brief, design methods, engineering tools, and reflective techniques in partnership with university staff and an external technology organisation. I also explored people within an aged care organisation work with external experts to plan sustainability strategy with a series of design methods, life cycle analyses, and problem solving exercises. Both these cases were chosen to examine the suite of resources people use to enact ES in Chapters 4 and 5 respectively. I re-examined the eco-design students and aged care team in Chapter 8 to reveal any agency people had in light of using such resources, or any rules they followed.

Next marketing projects within the new product development field were investigated to show the roles of different professional disciplines for ES in Chapter 6, particularly the power and influence they play in implementing such projects. My final organisational context was a program of new product development used to monitor resources people at universities and for profit organisations used, and rules they abided by, to enact ES in Chapter 7. By choosing different types of organisational cases to examine, I was able to determine common or unique issues evident (Yin, 2017). Importantly for management practice I used this as a basis to demonstrate who faces issues when enacting ES, what they use to overcome them, and whether they have the agency to do so.

Structuration theory was the key framework used for my research problem because it connects the interaction of agency and social structures. Literature shows that social structures influence ES in a number of ways, be that the resources used (Krause et al., 2009, Pullman et al., 2009, Aragón-Correa and Sharma, 2003), rules and norms applied (Falke, 2011, Wittneben et al., 2012, Böhm et al., 2012), or what groups influence how social
structures are arranged (Kassinis and Vafeas, 2006, Neubaum and Zahra, 2006, Mayes et al., 2014). Structuration can be used to consider people applying agency within organisations, whilst they draw upon social structures to do so (Giddens, 1984). Next I summarise the methodology I used to conduct structuration research about ES.

### 1.2 RESEARCH METHODOLOGY

Following conventions suggested by Saunders et al. (2009), I established a methodology for my research which I summarise below (and I detail in Chapter 3). I adopted interpretivism to investigate the relative perspectives people apply in social contexts (Lincoln et al., 2018). Hence I considered interpretations of people and their work, to explain circumstances where ES was enacted. An inductive research approach complemented interpretive research, enabling the flexibility to consider various interpretations of how ES was enacted. I could then direct my investigations toward data and emergent themes related to my research problem (Creswell and Poth, 2017).

I adopted a case study strategy (Yin, 2017). Cases were purposely selected to provide clarity about research questions from Table 1, which focus on people and their actions. Thus organisations for my cases were chosen where personnel and rules and resources they used when enacting ES could be observed. I compared data within and across my cases, so that similarities and differences could be established (Schwandt and Gates, 2018). Unique characteristics were then determined about people and their agency when ES is implemented.

Various data were collected for my research. Field notes were taken in cases I participated in, to record observations (Hammer et al., 2017). I documented what I did during two ES projects; what I saw other people do; and what I thought influenced actions and outcomes. In a case of ES in which I was a non-participant, interviews with key personnel were conducted so that their views were recorded (Brinkmann, 2018). I collected data in four semi-structured
from interviewees about what happened during and following that ES. Correspondence, reports, and surveys provided additional evidence about all cases (Gioia et al., 2013). As such relevant written case materials were collected to compare to notes and interview data.

An account of how people enacted ES was developed for each case, with the different angles that data used providing credibility. The credibility of an account grows when insights formed by analysing different data are shown to be plausible (Dey, 2003). Following Tracy (2010), written materials were analysed by comparing them to observational and interview data and collated in descriptive analyses of each case (MacInnis, 2011). Finally accounts from each case were analysed collectively using the three stage technique developed by Gioia et al. (2013). That analysis began with first order data such as what interviewees said; what reports stated; to what observations had been made. Moving on, second order theoretical themes about how people enact ES were developed by grouping those data for each case. Thirdly, aggregate dimensions were created by grouping themes, to explain common or unique aspects of people enacting ES both in and between cases. Therefore I moved from data to aggregate dimensions of ES systematically. Next I summarise the thesis structure.

1.3 OUTLINE OF THESIS

The rest of my thesis is structured as follows. Firstly, Chapter 2 problematizes the relevant literature of about ES. Problematization consists of a critique of dominant theories employed previously for a research domain (Alvesson and Sandberg, 2011). By problematizing extant research and underlying theories, I illustrate a lack of understanding about how people apply agency as they enact ES.

Chapter 3 details the methodology that I used to address my research questions. In line with Saunders et al. (2009) this consists of defining the philosophy guiding my work; my approach; the research strategy I applied; and the data, cases and analysis methods I used.
Chapters 4-8 contain research findings relevant to answering my research questions. These five chapters consist of research artefacts which I developed for my PhD, being four peer reviewed journal articles and one edited book chapter in the case contexts summarised at the end of Section 1.1. Each artefact helps address my sub research questions (See Table 1).

In Chapter 9 I discuss how my collective findings contribute to illustrating the role of agency and people in enacting ES.

I then conclude my PhD with Chapter 10, by considering the implications of my contributions, limitations, and future research opportunities. My contributions consist of nuancing past understanding of the ES domain, echoing and extending aspects of previous research.

Chapter 2 provides an extensive review of literature relevant to my research problem.
CHAPTER 2: LITERATURE REVIEW
2.0 INTRODUCTION

In this section I review literature related to environmental strategy (ES). Chapter 1 introduced my thesis. Chapter 2 expands on the theoretical concepts and knowledge that frame my research. I problematize extant research of the ES process, from planning, implementation, and review to refinement. Problematization is a way in which prior research can be examined to reveal important elements that have not previously been addressed (Alvesson and Sandberg, 2011). Whilst useful in showing many important aspects of ES, I problematize the dominant theories by showing a lack of an agency dimension, relating to how people enact ES. Addressing that deficiency, I develop a conceptual framework at the end of this chapter. The framework combines concepts pertaining to people applying their agency, and using social structures as ES is implemented within their organisational contexts. The framework guides my research thereafter to examine whether people can enact ES or not.

2.1 PROBLEMATIZING ES RESEARCH

ES is an approach that organisations use to minimise risks deriving from environmental impacts. Organisational strategies are typically characterised as processes set to achieve organisational goals (Porter, 1996). ES is strategy implemented with the goal of decreased environmental impacts from organisational activities (Papagiannakis et al., 2014). Impacts ES is aimed at addressing include issues such as climate change (O'Neill et al., 2017, Poloczanska et al., 2013), pollution (Brauer et al., 2016, Wan et al., 2016, Landrigan et al., 2017), and natural resource depletion (Klinglmair et al., 2014). During climate change, increased greenhouse gas emissions shift weather conditions leading to increasingly dangerous natural events (Cai et al., 2014, Pal and Eltahir, 2016, Cazenave et al., 2014). Pollution consists of substances released into the environment which can have harmful effects upon humans (Kim et al., 2015, Yan et al., 2016, Li et al., 2014). Natural resource depletion
reduces the available finite materials and facilitates environmental degradation (Venier et al., 2014). Risks to organisational operations then derive from environmental impacts such as those defined above. For example, organisations will have to manage increased natural disasters from climate change to ensure they can operate (Howard-Grenville et al., 2014). Thus, organisations implement ES to manage environmental impacts and risks they produce.

As environmental issues have grown, visibility of organisations implementing ES has increased. For instance Fortune 250 organisations reporting on sustainability activities increased from 39% to 93% between 1999 and 2010 (Kolk, 2008, Junior et al., 2014). With higher visibility of ES, related research has followed. Researchers have primarily drawn on three dominant theoretical lenses to research the ES process. The theories cover stakeholder’s influence (Freeman, 1984), institutions applied (DiMaggio, 1988), and resources used by organisations (Wernerfelt, 1984). In the next sections I examine research that adopts these theories as to what they show as useful for ES from an organisational perspective. Organisations cannot adequately counter challenges to implementing ES if they cannot guarantee their personnel can contribute effectively. Thus I also examine where both these dominant theories, as well as some others, have been used to initiate investigations about the role individuals play in ES. Not all aspects relating to people enacting ES is evident. Hence I problematize prior research in showing that it has both contributed to understanding ES, yet lacked a dimension explaining the agency people use when enacting it. Moreover, I justify why looking further at this individual aspect of ES is warranted. The first perspective to consider is the influence of stakeholders on ES.

2.1.1 Influence of stakeholders on ES

The first dominant theory used to research ES activities has focussed on stakeholder influence. Various stakeholders have an interest in how organisations operate, and are
generally defined as groups such as competitors, governments, and society (Freeman, 1984). Stakeholders of ES are parties with an interest in how organisations implement actions for the environment. External stakeholder influence is underpinned by the notion that organisations pursue stakeholders’ interests with their activities (Montiel and Delgado-Ceballos, 2014:126). Stakeholder interests in ES may be in it being implemented successfully, or otherwise, and are therefore important to consider.

In reviewing stakeholder approaches to sustainability, Clifton and Amran (2011) showed that organisations often default to satisfying interests of only a few stakeholders. Organisational activities are then influenced by these few groups, usually the most powerful stakeholders. Moreover in a review of how ES applied to supply chain management, individuals within organisations were revealed being afforded little attention (Touboulic and Walker, 2015). It is unclear if internal personnel are considered stakeholders at all by organisations applying ES. Internal people are particularly important stakeholders when they have concerns about ES, which is when personal expectations about the environment are different to the current situation. Bansal (2003) explains that ES can be achieved by fostering concern about environmental issues to be addressed amongst employees through education and communication. Recruiting people who already hold concern and skills to address those issues also helps, to sell and implement the actions required to implement ES. On this basis organisations should consider how their people influence ES as stakeholders.

Research has identified the way external stakeholders hold expectations for ES processes (Park-Poaps and Rees, 2010). Organisations juggle various strategies to address the range of expectations different stakeholders hold. Stakeholders can use their expectations to influence an ES, based on their interests. As expectations clash, stakeholders and organisations can end up with different views as to how ES is best implemented (Fyke and Buzzanell, 2013). For
instance Neubaum and Zahra (2006) demonstrated financial stakeholders such as banks and investors can dictate that ES implemented by Fortune 500 organisations favour profitable outcomes. Profit motives then compete with environmental impact reduction. Organisations can respond to competing interests by balancing environmental and economic expectations. Neubaum and Zahra (2006) showed this when a long term approaches to balancing financial and environmental expectations are applied, where actions supported benefited goals aimed at reducing environmental impacts. In another example, 250 consumers in China were asked about the actions of a paper organisation addressing environmental issues (Li et al., 2017). By the organisation cleaning up contaminated equipment and participating in Earth Hour, consumers were more likely to buy their products, contributing to profits. Consumers surveyed also viewed the organisation more favourably due to steps to implement ES. Yet how individuals enacting ES deal with such stakeholders is not clear. How people within organisations negotiate stakeholder expectations, such as clashing profit motives, must be examined further. Then it will be possible to gauge if they implement ES effectively, whilst balancing stakeholder tensions.

For ES, political stakeholders can demand very different types of outcomes, one to the next. Political stakeholder motives resulted in converse actions by the US and EU respectively, during Kyoto Protocol negotiations (Doh and Guay, 2006). During discussions for reduced global greenhouse gases, stakeholders from industries in the US argued for lower targets based on economic grounds. US leaders can often gain power by appeasing powerful groups (Fuchs et al., 2016), such as those industries with an interest in diluting environmental outcomes at Kyoto. Government interests in power can then directly clash with what is needed to address environmental issues. In contrast EU stakeholders at Kyoto lobbied for higher targets to reduce greenhouse gases. Lobbying consists of persuasive actions aimed at influencing stakeholders to change their expectations on an issue (Buhr, 2012). By giving a
voice to environmentally sensitive organisations and civil society at Kyoto, higher targets were achieved for the EU. Doh and Guay (2006) even demonstrated that EU stakeholders used an economic argument to do so, the same argument used by the US to reduce targets. Thus stakeholder research has been useful in scrutinising political stakeholders, such as those at Kyoto, and what their lobbying actions achieve. Organisations lobbying for and against policy shifts can block or enable action on environmental grounds (Fuchs et al., 2016). However, stakeholder research has yet to consider individuals and their involvement in lobbying efforts aimed at influencing ES. People could be pivotal in resisting or responding to political influence, so their enacting of ES under political pressure should be scrutinised.

Community stakeholders also help to shape ES, through what they value. Community stakeholders are defined here as groups organised around political or social causes or expectations (Kassinis and Vafeas, 2006). Values held by communities can derive from governing laws, their geo-location or the cultures of community members. Community expectations about the environment are then guided by their values, such as how to provision water; support soil health; or create rules for climate change (Raymond et al., 2009). For Australian miner BHP Billiton, Mayes et al. (2014) showed that aligning to community expectations enabled subsequent environmental actions that held legitimacy. When establishing a new mine, BHP recruited key stakeholder groups to be involved in a consultation process. Community stakeholder groups then helped to balance profit motives of BHP, with what were considered acceptable environmental outcomes. The consultation BHP initiated demonstrated how stakeholder concerns can help shape the implementation of ES. Alignment to community values provides organisations, such as BHP, with a form of social licence to act on environmental issues community groups expect (Owen and Kemp, 2013). Stakeholder research largely focuses on the influence of groups, ignoring internal individuals as part of that process (Touboulcic and Walker, 2015, Clifton and Amran, 2011). This was the
case during the BHP consultation, where groups were engaged rather than individuals (Mayes et al., 2014). The BHP case is symptomatic of the contribution of people to ES remaining unknown. Refocussing on individual stakeholders will show if their actions are important, such as when collaborative consultation is used to develop ES.

People within organisations have a stake in issues addressed by ES by being both employees, and potentially other types of stakeholders. Work routines for ES can then be shaped by values that people derive from their work, or say amongst other influences, a community to which they belong (Bansal, 2003). Their values drawn from a range of sources then frame their personal perceptions of an environmental issue (Banerjee, 2001). As people’s values are subjective, their perception of how an ES should be implemented can be at odds with what other stakeholders expect. For instance, tensions may exist for an employee enacting ES between what they believe as right from a work perspective, and what a community expects (Gond et al., 2015). Still, stakeholder research has not focussed on individuals dealing with multiple stakeholder expectations as ES is enacted, including their own. It would be useful to resolve how people negotiate personal and external expectations, and if that process influences any attempt to reduce environmental impacts.

Stakeholder theory has been useful albeit to predominantly highlight the influence of stakeholder groups, external to organisations implementing ES. What has become clear is that stakeholder groups can enable ES initiatives, such as EU representative groups at Kyoto fighting for climate change policy (Doh and Guay, 2006), or communities defining environmental expectations for BHP mining (Mayes et al., 2014). Stakeholder groups have also been shown to limit actions required to implement ES, like US industry groups resisting goals in Kyoto (Doh and Guay, 2006), or investor concern for profit over the planet (Neubaum and Zahra, 2006). However stakeholder research largely ignores individuals
within organisations, who are stakeholders by default when enacting ES. People may negotiate with stakeholders to achieve environmental impact reductions. Alternatively external stakeholders may dictate how managers behave; markedly influencing to how they enact ES. An overarching sub research question about individual stakeholders then is:

*Who within organisations is needed to enact ES?*

By investigating this question, key internal personnel can be identified who are needed to enact ES. Ideally people within organisations can collectively appease external stakeholder expectations; align actions with their own values; and achieve environmental impact reduction. For people who can do this, enabling resources are also required to help them achieve reduced environmental impacts. In the next section I review research that examines resources deployed by organisations when ES is implemented.

### 2.1.2 Resources used to implement ES

When it comes to implementing ES, resources are necessarily allocated to facilitate the requisite actions. Resource based theory (RBT) proposes that organisations succeed when resources are applied to achieve goals in competitive contexts (Peteraf, 1993). Resources include anything from tools, data, people, infrastructure to knowledge applied. RBT can be used to study how organisations implement strategies, and thus has been used extensively to understand how resources facilitate ES (Montiel and Delgado-Ceballos, 2014). Initially the natural environment was acknowledged as a central resource to an organisation’s operations by Hart (1995). Further RBT research showed that by mobilising resources to implement ES, organisations could be profitable, competitive, and care for the environment (Aragón-Correa and Sharma, 2003, Russo and Fouts, 1997). Nonetheless, scholars have concluded that it is difficult to find research that demonstrates how people use resources when reviewing RBT studies of ES (Aragón-Correa and Sharma, 2003, Touboulic and Walker, 2015). Establishing
if individuals can acquire and deploy resources will show if they are likely to achieve goals set for an ES. Hence more attention on people enacting ES with resources is required.

When designing ES, organisations tie efforts to existing resources to achieve environmental goals. Historically, this approach aims at ensuring new initiatives by organisations succeed by aligning to proven processes (Coopey et al., 1998). For ES, Krause et al. (2009) proposed the internal process, purchasing management, able to achieve both economic and environmental outcomes when integrated with ES. Purchasing management is an established organisational process used to optimise profit, quality and supply chains. Therefore when combined with ES, purchasing provides established resources to also achieve environmental goals. Zhu and Sarkis (2004) demonstrated something similar for 186 Chinese manufacturing organisations. By combining ES to existing quality assurance processes, they achieved ‘win-win’ economic and environmental benefits across their supply chains. Thus scholars have shown that organisations can reorient and combine resources to implement ES effectively. Yet it is not clear how individuals manage such resourcing changes to existing practices. Organisations cannot have confidence when they adjust resources, if they are unaware of how people expected to adapt to changes to enact ES, are affected.

Problems can also arise when organisations recalibrate resources to implement ES. RBT can be used to demonstrate that some resources inhibit goals organisations aim to achieve. As an example, Pullman et al. (2009) showed that economic and supply chain priorities caused problems for 32 US food organisations realigning existing resources to implement ES. Processes were subsequently prioritised to achieve cost minimisation and retain food quality. The same processes were to be deployed for ES, however only local environmental impact issues were addressed, such as land management. This was due to the competing priorities of product cost and quality. Somewhat counter intuitively, processes aimed at achieving
efficiency can also limit environmental goals. For instance for the 186 Chinese manufacturing organisations that improved ES with quality processes, the opposite occurred they applied ‘just in time’ processes (Zhu and Sarkis, 2004). ‘Just in time’ is a method that aims to increase efficiency by keeping manufacturing lean and simplifying processes to do so. Still in simplifying a process used to implement ES, features of the process required to decrease environmental impacts can be lost, which Zhu and Sarkis (2004) demonstrated for the Chinese manufacturing organisations. As the studies above show, RBT can identify when success is likely limited when organisational processes are adjusted for ES. What RBT does not illustrate is how people deal with realigned resources that cause them problems enacting ES. Organisations must be more cognisant of whether adjustments they make to resources limit their personnel in delivering environmental savings.

When new resources are deployed, they have the potential to benefit how ES is implemented. Life cycle assessment (LCA) is a tool now adopted by organisations to help decision making when ES is implemented (Hellweg and Canals, 2014). LCA identifies potential environmental impacts of a product, service or system under investigation (Baumann and Tillman, 2004). Rio et al. (2013) showed that when LCA data is introduced to decision making processes of ES, impact reduction options become more viable as a part of a set employee routine. Further, once LCA data from new tools is used for organisational milestones, goals set for ES can become routine as it has done at Nestlé and Wal-Mart (Verghese and Lockrey, 2012). At Unilever Bocken and Allwood (2012) illustrated the benefits of a process of discourse about product life cycle data, with stakeholders such as suppliers and retailers,. Discussions led to opportunities for ES implementation previously unknown to managers, such as in-store preferences for low carbon products. New resources introduced to people, such as LCA, can prompt them to think of fresh ideas when planning an ES, as was also evident at Unilever (Bocken et al., 2011). However, problems and subsequent
failures to implement ES can also occur when organisations introduce new tools. At Unilever it was found that failures could relate to resources provided, as well as how people use them (Petala et al., 2010). RBT studies do not focus sufficiently on how people handle new tools as they enact ES. Even if new tools show promise, like LCA, more attention should focus on why goals for ES remain elusive for people using such resources.

Resources can provide the foundation for decisions that help ES be implemented. People can make effective judgements by using resources. Yet individuals are often conceptualised as somewhat passive when ES is implemented. For example, with a RBT lens Carter (2005) referred to employees of organisations as ‘gate keepers of knowledge’, that knowledge a resource in itself. Such characterisations ignore the decisions that people make that influence how ES is implemented. Employees may use knowledge to inform action, such as understanding resource capacity required to achieve environmental impact reductions. ES implementation may then have a greater chance of succeeding, by people being well informed through knowledge. Scholars have called for more attention on how people use resources, above and beyond what RBT has shown for organisations (Aragón-Correa and Sharma, 2003, Touboulic and Walker, 2015). A key question about resource use then is:

_What resources assist people to enact ES within organisations?_

Related insights will inform organisations not only about what resources they need to provide, but how to guide those using them. Next I look at another aspect of people enacting ES, how institutions influence them and the actions they take.

### 2.1.3 How institutions guide implementation of ES

While resources provide the means for organisations to act, institutions guide activities performed to implement ES. Institutions have accepted conventions, such as established rules
and norms, that guide the practices of people and organisations (DiMaggio and Powell, 2000). For instance rules are formal expectations, such as legislation and regulations set by governments, which organisations have to abide by as they implement ES (Wittneben et al., 2012). Norms are less formal institutional expectations than rules, shaped by pressures from institutional entities such as markets, professions and society (Scott, 1987). Norms guide organisational behaviour through prescribed expectations of such entities. One prominent strand of institutional theory suggests organisations seek legitimacy by applying institutions that align to stakeholder expectations (Suchman, 1995). Therefore organisations apply established rules and norms so that their practices are deemed acceptable by their stakeholders when ES is implemented (Grob and Benn, 2014). Yet when organisations apply rules and norms it is less clear how people are affected by those institutions as ES is implemented. The way in which individuals navigate institutions is critical to understand if they are to have a chance of enacting ES effectively.

Norms guide organisational behaviour, by framing an expected way of doing things. For example financial expectations exerted by markets, such as achieving ongoing revenue, influence organisations. Carbon pricing, a common ES adopted by organisations that involves revenue generation, demonstrates that normalised expectations can shift the focus from the environment (Böhm et al., 2012). Hence actions aimed at environmental outcomes are affected by established business practices; in this case those that achieve a financial benefit. Wright and Nyberg (2016) focussed on five Australian organisations from the energy, finance, insurance, media and manufacturing sectors, where this was the case. The organisations reoriented the challenge of climate change to ‘business as usual’. Existing norms, such as those related to financial performance, influenced ES much like what happens with carbon pricing. Long held foci on practices aimed at profit prevail and environmental outcomes suffer. Institutional theory can help determine how norms affect organisations
when efforts to implement ES wane, such as in the examples above. Unfortunately, the influence of existing norms on people within organisations tasked to enact ES is not well understood. Identifying how individuals handle problematic norms could be an opportunity for organisations to assist their people to achieve environmental impact reductions.

Whilst norms guide action, rules formally dictate which actions should and should not be taken. In formally checking action, rules used in conjunction with ES can be problematic to how organisations respond to environmental problems. Legislation has been developed like this in the US, blocking organisational action on climate change due to vested interests in the fossil fuels industry (Falke, 2011, Wittneben et al., 2012). Legislated rules have thus limited greenhouse gas reductions. Internal policies within organisations can also restrict action on the environment. The voluntary nature of some policies, such as corporate social responsibility frameworks, can mute outcomes when ES is implemented (Steurer et al., 2005). Corporate social responsibility policies generally balance economic, environmental and social outcomes that organisations attempt to achieve (Slaper and Hall, 2011). However they are also often discretionary. Without consequences to applying them, only limited success can be expected. Brennan et al. (2015) showed such an issue for Australian universities implementing ES. Without policing policies with consequences for non-action or underperformance, universities failed to achieve expected environmental impact reductions. As organisations miss environmental goals, how individuals comply with rules could be decisive to the success of ES. A stronger focus on people and how they negotiate rules to limit or enable how they enact ES is pertinent.

When institutions create barriers to action, they can incentivise some stakeholders to resist an ES altogether. Existing norms can influence organisations to retain the status quo of their operations. Veal and Mouzas (2012) showed that European organisations have lobbied the
European Commission on how carbon trading markets are designed, that limited changes to their operations. The resultant carbon markets did not actually achieve the greenhouse gas reduction to adequately address climate change. Similarly Falke (2011) demonstrated US lobbying practices by organisations resulting in government legislation that has stalled action on climate change. Exxon’s public communications over many decades is one example of lobbying practices on climate change, where ongoing public disclosures resulted in sustained delaying of action (Supran and Oreskes, 2017). So organisations have engaged in practices linked to rules and norms that work directly against ES implementation. Institutional theory shows the influence that existing norms and rules can have so that ES is resisted. Nonetheless, the role of people within organisations when institutions stymie actions required for an ES is not well articulated. By focussing on individuals more, it will be evident how they can respond to problematic institutions, and whether they can enact ES, or not.

An important function institutions also serve is to guide ES implementation toward success. For instance the UN and EU used norms to force the aviation industry to address climate change in Europe more effectively (Buhr, 2012). Norms had progressed over time in Europe, so that climate change was broadly acknowledged by society as a problem that needed action. Also, political will to act on climate change had developed. Hence social and political norms had evolved to allow for the justification of new rules requiring aviation emission reductions with carbon pricing. The aviation industry was then compelled to act on addressing climate change. Nevertheless, the actions of individuals that led that ES to succeed for aviation were not evident in the European example. People may have driven aviation transformation by identifying opportunities as a result of social and political norms shifting. They could have shaped changes by actively engaging in the institutions that led to such a transition. The aviation example serves as a case for a stronger view of individuals’ relationship with institutions as ES is implemented. This leads to the following sub-research question:
What rules assist people to enact ES within organisations?

When norms enable or rules guide actions for an ES, understanding how individuals subsequently behave is beneficial. Organisations will then be able to set rules or instil norms to assist personnel when ES is implemented. Next I summarise my review of dominant theories applied to ES thus far, and propose how to better articulate the way people enact it.

2.2.4 ES insights from previous theories

Research of ES, reviewed above, has mostly drawn on stakeholder, institutional and resource-based perspectives (Montiel and Delgado-Ceballos, 2014, Touboulc and Walker, 2015). That research has focussed mainly on an institutional and organisational level issues, rather than issues relating to individual people. To clarify, Bronfenbrenner (1992) proposed a model of environmental systems that can be used to differentiate social levels that interact with one another. The ‘macrosystem’ level is made up of larger societal, governmental and ecological systems. Organisations operate as a ‘mesosystem’ level, of which individual people are a part. An ‘exosystem’ consists of other ‘mesosystem’ groups, such as external organisations to an organisation of interest. People within an organisation operate within the ‘microsystem’, often referred to as an ‘individual’ level of concern (Hahn et al., 2014a). For the most part, previous research has focussed on macro, exo or meso level aspects of how ES is implemented. Attention to the ‘microsystem’ is key if people enacting ES are to be understood (Clifton and Amran, 2011).

Figure 1 visualises the social levels that previous research domains have addressed for ES. Literature has demonstrated the resources organisations use (Krause et al., 2009, Pullman et al., 2009, Aragón-Correa and Sharma, 2003), rules and norms they apply (Falke, 2011, Wittneben et al., 2012, Böhm et al., 2012), or what stakeholder groups influence (Kassinis and Vafeas, 2006, Neubaum and Zahra, 2006, Mayes et al., 2014). Interactions between
social levels when ES is implemented has also attracted attention (Hahn et al., 2014a). For instance within the ‘macrosystem’, Whiteman et al. (2013) articulated efforts to build a more sustainable society by ‘mesosystem’ organisations working together to prevent environmental impacts in the ‘macrosystem’. Such investigations still predominantly focus on higher levels of interaction than that of individuals. As previously mentioned, Clifton and Amran (2011) showed that stakeholder theory defaults to a view of powerful groups influencing ES. In a review of supply chain management aspects of ES, Touboulic and Walker (2015) illustrated that research using stakeholder, institutional and resource based theories focused on organisations and external stakeholder groups. Gaps remain between higher level influences and people, represented by dashed arrows in Figure 1. People in the ‘microsystem’ are not examined, nor are their interactions with resources, institutions or stakeholders. Further scrutiny of these factors is required if people enacting ES are to be supported.

Figure 1 - Dominant theories at systemic levels for past examinations of ES
How people navigate larger social systems when enacting ES requires more attention. The way individuals use resources to reduce environmental impacts is not clear. How people balance stakeholder concerns remains debatable. Institutions that guide people when ES is implemented have lacked oversight. Next I review research focusing more on individuals to form a basis for understanding how people enact ES, through the agency they apply.

2.3 ENACTING ES THROUGH AGENCY

Agency is crucial to how people enact ES and associated goals achieved. Agency involves the judgements, actions and routines that people do for any set purpose (Emirbayer and Mische, 1998). The purpose of an ES is to reduce the environmental impacts of organisational activities (Papagiannakis et al., 2014). Judgements made by people then interplay with that purpose. Once decisions are made, people take action to achieve environmental impact prevention. Giddens (1984) describes routines as repetitive actions that people perform, that may be aimed at set goals. When appropriately developed or directed, routines can help facilitate action that lead to ongoing benefits for the environment (Naranjo-Gil, 2016). For instance, continuous improvement tasks for energy efficiency can be the focus of ES (Wittneben et al., 2012). By making continuous improvement for ongoing energy efficiency routine, compounding greenhouse gas reductions can result. The interplay of the various aspects of agency influences how people enact ES, and how successful they are at it.

Research domains have emerged that help understand aspects of agency as ES is implemented, through decisions (Hahn et al., 2014b), institutions (Wright et al., 2012), and actions that occur (Bocken and Allwood, 2012, Etzion et al., 2017). I review these research domains that include elements of agency next. I define what is already known, and what is not known that may further an understanding of how people enact ES.
2.3.1 Judgements made prior to enacting ES

One aspect of agency is the judgments made by people to work out what actions they should take to enact ES. They apply cognitive frames to make such decisions, about environmental issues to be addressed by an ES (Hockerts, 2015). Cognitive frames are the structure and content of thoughts that people use to make decisions (Hahn et al., 2014b). Cognitive frames research then provides some understanding of the mind-set used by managers to apply agency, before they act. By investigating cognitive frames that determine judgements made by people, some progress can occur in comprehending why goals remain elusive when ES is implemented. Yet, empirical cases of cognitive frames used by managers to enact ES are still not widely developed. Without example cases, cognitive frames research has not progressed beyond theoretical options for decisions available for people. Hence it is unknown if the cognitive frames managers apply, lead to routines resulting in ongoing environmental impact reductions, or not.

Various cognitive frames are available for managers that shape how agency is applied to an ES. A business case frame is a mind-set where managers retire options for goals for and ES at odds with other business goals (Hahn et al., 2014b). Business aims other than those aimed at the environment, such as financial goals aimed at maximising profits, control how decisions are made with a business case frame (Hockerts, 2015). Resultant environmental goals are then compromised with other elements of a business case. Thus a business case frame is not ideal for ES, in that it can limit what environmental impact reductions managers can achieve.

Alternatively, paradoxical cognitive frames allow managers to balance conflicting organisational aims whilst ES is implemented. By applying paradoxical cognitive frames, managers accept tensions between environmental goals and other factors of a business case (Hahn et al., 2014b). Managers may then consider the interconnectedness of environmental
and other business objectives, to act on them collectively (Ahn, 2016). Therefore paradoxical cognitive frames show promise for managers to achieve environmental impact reductions.

Accordingly, cognitive frames research links managers’ thought patterns to their choices made from alternatives available for ES within organisations. Beyond their judgements, cognitive frames research can lack oversight of the practical mechanism of agency, being action. Linking judgements to resultant action would likely enrich cognitive frames investigations. Then organisations could gauge what people think, their judgements, and how they act, or their routines over time. Subsequently they could equip personnel with the necessary rules and resources to make both the right decisions, and act on them effectively. Next I look at how institutions, such as rules, shape agency applied when ES is implemented.

2.3.2 Enacting ES through influential institutions

People apply agency with reference to institutions that guide their behaviour. Firstly, institutions contain norms that influence practices applied to ES. Some attempts have been made to understand norms that affect people and their practices as they enact ES. For Canadian oil and gas organisations, Gond et al. (2015) detected perverse employee practices in relation to environmental problems. Engineering employees believed that, as leaders in their field in oil exploration, their actions on projects were legitimate. Beliefs were based on norms derived from their profession, because they were implementing exemplary engineering outcomes for oil exploration. Jennings and Zandbergen (1995) previously noted the notion that by being ‘embedded’ in institutions affects people, their thoughts and their behaviour profoundly. Canadian engineers demonstrated that by being embedded within their profession, dominant norms markedly influenced their achievements even when practices had a negative influence on the environment (Gond et al., 2015). Nevertheless, sparse examples are available of how norms affect people when enacting ES. As for the Canadian engineers,
routines deriving from being embedded in institutions are significant, and shape how ES is implemented. Norms need better clarification as to how they affect the agency people apply. Norms beneficial to how people enact ES can then be cultivated by organisations. Attempts can be made to restrict or modify norms that limit their progress.

Institutions can also restrict the actions people need to take. If institutions conflict with actions to be taken, people struggle to enact ES. For example, 36 managers in Australian and global organisations used multiple identities and narratives to deal with set institutions whilst managing ES (Wright et al., 2012). Multiple identities consist of personalities that managers choose to project to stakeholders, depending on a stakeholder’s interest in the implementation of ES. Multiple narratives are different stories that managers use to engage one stakeholder to another. Wright et al. (2012) showed compromises occurred when the managers referenced norms that conflicted with what was set out for an ES. Compromises included less substantial action than was required by an ES, like taking staff on a tree planting day rather than transforming the carbon intensity of a supply chain. Some managers, who refused to change their narrative or identity to suit conflicting norms within their organisations, capitulated to the point of resigning. Therefore, rather problematically, institutions influenced managers to either give up, or to construct narratives and identities that compromised how ES was implemented. Wright et al. (2012) showed that a focus on norms that affect people is useful, however, such research is rare so more attention is required. Institutions can challenge people and the way they enact ES. Their agency, though judgments and action, might help achieve environmental impact reductions in spite of such challenges.

Institutions may challenge people taking action, but agency can help them resist so that they can achieve goals they set to achieve. Research has revealed that for people enacting strategies other than ES, institutions can affect their actions to the point of resistance (Hallett
and Ventresca, 2006, Scully and Creed, 1997). For instance in a formative case of embeddedness, Strauss et al. (1963) revealed medical staff selectively ignoring or applying rules designed by hospitals to implement better quality patient care. Rules that staff applied derived from norms they drew from, defining what they understood effective medical care to be. Thus if not provided space to act as they see fit, individuals can resort to activism to change their situation. In another study, Hallett (2010) showed how teachers pushed back against orders to apply conformity and accountability to their practices within schools. Teachers did so because of norms that framed how they perceived improved educational outcomes for their students should happen, that were counter to the new rules. In both the medical and educational cases above, people made judgements to resist institutions that organisations saw fit to apply. Similarly, people involved in ES may have a need to act in a similar way to medical and teaching staff above. They may need to redefine work contexts in spite of institutions dictating otherwise, so that ES can be implemented in the process.

Institutions may also help in enabling people to act. Whilst not an ES case, McPherson and Sauder (2013) show in their study of a US drug court how practitioners’ agency is present in their selection and use of multiple institutional logics. They found that actors draw upon logics as tools, and do so “in a contested environment to influence decisions, justify activities or advocate for change.” (McPherson and Sauder, 2013: p.167). For instance, entrepreneurial managers developing platforms for the emerging ‘sharing economy’ (Grinevich et al., 2017) have been shown to use institutional logics flexibly to enact ES. By combining economic and social logics together with ES, outcomes resulted that integrated environmental benefits successfully. In effect, institutions can act as a tool to leverage when people enact ES.

People can apply their agency to change situations, and shape the routines they deem necessary to perform their role within organisations. Still, the interplay between institutions
and personnel enacting ES is still not well established. Institutions should be positioned to allow personnel to address environmental issues. When institutional barriers exist, it is unknown if people within organisations apply their agency to resist or reorient them. Determining if people can challenge institutions will help demonstrate if they can enact ES, or not. Next I look more closely at the actions people take when organisations implement ES.

2.3.3 Actions taken as ES is implemented

As ES is implemented, action is the practical mechanism by which people apply agency throughout the process. The concept of ‘robust action’ helps describe social contexts that allows the application of agency to enact ES (Ferraro et al., 2015). In robust action, ‘participatory architecture’ defines conditions where many stakeholders can collaborate together on environmental issues. ’Multivocal inscription’ describes the resonance of an ES to a range of perspectives stakeholders hold. Multivocal inscription also aligns somewhat to common knowledge between people enacting an ES (Boks, 2006, Pascual et al., 2003); where everyone involved understands what is required to reduce environmental impacts. Finally, ‘distributed experimentation’ occurs in robust action, when many stakeholders in multiple places tackle a common environmental problem. The robust action concept is helpful then in linking agency and the social context under which an ES is implemented. However, robust action does not often focus explicitly on people, and elaborate on the components of agency they apply, or under what conditions. Without considering people, issues that they face when enacting ES cannot be supported or addressed by organisations.

Conditions under which actions are taken can affect how successful or otherwise people are when enacting ES. Robust action is good for characterising social contexts that either enable or block agency and how ES is subsequently implemented. For wind technology used as a renewable source of power, Etzion et al. (2017) compared the success of Denmark to failures
in the US. The Danish industry flourished. Many stakeholders participated in technological change, with clear goals set and understood for a successful national wind power industry to be developed. On the other hand, US organisations applied restrictive and secretive management procedures when developing wind technology. They did so with the premise of driving competitive advantage. US industry failed in comparison to their Danish counterparts who applied an open, robust action model. In another example, Etzion et al. (2017) investigated the potential for non-prescriptive reporting to benefit how ES could be implemented. With a flexible reporting process, organisations were less constrained so that they had the space to drive changes required to reduce environmental impacts. Thus robust action helps show how organisations may design social contexts, such as open collaboration channels or flexible reporting processes, to manage environmental challenges they face (Etzion et al., 2017, Ferraro et al., 2015). Still robust action research remains focused on organisations, rather than the people. Robust action that acknowledges individual agency may be useful to support employees and their actions through considered management decisions.

Various research lenses have been used to examine cognitive influence on actions people take action on environmental grounds within organisations. Sense making research is useful because meanings people use to act and interact with others can be explored, rather than looking at their actions without any cognitive context (Basu and Palazzo, 2008). As an example, 52 Finnish employees from an energy and financial company respectively were asked about how they sense environmental reporting (Onkila et al., 2018). They either considered reports as useful for internal change and/or external stakeholder engagement, or useless due to a range of deficiencies. For these employees, how they made sense of the role and nature of reporting influenced whether they, and in turn their organisations, could shift toward more effective environmental approaches. In another study, people were observed sense making in their sustainability efforts within the Dutch pig supply chain (van der
Heijden and Cramer, 2017). Supply chain stakeholders used various forms of collaboration, communication, and action to enact ES. In particular by making sense of information and situations they were in, important actions were taken such as building new relationships, applying novel financing models, and restructuring barriers to new practices. As a result, long term transformation to more environmentally conscious farming was realised. It is evident, sense making research illuminates important aspects of the meanings people use that shape their thinking to enact ES.

Human resource management, being processes organisations deploy to influence behaviour and action of their people, has also been used to study the cognitive side of people enacting ES (Renwick et al., 2013). For employees of a Chinese subsidiary of an Australian packaging company, when their work tasks were appraised, behaviours were more likely to be influenced company policy and processes due to human resource management (Dumont et al., 2017). For non-core work which was less to policed and rewarded, employees’ environmental values played a larger role in shaping how they enacted ES. Therefore human resource management research is useful in determining how much agency someone has, or how much they rely on structural factors. It can demonstrate if people are more likely to be controlled by routine, or can take action on the basis of their own set of values.

Action by people within organisations can also be at odds with goals set out within an ES. Petala et al. (2010) revealed managerial actions did not match organisational expectations detailed by an ES within Unilever. Product managers from the marketing discipline did not take responsibility for environmental concerns as expected, across product categories. They delegated responsibility to engineers, based their perception of environmental action was part of an engineering remit. Product managers applied agency in doing so, although not for the benefit of environmental outcomes. Engineering delegates were not empowered to take
actions as their managers were, or to modify their routines to do so. Also, product managers and engineering delegates expressed opinion when interviewed that environmental initiatives were low priority within Unilever anyway. Environmental initiatives had also not been well communicated by the organisation, or embedded the practices of employees. Therefore Petala et al. (2010) demonstrated failure to implement ES can be based on the interactions and attitudes of people involved. Insufficient power afforded to people tasked to act, as well as power of those determined not to contribute, was critical. The Unilever case provides a clear example of the value in looking at the role that people involved in ES do play. More cases may confirm that people capitulate when an ES is not easy for them, or their priority.

Supporting people with resources can enable them to apply agency when they enact ES. During later research at Unilever, the benefit of an ES process open to a range of stakeholders of product development was examined (Bocken et al., 2011). The stakeholders participated in the development and piloting of a tool that assessed ideas for ES initiatives. Participants collaborated in generating ideas under brainstorming rules which dictated that all ideas would be considered without fear of judgment. Cross disciplinary groups worked well together, Bocken et al. (2011) demonstrating that the open, collaborative approach fostered a range of new ideas. Solutions to environmental issues generally required many stakeholders to contribute to actions that followed. An open and collaborative process resulted in ES initiatives that were to require cooperation, a characteristic that Petala et al. (2010) had showed was seemingly lacking in other parts of the business. Further investigation may confirm open collaboration affords people agency to enact ES as it did for Unilever.

Actions that people take can be guided even more formally by the structure of an ES. Bocken et al. (2012) discovered that in another context at Unilever, managerial practices were dictated by rules and resources. Environmental considerations were embedded in stage gate
processes used to scope ideas early in product development. Consequently the agency of managers observed by Petala et al. (2010) to resist action on tasks was limited, by tasks designed into ES now being a requirement of managers. Rules dictated that environmental issues had to be considered as a part of normal product development routines. Bocken et al. (2012) also noted the ES was strengthened by coupling it to a business case, in assessing how difficult implementation may be. Hence a relationship between ES and other drivers of early product development were established, so that project delivery was made easier. The mix of rules that not just limit issues at odds with ES, but that result in routines for those enacting ES to achieve environmental impact reductions, needs further clarification.

The studies of Unilever combine individual perspectives of agency with the various social structures people interact with. Social structures consist of rules, resources and norms that people draw upon (Giddens, 1984). The relationship between agency and social structures was either beneficial, or limited what needed to be achieved. A structure-agency lens then assists establishing problems people experience when enacting ES. A question then is:

*Why are structure and agency important when people enact ES?*

Investigating agency and social structures in an integrated way will reveal how people behave in response to rules, in dealing with norms, and when deploying resources to enact ES. To this end, in the next section I explain a conceptual framework developed for my PhD that draws on structuration theory (Giddens, 1984). My framework considers social structures affecting people’s actions, and vice versa, so that agency as ES is enacted can be the focus.

**2.4 STRUCTURATION AS A LENS TO VIEW ES**

The role of people and their agency remains underexplored for ES. Organisations subsequently lack the knowledge to enable individuals to achieve goals set out for ES.
Structuration theory assists here, in focusing on the relationship between social structures and agency (Giddens, 1984). Structuration connects what people think, resources they use, rules and norms they abide by, and actions they take within organisational contexts. When people take action they effectively enact their agency (Giddens, 1984). Their agency is determined by how purposeful or unconscious they and how social structures influence them when they act. That relationship is visualised in Figure 2, being a ‘structure-agency’ lens to view ES. More specifically, a ‘structure-agency’ lens reveals how ES is enacted by people within organisations, by way of the social structures they draw upon to apply agency.

**Figure 2 - Visualisation of structuration theory, adapted from Giddens (1979)**

Giddens (1979) proposed that social structures consist of systems of signification, legitimisation and domination within organisations. Systems of signification determine how people make sense of information and help them communicate. Systems of legitimisation guide socially accepted actions, those that are considered normal. Systems of domination prescribe how people wield power or are controlled through rules and resources. People are, therefore, affected in how they interpret information, comply with norms, and use or succumb to power...
respectively. How people handle these three dimensions of social structure can determine whether they can apply agency or not when ES is implemented.

Social structures enable or inhibit agency, thus structuration theory is apt in explaining if people can enact ES effectively, or not. People may act as ‘expected’ in the workplace according to norms they apply when an ES is implemented. They may also take action to effect change to rules and resources used for an ES. Structure then is both the medium and result of action (Giddens, 1984), represented by the double-ended arrows in Figure 2. The resultant structure of a previous action affects any new action. A new action in turn influences new structural settings, and so on. Structuration can then reveal how people use agency to restructure their organisations, when required. In this way a ‘duality of structure’ exists, where structure is both the mechanism to apply, and result of, agency. Next I further detail the mechanisms within social structures that determine if agency is feasible for people.

2.4.1 Social structures that enable or constrain agency

People are enabled or constrained through social modalities they use. Social modalities are mechanisms within social structures that guide or facilitate action when ES is implemented. Therefore, social modalities either assist people to apply agency when enacting ES, or not.

Facilities are social modalities consisting of rules and resources, used by people to take action (Giddens, 1984). For example, a new policy for environmental impact reduction may be applied as a rule for all employees within an organisation. Power is wielded by those initiating and enforcing the rule. Those abiding by it are controlled by the same rule, so that environmental savings are achieved. The action of applying the policy shapes systems of domination (Willmott, 1981), so that people control or are controlled by rules. Power can also be exerted by the use of resources, such as tools and processes. People have varying levels of access or capacity to use resources that are available within organisations. Consequently,
whether people have the authority or mastery of facilities influences agency they can apply. Alternatively, they may be constrained so that they cannot use resources, and in turn fail to achieve goals they are required to achieve. Identifying the mix of facilities that constrain or enable people will show whether they are likely to be successful when enacting ES.

Actions that people take are governed by norms, which are social modalities derived from institutions (Giddens, 1984). People sanction their behaviour against norms when they enact ES within organisations, such as changing the way that they act at work because of norms. A change could be facilitated by personally held beliefs, such as wanting to improve professional conduct by reducing environmental impacts. The change in behaviour could also be affected by norms external to individuals, such as conduct considered correct within an organisational culture. So norms shape systems of legitimation, from standards that are expected of or are held by people within organisations (Willmott, 1981). Investigating how norms govern behaviour as ES is implemented - is pertinent. Structuration can reveal if norms help or hinder people to enact environmental savings.

Actions are also informed by interpretive schemes, which are social modalities that help people derive meaning from information (Giddens, 1984). People convey information in various ways, such a discussion, body language, electronic data, or written documents. For instance, conversations, drawings and numerical data may be used in a meeting to communicate objectives set out in an ES. People at that meeting may apply interpretive schemes to understand those communications. They interpret that information into sense (Weick, 1995), to be meaningful to their work (Willmott, 1981). Thus information flow, and the ability of people to understand information, affects how they enact ES. If people communicate and make sense of information effectively, ES is more achievable.
As people take action, they apply mental judgements to decide how to act. Hence Giddens (1979) noted that social structures are not only external to a person, but consist of their memory traces. People use knowledge they retain to make decisions. By taking the time to think about their decisions, people have the capacity to evaluate their situation more critically (Giddens, 1984, Winch, 1990). They can then better apply agency, by reflecting on action before taking it, as ES is implemented. Understanding what people think as well as how they act provides a comprehensive view of their agency. Structuration provides the basis to understand if individuals have the agency to think and do what is required to enact ES.

As people enact ES, social modalities connect people to external social structures. People use thought processes to simultaneously consider and implement actions. Previous theorizing of the ES process has considered these aspects of agency separately. Cognitive frames research has conceptualised mental judgements as a precursor to actions delivering environmental impact reductions (Hahn et al., 2014b). Robust action research has detailed external influences, such as institutions and resources, on actions taken for ES (Etzion et al., 2017). However when structuration is applied; norms, resources, rules, information and thoughts are considered collectively to explain agency used to enact ES. Structuration paints an integrated picture of cognitive and physical components of agency, and what characteristics help people succeed when ES is implemented. Throughout this section it has become clear that social structures enable or constrain people and their agency. In the next section I conclude the chapter by showing how structuration can assist in articulating how people enact ES.

2.4.2 Structure and agency interact to affect how ES is implemented

Structuration theory can draw attention to people, and if they can apply their agency for good outcomes for the environment. The theory can demonstrate what rules and resources they may use in order to implement ES. Structuration can also be used to determine if people have
the cognitive capacity to enact ES. Alternatively, the theory can show if agency is constrained so that business as usual is inevitable. Using structuration makes it clear if people can act for environmental causes with the social structures they encounter.

Hence the structure-agency relationship is the focus of my research of ES. I developed a conceptual framework in order to investigate the interaction between agency and social structures (from Figure 2) when ES is implemented. The framework, Figure 3, includes actions (see yellow arrows) related to activities commonly performed by organisational personnel, include planning, implementation, review, and refinement tasks (Thompson et al., 2008). The red arrows represent an effect on social structures from those actions, or effect of social structures on actions. Figure 3 also includes the social levels relevant whilst ES is actioned (from Figure 1). Throughout my PhD I used Figure 3 as a conceptual framework to examine the relationships that influence how people enact ES.
Figure 3 – *ES conceptual model: Strategic sequence (Thompson et al., 2008) consisting of action and social structure (Giddens, 1984)*

For actions that are taken for an ES; Figure 3 frames when social structure and agency interact. Understanding how people apply agency is required if organisations are to have a chance to succeed at implementing ES. People may convey information on ES projects, with good information interpreted well or incorrectly. Then actions can fail to achieve the intended outcomes. Norms can dictate behaviour of organisational personnel that allow for or block the actions required to deliver environmental benefit. Personnel can also use power to
navigate rules and master resources for both positive and negative effect. Therefore when ES is implemented, all of the above aspects of agency lead to the question;

*How do people act within organisations to benefit the environment?*

With structuration, an integrated agency based perspective of ES can be developed. The theory is a lens to view people, and establish their ability to enact ES. In Chapter 3 I detail the methodology I used to conduct my research to that end.
CHAPTER 3: RESEARCH METHODOLOGY
3.0 INTRODUCTION

My research examines how people enact environmental strategy (ES) within organisations. That focus was established in Chapters 1 and 2, where I highlighted the lack of clarity about people and the agency they apply whilst ES is implemented. Hence my research is guided by the set of research questions that emerged from Chapter 2. The questions are included in Table 2 below.

Table 2 - Sub research questions framing my PhD

<table>
<thead>
<tr>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>What resources assist people to enact ES within organisations?</td>
</tr>
<tr>
<td>What rules assist people to enact ES within organisations?</td>
</tr>
<tr>
<td>Who within organisations is needed to enact ES?</td>
</tr>
<tr>
<td>Why are structure and agency important when people enact ES?</td>
</tr>
</tbody>
</table>

In this chapter I detail how I conducted my research to answer the questions in Table 2, with an overview of the methodology I employed for my PhD. In line with Saunders et al. (2009) my methodology consisted of defining a guiding philosophy, my approach, the research strategy I applied, and then the data, cases and analysis methods I used. The cases for which my research was conducted are summarised in tables within this chapter. Issues of research quality in relation to answering the research questions are also covered throughout, relating to rich rigor; credibility by way of thick description; multivocality; and sincerity in my results by way of transparency and self-reflection (Tracy, 2010). I also completed my research co-researchers/ authors. The contributions of each researcher in the research process are stated in tables contained in Appendix 2. I conclude the chapter by summarising the limitations of the research. Limitations provide guidance on how to consider research results appropriately as related to the context in which they were generated (Saunders et al., 2009). Overall this chapter provides deep insight into my methods, and how they affect my findings.
3.1 INTERPRETIVE RESEARCH PHILOSOPHY

Researchers apply philosophy to frame how reality is defined and knowledge is sought when examining a research problem (Denzin and Lincoln, 2018). The nature of knowledge developed is then based on how reality is considered for a context researched. Scholars have provided extensive detail on the strengths of one philosophy over another when used for research (Saunders et al., 2009, Lincoln et al., 2018). Three common philosophical positions and related attributes when applied for organisational research are summarised in Table 3.

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Positivism</th>
<th>Interpretivism</th>
<th>Pragmatism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ontology (treatment of reality)</td>
<td>Objective (tangible) and single</td>
<td>Subjective (socially constructed), multiple</td>
<td>Objective and subjective, single and multiple, chosen to fit research</td>
</tr>
<tr>
<td>Focus</td>
<td>What is representative in a general context</td>
<td>What is unique in a local context</td>
<td>What is locally specific and/or representative</td>
</tr>
<tr>
<td>Outcomes</td>
<td>Predicting phenomena from theory, explaining related observations</td>
<td>Emergent understanding/description of phenomena, building theory</td>
<td>Explain, predict and/or describe phenomena</td>
</tr>
<tr>
<td>Axiology (treatment of values)</td>
<td>Rigid separation of researcher and their values from research</td>
<td>Value bound, as researcher interacts and participates in research</td>
<td>Values used for results when researcher adopts subjective views (or both objective and subjective)</td>
</tr>
<tr>
<td>Epistemology (knowledge used or resulting)</td>
<td>Laws for observable phenomena Facts Precise measurement (time and context/s)</td>
<td>Meanings Relative (time and context/s)</td>
<td>Either/or both objective phenomena and subjective meanings</td>
</tr>
<tr>
<td>Example of outcome</td>
<td>How many people think or do something, or have an issue.</td>
<td>What and/or how some people think or do something a certain way, or have an issue.</td>
<td>What and/or how and/or how many/some people think or do something a certain way, or have an issue.</td>
</tr>
</tbody>
</table>

Note: Adapted from Saunders et al. (2009) and Lincoln et al. (2018)

As Table 3 summarises, different philosophies have unique strengths that make them beneficial to research organisations. Positivism is beneficial to make predictions about organisations using existing theory (Saunders et al., 2009). One objective reality exists for positivism, external to what people experience (including the researcher). Observable
phenomena are measured to confirm or discount predictions (Lincoln et al., 2018). General relationships then develop, to explain what organisations do in the world.

Interpretivism frames reality as defined by social constructions of people within or outside of organisations (Lincoln et al., 2018). Social constructions are mechanisms and phenomena created and used by people that include language, consciousness, and shared/ personal meanings (Myers, 2008). Specific aspects of understanding develop through the subjective way in which people apply or are influenced by social constructions. Meaning about research problems then centres around what individuals do and/ or what they think.

Pragmatism is beneficial in combining objective and subjective elements of a problem depending on the aim of the research (Saunders et al., 2009). Pragmatism helps both explain observable and measurable aspects, and/ or describe meanings contained within organisational contexts that relate to people. General, specific, or combinations of the two types of knowledge result, depending upon what the researcher is focussed on understanding.

As Chapter 2 explained, people are affected by what they use, such as tools and rules, or what they think when taking action. Yet scholars reviewing ES have noted very little research has focussed on individuals, even as organisations struggle to achieve environmental impact reductions (Clifton and Amran, 2011, Touboulic and Walker, 2015). My questions in Table 2 specifically focus on how people interact with social structures and apply their agency when enacting ES. As such, the philosophy I adopted for my PhD was interpretivism.

According to interpretivism, individuals use social constructions that in turn shape their realities (Lincoln et al., 2018). Social constructions that people use are helpful to describe how they enact ES. For instance, managers make mental judgements before taking action (Hahn et al., 2014b). Thus consciousness is the social construct shaping judgements people
make cognitively for an ES. Managers also communicate amongst one another to decide what actions to take (Pascual et al., 2003). Language is then a social construct influencing decisions as people communicate about tasks for an ES. By scrutinising what people experience, the way they enact ES can be understood from within the social context of organisations. Therefore an interpretivist philosophy is appropriate in relation to my research.

In summary, interpretivism enabled me to investigate people, their social contexts within organisations, and their realities that framed their actions. I could then ascertain if people could reduce environmental impacts, or not, within their working contexts. In the next section I detail an approach I applied that suited my research problem.

3.2 INDUCTIVE RESEARCH APPROACH

With an interpretive philosophy, I applied an inductive approach to examine people enacting ES. Various approaches were available for the context in which my research problem occurs.

Deductive approaches are designed to test proposed hypotheses developed from previous theory (Åsvoll, 2014). Knowledge develops by way of empirical experiments in order to extend current understanding or propose new theoretical directions.

Alternatively, abduction is a form of reasoning where a preliminary hypothesis is applied to a phenomenon that is unclear (Charmaz et al., 2018). Abduction is often used when an issue cannot be explained directly by previous theory. This approach is helpful when the hypothesis is explored, through which the problem is then understood (Åsvoll, 2014). Fragments of prior knowledge or theory are applied to frame the hypothesis. That knowledge can be transformed or confirmed as the research process is conducted.
Induction is an approach where emerging themes are crystallised as research progresses, without a prior hypothesis (Creswell and Poth, 2017). It can provide insights on which theories can be built, as themes are refined from data in the field (Gioia et al., 2013). Activities within organisations conducted by individuals for ES have lacked attention, where the focus has been more on influential resources used, stakeholder groups, or institutions (Touboulc and Walker, 2015). Induction then was an approach well suited gain deep insights about agency, when little theory or information existed about people enacting ES by applying agency. Therefore induction was applied to generate an understanding of people and how they applied agency throughout the ES process.

By applying an inductive research approach per Forman et al. (2008), themes were uncovered progressively as I examined ES. For instance, at my first two research sites I collectively investigated what and how resources may be required to implement ES. Still, data from these sites were inadequate in revealing why people had capacity or otherwise to enact ES. As such, in further research of these sites I focused on a broader range of social structures affecting people enacting ES over more tasks. Thus as Creswell and Poth (2017) explained, my understanding evolved as themes developed between cases I scrutinised. Also by applying induction, I redirected my research to data that were relevant to those themes that developed, based on findings from previous cases (Creswell and Poth, 2017). For example, the first two research sites I studied revealing resources used by people to successfully implement ES, were revisited again later as a collective case study. The new case analysis scrutinised the influence of rules, norms, resources used, and interpretations applied, as a set of practices. Structure and agency became the focus of the new analysis, refining how people and their actions were understood.
In summary, induction assisted me developing an understanding of how ES is enacted as my research progressed. I could be flexible with an inductive approach to revise and revisit themes that emerged from my cases as new data or understanding came to hand (Forman et al., 2008). Then I could redirect efforts to clarify themes emerging across my research sites (Creswell and Poth, 2017). Next the strategy that I used to organise my approach is described.

**3.3 CASE STUDY RESEARCH STRATEGY**

I adopted a case study strategy for my research (Yin, 2017). Using case studies I could collect data from specific research sites in which people enact ES. Thus cases assisted me to systematically analyse data relevant to my research questions (Saunders et al., 2009). I needed data about the thoughts and actions people applied when enacting ES. A case study research strategy was helpful to acquire these types of data. Organisations historically plan tasks for people to undertake, and resources to use, to achieve organisational goals (Hofer and Schendel, 1978). Activities commonly enacted by organisational personnel include planning, implementation, review, and refinement tasks (Thompson et al., 2008). Hence when people enact ES, their actions occur in relation to the tasks they participate in. Four cases covering tasks performed when ES is implemented provided enough data about people and their actions, each of which are summarised in terms of the criteria used to choose them in Table 4.

Apart from tasks, cases were selected where personnel enacting ES could be examined. I also wanted to capture any similarities or differences to how individuals enact ES, between different types of organisations through the cases. By identifying similarities between different types of organisations, I could start to develop themes with cross organisational to industry sector applicability (Creswell and Poth, 2017). Any differences, between similar or different types of organisations, would show that there are also specific organisational based issues that need to be considered when people enact ES. Therefore using different types of
organisations for my cases were beneficial specifically, and more broadly. Finally cases selected were from industry projects or contexts in which I had participated in, or had access to. I mention access as a matter of transparency, because not all organisations are agreeable to researchers observing them (Tracy, 2010). Therefore data were collected from organisations who agreed to participate in my research, about what people used and achieved in various tasks performed to enact ES. I developed five individual research artefacts, listed in Table 4, to examine the specific cases I had selected. The research artefacts consisted of four peer reviewed journal articles and one edited book chapter (Chapters 4-8).

Table 4 - Summary of cases

<table>
<thead>
<tr>
<th>Case</th>
<th>Tasks for ES</th>
<th>Case participants (people to observe)</th>
<th>Artefact linked to case</th>
<th>Case comparability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undergraduate eco-design course</td>
<td>Implementing, reviewing and refining tasks within an organisation</td>
<td>- Students - Technology personnel - Academic staff</td>
<td>Article 1 (Lockrey and Bissett-Johnson, 2013)</td>
<td>University/ business organisations enacting/ learning ES tasks, where people and their actions can be compared to similar/ different organisational cases</td>
</tr>
<tr>
<td>Planning for ES for aged care organisation</td>
<td>Planning the development of ES within an organisation</td>
<td>- Aged care personnel - Consultants/ academic experts</td>
<td>Article 2 (Clune and Lockrey, 2014).</td>
<td>Business/ university organisations enacting ES tasks, where people and their actions can be compared to similar/ different organisational cases</td>
</tr>
<tr>
<td>Review of ES used in new product development sector</td>
<td>Planning, implementing, reviewing and refining tasks for organisations within an industry sector</td>
<td>- Researcher - People/ organisations in reviewed literature</td>
<td>Article 3 (Lockrey, 2015)</td>
<td>Business/ government/ NGO organisations enacting ES tasks, where people and their actions can be compared to similar/ different organisational cases</td>
</tr>
<tr>
<td>Government program for new product development using ES</td>
<td>Implementing, reviewing and refining tasks during and following an ES being enacted</td>
<td>- Researcher/s - People/ organisations involved in program</td>
<td>Article 4 (Lockrey et al., 2016)</td>
<td>Government/ business/ organisations enacting ES tasks, where people and their</td>
</tr>
<tr>
<td>Case</td>
<td>Tasks for ES</td>
<td>Case participants (people to observe)</td>
<td>Artefact linked to case</td>
<td>Case comparability</td>
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<tr>
<td>----------------------------------------------------------------------</td>
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</tr>
<tr>
<td>Undergraduate design engineering course; and planning for ES for aged care organisation (both revisited cases)</td>
<td>Planning, implementing, reviewing and refining tasks within organisations</td>
<td>- Students - Industry personnel - Consultants/ academic experts</td>
<td>Book chapter 1 (Lockrey et al., 2018)</td>
<td>University/ business organisations enacting/ learning ES tasks, where people and their actions can be compared to similar/ different organisational cases.</td>
</tr>
</tbody>
</table>

Actions taken on tasks for ES are diverse, because of the various people who enact them, and contexts in which they occur. Following Yin (2017), four cases facilitated enough coverage of the boundaries of my research problem; people enacting ES through various tasks within organisations. Multiple cases also helped me extract evidence from different sources to scrutinise my research problem from a number of angles as per Schwandt and Gates (2018). By comparing multiple cases, similarities and differences about my research problem were identified. For instance in all of my research artefacts people used life cycle assessment (LCA) tools and design methods when enacting ES. Yet Book Chapter 1 was developed partly to provide further clarity about different ways people used LCA to inform their actions. Therefore cases were beneficial to provide nuanced examples of people enacting ES, by clarifying “many different issues, according to the nature of the problems the investigator sets out to illuminate” (Giddens, 1984 p. 327). I developed a deep understanding about people, their sentiments, their interactions, and any behaviours that were occurring (Woodside, 2010). Cases used in my research are further detailed in Table 5, starting with a brief case description and how long the case lasted,
In the next sections I expand on the settings of my cases described in Table 5, in relation to each specific research artefact. I describe the procedures I used to access cases, the research participants, and what each case contributed to my research.

### 3.3.1 Case for Article 1 - ES implementation and refinement tasks

In order to observe what occurs as ES is implemented, I first examined an undergraduate eco-design university course for Article 1 (Lockrey and Bissett-Johnson, 2013). The eco-design course was aimed at training students to design products with reduced environmental impact, with the help of university staff and an external industry partner (IP). Whilst not an employee-organisation based case in a pure business context, the course was still relevant for my research. Students learned how to design under an ES framework, whilst their designs...
were made available to inform the actions of industry partner in business beyond the course. I had a case to observe various people enacting ES that I could compare to different types of organisations, such as purely business contexts. The case assisted in developing both cross organisational/ sector themes (Creswell and Poth, 2017), as well as specific research insights.

My co-author and I chose the case because we could observe and interact with people from two organisations, a university and an IP, as the ES was implemented. Thus, this was action research, as we participated actively in the case (Swann, 2002). Action research involves researchers actively observing as well as intervening in contexts under study (Gaziulusoy et al., 2016). We monitored other participants, as well as reflecting on our own involvement and actions whilst enacting the ES.

We also chose the eco-design course as a case because it was repeated through a series of semesters over four years. The case could be monitored as people managed and modified tasks they participated in over that time. Therefore, people were observed longitudinally (Tsang, 2014). That way anything that remained the same, or changed, over multiple iterations of the ES was identified. For instance we could observe if resources used in the eco-design case were ever modified due to problems encountered on tasks by students. With these characteristics, we had a case combining ES implementation, feedback and refinement tasks for Article 1. In a longitudinal context we could then asked the question;

*What resources assist people to enact ES within organisations?*

Students used tools and processes to produce eco-designs; so we could observe resources used to enact the ES process. Students also interacted with the IP, which provided an external influence on the tasks they enacted. Article 1 was then characterised as a cross disciplinary new product development (NPD) team enacting an ES with resources and external influences.
That context is consistent with previous micro level case studies of ES during NPD, to which we could compare our results to (Petala et al., 2010, Bocken et al., 2012, Bocken et al., 2011).

### 3.3.2 Case for Article 2 – Planning an ES

Organisations plan ES, so that personnel know in advance what tasks and resources they need to apply to achieve environmental improvements. Thus for Article 2 I reviewed such a context, where a team planned for ES processes (Clune and Lockrey, 2014). Article 2 was a single case study of a major Australian aged care organisation preparing an ES over six month time horizon. Observations were made over a shorter period that the eco-design case, as planning requires less time than the other tasks, such as implementing or refining ES.

My co-author and I chose the aged care case, because we had access to observe and interact with a range of people working together in the planning phase of an ES. For instance environmental impacts from aged care operations were quantified by external experts. They then worked with internal and external personnel to design a plan aimed at reducing those impacts through a series of workshops. Like Article 1 we used action research, since my co-author and I also participated in and contributed to planning (Gaziulusoy et al., 2016).

As Bocken et al. (2011) demonstrated, constructing a plan to tackle environmental issues can benefit from a range of disciplinary expertise. Similarly, in the aged care case input was contributed from executive management, operations, nursing, food services, and finance. We also monitored external experts in sustainability, engineering and design (including ourselves) who participated in planning workshops. So during planning, the connection between people enacting ES from organisational departments, and externally, were the focus. As a result, we could compare differences internal and external influence had on the ES.
Also aspects of social structure were considered; whether they were design tools or collaboration methods used to plan. Therefore, we looked to answer the question;

*What resources assist people to enact ES within organisations?*

People were observed as they proposed options for ES through the resources they used, including their navigating any issues that arose. For example, LCA was applied to identify aged care practices where most environmental impacts were occurring in aged care. Design methods were used to determine what to do about practices with high impact. Subsequently, we could identify resources that assisted in planning, and how people from different disciplines collaborated to frame a resultant ES.

### 3.3.3 Case for Article 3 - ES enacted within an industry sector

NPD is historically a prominent industrial context where organisations implement ES, leading to the marketing of environmental credentials of products to external markets (Charter and Clarke, 2008, Baumann et al., 2002, Peattie, 2001). Hence as per Finfgeld-Connett and Johnson (2013), a systematic review was conducted in Article 3 about ES enacted within the NPD sector (Lockrey, 2015). The review sought to establish the role that resources play for various disciplines implementing ES for NPD projects.

The resource of interest for my review was LCA, a prominent scientific tool used to measure environmental impacts (Hellweg and Canals, 2014). That decision to concentrate on LCA was because it is a tool that can be selected for various tasks enacted for ES in NPD. Thus the case was chosen to examine departments, their interactions, and common tools and processes they employed (Atuahene-Gima and Evangelista, 2000). The question was then asked:

*What resources assist people to enact ES within organisations?*
Whilst enacting ES with tools, particular disciplines and the social position they command can shape their actions (Bansal, 2003, Wright et al., 2012). My review of ES within the NPD sector specifically scrutinised marketing, and their interactions with other disciplines to determine the aspects of power involved (Griffin and Hauser, 1996). Marketing was selected due to the growing influence and power of the discipline within organisations (Goldman and Grinstein, 2010). Management, sustainability, engineering and design personnel were also considered, because those departments generally interact during NPD (Mishra and Shah, 2009). Power wielded by disciplines, through for instance the use of tools, or their organisational role, was assessed in relation ES. The way in which powerful people access tools to excel at tasks, or to inhibit others, was also considered. I looked to find out;

*Who within organisations is needed to enact ES?*

Thus people, and the routines and actions they partake in within organisations, were the research focus. Planning through to refinement tasks involved with ES were scrutinised. In addition, some external influences were examined, such as government legislation (Rex and Baumann, 2007), markets (Pickett-Baker and Ozaki, 2008, Thirkell, 2012) and supply chain partner’s stake in the ES (ECRM, 2010). In summary, the review collectively investigated people performing tasks, with resources, whilst dealing with external factors in enacting ES.

### 3.3.4 Case for Article 4 - Outcomes and after-effects of ES

Organisations implement ES with particular aims, the effects of which can be felt well beyond goals are achieved. Although actions taken for aims set out by ES may have obvious consequences, they may also have unforeseen ramifications afterwards. Therefore Article 4 reviewed outcomes and after-effects of an ES (Lockrey et al., 2016). A similar industry context to Article 3 was chose for the case, however this time a critical reflection of an NPD program was conducted. Critical approaches can challenge preconceived notions of an issue

EcoRedesign was selected as a case, as it was an Australian Government funded ES run by RMIT University from 1994-1997. During EcoRedesign, government assisted NPD partners with funding and resources to reduce the environmental impacts of their products and services. The purpose of the critical reflection was to examine the effect of resources, rules and the structure of the EcoRedesign program on achieving environmental benefits, and on the people involved. As such we looked to answer the questions;

*What rules assist people to enact ES within organisations?*

*What resources assist people to enact ES within organisations?*

Investigation of cross disciplinary teams involved in EcoRedesign projects helped us address these questions. Projects during EcoRedesign consisted of these personnel designing and commercialising products with low environmental impacts. The ways management, marketing, engineering and design personnel worked with rules, and resources during NPD were explored. My co-authors and I had access to interact with personnel involved in EcoRedesign, and to archival material from the program. As a result our perspectives on people and their agency were grounded in the experiences of those who directly participated in EcoRedesign.

Observations were made about EcoRedesign from when it was implemented, refined, and after it concluded. Thus our reflection took a longitudinal view (Tsang, 2014). With a longitudinal view we also sought to define effects on participating personnel and organisations, decades after EcoRedesign finished. For instance, we considered personnel
contributing to projects after EcoRedesign, to gauge if they could enact positive environmental change in their later career trajectories. Also, external influences were reviewed, such as government policy and market conditions, were also assessed. Hence our research encapsulated implementation and feedback tasks, with external, organisational and individual influences on EcoRedesign, and after it concluded.

3.3.5 Case for Book Chapter 1 - Agency and social structures shaping ES

Finally, I took a specific focus on the interaction between structure and agency as people enacted ES within organisations. By doing so I sought clarity about themes that had emerged from my first four research artefacts. With my co-authors, we applied structuration to examine agency and social structures shaping ES (Lockrey et al., 2018). My previous four research artefacts had uncovered the ‘what’, ‘how’ and ‘who’ of organisations implementing ES. My co-authors and I now aimed at explaining ‘why’ actions played out in particular ways as people use agency to enact ES. We asked the question;

Why are structure and agency important when people enact ES?

To answer this question we chose to re-analyse and combine the eco-design and aged care cases from Articles 1 and 2 respectively. This was because collectively the two cases provided us access to the range of typical tasks performed when people enact ES.

Our research included external, organisational and individual social levels interacting as ES was implemented. Therefore we could investigate agency in terms of both the interactions people have within their organisations, and with externalities. As an example, in the eco-design case the students, university staff and an IP interacted with each other. They did so within a formally constructed but circumscribed setting, a university course. A range of tools were used so that design ideas were proposed, analysed, discarded or refined. Alternatively in
the aged care case, executive management created a flat power structure with new tools available to be used for the planning context. That structure was a departure from previous hierarchy for aged care employees, consisting of set roles and responsibility. Collaborations with external experts were also a new initiative that was introduced to planning for the aged care ES. It signalled another change to the social structures aged care personnel had to deal with. So our study framed the agency of participants through their interactions with each other, external people, rules they followed, or resources they leveraged. We could scrutinise those relationships, to determine if they assisted people to deal with environmental problems.

In summary, my cases provided visibility of people and the social structures they accessed when ES was implemented. Each case and connected artefact helped me answer specific research questions I sought to address, as I have detailed in the sections above. Those research artefacts and related question/s are summarised in Table 2.

Table 6 - My PhD research artefacts, and research questions that they answered

<table>
<thead>
<tr>
<th>Artefact linked to case</th>
<th>Sub research questions addressed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Article 1 (Lockrey and Bissett-Johnson, 2013)</td>
<td>What resources assist people to enact ES within organisations?</td>
</tr>
<tr>
<td>Article 2 (Clune and Lockrey, 2014)</td>
<td>Who within organisations is needed to enact ES?</td>
</tr>
<tr>
<td></td>
<td>What resources assist people to enact ES within organisations?</td>
</tr>
<tr>
<td>Article 3 (Lockrey, 2015)</td>
<td>What rules assist people to enact ES within organisations?</td>
</tr>
<tr>
<td>Article 4 (Lockrey et al., 2016)</td>
<td>What resources assist people to enact ES within organisations?</td>
</tr>
<tr>
<td>Book Chapter 1 (Lockrey et al., 2018)</td>
<td>Why are structure and agency important when people enact ES?</td>
</tr>
</tbody>
</table>

In the next section I look at data I collected to determine how people enacted ES, within my cases.
3.4 RESEARCH DATA

From the cases I investigated, I collected data to help establish how ES was enacted by people within organisations. Many data from multiple sources can be used to articulate scenarios that people participate in, when ES is implemented. By using multiple sources and types of data, I could construct rich accounts of the ES process (Weick, 2007). New understandings of agency used by people could then emerge, through the data I gathered.

My research was conducted primarily with qualitative data, summarised in Table 6. In this section I expand on Table 6 to describe the variety of data I used. I also convey the ‘rich rigour’ embedded in my research design (Tracy, 2010). I do so by demonstrating how I used multiple data to ‘show’ rather than ‘tell’ insights that emerged as ES was being enacted.

<table>
<thead>
<tr>
<th>Artefact</th>
<th>Data</th>
</tr>
</thead>
</table>
| **Article 1**  
(Lockrey and Bissett-Johnson, 2013) | Qualitative  
Observations (notes 2 pages), student design project outcomes (x 35 team projects), course surveys (22 over 3 years), industry feedback (x 20)  
Quantitative  
LCA results (x 35 team projects), course surveys (22 over 3 years), industry feedback (emails x 2) |
| **Article 2**  
(Clune and Lockrey, 2014). | Qualitative  
Observations (5 pages of notes), workshop material (11 x A3 mind maps, 30 x post-it notes), project report, photos, industry feedback (emails x 3)  
Quantitative  
LCA results (project report) |
| **Article 3**  
(Lockrey, 2015) | Qualitative  
Literature (from 149 sources)  
Quantitative  
Literature (from 149 sources) |
| **Article 4**  
(Lockrey et al., 2016) | Qualitative  
Semi structured interviews (x 3), reflection (notes 7 pages), ES material and literature (from 35 sources) |
| **Book chapter 1**  
(Lockrey et al., 2018) | Qualitative and quantitative  
As above from Article 1 and 2 |
Data I was interested in collecting included information about and from people from my cases, as detailed in Table 5. Therefore, ethics is relevant as to how a researcher relates to people participating in research. Ethics for interpretivist research acknowledges the relative aspects between humans, their interactions within, and understandings about the world (Christians, 2018). How a researcher interacts with research participants and relevant data is then framed by that ethical view. Research ethics approval on that basis was sought from RMIT University. A plain language statement was developed to provide potential external participants in my research. The statement explained what the research was about, how their data would be used, and measures to protect data. It also described their rights as a participant during and after the research was conducted. Ethics was subsequently approved by RMIT University, the approvals included in Appendix 3. I applied the procedures from the ethics application regarding participant rights and data as I accessed my research cases.

Various data were collected. Firstly, I observed events that took place at my research cases (Hammer et al., 2017). Following Emerson et al. (1995) I recorded observations of said events by taking field notes, about features of ES that stayed the same, changed, worked, and did not work. I also conceptualised what those characteristics may have meant for people enacting ES. To do so I followed the initiation of an account detailed by Dey (2003) in using accessible data, reading and annotating notes of data from contexts observed. My co-authors and I also noted our own involvement and action within the ES, and how we may have influenced outcomes (Gaziulusoy et al., 2016).

Secondary data were also used within my research. Written correspondence, documents, and materials generated during tasks performed for ES were collected. I had access to these data as a participant in many of my research contexts, as well as archival material at RMIT University. These secondary data were useful to compare insights and validate what we had
recorded in our observations (Gioia et al., 2013). For instance, in Article 1 and Book Chapter 1, annual course briefs demonstrated tasks, rules and resources included in the ES that evolved over time. Qualitative student and industry feedback described how ES was implemented. These multiple data provided evidence of what people were thinking and doing. As per Weick (2007) such data comparisons helped us build further richness to our accounts, in our case of actions taken by people enacting ES.

Secondary data were also used for Article 3 when literature sources were collated in a systematic review as described by Finfgeld-Connett and Johnson (2013). I did so to bring together the various previous explanations of ES in the NPD sector. Data gathered consisted of a combination of qualitative and quantitative information deriving from a number of databases. Sources included ProQuest, Google Scholar, Scopus & Science Direct (Elsevier), Wiley Online Library (Wiley), Emerald Management Xtra (Emerald). Some 149 relevant articles were identified. Although some databases extended as far back as the 1880s, searches were conducted from 1990 onwards. Timing of this sort coincided with when ES started to become prominent and cited in NPD literature sources. Search terms were employed to identify literature relevant to how people enacted ES. Data were identified to examine further when search terms appeared in either the article, abstract or title. Relevant data about NPD and marketing used with ES was then collated, and investigated further.

For Article 4 my co-authors went further, supplementing secondary data with a suite of stakeholder interviews (Brinkmann, 2018). Four stakeholders involved with EcoRedesign were invited to participate in one-hour long interviews. Subsequently, three semi-structured interviews were conducted for an hour each, consisting of five prompting questions about the impact of the EcoRedesign program. Interviews provided a good representation of EcoRedesign stakeholders, as only a handful of projects were conducted during EcoRedesign,
each consisting of small cross disciplinary teams. Stakeholders across teams and projects
during EcoRedesign were interviewed. The interviews were held during 2015, and conducted
via telephone, or in person. Interview observations were also recorded in note form. A written
response to initial questions was also provided by one stakeholder. Coding and data
interpretation were conducted manually due to the small sample size and volume of data
collected. Resultant data consisted of stakeholder observations of EcoRedesign, detailing how
they and others acted during and after the ES concluded.

Interviews conducted for Article 4 were semi-structured to allow stakeholders to provide data
describing their recollections of ES. Following Brinkmann (2018), in being semi-structured,
anything interesting occurring that stakeholders were aware of, or divulged, about how ES
was enacted, could be noted. Stakeholders contributed personal reflections, regarding why
outcomes, successful or otherwise, occurred as ES was implemented. Reflections also
involved them assessing the thinking behind actions taken as ES was enacted. Their
assessment of the contribution of ES to organisational aims of reducing environmental
impacts was also recorded. Additionally, stakeholders interviewed identified why some
outcomes and stakeholders had continued to be relevant to future projects and career
trajectories. By drawing on multiple perspectives in this way we added further richness to our
account as detailed by Weick (2007), and account of agency applied and consequences
following and ES,

Some quantitative data were relevant to explain aspects of agency applied in implementing
ES. In combining and comparing qualitative insights and quantitative data (Eisenhardt, 1989),
more dimensions of ES became apparent. In Article 2 initial LCA benchmarking calculations
demonstrated the potential to implement environmental savings from the actions proposed for
aged care. Financial data also provided evidence of how actions may be implemented over
the life of the aged care ES. Additionally, anecdotes from workshop observation helped identify reasons why combining environmental and economic aspects of aged care may assist ES being successful. Quantitative data provided detail of what economic and environmental actions achieve. Furthermore, qualitative data revealed how and why related goals may be achieved. Thus multiple data, mostly qualitative and some quantitative, helped me to clarify why structure and agency are important when enacting ES. In the next section I show how I analysed my data. As Yin (1992) explained, synthesis of multiple data enables explanations of research phenomena to became more representative. Subsequently, with multiple data my analyses could produce clarity about how people enact ES, and what that means for achieving environmental goals.

3.5 ANALYSIS METHODS

A number of methods were applicable to analyse data I collected to understand how people enact ES. I applied multiple analyses to data from contexts where ES occurred. My selection of methods depended on the context where each of my research projects took place. Methods were matched to the various data and sources I accessed, summarised in Table 7.

<table>
<thead>
<tr>
<th>Artefact</th>
<th>Analysis methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Article 1 (Lockrey and Bissett-Johnson, 2013)</td>
<td>Note taking of observations (Hammer et al., 2017), comparison of observations and secondary data from project cases to develop meaning of contexts with co-authors (Dey, 2003), member checking to clarify or refine meaning developed (Tracy, 2010)</td>
</tr>
<tr>
<td>Article 2 (Clune and Lockrey, 2014)</td>
<td>Note taking of observations (Hammer et al., 2017), comparison of observations and secondary data from project cases to develop meaning of contexts with co-authors (Dey, 2003), member checking to clarify or refine meaning developed (Tracy, 2010)</td>
</tr>
<tr>
<td>Article 3 (Lockrey, 2015)</td>
<td>Systematic literature review from 149 sources (Finfgeld-Connett and Johnson, 2013), descriptive analysis using pre-theoretical coding framework (MacInnis, 2011)</td>
</tr>
<tr>
<td>Article 4 (Lockrey et al., 2016)</td>
<td>Note taking during interviews (Gioia et al., 2013), comparison of interview data and secondary data from project cases to develop meaning of contexts with co-authors (Dey, 2003), member checking to clarify or refine meaning developed (Tracy, 2010)</td>
</tr>
<tr>
<td>Book chapter 1 (Lockrey et al., 2018)</td>
<td>Descriptive analysis (MacInnis, 2011), using the ‘Nine Ps’ from Brennan et al. (2015) as a coding framework, member checking to clarify or refine meaning developed (Tracy, 2010)</td>
</tr>
</tbody>
</table>
With the methods in Table 7 I then generated insights about how ES was implemented, to inform theory and practice. I expand on my research analysis methods summarised in Table 7 in the sections below.

### 3.5.1 Articles 1, 2, and 4 case analysis methods

For Articles 1, 2 and 4, my co-authors and I analysed and compared the various data deriving from each research case (Tracy, 2010). We documented our observations separately both during and following actions occurring for each case in which ES was implemented. Observations were made in an action research mode (Swann, 2002). Therefore we participated by observing, acting during, and reflecting on the cases selected for Articles 1, 2 and 4 (Gaziulusoy et al., 2016). By being participants we had first-hand experience of different roles we and others took for ES, and the resources available and rules defining actions taken. For instance for Article 2 we were external experts supporting aged care staff in their planning of ES. We had to acknowledge for this case we influenced decisions and actions by way of expert advice through the use of life cycle tools and design methods. Thus reflexivity was required, as we were not only researchers, but participants within research cases. As Tracy (2010) suggested, self-reflexivity is applied to make sense of what is occurring, including the role that we as participants play. For all cases where action research was used and I was a participant, reflexivity was key to separate I did, what I sensed, what others may have experienced, and then what that all meant. Thus we then worked through our separate recollections together to determine whether what we had documented collectively made sense. Thus we applied a measure that ensured what had been observed and sensed aligned between researchers and other case participants (Taylor and Lindlof, 2002).
Collectively we developed descriptive analyses of ES cases in Articles 1, 2 and 4. We did so by connecting our observations to documents, correspondence survey data, and other data from the research cases (Coghlan and Shani, 2014, MacInnis, 2011). For example for Article 2, mind maps, post-it notes, and system drawings were generated whilst the aged care ES was developed. These data were compared to observations, to determine how the ES progressed by those participating in aged care planning workshops. Our description of people enacting the ES development was then made credible by confirming details from a number of angles. In Article 1, quantitative data in the form of numerical student satisfaction rankings and project grades provided detail of what students experienced and achieved due to structure-agency relationships. However, qualitative data from written survey responses from students articulated why course changes had empowered them sufficiently to design good environmental outcomes. So our description of student achievements and changes to the course was validated by comparing a range of perspectives.

Following Coghlan and Shani (2014), for Article 4 we developed a written reflection connecting observational data to secondary EcoRedesign material such as reports and newsletters. The dimension of how EcoRedesign was enacted by people remained incomplete by only looking these data. Hence semi structured interviews were carried out (Brinkmann, 2018). All of these interviews were undertaken solely by me, or by me with another researcher. Only 3 interviews were conducted, however this was judged as sufficient. There were only around 30 participants in the EcoRedesign program in total, and the 3 interviewees represented the range of disciplines and organisations that participated. Quotes captured from interviewees were included in our descriptive analysis, complementing document analysis and observations made throughout our research. A multi-vocal quality then developed in our account as described by Taylor and Lindlof (2002). The account was narrated by multiple people involved in EcoRedesign voicing what they experienced occurring. For instance, one
interviewee explained the direct correlation between their EcoRedesign experiences to their sustainability work in the following decades. Another noted the market conditions and organisational tensions affected the program. Yet another critiqued the focus on product development, rather than capacity building of people during EcoRedesign. As these individual perspectives show, personal anecdotes provided richness to our account of people enacting ES that would have been difficult with only secondary data.

In summary, for Articles 1, 2 and 4 credible accounts about how ES is enacted developed by analysing a range of data. In this way new insights of ES resulted, reflecting nuanced aspects of the interplay of social structures, agency and people.

3.5.2 Article 3 analysis methods

The NPD sector provided a unique case to demonstrate how ES is enacted for Article 3. As per Finfgeld-Connett and Johnson (2013) I undertook a systematic literature review to analyse extant research. My review followed Baskerville and Vaishnavi (2016) by using a pre-theoretical framework, where data were arranged using three key lenses. My lenses were selected to investigate the organisational context (Pettigrew, 1979), LCA use as a tool (Baumann and Tillman, 2004), and environmental marketing as an outcome of NPD projects (Peattie, 1992). My framework was developed through abductive reasoning from these lenses (Åsvoll, 2014). The framework was a representation of the context and relationships organisations use to deploy ES was understood prior to the literature review commencing.

As Finfgeld-Connett and Johnson (2013) suggest I systematically arranged data, for my review by using my framework. I specifically focussed on the role of people, and tools they use while ES is implemented. I developed a descriptive analysis to arrange related concepts that I discovered from literature sources (MacInnis, 2011). For example, departmental interactions and power struggles that occur between NPD and marketing disciplines were
captured through a range of quantitative studies, mainly based on survey data (Homburg et al., 1999, Atuahene–Gima and Li, 2003, Atuahene-Gima and Evangelista, 2000). Explanations as to how people interact with social structures, such as when they struggle to enact ES due to rules and processes, derived from qualitative studies (Petala et al., 2010). A series of insights resulted, describing how departments deal with social structures in taking actions. Subsequently, my pre-theoretical framework was refined with the insights I had developed, to build further clarity about how people within organisations enact ES.

3.5.3 Book Chapter 1 analysis methods

For Book Chapter 1, my colleagues and I offered a way to articulate how ES is enacted by analysing it with structuration theory (Giddens, 1979, Giddens, 1984, Giddens, 1993). Our analysis was operationalized by using Brennan et al. (2015) ‘Nine Ps’ of behavioural infrastructure as a coding framework. The ‘Nine Ps’ provided categories that helped organise data to show why social structure and agency are crucial to enacting ES.

Interesting concepts regarding agency developed by reading and annotating notes of data from observing people enacting ES (Dey, 2003). For instance, my co-authors and I identified tensions between people whilst we observed them developing an aged care ES. It remained ambiguous as to what those tensions may have meant, or where they derived from. Therefore, further data were sought, such as post-it notes and mind maps from aged care planning workshops. Tensions were confirmed in written material from the workshops; through ideas for ES that some participants thought clashed with organisational practices. As per Tracy (2010), checking our insights with industry participants also assisted in ensuring accuracy in our account regarding tensions during aged care ES planning. By applying such steps we instilled rigour and credibility in our account (Dey, 2003, Schwandt and Gates, 2018).
Written material and conversations were also examined, to explain different perspectives of negotiations between personnel in the development of the aged care ES. As Richardson (2000 p. 934) put it “What we see depends upon our angle of repose.” We chose a range of angles, firstly observing people proposing ideas, and then their arguing about current and new aged care practices. Then a financial plan that resulted for the aged care ES was scrutinised, to determine what agreements were made and compromises reached during planning. As per Dey (2003), this iterative approach shows that we analysed data by moving from immersing ourselves in observations, to revisiting secondary data where required. Hence a rich description following Weick (2007) resulted, by combining various data from different perspectives about people and how they enact ES.

3.5.4 Member reflections to check analyses

As briefly mentioned in the previous section, I applied a key method throughout my research to verify my results. I drew on member reflections to check what I’d observed and synthesised in my analyses. Member checking is applied by “taking findings back to the field and determining whether the participants recognise them as true or accurate” (Taylor and Lindlof, 2002 p. 242). I sought such input by providing transcripts of articles and project findings, at various points of completion, to participating research partners or co-authors. A member checking measure verified that what had been observed and sensed aligned with research participant recollections. This avoided conflict where participants had suggestions on where that understanding may have differed from theirs. I include some of those accounts as a matter of transparency to ensure credibility of the outcomes (Tracy, 2010). For Book Chapter 1, suggestions to improve our description included:

“The key objective of the project is the implementation of the ‘how to design’ for strong design for environment outcomes, falling under the different Nine Ps to
implement this service. As the case study reads now it emphasises the product outcome/s as the environmental outcome, whereas I would argue that it is the ‘learning’ that is the outcome via the undertaking of the project.”

Perspectives about learning during the eco-design course had not been prominent in our original description of the case for Book Chapter 1. Such suggestions, amongst others, provided additional evidence about how agency is applied by people resourced to enact ES.

I also provided an early Article 2 manuscript to the aged care industry partner and other academic colleagues outside the action research. That was important as action research is full of choices (Reason, 2006). So reflecting on our decisions and perceptions both during and in the writing up of our research was required (Coghlan and Shani, 2014). A colleague from Karlstad University suggested that the planning process was not sufficiently explained; this we rectified. The tools and processes provided for planning were specifically linked to what happened in the workshops and subsequent reporting. Actions were then described more succinctly by way of how resources were drawn upon to plan an ES.

Additionally, for an early draft of Article 4 an interviewee emphasised the following regarding external factors affecting the two product cases used in the article:

“The lack of energy rating labelling for small appliances meant people were deprived of a visual benchmark to nudge/inform their thinking environmentally when making a purchase decision.”

Details about market influences then helped us more clearly articulate external factors on achieving goals associated with ES in Article 4. Our refinements particularly related to how these influences led to ES success and failure in light of conditions outside organisations.
In the next section I detail the analytical methods chosen to organise my collective findings. My collective analysis consolidated my explanation of whether people could enact ES to effectively tackle environmental problems faced by organisations.

3.5.5 Analysis methods for collective findings

Findings from each research artefact were collectively analysed using a technique described by Gioia et al. (2013). My collective analysis started with first order data collected for each of my artefacts, data that described how people enacted ES. Second order theoretical themes emerged, each built from multiple first order data confirming how ES was enacted. Related aggregate dimensions were formed by combining second order themes, as to why actions occur as they do for ES. The iterative nature of my collective analysis method meant that I moved systematically from data to aggregate dimensions. My transition from data, to second order themes, to aggregate dimensions are included in Appendix 1. I tabulated transitions from data to aggregate dimensions for each or my research artefacts (Currie and Spyridonidis, 2016). By that process, I developed a nuanced account how people enact ES through agency and structure bedded in data I had collected.

As aggregate dimensions developed, I sought data that confirmed them across the cases I was analysing. Some aggregate dimensions were common across multiple research artefacts. For instance, the importance of the power of particular people and disciplines enacting ES became clear in Article 3. Article 4 was then analysed for more evidence of power playing a part in how ES was implemented during the EcoRedesign program. An aggregate dimension formed describing people embedded in domination structures, and thus affecting them as they applied their agency. Similarly in this way more aggregate dimensions were developed within and between research artefacts describing how structure and agency affect how ES is enacted. I discuss the limitations of my research next.
3.6 LIMITATIONS

In choosing to conduct predominantly social and case based research, there are a number of limitations to my PhD. I was a participant in the contexts which I examined, as is common with action research (Swann, 2002). As such my involvement had the potential to be biased in being framed from my own perspective. Thus there was the potential I could miss key insights deriving from other participants. To counter this issue I included my own perspectives, as well as perspectives from other participants to include the range of views about what occurring in research contexts I investigated. As Saunders et al. (2009) describe, by including human perspective, my research was subjective and value laden. For this reason following Coghlan and Shani (2014) I used reflexivity to compare and reason with perspectives of others, my own views, and other data demonstrating how ES was enacted. However it must be started that my research is not framed as representing one reality where organisations implement ES. Instead I reveal the multiple realities and perspectives people use whilst enacting ES.

My data analyses drew from a combination of primarily qualitative data (Creswell and Poth, 2017). Therefore, I conducted a qualitative and descriptive analysis as per MacInnis (2011), identifying themes that were combined into key aggregate dimensions about how ES is enacted, using methods developed by Gioia et al. (2013). For example, for Article 4 I utilised a small sample size through three in-depth semi structured interviews, with key people involved in the EcoRedesign. Such a small sample size is a limitation in itself, however as previously stated Section 3.5.1 it was deemed appropriate as there were only a small number of participants during EcoRedesign. To build more credibility to the account beyond such a limitation, I also compared interview data with secondary data that had documented EcoRedesign, such as newsletters, reports and literature. People interviewed were then provided the synthesis of those data to clarify their recollections, and further verify and build
richness to my account. Thus although data I collected from people may be considered limited, a range of sources and techniques helped me build a comprehensive and credible picture of ES processes examined. My research does not provide definitive measurements of relationships related to the ES process. My findings provide contextual explanations of how and why ES organisations implement ES.

My research was completed with a number of case studies using Yin (2017), in order to show how ES is enacted. Case studies can be considered limited in that they only provide visibility of phenomena within the bounds of a case site. However for my research I was interested in quite specific data. For instance case selection was important to identify why and how people in specific contexts were enacting ES. So as a limitation that knowledge only resulted about specific cases of ES, it was a key aim of my research also. This limitation was reduced by using multiple cases, to help identify similarities and differences common to ES across contexts following Yin (2017). For instance LCA tools and design methods were commonly used by people to achieve outcomes designated by ES across my cases. A multiple case research strategy then helped build theoretical dimensions detailing those specific resources within and across cases.

I used cases that I had access to, in which people could be examined in what they used and achieved through various tasks performed to enact ES. Organisations are not always agreeable to researchers examining them (Tracy, 2010). This can prove a limitation in itself. It may have also meant only organisations predisposed to success or proficiency deploying ES participated. That was not the case as the EcoRedesign case choice showed through the failures of Kambrook (Lockrey et al., 2016), or where clear tensions between people participating in aged care planning existed (Lockrey et al., 2018). Limitations provide
potential pathways where new research may take (Brutus et al., 2013). I explore those options in Chapter 10.

To sum up, there are issues in achieving environmental goals when people enact ES within an organisation. My five research artefacts were set up to interrogate such problems. The research artefacts I developed were aimed at investigating how people enact ES, and now follow in Chapters 4-8. Following my artefacts I discuss how my research addressed my research questions in Chapter 9. Then I conclude my PhD with the implications and limitations of my research, and an agenda for future research derived from my work.
Designing pedagogy with emerging sustainable technologies

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A B S T R A C T

There is a need for higher education to cultivate deep knowledge and skills in the ever-evolving area of sustainability. This paper explores one strategy for teaching Product Design Engineering students Design for Environment. A critical aspect is the connection between an industry partner, MicroHeat Technologies, who have developed water and energy efficient point of use water heating technology, and undergraduate students from Swinburne University with competencies in both design and engineering. This paper documents how students can explore Design for Environment strategies in a project based learning environment, verifying and quantifying environmental gains throughout the design process from concept to detailed design proposal. Engineering methods such as whole systems design and life cycle assessment were used to better equip these student designers with the tools to quantify the benefits of proposed designs in relation to sustainability. The student group was introduced to the MicroHeat technology, which has the capacity to be at the forefront of Design for Environment, the authenticity of which was used to enhance student engagement levels. The project successes were demonstrated by exceeding the industry partner expectations in terms of the breadth and high resolution of outcomes, detail for manufacture and usability. The student work revealed how higher education tied to industry innovation could prepare students to contribute to curtailing the ecological crisis when based in industry, in this case by integrating credible technology options with effective Design for Environment methodology into the design process and outcomes. These results strengthen the case for educators in sustainability to explore industry-based partnerships for cross-disciplinary student projects, with the course now running for a fourth successive year. In consultation with students and the industry partner, Swinburne staff members continue to refine the curriculum, to improve outcomes both from a project and pedagogical perspective.

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1. Introduction, objectives of the project

Sustainability is a major global issue and as such one of the key drivers in the education of designers and engineers, who will become the sustainability practitioners of the future. This is a timely focus in line with the current declaration from the United Nations (UN) of a Decade of Education for Sustainable Development (DESD) from 2005 to 2014, the birth of which originated through the Johannesburg Plan of Implementation (UN, 2002). As an example of the importance of these disciplines to the production of sustainable products, 70% of the environmental impacts of a product are locked in at the design stage (Lewis et al., 2001). This paper explores one strategy for teaching Design for Environment (DfE) to Product Design Engineering (PDE) undergraduate students utilizing the example of a project undertaken in partnership with Australian technology developer MicroHeat Technologies Pty Ltd.

PDE is a course delivered jointly by the Faculties of Design and Engineering and Industrial Sciences at Swinburne University in Melbourne, Australia. It is an undergraduate course running for 4 years with an optional extra year in Industry Based Learning (IBL) where students are hosted by an industry partner in a work environment. Mandatory design courses run by the Faculty of Design utilize and reinforce the knowledge acquired in the more traditional engineering sciences units run by the Faculty of Engineering. 3rd year PDE students come to the semester long design course reported in this paper with competencies in material science, engineering mathematics, thermodynamics and machine design, and are preparing for the possibility of IBL the year following.

The paper documents how students’ explored DfE strategies through project based learning, verifying and quantifying the potential environmental gains of their designs. The unique aspect of
this project is the connection between an industry partner who has developed an efficient technology, and undergraduate students with competencies in both design and engineering. It has been argued that the engineering disciplines predominately work in the knowledge domain, requiring a focus on the search for one correct answer and engagement within the arena of convergent thinking (Dym et al., 2005). Design on the other hand deals with the conceptual domains (Dym et al., 2005), meaning a focus on searching for multiple opportunities, or for a multitude of alternative answers, thus utilizing divergent thinking as a part of the creative process (Design Council, 2005). This paper explores how these two disciplines can be applied together to a sustainable product design project. It also examines how an industry connection enhanced student engagement and that outcomes exceeded the expectations of this partner.

1.1. Sustainability in the design and education landscape – the project background

From 1900–1995, US raw material consumption per capita increased fivefold and still accounted for around a third of world consumption by weight (Matos and Wagner, 1998). Combined with a tripling of the world population in that time, this becomes alarming with only 15–20% of the world highly developed to a western style of consumption (UN, 2009). As the world population increases and more people move from a developing world to a first world lifestyle, consumption is moving to a more unsustainable level. Manzini argues the model of industrialized society so far can be expressed as “more wellbeing is equivalent to more consumption and less social quality” (Manzini et al., 2008 p. 259). Sustainability appears to be at odds with this model, as it could be argued that the public perception of sustainability means to do without, or to degrade the user experience of the product. Even as the environmental debate has started to become more prominent, consumer purchasing patterns still appear to be detached from sustainability based decision making (Deloitte, 2009, p. 7). A trade-off is that as consumers do not actively engage with sustainability, consumption increases (Tukker et al., 2010; White, 2009). One strategy is to design more sustainable products. Many new products do purport to be sustainable. Whether or not these products are in fact environmentally preferable is debatable and often leads to ‘greenwashing’1 where claims can be often unsubstantiated or spurious (Davis, 1992), disconnected from environmental improvements (Brennan and Binney, 2008), or even void of marketing or environmental philosophy (Peattie and Crane, 2005).

LCA has long been utilized as an objective scientific method to identify environmental impacts of products and services (Heiskanen, 2000) and as such is seen as an appropriate design tool for the MicroHeat design course. Generally the environmental sustainability of products or the environmental credibility of products can be verified with life cycle assessment (LCA)2 within the design process (Vinodh and Rathod, 2010). In industry LCA is often overlooked at the design stage because of limited internal expertise, prohibitive consultant costs, no compliance requirements, or ambivalence from stakeholders (including clients and upper management), often leading to designs poorly considered environmentally (Lockrey, 2011). To make LCA more manageable organizations often use ‘footprinting’ to report on environmental impacts of interest (Cucek et al., 2012) sometimes drawing upon streamlined LCA tools (Schaltegger and Csutora, 2012a). This is the approach taken in the MicroHeat course, using primary data for component masses and use phase resources, combined with secondary data (existing life cycle inventories for materials, manufacturing, and end of life, and existing impact assessment methods) to determine the impacts of student product designs.

New technologies focused on the efficient use of resources can enable designers to design products that radically reduce consumption. An example of the potential for technology to offer impact savings is seen in projects undertaken by Woking City Council in the UK. Woking Council applied an energy efficiency strategy, where the ‘business as usual’ model was reworked in order to fund initiatives with a short return on investment. The savings from these improvements were then re-invested into future energy efficiency projects, where savings became larger, and larger projects became more viable (Thompson, 2007). Such life cycle or a whole systems3 projects have ensued in London and Sydney managed by key personnel from the Woking venture, driving environmental impact savings with innovative economic models whilst maintaining the perceived social fabric of everyday life (Thompson, 2007). In some cases they drastically reduce costs with reduced resource consumption in use (Stasinopoulos et al., 2008). Students are encouraged to take a systemic approach to the designs they produce for the MicroHeat course.

Higher education has in recent times been transitioning to a sustainability focus, in line with the UN DESD (Dlouhá et al., 2013; Müller-Christ et al., 2013), in spite of a parallel stagnation or overlap of global programs slowing moves towards a more sustainable global environment, as evident in the results from Rio+20+ (Tukker, 2013). It has been recently noted and debated within academic forums that this sustainability education focus often requires cross disciplinary expertise (Huisingh et al., 2013; Lozano, 2010), a mixture of technical and creative skills i.e. ‘the sciences merging meet the arts’ (Huisingh et al., 2013), systems thinking (Haemmerle et al., 2012), and effective eco design strategy and tools (Haemmerle et al., 2012).

1 Greenwashing being actions ‘to make people believe that your company is doing more to protect the environment than it really is’ Cambridge Dictionaries Online, 2011. Cambridge Advanced Learner’s Dictionary. Cambridge University Press, Cambridge UK.
2 LCA is the process of evaluating the potential effects that a product, process or service has on the environment over the entire period of its life cycle and is documented in the ISO 14040 series of standards.
3 A whole systems approach actively considers the inter-connections between sub-systems, and solutions are sought that address multiple problems via one and the same solution, or the whole system.
et al., 2012; Spangenberg et al., 2010) such as LCA, with which to train students in effecting positive environmental changes. It has also been argued that it is important for education to keep up with the shift of industry to sustainability based landscape (Desha et al., 2009). These principles and the overarching UN directive on DESD helped guide the framework of the Swinburne MicroHeat course in PDE.

1.2. Water heating technology and where it fits into the Australian market

Australia has increasing resource consumption issues, including in energy and water. MicroHeat is developing technologies that deal with both areas, focusing on the research and development of highly controlled rapid fluid heating technology. The MicroHeat Continuous Flow Electrical Water Heater (CFEWH) relies on the conductivity of water that is energized using inert electrodes (steel with a ‘trade secret’ coating) in the water. A microprocessor controls outlet temperature at high or low flow rates or any input temperature. The system calculates the energy required to heat water to the desired temperature at given flow rates, which can be as low as 1.5 L per minute and is something no other ‘instant’ technology offers due to thermal constraints of heat exchangers. The control and point of use delivery make for a technology promoting significant reductions in energy and water use (VCAMM, 2009).

CFEWH technology is affected by changes to national building code regulation of water heaters. Australian water heaters are subject to limitations through the National Construction Code (NCC), in conjunction with relevant Australian Standards. New regulations aim to phase out the most greenhouse gas intensive water heaters, stating that the greenhouse gas intensity of the water heater should not exceed 100 g CO₂ equivalent per MJ of thermal energy delivered, as determined in accordance with Australian Standard AS4234 (Wilkenfeld, 2009). The two major methods used to heat water in Australia are with electricity and gas. Electricity in Australia is generated primarily from coal-fired power stations, which is greenhouse gas intensive (272 g of CO₂ equivalent released per MJ energy delivered to heat water). Gas, although a fossil fuel, is less intensive (61–65 g of CO₂ equivalent per MJ energy delivered to heat water) (Australian Building Codes Board, 2010). Little consideration is given to either system contexts (particularly acute with hot water storage units or large ring main type systems in apartments or commercial buildings), or ongoing centralized system requirements (such as dead water portions previously heated which cool in pipes, pumping, heat tracing, pilot light or stand by energy).

The new NCC effectively limits the installation of traditional domestic stand-alone electric hot water services, no matter how efficient the overall systems these are installed into are. This is a barrier to MicroHeat in Australia because CFEWH are reliant on electricity that is predominantly generated from brown coal on the Eastern seaboard of Australia. However under the NCC regulations other parts of the domestic and commercial market are open to the application of CFEWHs. Examples are low water use dwellings with one bedroom, apartment complexes, commercial buildings with kitchenettes, and hotel rooms. New regulations also open the possibility for electrical heaters being used as boosters, or top-up products on less greenhouse intensive systems utilizing gas and solar power. CFEWH technology could also be incorporated in electrical appliances, where restrictions are more on energy efficiency rather than on greenhouse gas performance (as they generally use electricity anyhow). Thus the energy efficiency advantages of the MicroHeat technology seem promising in sectors such as small appliances, water heating at point of use and low water usage scenarios.

Drought and climate change have shifted the water debate in Australia so drastically that stringent water restrictions have been applied to households for long periods of time. In the Australian market MicroHeat’s unique technology heats the water at the point of use, and only heats the water required by the user. Currently centralized hot water systems waste water and energy, due to stand by requirements to keep water hot on demand, and dead water losses when consumers turn on taps and wait for hot water (i.e. when hot water storage and supply is remote to the point of use and a portion of the water that was originally hot cools in the pipes when the tap is turned on). Energy lost from standby energy or water cooling in pipes is not accounted for in Australian Standards, with a focus on the initial water heating only. With energy and water efficiency now on the national agenda, these are strengths for MicroHeat to explore.

Now that the water heating industry is facing regulation changes, there is growing demand for a new approach water heating that can offer resource conservation. This coupled with the recognition that higher education institutions need to cultivate students’ knowledge and skills in the ever evolving area of sustainability (Sterling, 2004) make the industry partnership between Swinburne and MicroHeat ideal.

2. Methods — the student design strategy within the design course project

The MicroHeat course was developed around a project based learning strategy and utilized design course techniques that allowed students to build their skills and applied knowledge through direct and collaborative tasks, and elements of experiential learning (Boud and Walker, 1993). The design strategy (Fig. 1) for the course generally follows Sheppard’s characterization of ‘what engineers do’, in scoping, generating, evaluating and realizing ideas (Dym et al., 2005).

The project runs via 2 h weekly classes over 12 weeks, involving around 15–20 teams of 2 or 3 students per semester, completing their 3rd year of PDE. A series of design tasks transition the students through an iterative process from problem setting to preliminary layouts through to 2D and 3D product detailing. At each milestone in Fig. 1, an assessment and review point at the end of each phase, students are asked to reflect upon their proposal and to consider it within the wider social, economic and environmental contexts.

In Fig. 1 the design tasks are listed for each phase of the project, the end of each phase signed by an assessable milestone mapped against Sheppard’s characterization of ‘what engineers do’. The cycling review points shown in Fig. 1 indicate the critical review process that directs students to reflect upon their proposals, and to either confirm or modify their proposals before moving the project into the next phase.

The design strategy begins with a scenario for the application of the MicroHeat CFEWH technology. In the first year that the course ran in 2010 students were allocated one of the following scenarios:

1. Hot water systems servicing low volume user multiple dwellings/amenities (i.e. small systems in parallel or centralized systems for apartments, commercial buildings, etc.).
2. Hot water domestic systems using solar, and boosted by electric hot water heater.
3. Hot water appliances (i.e. kettle, hybrid water heater/boiler, coffee machine).

In the years following 2010 this scope was narrowed to scenarios (1) and (3) only, as scenarios (1) and (2) were identified as similar. The rationale for this was to simplify the project and evaluation process.
After a scenario is allocated to students, they are asked to explore the possible uses of the MicroHeat technology within the boundaries of their allocated scenario in the scope phase. They explore applications of fluid heating from a functional perspective including cooking, cleaning and heating, as well as market perspectives. The CFEWH technology is considered scalable and configurable, which opens project possibilities ranging from products the size of a small domestic appliance to larger scale commercial applications such as multiple gym showers. This problem setting process encourages students to consider multiple solutions via divergent thinking (Dym et al., 2005), and to compare them rather than search to develop the one solution. This open-ended approach differentiates the design course from many of the other subjects in the PDE course, where more convergent thinking is required that focuses the field of enquiry early. This leads to the search for one possible solution (Dym et al., 2005), which is not always desirable when looking for creative solutions to complex problems.

Design methods such as the Feedback Capture Grid (Stanford, 2009) as presented in Fig. 2, are employed to encourage and facilitate reflection in the generate and evaluate phases. Stanford’s method suggests that the Grid is a systematic tool for capturing and critiquing feedback. The Grid depicted in Fig. 2 facilitates students recording their own feedback in a systematic way, across the 4 quadrants. The quadrants suggest new ideas or issues to be dealt with and prove particularly helpful in the review stages before the realize phase depicted in Fig. 1.

The Feedback Capture Grid Fig. 2 enables a feedback process guided by staff. Concept pin ups, where teams pin up or project their work for discussion with the group and staff, are used together with the Grid. These critiques coincide with assessment points or for work in progress reviews in sharing information with the bigger cohort. By documenting their own feedback and critiques on the Grid, students remain engaged in the review process.

The realize phase includes the proposal of ‘in use’ scenarios, which is particularly important for products that consume resources during the use phase of the life cycle, such as appliances (e.g. dishwashers or kettles) that use the majority of their resources, such as energy and water, in operation (Sweatman and Gertsakis, 1997). To determine where the greatest environmental impacts occur, various tools are applied from conceptualization through to detailing for manufacture, discussed in Section 2.1.

2.1. DfE educational scaffold within the design strategy

The educational scaffold as presented in Fig. 3 describes how and where in the design process, DfE thinking and themes were applied to the project. In Fig. 3, the phase names of the project have been modified from Fig. 1, to reflect the relevant DfE objective and activity of each phase. For example scope is retitled as problem setting, evaluate is re-titled as guesstimate (a term referred to by Dym et al.) and realize is re-titled as verification. This educational scaffold represents a combination of DfE, engineering and user centred design techniques.
The series of phases in the educational scaffold defined in Fig. 3 allows students to explore and focus on the ecological elements of the resulting product designs, as well as investigating the economic and social aspects (Fuad-luke, 2007), particularly acute in the problem setting and create phases.

During the create and guesstimate phases engineering methods such as whole systems design (WSD), thermodynamics, machine design, material selection, manufacturing and streamlined LCA are used to better equip student designers with the tools to quantify technical viability and any benefits of proposed designs including environmental impacts. Elements of this type of analysis have been attempted previously in scientific based pedagogy and in industry (Byggeth et al., 2007; Byggeth and Hochschorner, 2006; Gutierrez-Martin and Huttenhain, 2003). However such scaffolding can also be lacking in current frameworks in both engineering/design pedagogy and industry, where methods are often challenging or seen as detached from mechanisms by which DfE can be effectively gauged and implemented (Clune, 2006; Rahman and Post, 2011; Schaltegger and Csutora, 2012b; Vezzoli, 2003).

The design brief encourages energy and water savings as a sustainability value proposition, and the results in section 3 illustrate that usability and user experience are as important to the final product and system proposition as the resource savings offered by the MicroHeat technology. This means that in addition to detailing the product for manufacture, scaling the technology appropriately, and delivering the desired water temperature, student teams also need to develop user centred outcomes that apply to user interactions.

In the guesstimate phase shown in Fig. 3 students are encouraged to use calculations to quantify environmental gains early in the design process. Students initially scope out a broad range of solutions in the problem setting and create phases that are then accompanied by ‘back of envelope’ calculations to estimate the energy and water requirements. The importance of estimates has previously been documented where “good systems designers are usually good at estimation — they can efficiently determine the relative size of physical parameters and identify those that can be safely neglected, at least for specific purposes” (Dym et al., 2005). Most students struggle with this aspect, probably because their engineering training suggested that precision was required. In this case calculations can be approximate and exploratory so as to allow design decision-making to determine and offer guidance as to what could be a feasible direction by comparing a range of options.

During the proposition and verification phases, energy balance, that is a calculation that determines the energy required and lost in a system, is used to obtain the annual energy consumption of the final student product designs. Student teams select and energy balance a competitor to MicroHeat that performs closest to a similar function (including additional energy required for losses associated with water heat drops in storage tanks and pipes, standby heating requirements, lower efficiency considerations, set power ratings, and thermal conductivity properties of insulation). The majority of energy consumption information on competitor products is obtained from commercial literature/specifications. Generally this could be considered a WSD analysis, above and beyond a compliance approach.

The water savings associated with ‘point of use’ designs using MicroHeat are compared to competitor products with water losses, for example water wasted from cooling water in systems such as pipes, or water tipped out of appliances post a heating/cooling cycle. Student teams and staff agree upon a system layout that optimizes MicroHeat are compared to competitor products with water losses, for example water wasted from cooling water in systems such as pipes, or water tipped out of appliances post a heating/cooling cycle. Student teams and staff agree upon a system layout that optimizes MicroHeat are compared to competitor products with water losses, for example water wasted from cooling water in systems such as pipes, or water tipped out of appliances post a heating/cooling cycle. Student teams and staff agree upon a system layout that optimizes

\[ Q = \frac{(c_p V \rho_{water} \Delta T)}{EF} \]  

\[ Q = \text{energy (kJ) required to heat discreet volume (V) of water} \]  
\[ c_p = \text{specific heat of water (J/kg.K)} \]  
\[ V = \text{volume (m}^3\text{)} \]  
\[ \rho_{water} = \text{density of water (kg/m}^3\text{)} \]  
\[ \Delta T = \text{change of temperature (°C)} \]  
\[ EF = \text{efficiency of the water heater} \]

\[ C_p \] is assumed to be 4180 J/kg K and \( \rho_{water} \) was set at 997 kg/m\(^3\) at 25 °C average for all energy calculations.

This series of equations is sometimes adapted to a dynamic equation if flow is involved, and to include phenomena such as insulation heat loss, of centralized systems requiring ‘on demand’ set water temperatures. Generally the direct water heating requirements and standby hot water requirements are determined using Equation (1).

The first time the course ran in 2010, students determined use phase energy from a 10 year product life, the energy consumption converted into greenhouse gas emissions using the National Greenhouse Accounts (NGA) Factors (Australian Government, 2009). This was combined with materials carbon and energy data from Bath University’s Inventory of Carbon and Energy (ICE) (Hammond and Jones, 2008). ICE is a relatively recent and free database of common construction materials, and the amount of
Energy required and CO₂ equivalent emitted to produce those materials.

In later years of the project students were introduced to Greenfly streamlined LCA tool where they used the use phase data for water and energy, and combined with their product design component materials, manufacturing, distribution and end of life waste management data, simplifying the process of assessing impacts of the products they designed over the entire life cycle. Greenfly is a free DfE tool developed for designers to use as a streamlined LCA in the design process. It uses a web interface and database where designers login, model their products, and assess the environmental impacts of those products (from background life cycle inventories and impact assessment for the Australian context).

2.2. Curriculum mirroring industry

The curriculum was designed to mirror an industry project, running with specific milestone phases as per the design strategy and educational scaffold outlined in Figs. 1 and 3. These assessment points put more emphasis on a series of project tasks, rather than on evaluation of the final outcome alone, much like a professional industry project. Each task directs the student team to explore a different aspect of the project, with the outcomes contributing to the design and development of the final product.

From the initial scoping phase of the project, students are required to explore 10 different ways to use the technology presented in sketch form in the generate phase; each team develops an argument to select 3 concepts to be further developed and subsequently more detailed versions of these are generated. This selection criterion includes consideration of DfE, usability, user need and market acceptance. One concept is selected from the 3 conceptual directions at the evaluate phase, refined in another generate phase, and detailed for manufacture in 3D CAD for the realize phase.

The assessable tasks are designed to take the students through both divergent and convergent thinking processes. The final design outcome is detailed as a series of rendered images, CAD files and engineering drawings. Submissions provide points for critical feedback from both staff and industry partners. Several types of design language are utilized to communicate divergent project progress, such as a series of sketches, prototypes, sectional layouts, CAD models and rendered images. Mathematics was utilized early in the design process to aid with convergent design decision making from divergent ideas, an important skill prior to embarking on IBL.

The first time the project ran in 2010, Students were given progressive written feedback from staff on each of the assessable tasks. In later years this feedback and assessment was tabulated in the form a graded descriptive rubric. The curriculum is delivered through a series of two-hour course classes that does not allow much one-on-one consultation on projects, so using design studio techniques such as small group peer reviews (including the Feedback Capture Grid in Fig. 2) helps student teams to think critically about their projects. Some one-on-one discussion is always necessary, especially in the later phases of the project when dealing with highly complex assembly and manufacturing issues.

By focussing on assessment on the process combined with industry partner reviews, students receive realistic feedback of their work, readying them for client interactions on IBL. However, the pitfall of a focus on process is that it requires a consistent effort from students throughout the semester.

Teams that work consistently, meeting the milestones and assessment points throughout the semester, generally present projects that are highly resolved, clearly articulating both the user centred system of use and environmental benefits. The timing of the milestones allows for reflection and an iterative approach to outcomes.

On the other hand, those teams that do not maintain consistent effort do not undertake all the tasks and the resultant artefact is of lesser resolution. Those teams that do not apply a consistent effort often make mistakes in the calculations in the guesstimate phase; these mistakes carry through the project and became evident at the end of the project. The teams that do not work consistently usually achieve lower academic assessment scores as they don’t submit all the tasks; however this is not disclosed to the industry partner, who scores the artefacts independently using their own criteria. Hence a project may achieve a low score from an academic perspective but a higher score from the industry partner, as the criteria and weighting are significantly different. The criteria for assessment used by both Swinburne staff and MicroHeat staff can be seen in Figs. 4 and 5.

Figs. 4 and 5 reveal how education and industry may view the same outcome quite differently. In this project the educational objective is to increase DfE knowledge and its integration and application to a user centred design process. The industry partner is looking for diverse, novel, commercially viable, and innovative applications for their CFEWH technology.

3. Results – examples of student outcomes

When the students’ product proposals were compared to products produced by competitors over a 10-year period, there were energy and water savings across the board. This demonstrated that DfE knowledge had been applied to the project outcome. Some resource savings were to be expected given the efficiency and resource savings that the MicroHeat CFEWH Technology alone offered. However results did not always translate to a greenhouse gas emission savings in the Australian context, as the coal fired electricity distribution system is almost 5 times more greenhouse gas intensive than the gas network. This can be offset by the inefficiency of gas combustion heat exchange and system losses, and will shift as the Australian electricity grid drops (as is already happening) in greenhouse gas intensity with a shift to renewable energy and gas fired power stations. Generally in regions with less greenhouse gas intensive electricity supply and distribution systems such as Europe and the USA, the student designs would appear less greenhouse gas intensive. The Greenfly results also confirmed that the use phase dominated all impact categories, with materials, manufacturing and end of life cycle phases only making small contributions.

The educational scaffold outlined in Fig. 3 also increases students’ awareness of the multiple ways that DfE advantages can be achieved in comparison to existing products and systems. This is achieved by constantly embedding DfE throughout the design process above and beyond energy and water, including concepts such as material selection, design for disassembly, retro fitting, recycling and upgradeability (also facilitated through Greenfly). Below are some of the project outputs.

![Fig. 4. MicroHeat evaluation criteria for the project as a whole.](Image)
3.1. Commercial gym shower, visible consumption creating user accountability

This system was designed to heat water at the point of use for a gym. The student research revealed that if a user pays system was employed, the product would be more attractive to gyms to install. The product interface therefore included a card reader and screen indicating usage and cost for each use. By proposing a user pays interface, the system informed users of their energy and water consumption and made them accountable for their energy consumption and behaviour. In this case the product was designed to be retro fitted to an existing gym, reducing the environmental load of waste in replacing entire hot water systems (Fig. 6).

3.2. Commercial glass washer, saving time, money, water, energy and detergent

This commercial glass washer focused on water saving and instantaneous hot water generation potential of the MicroHeat technology. Commercial dishwashers currently use large volumes of water, detergent and energy and often older heat exchange storage systems and infrastructure, such as boilers. This team proposed that steam could be partially used to sterilize the glassware, making for a quick turnaround glass wash that utilized less water and detergent and offered clear additional environmental gains in this area (Fig. 7).

3.3. Kettle for discreet volume of water at a specified temperature

By looking at current user behaviour, this team proposed that electric kettles are used to boil far more water than is required. This new product proposal heated the water as it was poured rather than statically, so that the exact amount of water that was used was heated. The new kettle heated water with 98% efficiency based on the CFEWH technology, whilst current electric counterparts heat water at a much lower efficiency depending on factors such as water volume in the kettle, heat exchange design and location. A clear window set into the kettle side showed the volume of water in the unit and provided feedback to the user as to the volume required. The display on the top of the kettle indicated the water temperature, which can be adjusted by the user, and provides a real time indication of the actual water temperature (Fig. 8).

3.4. Reimagining ‘Bush Camp’

In this project, the team that undertook this project drew on their experiences in the army reserve. They developed a product that could be used to reheat army rations rapidly. The final proposal involved two heating vessels of differing sizes used to heat different volumes of rations, with a universal lid that contained the battery and MicroHeat technology. The lid also interfaced to a larger communal charging base that could charge multiple lids at the one time. The other advantage of this proposal was the reduction in the amount of fuel and cooking units each soldier would now need to carry to heat their food. The heating vessel could also double as a bowl, removing the need to carry different vessels for heating and serving food (Fig. 9).

3.5. Cottage industry milk production

This project looked at the opportunity to use CFEWH technology as the basis for a miniature milk pasteurizer for the tourism industry. The product took advantage of a technological ability of CFEWH to work with a range of fluids (through inert electrodes) at an accurate, efficient heating dosage, to simulate industrial pasteurization in a bench top unit. This team identified markets that included ‘bed and breakfast’ owners, farm accommodation...
vendors, and hobby farmers that require this process at small scale. The team also looked to simplify industrial scale alternatives, and in doing so made the process of pasteurization manageable at a scale that was suitable desired market, also offering a point of difference (Fig. 10).

4. Discussion – project success and modifications from student and client feedback

Design course projects are often challenging for PDE students, as there is no single answer as per their experience with engineering exams and testing. Diverse outcomes continue to be demonstrated by a new cohort of students each year, the majority of projects exploring new areas for the application of the MicroHeat technology. This confirms the strength of a problem setting approach combined with the divergent thinking of design practice.

The student feedback in all years thus far was positive. As required by formal Swinburne process, student feedback was sought as evaluation for the project. Despite the generally low response rates (between 24% and 30% year on year), 88% of respondents stated that the project offered them the opportunity to apply their learning and 100% agreed that the assessment tasks assisted their learning. Students commented that the application of real world aspects and the introduction of an industry partner helped them to maintain their motivation to work on the project, which mirrors previous academic propositions (Boks and Diehl, 2006) and successful industry based academic design streams (Jedwab and Zivanovic, 2010). Survey questions students are asked to rank the course with are listed in Table 1, which were complimented by critical comments from students regarding the subject overall.

One student wrote in response to the survey in 2011: “There is a broad variety of learning and teaching in this subject…. They (staff) were interested in our work and gave good feedback responding quickly to emails. I also thought this was a good step up from previous product design subject, expecting us to make our products manufacturable and looking into all aspects in their life, from energy consumption to where we were going to get all the parts from. It allowed us to bring more of our engineering knowledge into our projects.” (Swinburne University, 2011) Another wrote in 2010, when asked to comment on the best aspect of the subject; “Getting to do projects instead of just being taught through a PowerPoint slide” (Swinburne University, 2010).

Several connections between this project and the Dym et al. description of design thinking in an engineering context can be drawn:

“There are many informative approaches to characterizing design thinking, some of which are now detailed. These characterizations highlight the skills often associated with good designers, namely the ability to:

- Tolerate ambiguity that shows up in viewing design as inquiry or as an iterative loop of divergent − convergent thinking;
- Maintain sight the big picture by including systems thinking and systems design
- Handle uncertainty
- Make decisions
- Think as part of team in a social process
- Think and communicate in the several languages of design. (Dym et al., 2005, p. 104)

Firstly the design strategy and educational scaffold intersect and encourage an iterative process through structured phases and set assessable tasks at the end of each phase, including both design and evaluative tasks.

Secondly, although this project utilizes several review and reflection points as shown in Fig. 3 to help structure the design

Table 1
Student survey questions.

<table>
<thead>
<tr>
<th>This unit is well organised</th>
</tr>
</thead>
<tbody>
<tr>
<td>I receive helpful feedback on the assessment in this unit</td>
</tr>
<tr>
<td>Learning materials and resources for this unit meet my learning needs</td>
</tr>
<tr>
<td>I have learned a lot in this unit</td>
</tr>
<tr>
<td>I am given opportunities to apply my learning in this unit</td>
</tr>
<tr>
<td>The assessment tasks in this unit assist my learning</td>
</tr>
<tr>
<td>I find this unit difficult compared with other units in my program</td>
</tr>
<tr>
<td>Overall, I am satisfied with this unit</td>
</tr>
</tbody>
</table>

Fig. 9. Army food heating by Mark Mazzone and Brad Attwood (Product Design Engineering 3rd year Swinburne University, 2011).

Fig. 10. Boutique milk pasteurising system by Adrian Jarvis and John Kyrlenko (Product Design Engineering 3rd Year Swinburne University, 2012).
process, each project starts with a problem not a product, so there is an added level of uncertainty. Each team also has to find a way to communicate project progress using appropriate design language being verbal, visual, physical modelling, computer generated or calculations in order to develop a viable design rationale from this initial ambiguity.

Thirdly, having students undertake calculations and self-critique methods throughout the project enables effective decision making to verify and estimate the viability of each proposal. This is challenging for staff and students alike, as each team’s project provides different contexts and variables. By instructing students to consider the whole system and providing sufficient tools when undertaking calculations, WSD is embedded in the project, and heightens student understanding of the quantifiable nature of DfE.

Annual staff reviews of the curriculum and student feedback, particularly in response to time management and workload concerns, has led to modified deliverables and timing for the project. These reflections have led to better tools being embedded within the pedagogical framework, and has helped to make the experience more engaging, manageable and relevant for students. Changes to the curriculum by staff have included assessment procedures and changes to the deliverables and the timing of submissions.

The first change has been in simplifying the scenario choices to 2 at the beginning of the project, as detailed in Section 2 of this paper. Simplifying the scenario definitions meant students had more clarity from the start of the project and found it easier to begin their market analysis. It also became apparent after the first time the course ran in 2010 that some design outcomes within the original scenario 2 could in fact fit within the brief for scenario 1.

The second change has involved streamlining the environmental impact assessment in the verification phase shown in Fig. 3, by shifting from calculating the carbon equivalent impacts of the artefact outcomes to utilizing the streamlined LCA tool Greenfly. Students now enter use phase data for water and energy, as well as the manufacturing, distribution and end of life data for designs into the Greenfly software. Students find that using Greenfly is more user friendly than generating calculations by hand, and additionally Greenfly software provides embedded design tips. Using Greenfly analysis students now generates consistent reports that effectively communicate the life cycle impacts for water, energy, greenhouse gases and solid waste.

Thirdly in terms of assessable deliverables, the number of dimensioned 2D Engineering drawings has been reduced as has the requirement for a digital journal documenting the whole project. It was decided that the time spent dimensioning and generating more traditional engineering drawings was less relevant in the current environment of digital 3D CAD files. Exploded and sectional views, drawn to AS1100 engineering drawing standard, allow for more effective use of time spend modelling in 3D CAD and clearer communication of resulting designs and systems. Removing the requirement of the submission of journal at the end of semester containing all project work eradicated double submission material due to progressive assessment at the end of each phase.

Staff also developed an assessment rubric to enhance and align feedback to specific assessment tasks. The reduction in the number of submission requirements was a direct response to staff and student feedback.

The project will run for the fourth time in 2013. Students who have undertaken this design course have thus far exceeded the industry partner’s expectations in terms of both the breadth of and resolution of outcomes. MicroHeat formally judged each project quantitatively in line with the criteria in Fig. 4, and has cited the following project successes qualitatively in correspondence with staff at the University.

- An industry presentation prior to project commencement provides students with practical understanding of the MicroHeat technology and potential applications. A strong understanding of the scope for the application of the technology enhances the search for creative applications.
- There are high engagement levels and interaction with students.
- Re-visiting student progress at concept stage at mid-way point is extremely beneficial.
- The ability to confirm MicroHeat’s own development concepts ideas through the work of students verifies the company’s own product development strategies.
- The lecturers are conversant with MicroHeat technology which enhances their input in helping students to generate real world outcomes.
- Students seem fully engaged in the ‘question and feedback’ session at the end of the year.
- The project complies with MicroHeat social responsibility charter (D’Eramo, 2012).

Critical review of the course is conducted annually, and is based on feedback from staff, students and the industry partner. In regards to the latter, MicroHeat has proposed some improvements to the project. Whilst they perceive student presentations and projects to be of a high calibre, MicroHeat staff often felt that time limitations were restrictive to provide formative feedback to the appropriate depth. MicroHeat also felt that the rooms at the University where often not conducive for appropriate evaluation of student work, being either too small or the projection being difficult to view. Both of these issues have been noted by the University staff as they are timetabling issues. MicroHeat also suggested a link in with Swinburne’s School of Entrepreneurship to assist with the value proposition of solutions, and exciting proposition that may be looked at in the future.

The student work, and student/industry partner feedback, suggests that this form of higher education approach, the unique student skill set, tied to industry technology innovation, can result in credible, sustainable design outcomes with a high level of student engagement.

5. Conclusion

Developing student understanding of DfE is critical to the success of professional sustainable design and engineering practice. The project in this paper achieves this in a number of ways.

Firstly this paper documents a design strategy and educational scaffold used in an industry connected design course at Swinburne University. This instils cross disciplinary techniques and an understanding of how to contribute to curtailing the ecological crisis once students enter the workforce. Of particular importance to this is the intersection of industrial design, engineering and industry.

Secondly, the project detailed in this paper allows students to clearly articulate and validate their proposals environmentally through LCA and WSD. There is no one way to practise DfE successfully, but by building student awareness of the potential impact of design decisions, product design engineers can be educated to not only design products, but to be able to consider their product within wider environmental, economic and social systems.

Thirdly, the sustainable benefits (determined through water/energy calculations and Greenfly streamlined LCA software) of each design outcome from an early stage form part of the entire design process, including competitor product benchmarking. The verification process pushes student teams to quantify the sustainable benefits of their proposal throughout the entire project, ensuring that sustainability is firmly embedded from concept to final design.
Finally, the value of an industry partner is imperative in increasing student engagement in Excelling in their product design outcome, configuration, usability and commercial viability. This real world evaluation of outcomes as opposed to an arbitrary design and development process, which is the pedagogical focus, contributes to more realistic project outcomes.

The successes of the MicroHeat course have been formalised by exceeding the industry partner expectations in terms of the breadth and the resolution of outcomes, with the project running for the fourth time in 2013. In reviewing the series of tasks that build the curriculum through engagement with students, industry partner consultation, and self-reflection, academic staff will continue to enhance the course in order to improve the outcomes both from a pedagogical and industry expectation perspective.

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Swinburne University, 2011. Student Feedback Survey – Semester One, HDPD314. Swinburne University, Melbourne.


Developing environmental sustainability strategies, the Double Diamond method of LCA and design thinking: a case study from aged care

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**Abstract**

This paper introduces a process to develop context-specific environmental sustainability strategies by utilising streamlined Life Cycle Assessment and design thinking. This process is referred to as the Double Diamond method of Life Cycle Assessment and design thinking, and is supported by an empirical case study of a major aged care organisation in Australia. The process asked four strategic questions to inform the development of the sustainability strategy: (1) What areas of aged care have the highest environmental impact? (2) How do the areas of high environmental impacts relate to day-to-day organisational practices? (3) What alternatives are available to reduce these impacts? and (4) How could the alternatives formulate a plan to reduce impacts over time? Each question requires a specific disciplinary approach to answer, drawing on Life Cycle Assessment, social sciences and co-creative problem solving from design. The applied process can be viewed as an extension of ecodesign, moving from a product-centric focus into an organisational setting, in part due to the emerging field of design thinking. The outcome of the case study is a plan proposing a mix of social and technical strategies to theoretically reduce carbon dioxide equivalent emissions by 54% over a ten-year time frame. Tying the plan together was a financing strategy that scaffolds strategy implementation across time. The paper provides insight into the environmental impacts of the aged care sector, the development of sustainability strategies, and a means to integrate Life Cycle Assessment into a creative problem solving process that may help businesses curtail environmental impacts.

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1. Introduction

This paper introduces a process to develop context-specific environmental sustainability strategies by utilising streamlined Life Cycle Assessment (LCA) and design thinking. This process is referred to as the Double Diamond Method of LCA and Design Thinking. The Double Diamond process is appropriated from the design problem solving process (UK Design Council, 2005). This is usually a product-centric design process, however, is applied in this case study to an organisational setting. The case study is on a major aged care organization; with results drawn from a site catering for 225 residents in the eastern suburbs of Melbourne, Australia.

The process asks four strategic questions to inform the development of the sustainability strategy:

(1) What areas of aged care have the highest environmental impact?
(2) How do the areas of high environmental impacts relate to day-to-day organisational practices?
(3) What alternatives are available to reduce these impacts? and
(4) How could the alternatives formulate a plan to reduce impacts over time?

In order to answer these questions, approaches from a range of disciplines were used, making the Double Diamond process an inherently multidisciplinary approach. Streamlined LCA was used to identify which areas had the highest environmental impact. Social practice theory from the social sciences was drawn upon to...
gain an in-depth understanding of everyday organizational practices such as how the menus were planned (due to the foods 40% contribution to carbon dioxide equivalent, or CO$_2$-eq impacts$^2$) and creative problem solving methods from design were used to identify alternative practices. In addition to drawing on multiple disciplines, the case study was completed in a participatory co-creative environment with external experts in LCA, social science, design and engineering collaborating with key internal stakeholders from the organization (e.g. the CEO, accountants, facility managers and carer representatives).

The paper is presented in the following sections: the background outlines the literature that has informed our approach of integrating LCA into the design process; the methods section expands on the Double Diamond process; the results section presents the strategic plan for the aged care facility that outlines a mix of socio-technical strategies to theoretically reduce CO$_2$-eq emissions by 54% over a ten-year time frame. A discussion on the reproducibility and validity of the Double Diamond process closes the paper.

2. Background

The background section presents an overview of the literature that informed the development and application of the Double Diamond process. This includes our understanding of unsustainability, the requirement to focus on organizational practices, and the two key theoretical frames used in LCA and design thinking.

2.1. The challenge of 'unsustainability’

The term ‘sustainability’ can be contentious. Common definitions such as the Brundtland Report define sustainable development in terms of intergenerational equity, in:

“Development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (World Commission on Environment and Development, 1987).

Although descriptive of a desirable objective, this definition of ‘sustainable development’ provides little guidance as to how it can be achieved. In addition, a plethora of definitions, frameworks, principles and indicators have also been developed to assist organizations approach sustainability (see for example Kirkby et al., 1995; Lozano, 2008b), however what ‘sustainability is’ is still contested (Clifton and Amran, 2011).

The position used within this paper is that if positive actions are to be developed by organizations, it is necessary to make sense of specific present actions that are clearly ‘unsustainable’. By focusing attention on the most ‘unsustainable’ practices it is possible to identify the change that needs to take place to achieve the goal of sustainability (Fry, 1999). The term ‘unsustainability’ is favoured over sustainability as it encourages an acknowledgement and critique of current practices that are ‘unsustainable’, countering the limitation of sustainability being hard to define with no universal definition widely accepted (Clune, 2009). As Fry states;

“Striving for solutions without having a fundamental grasp and definition of the problem can never advance sustainment (unless by chance)” (2000, p.4).

Therefore an understanding of ‘unsustainability’ is viewed as a pre-requisite to developing sustainable strategies (Clune, 2009).

Responding to unsustainability requires the confrontation of scale and time frames. Large scale transformation is required in a short period of time, and will need to be sustained for the long term (Lozano, 2008b). The present use of natural resources is beyond the limits the carrying capacity of the planet, thus is one common ‘unsustainable’ element (Ewing et al., 2009). Alongside humanity’s expanded ecological footprint has been the increase in greenhouse gas emission, contributing to human induced climate change. This project identified a 50% target reduction in CO$_2$-eq emissions from 2010 levels by 2020 in accord with Preston and Jones (2006).

Progressive organizational approaches identify that a socio-technical approach involving people, systems and processes (Lozano, 2008a, 2008b; Mebratu, 1998) is required to deal with the relational complexity of ‘unsustainability’. These principles are embodied in the approach utilised in this paper. Less explored in the literature is the requirement for creative problem solving to ideate future strategies that reflect the enormity of the unsustainability challenge. Methods presented in this paper are viewed to contribute to this lack of clarity.

2.2. Responding to ‘unsustainable’ practices

In contrast to the enormous scale of ‘unsustainability’, common mitigating initiatives within Australia tend to take a narrow view. For example, the ‘light globe and water bucket syndrome’ (Clune, 2010b) describes two practices that Australians take part in; changing to energy efficient light globes; and, placing a bucket of water in the shower to catch water to re-use on plants in the garden. While both activities generate positive incremental outcomes, if the actual direct contribution of the activities is assessed, both are inadequate in achieving the significant change required to move towards a sustainable future. For example lighting, which has been at the centre of many energy reduction strategies (Origin Energy, 2007) is responsible for 1.35% of an individuals CO$_2$-eq emissions (extrapolated from Dey et al., 2007), versus the practice of eating which is responsible for 28.3% of an individuals CO$_2$-eq emissions. Only by considering embodied resource use may ‘unsustainable’ practices be identified, and effective mitigating initiatives identified.

One of the major claims made by social practice theory is that consumption occurs through everyday practices (Warde, 2005). For example, in the practice of eating, differing foods have differing environmental impacts (Eady et al., 2011), and the refrigerator, freezer and microwave provide a level of convenience [and energy use] for food preparation, storage and cooking practices (Shove, 2003) that are dynamic and have changed significantly over time. With respect to organizational practices, resource consumption again takes part as an outcome of everyday practice, for example the provision of care for a patient, the maintenance of a building, or the planning of a menu. It is within these routinized practices that resource consumption occurs or is locked in. If change is desired for sustainability, then routinized organizational practices may need to change. An understanding of the complexity of organizational practices (Kemmis, 2005, 2007) is viewed to enhance the capacity for affecting change management strategies to be identified, from both a social and a technical perspective.

Responding to embodied impacts is challenging, as Dey et al. write;
“If every Australian household switched to renewable energy and stopped driving their cars tomorrow, total household emissions would decline by only about 18%” (2007, p.271)

This raises two key questions carried through the study: what accounts for the remaining 82% of emissions and, how can they be strategically reduced? The following section briefly introduces two theoretical frames capable of answering these two questions.

2.3. Theoretical frames to respond to unsustainability by organizations

Lifecycle analysis is used as a technical frame to address the question of ‘how to identify embodied emissions’, and design thinking is proposed as a creative frame to address ‘how they may be strategically reduced’.

2.3.1. Lifecycle analysis (LCA) and use by organizations

As the problem of unsustainability has become more apparent to society, the embodied environmental impacts of the products and services provided by business are increasingly being scrutinised. LCA is the “compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its lifecycle” (ISO 14040:2006). It has long been used as a scientific method to identify environmental impacts and has been widely accepted and adopted within the corporate sector (Heiskanen, 2000).

LCA, as a tool for organizational change has been limited due to the nature of the complex scientific findings it generates. Palmer et al. suggest:

“Do not expect them [organizations] to know what to eventually do with a completed LCA study...experience has shown this to be rarely the case” (2011, p. 470).

Similarly, Robert and Schmidt-Bleek (2002) have suggested that LCA rarely influences business decisions due to a lack of systems thinking or integrated strategy. This suggests that there is scope to better integrate LCA within an organizational decision making process, as proposed by Robert and Schmidt-Bleek (2002) and further investigated through the methods adopted in this paper. In addition, LCA is traditionally applied to a particular product system retrospectively. Once the system has come into being LCA is used to make claims about the environmental credibility of that discrete system (EDF, 2004). The problem here is that a product or system has already been manufactured or procured, with the environmental impacts ‘designed in’.

Ecodesign emerged in the mid 1990’s as a framework to integrate streamlined LCA’s (or lifecycle thinking) into the product development process to reduce the environmental impacts of individual products (Brezet and Hemel, 1997; Ryan et al., 1997). Ecodesign attempted to shift LCA into the design stage and integrate environmental impacts as a performance indicator like cost or tensile strength (Verghese and Lockrey, 2012). The design stage is often considered the best time to consider environmental aspects, with designers and engineers locking in up to 70% of the environmental impacts of a product, with up to 85% of the financial costs also defined at this stage (Lewis et al., 2001). Companies such as Walmart, BASF, Toyota and SC Johnson have employed this streamlined approach in their design processes, which has roots in eodesign (ECRM, 2010; Salting et al., 2002; SC Johnson, 2004, 2010; Sterling, 2007).

While the origins of eodesign are intensely ‘product focused’ (Fletcher and Goggin, 2001), the emergence of design thinking in business settings provides an opportunity to revisit the capacity of eodesign to integrate LCA within a design process and reduce the environmental impacts in an organizational setting. In the spirit of eodesign, this paper posits that the design process could be applied to develop strategic organizational plans, by using streamlined LCA as a prescriptive tool for what could be done to reduce environmental impacts as opposed to being completed as retrospective audits. Here lies the major contribution of this paper, a case where LCA can be considered with strategic and design methods to help inform decision making prospectively within business.

2.3.2. Design thinking and the designers as facilitator

A recent interest in design thinking has emerged within business as a process for solving complex or ‘wicked’ problems (Brown, 2009) such as ‘unsustainability’. This process originated in product design and architecture and can also be applied to non-object based solutions. Design thinking involves the synthesis of various, often disparate, ideas into multiple plausible solutions. Swann (2002, p.51) describes the design synthesis process as “intuition, inspirational guesswork and holistic thinking”. Cross (1989) articulates the difference between design and engineering by suggesting that designers solve complex problems while synthesis in the generation of multiple solutions—many quick solutions are generated until one works. This differs from scientific or engineering disciplines in which problems are generally solved through analysis and convergent techniques (Dym et al., 2005).

The creative process is explained by Schön (1991, p.68) as continuous on-the-fly ‘reflection in action’. Herbert Simon’s (1969, p.129) notion of design is that it does not just create new objects and artefacts but that designers attempt to “change existing situations into preferred ones”. Design has a history of improving existing conditions. This understanding of design contrasts the view of designers as merely stylists or makers who produce user-friendly products to meet “what are generally taken to be pre-existing needs” (Shove et al., 2007, p.9). An important additional to understanding ‘design as problem solving’ is that we are all designers:

The practice of design as a thing that people do predates professions. In fact, the practice of design — making things with a useful goal in mind — actually predates the human race. Making things is one of the attributes that made us human in the first place (Friedman, 2000, p.5).

If we acknowledge that we are all designers, then using a participatory approach to designing, (involving stakeholders) becomes logical. Participatory design aligns with the argument that ideas are most powerful when developed from the ‘inside out’. Within participatory design users are seen as co-creators in developing the problem setting, and solutions with respect to sustainability. Participatory design views ‘the people as true experts in domains of experience such as living, learning and working’ (Sanders, 2008). Participation is also widely identified as important within sustainable development literature (e.g. Klauer, 1999), as “interaction among affected entities helps define the interrelationships of concern” (Born and Sonzogni, 1995, p.171). The case study presented in this paper is located in a participatory or co-design framework where the designer facilitates the creativity of the stakeholders to identify potential solutions to opportunities identified through LCA.

2.4. Issues relevant to aged care in Australia

The aged care sector in Australia is not immune to environmental pressure, so it is logical to assume that the needs of...
residents, resident’s families, employees, product suppliers, investors and managers will also share an increasing expectation that environmental concerns are considered in decision making and responded to appropriately. In addition, the sector will manage significant growth. Internationally, ‘Population ageing is unprecedented, without parallel in human history—and the twenty-first century will witness even more rapid ageing than did the century just past’ (UN, 2002). The aged care sector in Australia is expected to increase substantially with the population aged over 85 expected to increase at least four-fold by 2047 (Productivity Commission, 2008). The growth expected within the sector is a significant opportunity for investment in capital expenditure, and allows environmental considerations to affect the efficiency of capital systems. With this opportunity also comes the responsibility to ensure capital expenditure decisions will deliver long-lived functional, environmental and economic outcomes.

Sustainability of aged care in Australia has been discussed by the Productivity Commission Trends in Aged Care Services: some implications report (Productivity Commission, 2008), however it predominately relates to ‘economically sustaining’ aged care into the future by “fiscal sustainability—in developing an affordable and effective residential care system” (2008, p.3). The focus is almost entirely on efficient economic management of resources and does not directly address the ecological impact of aged care unless linked to increases in resource use.

A review of international literature identified two areas likely to have high environmental impacts in the provision of aged care in: (1) building energy use and (2) procurement activities. Within an aged care setting buildings are likely to be energy intensive. The Energy Information Administration in the USA (2006) identified food services and the health care sector to be large energy consumers, both of which would be expected to be incorporated into typical aged care facilities. Results of a UK National Health Services study found 59% of the climate change inducing emissions were generated through procurement (supply chain activities of companies producing goods and services) in comparison to 24% related directly to the emissions due to building operation (Abbott et al., 2010). At the time of writing no LCA studies were publically available for the aged care sector in Australia.

3. Method

The relational complexity of unsustainability requires a mixture of methods capable of (1) understanding the environmental impacts, and (2) suggesting creative solutions for alternative practice. Life Cycle Assessment (LCA) and design thinking were the predominate methods used to develop the context-specific sustainability strategy. This process is referred to as the Double Diamond Method of LCA and Design Thinking (Fig. 1). The Double Diamond method is founded on four specific questions:

(1) What areas of aged care have the highest environmental impact?
(2) How do the areas of high environmental impacts relate to day-to-day organizational practices?
(3) What alternatives are available to reduce these impacts?

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Questions, method, mode of thinking and stakeholders for aged care Double Diamond approach.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question</td>
<td>Method</td>
</tr>
<tr>
<td>1. What areas of aged care have the highest environmental impact?</td>
<td>Streamlined life cycle assessment using input output analysis; and site visits by energy expert.</td>
</tr>
<tr>
<td>2. How do these areas relate to day-to-day organizational practices?</td>
<td>Extrapolate impact to practices and social practice theory.</td>
</tr>
<tr>
<td>3. What alternative practices are available to reduce the impacts of the practices?</td>
<td>Design thinking, participatory design workshops and creativity methods.</td>
</tr>
<tr>
<td>4. How could the alternatives formulate a plan to reduce impacts over time in a cost effective manner?</td>
<td>Simple financial and energy efficiency models.</td>
</tr>
</tbody>
</table>
(4) How could the alternatives formulate a plan to reduce impacts over time?

The diamonds in Fig. 1 represent the convergent and divergent mode of thinking employed in relation to the question being asked. The Double Diamond in Fig. 1 can be considered as lying on an x and y-axis. The questions are posed sequentially over time on the x-axis, and the y-axis tracks thinking employed to answer those questions. Modes of thinking either expand to a divergent approach (double peak), or a more focussed convergent approach (intersection) in order to refine the ideas explored at the previous divergent stage. The questions, method, mode of thinking and stakeholders involved in a Double Diamond approach for aged care, are summarised in Table 1 and presented in detail in the following section.

3.1. What areas of aged care have the highest environmental impact?

Initially a divergent mode of thinking is employed, seeking to identify all potential environmental impacts that could occur in a product, system or service. Streamlined LCA (Fig. 2) is selected as the technical method for assessing environmental impacts as it takes a holistic view that considers impacts associated with material and energy flows that manifest both ‘upstream’ and ‘downstream’ from the aged care facility. Impacts considered include those generated in the supply chains that create and bring products and energy into the facility, and impacts that occur to treat wastes and other flows that leave the facility.

This study did not apply full LCA in pure accordance with ISO14040, rather a ‘streamlined’ approach guided by ISO14040, enabling high-level view of impacts suitable for guiding focus and benchmark. Streamlined LCA is differentiated from full LCA by the degree to which primary data is collected and the complexity of the underlying life cycle model. Streamlined LCAs typically abbreviate modelling and use generic data in order to achieve quick indications rather than detailed quantifications.

The aged care LCA was modelled on a facility that catered for 225 residences in the eastern suburb of Melbourne, Victoria. The site was selected as it provides both low and high care residential aged care, retirement living accommodation, and community respite and day programs. The core service of the facility is defined as being the provision of residential aged care to a certified standard. This service is measured using the following function unit:

‘One bed-day to a certified standard of care’

Impacts were measured in accordance with this functional unit based on the key ‘practice’ of the organization. The scope of unit processes included were those relating to the provision of this service. The LCA was modelled using SimaPro 7.1 software (PRé, 2013).

3.1.1. Process impacts considered

The LCA process considered the environmental impacts of all Australian economic sectors. As Druckman and Jackson state “a good starting point for investigating CO2-eq emissions due to consumption is to look at expenditures” (2009). Expenditure items from the ‘Statement of Financial Performance’ reports for the site were analysed, and relate to the ‘items of interest’ that are considered in the LCA. Invoiced items considered are summarised in Table 2. These items were derived from receipts, accounts, invoices, bank statements and advice supplied by the aged care provider. Excluded from the analysis were impacts associated with capital expenditure, particularly those relating to the construction of buildings, and labour. Most of these items would be amortised over a number of years, so their impacts were estimated to have little impact relatively over the course of a year than the items that were included as consumed within the year (i.e. Table 2 items).

The ‘Input/Output’ LCA database developed by the University of Sydney for the Australian Economy (2005) was used to translate units of expenditure to impacts. This relates economy-wide

Table 2

Economic sector and input/output classification.

<table>
<thead>
<tr>
<th>Items considered</th>
<th>Input/output sector as selected from LCA database</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper towels</td>
<td>Paper containers and products</td>
</tr>
<tr>
<td>Medical supplies</td>
<td>Pharmaceutical goods for human use</td>
</tr>
<tr>
<td>Incontinence pads</td>
<td>Pharmaceutical goods for human use</td>
</tr>
<tr>
<td>Fruit &amp; veg.</td>
<td>Vegetables, fruit, juices and other products</td>
</tr>
<tr>
<td>Cereals</td>
<td>Flour, cereal foods, rice, pasta and other products</td>
</tr>
<tr>
<td>Red meats</td>
<td>flour mill products</td>
</tr>
<tr>
<td>Poultry &amp; eggs</td>
<td>Poultry and eggs</td>
</tr>
<tr>
<td>Dairy</td>
<td>Dairy products</td>
</tr>
<tr>
<td>Bakery items</td>
<td>Bread, cakes, biscuits and other bakery products</td>
</tr>
<tr>
<td>Oils &amp; fats</td>
<td>Oils and fats</td>
</tr>
<tr>
<td>Sugars, seafood, spices</td>
<td>Raw sugar, animal feeds, processed seafoods, coffee, spices</td>
</tr>
<tr>
<td>Softdrinks and syrups</td>
<td>Softdrinks, cordials and syrups</td>
</tr>
<tr>
<td>Cleaning materials</td>
<td>Soap and other detergents</td>
</tr>
<tr>
<td>Laundry materials</td>
<td>Soap and other detergents</td>
</tr>
<tr>
<td>Maintenance materials</td>
<td>Residential building, construction, repair and maintenance</td>
</tr>
<tr>
<td>Electricity</td>
<td>Electricity supply</td>
</tr>
<tr>
<td>Gas</td>
<td>Gas production and distribution</td>
</tr>
<tr>
<td>Water &amp; sewerage</td>
<td>Water supply, sewerage and drainage services</td>
</tr>
<tr>
<td>Office supplies</td>
<td>Printing and stationary services to printing</td>
</tr>
<tr>
<td>Computers</td>
<td>Electronic equipment, photocopying, vending and gaming machines</td>
</tr>
</tbody>
</table>
environmental impacts to dollars of spend for specific economic sectors (See Table 2).

3.1.2. Site visit

A site visit was undertaken to review obvious areas for potential improvement, particularly in the area of energy consumption. This visit sought to ensure that the LCA study remained grounded in real issues facing the site, so as to not overlook key physical issues.

3.2. How do these areas relate to day-to-day organizational practices?

Key themes for discussion were interpreted from the streamlined analysis, identifying ‘hotspots’ in the aged care facility system where the greatest environmental impacts occur. The Pareto principle, or the 80:20 rule, can often be identified in this phase of hotspot analysis, identifying where a large proportion of impacts are accounted for by a small proportion of components to the system. Such insight allows strategic focus on areas that appear to matter most. Discussion centres on themes relating to the largest impacts. The interpretation of the LCA results was not as linear or simply identifying areas of largest impact. Synthesis of results into meaningful themes is characteristic of when design thinking connects disparate pieces of information into manageable chunks (Basic, 2007). “What is the problem?” is the most useful question to ask at this stage. The emerging themes from this stage were organisational practices such as menu planning that enable interpretation via social practice theory.

3.3. What alternative practices are available to reduce these impacts?

To identify what alternative practices that could ultimately reduce the previously identified environmental impacts, two all day long ‘participatory design workshops’ were held. Participatory design workshops are workshops where organizational stakeholders and users work together to co-create possible solutions. The workshops were selected with the premise that engaging the organization in co-creating solutions assists in taking ownership of the sustainability strategies that were to be developed.

The design of the ‘participatory design workshop’ is an activity in itself that follows the design process (see for example Cruickshank and Evans, 2012). The participatory design workshop developed for this project spent an equal amount of time defining the problem following Clune’s (2008) principle of ‘how you define is how you design’ and Fry’s (2004) critique of sustainable design approaches, in that success depends on being critically informed. The participatory design workshops were therefore separated into two all day events, focused on defining the problem of unsustainability, and designing potential solutions. The workshop aims and agenda are presented in Table 3.

Within both workshops, key stakeholders were engaged and included both on-site and remotely via video link. Participants within the workshops included external practitioners with expertise in LCA, design, engineering, accounting, and energy efficiency complimented by internal stakeholders from procurement (accounts), facilities management, regional management, catering, nursing, and the Chief Executive personnel.

3.3.1. Participatory design workshop 1. defining: a problem well put is a problem half-solved

Participatory design workshop 1 was dedicated to understanding organizational practices, with an understanding that sound definition of the problem at hand will, by default, increase the likelihood that the designed solution will be more satisfactory. The defining process involved discussions about the streamlined LCA results, and the areas of highest strategic impact. Participatory design workshop 1 also aimed to understand why the system is ‘as it is’. Discussing environmental impacts with the language of everyday practice (i.e. procurement and menu planning) enabled all participants to contribute to the discussion without technical scientific understanding of energy or CO2-eq emissions. Through group discussion information was gathered on why the everyday practices exist as they do, who is responsible, how they are planned and how they are managed. The technique of asking 5 why questions (IDEO, 2002) was frequently used to probe deeper into why the practices exist. This discussion of everyday practice is often seen as disruptive, questioning standard practice and presenting alternatives. The discussion of practices often acknowledges that the existing state is not always preferred. It also provides an understanding of the existing positive initiatives that could be built upon or amplified, and initiatives that may need be reorientated, or developed in workshop 2.

The workshop closed with the novel technique of silent reading of best practice case studies of provocative and progressive thinking in relation to the developed themes. This was completed in preparation for the ideation phase.

3.3.2. Participatory design workshop 2. designing: what are the alternatives?

Once a sound problem definition was identified, potential solutions for each theme can be conceptualised through participatory brainstorming and creative sessions. This occurred in the form of the second all day workshop. The creative problem solving techniques utilised in the Workshop 2 have origins dating back to Osborne (1963). Solutions were generated by prompting questions from the design facilitators, such techniques are widely adopted in design practice (IDEO, 2002; Martin and Hanington, 2012; Stickdorn and Schneider, 2010). Techniques used included:
Table 4
Breakdown of estimated energy use for electricity and gas (DEWHA, 2008).

<table>
<thead>
<tr>
<th>Estimated energy breakdown</th>
<th>Electricity</th>
<th>Gas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Washing</td>
<td>2.9%</td>
<td>6%</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>9.8%</td>
<td>18%</td>
</tr>
<tr>
<td>Office equipment</td>
<td>2.9%</td>
<td>6%</td>
</tr>
<tr>
<td>Refrigeration</td>
<td>2.9%</td>
<td>6%</td>
</tr>
<tr>
<td>Cooking</td>
<td>4.9%</td>
<td>2%</td>
</tr>
<tr>
<td>Lighting</td>
<td>16.6%</td>
<td>31%</td>
</tr>
<tr>
<td>Water heating</td>
<td>20.5%</td>
<td>8%</td>
</tr>
<tr>
<td>Space cooling and ventilation</td>
<td>8.3%</td>
<td>15%</td>
</tr>
<tr>
<td>Space heating (boiler house 1)</td>
<td>17.1%</td>
<td>5%</td>
</tr>
<tr>
<td>Space heating (boiler house 2)</td>
<td>14.1%</td>
<td>4%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 5
Results per bed-day of aged care provision at aged care provider.

<table>
<thead>
<tr>
<th>Environmental indicator</th>
<th>Unit of measure</th>
<th>Result per bed-day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate change</td>
<td>kg CO₂-eq</td>
<td>42.8</td>
</tr>
<tr>
<td>Water use</td>
<td>kL</td>
<td>1.5</td>
</tr>
</tbody>
</table>

4.1. What areas of aged care have the highest environmental impact? Streamlined LCA findings

The results of the streamlined LCA estimate that for ‘one bed day,’ 42.8 kg CO₂-eq emissions are emitted and 1.5 kL of water consumed (Table 5).

The climate change and water use impacts of aged care, per bed-day, are slightly lower than those of the average Australian (51.8 kg CO₂-eq from Dey et al., 2007); however, they are directionally consistent. Although the results are lower than the average Australian’s impact, the streamlined nature of the LCA does not make it possible to conclude that this difference is meaningful, only that the results seem reasonable (a further study that looks in detail at the difference between the average Australian and aged care practice would be well worthwhile).

The drivers of climate change impacts are shown in Fig. 3. Electricity (43%) and gas (6%) contribute to almost half (49%) of the impact of care. Food is the second highest driver, contributing a total of 40% of climate change impacts, as has been explored previously as a major impact category in various consumer contexts (Dey et al., 2007; Lenzen and Foran, 2001; Saarinen et al., 2012; Williams and Wikström, 2011). The balance of 9% is due to assorted supplies and the provision of water. Overall, the use of energy on site (electricity and gas) and the provision of food, contribute 91% of the total climate change impact of aged care provision.

4.2. How do the areas of high environmental impacts relate to day-to-day organizational practices?

The convergent interpretation of the LCA identified environmental impact hotspots, highlighting a Pareto-like principle in that 25.2% of the care provider’s expenditure (electricity and meat...
consumption) account for 62% of its climate change impact. The interpretation moved from scientific data to day-to-day practices under three themes:

- Capital purchasing decisions — procurement of appliances and capital
- Thermal comfort — providing comfort through heating and cooling
- Food and diet — nutrition to menu planning and meal preparation

Initially the care provider’s key concerns were highly visual, such as paper use, disposable rubber gloves or the high number of incontinent pads (accounting for around 3% of the total climate change impact). LCA identified areas previously not considered, such as food, which had 40% of the climate change impact, a far greater impact. The process redirected the designers to areas of most significant environmental importance, highlighted in Fig. 3.

4.3. What alternatives are available? Practices to amplify, and practices to reorientate

The outcomes of participatory design workshop 1 are presented with respect to the three themes outlined above identifying numerous practices for the organization to amplify, or reorientate.

4.3.1. Capital purchasing decisions

Energy (electricity and gas) was estimated to be responsible for 49% of the climate change impact of residential aged care site. Site visits to the aged care facility indicated that significant savings could be made through both capital investment and behaviour change.

While participants could easily suggest more energy efficient or renewable solutions, the real discussion was on how such opportunities could be financed, and ensuring that future capital projects were future proof and installed following the ethos of sustainability. Several precedents existed for retrofitting items to improve performance, and a desire to reorient from a decentralized to centralized procurement approach also existed.

From the group discussion surrounding upgrading and retrofitting existing sites, precedents were identified that replaced and upgraded items on sites when they were not operating effectively. For example air-conditioners were relocated to improve air-flow. Glare on west facing windows were reduced through the installation of blinds, which by default makes the environment more comfortable and reduced energy needs. These upgrades address problems of comfort, and could be amplified. However, how efficiency improvement opportunities such as insulation, glazing, curtains, reflective roofing or shading are financed at present was not formalised — and unlikely to be achieved in the existing framework, and identified as a practice to reorient.

From the discussion surrounding procurement, a decentralized purchasing strategy exists at present, in that each site is autonomously responsible for purchases. A shift is occurring on items that were previously purchased by patients, to be purchased centrally by the care provider. The desire is to move to a more centralized procurement policy, which could attach an efficiency agenda to purchasing. This could apply to items such as televisions, vacuums, laundry, kitchen appliances, and air-conditioners.

Attaching an efficiency agenda to purchasing presents both efficiency and financial savings. How capital could potentially be created to finance projects was introduced through a case study of Woking Council in the UK (Thompson, 2007) introduced by the project team where reinvestment of savings from efficiency gains was placed into renewable technologies. The discussion engaged not only in what is and what could be, but how this could be created — or integrated into existing practices.

4.3.2. Thermal comfort

Air-conditioning (heating and cooling) uses a significant amount of energy at the aged care site. Altering the thermostat is one means to save energy. To shift the temperature often requires a change in behaviour from both staff and residents within the facility. This area of focus explores looking at thermal comfort holistically.

The link between high energy consumption and thermal comfort was a key connection to make between LCA results and daily practices. It became clear that the present system of air-conditioning was not satisfying all of the patients. The strategy of removing the ability of staff to adjust thermostats was not ideal, and it was identified that high care patients may be kept warmer through personal as opposed to space heating. Timing of practices such as hair washing could also assist to keep patients cool in summer, and manage thermal comfort.

The concepts of adaptive temperature and zoning (Dear, 2007) and the Japanese Government’s cool biz campaigns (Lakeridou et al., 2012) of appropriate clothing attire were discussed from the selection of best practice case studies. Adaptive comfort temperature recommends slightly higher setting of the thermostats in summer and cooler settings in winter. Zoning identifies areas of the buildings that may be cooler after particular time periods where there is low use.

4.3.3. Food

Food accounted for 40% of the climate change impact, and 80% of the embodied water used in the provision of residential aged care at this site. The majority of food related climate change impact (48%) comes through the production of red meat, particularly beef. Recent work surrounding the carbon impact of food has been conducted by catering and health care organizations (BAMCO, 2007a, b; Lagasse and Neff, 2010) providing a precedence for discussion. This area of focus explored how to reduce the climate change impact associated with their catering. Through discussion it was determined that:

- the facility menu is planned in consultation with patients and families
- patient meal requests are added to the menu
- the menu is approved by nutritional expert
- food is purchased for a 4 week menu cycle
- Tasmania purchases food through government schemes (DHIS)
- the local prison grows and prepares fresh vegetables for Tasmania’s sites
- fruit and vegetables are delivered three times a week
- food is delivered
- food is prepared and cooked in a central kitchen on site
- pre-prepared meals are often used, however a preference exists for fresh
- the food is consumed

From this understanding surrounding how the current menu is planned, a process for consultation with patients and families for menu planning already exists, with strong relationships with suppliers (to the extent that they may change serving size to reduce waste). In addition, the facilities have run food themed days and are currently in the process of completing a ‘plate waste’ study. This existing framework could be expanded to include a discussion around low carbon diets.

The second workshop explored the variety of ways the themes outlined above could be transformed at various scales, i.e. minor and major, no cost, low costs, short term, long term or factor ten improvements. This approach provided a diversity of solutions that
were documented. The workshop closed by voting on ideas that would seem most desirable (see Fig. 4). The resultant plan developed from ideas generated in the participatory design workshops, and is presented in the following section.

4.4. How could the alternatives formulate a plan to reduce impacts over time?

The previous three stages generated numerous ‘solutions’ that the aged care site may wish to engage in to reduce the environmental impact of aged care. The number of solutions identified could be described as an unmanageable wish list of things to consider. To make sense, the ‘solutions were scaffolded into a plan in order of current feasibility, largely drawing upon the McKinsey Quarterly cost curve for greenhouse gas reduction by Enkvist et al. (2007). The curve provides a useful guide to the most cost effective climate change abatement strategies, enabling the prioritising of solutions that offer a return on investment first. The Environmental Sustainability Plan is presented in two sections:

- Food: reducing the climate change impact associated with food
- Energy; a long term strategic vision

Each action has been assessed in terms of the benefits it could provide and the potential costs involved\(^5\). A summary the

\(^5\) Note that the estimates shown are indicative only and require specific advice and quotations to determine final costs and savings expected.
Environmental Sustainability Plan is provided on the following section indicating the timing for each strategy, and the potential reduction in climate change potential (see Table 6).

The sustainability plan developed from the results of the LCA and workshops consists of initiatives that can be implemented in isolation, or ideally as part of a large strategic program. In general, economic optimisation is achieved when clean energy supply strategies (such as solar panels, explored in Section 4.6.9) are deployed after demand side options (energy efficiency and demand reduction) have been exhausted. While some opportunities appear to have a high upfront cost, Fig. 6 illustrates the theoretical model of investment and savings that optimise the return on investment. Negative costs shown refer to strategies that actually generate net financial benefits rather than costs. Sustainability actions are summarised in Fig. 5 and Table 6 and discussed in detail below.

4.5. Food; reducing the climate change impact associated with food

Three strategies are selected to engage with and reduce the climate change impacts associated with food.

4.5.1. Food diet strategy — low carbon menu planning (up to 25% reduction in food impacts)

Community consultation and nutritional consultation for menu planning provides a useful platform that could include discussion around low carbon diets. Hospitals within the USA have trialled meat free Mondays and revised diets to reduce their carbon footprint associated with food (Lagasse and Neff, 2010; Pencheon et al., 2009). The model presented by the Bon Appetit catering company (York, 2009) achieved an estimated 25% reduction in carbon related to food via menu planning. Bon Appetit’s carbon calculator and strategies were generated by collating publicly available peer reviewed data on food impacts (BAMCO, 2007a, b). Dedication from a number of staff responsible for menu planning would be required for similar initiatives to be implemented.

It should be noted that the data available surrounding the climate change impacts of food vary. The Bon Appetit calculator is a useful starting point, although based on US data. As a general rule ruminate livestock (beef and lamb) have a higher impact than non-ruminate livestock (pork, kangaroo, chicken, rabbit and fish). A shift to serving a higher ratio of vegetables within meals is also a general rule used to reduce the impact of food. Bon Appetit Catering Company (York, 2009) served a more culturally diverse range of dishes (which generally have higher vegetable ratio) to reduce the carbon intensity of their meals. It was discussed within the workshops that some sites already perform food theme days so this theme may be easily implemented.

4.5.2. Food waste strategy (up to 5% reduction in food impacts)

The plate waste studies currently being completed in Tasmania sites are a positive initiative any reduction in food waste further reduces the climate change impacts as well as financial costs associated with food.

Reporting on the results of the plate waste studies, documenting the initiatives that emerge from the study, and then recording the results of the intervention can be applied directly into this strategy immediately. If 5% of food waste can be reduced — a 5% reduction in the carbon impacts associated with those food can be achieved potentially with a 5% economic saving of those foods (clearly some foods have higher carbon and financial costs than others).

4.5.3. Aged care as a site of production

Strong interest has been raised in locating community gardens within care facilities. While complete self-sufficiency may not be possible, supplementing menus from food produced on site...
engages in a holistic approach to sustainability. Vegetable gardens exist on some locations, with residents excited when local produce is served.

The initiative has added benefits of:

- providing exercise and entertainment for patients
- providing a medium to engage patients in the ecological issues associated with food
- Providing a potential means for community engagement

Vegetable suitability for cooking from a safety perspective would require forethoughtful planning of how to integrate into the menu plan. The interest in Melbourne community gardens is growing, and could support the installation of gardens on sites. Local Schools, community groups, councils or TAFE’s are all potential partners.

With respect to future build projects, the sites could be landscaped with edible gardens, including nut and fruit trees that have high nutritional values.

4.6. Energy: a long term strategic vision

The strategies below are selected to address the climate change impacts associated with energy consumption in aged care.

4.6.1. Energy monitoring and targeting (up to 10% of energy impacts)

The first strategy involves creating an energy map of the aged care site, enabling a targeted approach to investing in energy saving solutions, and measuring success. The energy savings captured by giving consumers direct feedback about their energy usage can lead to savings in the order of 5–15%. The cost associated with planning implementing and energy monitoring varies with the levels of system sophistication, e.g. from hand held energy meters to more complex online monitoring systems.

4.6.2. Procurement strategy (up to 8% of energy impacts)

Implementing a centralized procurement strategy to purchase efficient appliances potentially has no costs outside the setup time, general maintenance and replacement of old appliances. Government websites also provide advice on appliance energy consumption i.e air-conditioners, refrigeration and HWS (DCCEE, 2013). Other systems may require searching for the lowest energy consuming appliances as an indicator of performance.

4.6.3. Thermal comfort strategy (up to 30% of heating and cooling impacts)

The management of thermal comfort within the facilities can be managed through a variety of technological and behavioural change strategies. Empirical studies have highlighted a 30% saving of heating and cooling through using the timer based approach (Davidsson and Boman, 2000). The proposed strategy could include:

Using programmable thermostats set to 16°C at night in commons areas — increasing the temperature during the day time to the adaptive thermal comfort limit. In addition, setting thermostats to turn heating/cooling to unused offices and meeting spaces either down or off overnight.

Using adaptive thermal comfort ranges for Melbourne (Table 7), could be particularly useful in summer as patients were reported to be uncomfortable being cold and not hot. Documenting the process of managing comfort over time is critical; recording temperature adjustments and noting feedback from staff and patients.

Separate individual comfort strategies may be required for patients with poor circulation to keep warm. This could include a range of personal heating strategies such as: low wattage thermal...
Table 6
Summary of sustainability actions.

<table>
<thead>
<tr>
<th>Ref</th>
<th>Description of strategy</th>
<th>Timing</th>
<th>Climate change impact reduction</th>
<th>Initial cost</th>
<th>Savings per annum</th>
<th>Cumulative climate change reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>kg CO2-eq per bed/day</td>
<td>%</td>
<td></td>
<td>kg CO2-eq</td>
</tr>
<tr>
<td>1</td>
<td>Food: Food consumption contributes to 16.39 kg CO2-eq and 1240 L water/bed day of care. A menu planning and reduced plate waste strategy could lead to a 25% reduction in carbon and water over three years, with incremental improvement thereafter.</td>
<td>2010</td>
<td>4.10</td>
<td>9.6%</td>
<td>Low</td>
<td>Limited savings</td>
</tr>
<tr>
<td>2</td>
<td>Energy Monitoring: Energy contributes to 20.91 kg CO2-eq/bed day of care. Monitoring all energy use and developing energy reduction initiatives is estimated to reduce energy by 10%.</td>
<td>2011</td>
<td>2.09</td>
<td>4.9%</td>
<td>Low</td>
<td>$8000</td>
</tr>
<tr>
<td>3</td>
<td>Procurement Strategy: a long term focus on energy efficiency through a procurement strategy is estimated to lead to an 85% reduction in electricity use over time</td>
<td>2011</td>
<td>1.08</td>
<td>2.5%</td>
<td>Low</td>
<td>$9000</td>
</tr>
<tr>
<td>4</td>
<td>Thermal Comfort Strategy: a revised thermostat and comfort strategy leads to an estimated 30% reduction on HVAC costs.</td>
<td>2011</td>
<td>1.58</td>
<td>3.7%</td>
<td>Low to medium</td>
<td>$20,000</td>
</tr>
<tr>
<td>5</td>
<td>Insulation: increased insulation in the independent living units leads to an estimated 30% reduction in boiler house 1 energy costs.</td>
<td>2011</td>
<td>2.75</td>
<td>6.4%</td>
<td>Medium</td>
<td>$10,000</td>
</tr>
<tr>
<td>6</td>
<td>Boiler Variable Speed: through installing Variable Speed Drives in boiler house two, potential savings of 10% to its operating costs may be achieved.</td>
<td>2011</td>
<td>0.08</td>
<td>0.2%</td>
<td>Low to medium</td>
<td>$2000</td>
</tr>
<tr>
<td>7</td>
<td>Lighting: A comprehensive audit in 2014 could reduce lighting related electricity use by an estimated 40%.</td>
<td>2014</td>
<td>1.20</td>
<td>2.8%</td>
<td>Medium</td>
<td>$20,000</td>
</tr>
<tr>
<td>8</td>
<td>Air-Conditioning: replacing boiler house 1 with reverse cycle air-conditioners for heating and cooling increases electricity use for the HVAC system by an estimated 59%. The energy use attributed to boiler house 1 is reduced by 50%. This strategy is linked to the following CHP strategy in reducing electricity sourced from brown coal.</td>
<td>2015</td>
<td>2010</td>
<td>0.07</td>
<td>0.2%</td>
<td>Medium</td>
</tr>
<tr>
<td>9</td>
<td>CHP HWS: Combined Heat and Power gas fuel cells generate 17% of the sites original electricity needs, and provides Hot Water for 40% of the site. The strategy replaces boiler house 1 entirely, (attributing 50% of the energy use reduction from boiler house 1.</td>
<td>2015</td>
<td>3.28</td>
<td>7.7%</td>
<td>High</td>
<td>$30,000</td>
</tr>
<tr>
<td>10</td>
<td>Photo Voltaic Solar Panels: 868 400w solar panels could be installed to meet 44% of the original electricity needs. This would enable self-sufficiency in electricity.</td>
<td>2020</td>
<td>7.64</td>
<td>17.9%</td>
<td>Very high</td>
<td>$200,000</td>
</tr>
</tbody>
</table>

* NB. The air-conditioning strategy also includes the replacement of old air-conditioners with the most efficient models and installations as part of the procurement cycle. The savings in italics indicate costs if initiated in 2010 to replace boiler.

4.6.4. Building insulation (up to 30% of impacts from boiler house 1)

Retrofitting insulation in independent living areas should improve thermal comfort, and provide an energy saving over time. This strategy may also include low-tech shadings, appropriate curtains and special attention to insulate and reflect hydronic heating panels into the rooms. Chapman et al.’s study identified that a ‘typical’ household benefited from net energy savings (metered electricity and gas) of 13% after the installation of insulation (2009). Medium level of investment is required here.

4.6.5. Monitoring and variable speed drive (up to 10% of gas from boiler house 2)

Monitoring the outtake and return temperatures in boiler facilities and utilising a variable speed drive pump may further improve efficiency. The pump speed can be experimented with to
identify the minimum speed required to circulate the water at an appropriate temperature. Note that the age of boiler facilities suggest asbestos could be problematic due to age and a barrier to upgrades. Medium level of investment is required here.

4.6.6. Lighting systems (up to 40% of lighting impacts)

The lighting strategy proposes a comprehensive audit and upgrade to LED lighting throughout the facility. The timeline is proposed as the costs of LED lighting systems continue to be reduced, as this could be high cost if actioned immediately. The lighting upgrade may include additional day lighting, and identify where lighting is not effective (such as hidden fluorescent tubes in entrance to the site). It was estimated that lighting may account for 30% of electricity demand (National Grid, 2002).

4.6.7. Air-conditioning

The air-conditioning (AC) and hot water strategy (described Section 4.6.8) are proposed as solutions in tandem; they enable the decommissioning of one boiler facility. This involves retrofitting independent living areas with 14 of the most efficient ACs (for heating and cooling), and replace existing ACs with efficient models as they are due for replacement. If existing ACs are replaced with the most efficient units, then the operational costs associated with those units may be substantially reduced. This is potentially high cost if undertaken immediately. A more efficient approach may be to stage replacement of existing units as they reach the end of their service lives.

4.6.8. Hot water systems that also generate electricity: replacing boiler house 1 with decentralized combined heat and power (CHP) (generate 17% of site electricity and 40% hot water)

A future orientated strategy proposed to reduce gas use by 20%, and generate 17% of electricity. One boiler house may be replaced by a series of decentralized combined heat and power (CHP) gas fuel cells (like those available from Ceramic Fuel Cells Limited, 2013). At present the technology is available for commercial applications, with plans to move to residential distribution as the price falls with increases in production. This may indeed become a viable alternative in the future with the rise of the fuel cell market to date, cost reductions thus far in the sector, and projections of what the non-automotive fuel cell may indeed look like in the future if favourable conditions exist (Upreti et al., 2012).

4.6.9. On-site energy production (no electricity grid requirements)

This future scenario proposes photovoltaic panels be installed to provide the remaining electricity required at the Melbourne site by 2020. The metrics for the roof top space (see Fig. 7) are roughly:

- 5000 m² north facing rooftop
- 705 m² west facing
- 625 m² east facing
- 6430 m² total rooftop space suitable
- The north facing space could fit 1560 solar panels of dimensions 1560 mm × 1046 mm

The energy demand from the aged care site is estimated to be 429 MWh/year after the previous initiatives have been completed. To generate this amount of electricity requires 1174 kWh/day to be produced in Melbourne. In 2020 a conservative forecast suggests a 400 W solar panel will be available on the market. 734 × 400 W panels — 294 MW system producing 1174 kWh/day in the 4 h of solar producing light available in Melbourne. This system would produce all of the site’s remaining electricity. The estimated cost of the above system would be in the range of $1.6–2 million ($5.50–$6/W). At this time the cumulative cash flow savings would require financing of $935,000 with a cumulative simple payback of just over 4 years (if completed with all strategies).

4.7. Plan execution and management

Although laying out logical areas for attention, detailed development and implementation of sustainability initiatives require dedicated resources. Although this could be achieved through existing organizational leadership, the specific nature of sustainability issues may require dedicated sustainability resources be deployed to oversee plan development, implementation and to track progress.

5. Discussion

The time to respond to the global ecological crisis is relatively short. The Double Diamond method of life cycle and design thinking presented in this paper provides a process to identify practices that can be targeted with the highest impact, based on objective science. It uses design thinking to develop strategies to respond to the environmental crisis in significantly reducing impacts in a participatory manner. The case study enables a theoretical 54% reduction in climate change impacts in the provision of aged care over a ten-year time. The following section reflects on how the Double Diamond process may differentiate from the development of traditional sustainability strategies, and how the process may be suitable for similar projects with respect to reproducibility and validity.

5.1. Reflection on the Double Diamond process

Reflection on the Double Diamond process can occur by teasing out how this approach may have differed to developing traditional sustainable strategies.

The inclusion of LCA within a broad problem solving design process enabled LCA to inform the development of a suitable strategy. The use of LCA as opposed to a simple energy and carbon audit led to the inclusion of food as a significant area of focus. It is assumed that this would be excluded from a traditional carbon audits. If an LCA had been completed in isolation, it is assumed that the organization would have been challenged to develop actions to implement based on the results of the LCA.

The use of social practice theory assisted in framing the LCA results in thematics to enable discussion with the organization. This may have traditionally been techno-centric, i.e. lighting, air-
conditioning and KWh’s, as opposed to the focus on organizational practices such as procurement and financing or menu planning. This reframing was seen as central to enabling the organization to participate in the co-creative ideation process, and enabling socio-technical solutions to be developed.

For the organization, the Double Diamond process can be seen to have shifted their understanding of unsustainability, in the environmental problems they faced. At the outset of the project the organizations environmental concerns were highly visual, such as paper use and the high number of incontinent pads used. The process shifted the thinking of the organization from the visual to the embodied. An unexpected result of the participatory design workshop was being thanked for the informative sessions. The workshops were not developed as educational sessions, however the have had merit in this capacity.

5.2. Validity and reproducibility

The Double Diamond process provides an overarching framework that is replicable. The process has been utilised in a diverse range of projects from informing sustainable decision making for the operation of Davis base in Antarctica which commenced in 2013 (Verghe et al., 2013), to educational settings assisting students designers to reduce carbon emissions via their design work.

The Double Diamond framework, as presented, works across disciplines often with opposing epistemologies, from traditional quantitative scientific approaches dealing with environmental and economic modelling, to understanding day-to-day practice that is largely qualitative and has roots in social science. The overarching framework originated from design, and can be viewed as a quasi-mixed method approach to problem solving that does not have a strong epistemological position at present.

Elements of the process such as environmental and economic modelling can be located within a scientific approach, and are readily replicable. For example, the streamlined LCA process is reproducible, and viewed as appropriate for an internal sustainability strategy. The results of the LCA were cross-referenced with national averages and can be viewed as indicative of where the major impacts within aged care lie for the organisation. The findings could also be generalized to reflect the impact of aged care sites with a similar climate, and energy emission factors to the Victorian grid (1.17 kg CO2-eq/kWh, DfCCSR, 2013).

The participatory design workshops and methods would always be context specific, informed by a critical engagement with the problem at hand, and therefore are difficult to replicate. Approaches to design that attempt to be overly formulaic “explicitly organized, rational and wholly systematic” have traditionally failed (Cross, 2007, p. 44). To illustrate the diversity of potential design workshop methods, three key reference texts on design methods identify 177 methods that could be applied to produce insight into a given problem (IDEO, 2002; Martin and Hanington, 2012; Stickdorn and Schneider, 2010). The terminology of a toolbox of methods is an appropriate metaphor for developing participatory design facilitation in that it resolves on the selection of the appropriate design methods (tools) for specific tasks. The 100 universal methods of design presented by Martin and Hanington (2012) include a schematic to assist in selecting appropriate methods for appropriate circumstances. Developing workshops is a design activity in itself (see for example Cruickshank and Evans, 2012).

The role of internal and external expertise within the participatory design process also adds another challenge in developing replicable processes. The case study was enhanced by the inclusion of external expertise on sustainability, economics and engineering that had answers ‘at hand’ to inform discussion and ideation concepts in the workshops, similarly internal expertise on processes of aged care were invaluable. IDEO acknowledge the requirement for a diverse range of stakeholders and disciplines to be represented in interdisciplinary design thinking (Moggridge, 2008). Our observation was that the participatory design workshops were very similar to running an ideation session in a design studio, except participants were not solely designers. The challenges discussed with regards to validity and reproducibility are representative of applied interdisciplinary work that engages in complex problems.

6. Conclusion

The presented case study outlines the implementation of the Double Diamond process to develop a strategic sustainability plan for an aged care organization. The study contributes to three distinct areas: the aged care sector, sustainability strategies and LCA.

For the aged care sector, the study provides indicative results of the climate change and water use impacts of residential aged care. The results estimated that 42.8 kg CO2-eq emissions are emitted and 1.5 kL of water used for ‘one bed day’ of care. Electricity (43%) and gas (6%) contribute to almost half (49%) of the impact of care. Food was the second highest driver, contributing a total of 40% of climate change impacts. The results are seen as indicative of aged care facilities in Victoria, and international facilities with a similar climate and energy mix. The outcomes of the case study illustrate a sustainability plan that could theoretically reduce emissions by 54% in a financially achievable manner.

The Double Diamond method provides a problem solving process for organizations to develop sustainability strategies based on objective science to significantly reduce environmental impacts. The questioning within the Double Diamond process enables clear contributions from specific disciplines to contribute to a holistic plan. The integration of streamlined LCA into product design is not new, however the emergence of design thinking in business settings provides an opportunity to test out the capacity of LCA within a design process to reduce the environmental impacts in an organizational setting.

For LCA practice, the presented Double Diamond process provides a means to integrate LCA into a creative problem solving process to inform strategic decision-making prospectively within business that may well help contribute to curtailing environmental impacts.

Acknowledgements

The authors would like to acknowledge and thank the following people for their contribution to the project. For their valuable contribution in the participatory workshops, we thank members of the Steering Group committee: Carol Fountain, Robyn Batten, Melissa Nicholson, Santhi Goode, Sally De Visser, Russell Purchase, Chris Wood, Marianne Zarb, Garry Knight, Yvonne Wells, Kerry Whittlock and Aileen O’Rourke. We thank energy efficiency expert Alan Pears, for the completion of the initial efficiency audit of the aged care facilities, and Chris Wood and John Pidoto for their valuable time in enabling the audit. Finally, we thank Andrew Carre from the Centre for Design RMIT for writing earlier publications relating to this document, and Tara Andrews from the University of Western Sydney for assistance in facilitating the participatory workshops.

References

CHAPTER 6: ARTICLE 3 - ES ENACTED WITHIN AN INDUSTRY SECTOR

(PAGES 1-15)

A review of life cycle based ecological marketing strategy for new product development in the organizational environment

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ABSTRACT

Life cycle marketing strategy is emerging as a way for firms to enhance new product development efforts whilst managing ecological impacts. Such pursuits combining life cycle assessment and ecological marketing offer promise when it comes to assisting firms to decrease product based ecological impacts. The current lack of definition has implications for firms running such strategies with potential for adverse outcomes from well-meaning projects ranging from incorrect claims to the market place, through to products that actually contribute to, rather than mitigate, ecological impacts. The first contribution of this paper is the identification of key aspects of the emerging area of life cycle marketing strategy, and where these insights apply in practice. The reason to do this is to create an understanding of life cycle marketing strategy and the extent of issues facing marketers and companies embarking on such strategies. Life cycle marketing strategy is analyzed in the context of a new product development framework, to explore where it may fit within organizations. This is a pre-theoretical inductive framework rather than deductive allowing the model to be flexible and adaptive as further knowledge is uncovered. Investigations identify who or what may drive marketing strategies incorporating life cycle assessment, and how life cycle assessment may integrate into such strategies in organizations engaged with new product development. Insights meaningful to current managerial practice are developed using an organizational environment, life cycle assessment and ecological marketing lens, which derive from and develop the pre theoretical framework. This paper also contributes propositions for further organizational based research, in order to consolidate the findings of this review further with the body of new product development knowledge. Review results, insights and further research is envisioned to assist firms by providing a method to support global efforts in attaining ecological sustainability, rather than adversely contribute to ecological impacts through the marketing process.

1. Introduction

Ecological sustainability is an increasing challenge for organizations, as stakeholder attention on ecological phenomena such as pollution, climate change, drought, food security and peak resource continues to grow (Coombs, 2010). Resource consumption growth can be linked to world population increases, compounded by raw material consumption growth (Carpenter et al., 2011) in Western countries through the excesses of the twentieth century (Matos and Wagner, 1998). As the twenty-first century unfolds, resource depletion will escalate if the developing world (some 75% of nations globally) begin to consume at the same rate as the highest developed countries currently do (UN, 2009, UN, 2013), and as such put further pressure on the Earth’s ecology (Barnosky et al., 2011). References to ‘ecology’ will be used throughout this paper to refer to the Earth’s biosphere and concepts related to it. Elsewhere ‘ecology’ and ‘environment’ are often interchangeable at a philosophical level. To avoid confusion however, discreet references to ‘environment’ will be used only to describe the conditions and influences surrounding business that frame corporate policy.

Whilst the rate of growth in material consumption is a problem for the globe, sustainability has been one approach to combat such ecological pressures in the organizational environment. Common definitions include that of the Brundtland Report, Our Common Future describing sustainable development as “Development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (Brundtland, 1987 pp.

Abbreviations: EM, ecological marketing; LCA, life cycle assessment.
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http://dx.doi.org/10.1016/j.jclepro.2015.02.022
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Although definitions such as this help guide organizations in dealing with ecological degradation from a top level, further definitions, frameworks, principles and indicators that have been developed subsequently to assist in implementing sustainability strategy in the corporate context (Kirkby et al., 1995; Lozano, 2008), include that of eliminating ‘unsustainable’ practises or products (Fry, 1999).

Approaches to sustainability by organizations are, however, still often deficient in delivering what is best for the planet (Clifton and Amran, 2011), which can present real challenges in implementing strategies to tackle ecological issues. Organizational environments for the purposes of this paper are those entities in a definable boundary where organizational activities take place (Zheng et al., 2010).

Organizations must address ecological concerns at a practical and localized level in pursuit of sustainable outcomes. One mechanism that offers hope here is that of the ecologically conscious new product development process and its connection to ecological marketing (EM). EM is often referred to as environmental or green marketing, and is defined as a process of marketing of a product or service on the basis of credentials that offer superior ecological performance or an ecological benefit (Peattie, 1992; Pickett-Baker and Ozaki, 2008).

For the purpose of this paper, new product development is defined as a process of developing new products through a number of defined phases (Cooper, 2008). New product development processes are usually run with cross functional teams such as research and development, design, engineering, manufacturing, marketing and procurement departments (Mishra and Shah, 2009).

Companies take a number of approaches to ecologically conscious new product development, commonly defined as Ecodesign, ranging from improving products individually to building ecological considerations systematically into the development process (Tingstrom and Karlsson, 2006.). Successful new product development linked to EM often hinges upon what approach within this range is taken by technical disciplines delivering products (research and development), as well as how collaboration, communication, common understandings, and management engagement transpires with departments such as marketing delivering EM (Boks, 2006).

Marketing as a process, is the activity, set of institutions, and processes for creating, communicating, delivering, and exchanging offerings that have value for customers, clients, partners, and society at large (Keefe, 2008). At a fundamental level marketing attempts to influence behaviour by leveraging psychological attributes when a stakeholder determines an exchange decision (Ajzen, 1991). At a strategic level marketing is concerned with decisions and planning in regards to this process such as determining functional marketing areas of importance (Zinkhan and Pereira, 1994), market segmentation and targeting or positioning based on a marketing mix (Slater and Olson, 2001). More recently marketing theorists argue that the purpose marketing serves has shifted to be at odds with these definitions and the original philosophies that created the discipline (Webster and Lusch, 2013; Wilkinson and Young, 2013; Thirkell, 2012).

Suggestions have developed that marketing has become too specialized in focusing on small problems and servicing single systems, stakeholders, or foci (Wilkinson and Young, 2013), and increasingly so with an economic rather than a social agenda (Hastings, 2013). By being more specialized and myopic in focus, marketing can lack the ability to tackle larger problems involving the needs and wants of multiple stakeholders operating in a complex network of systems. That said, social marketing has grown over recent years in which marketing technology has been used to solve problems with people and planet in mind (Andreasen, 1994), rather than an economic organizational benefit. By the American Marketing Association definition (Keefe, 2008) this aligns, where marketing is beheld not only to consumers or shareholders, but also society, which in turn mandates sensitivity to systems such as the ecological biosphere in which society operates. Notions of the marketing process operating in and interacting with complex systems is not new and can be dated back to original philosophies defining marketing (Wilkinson, 2012; Fisk, 1967). Without a systems perspective, marketing departments may be risking a lack of capacity to deal with issues such as global ecological crises.

Popular in using EM, a consideration of ecological issues, has grown from this early definition of the concept (Fisk, 1974). Green marketing extended an acknowledgement to act, to proposing combining customer needs, organizational pursuits and ecological requirements for product marketing, deriving from market and legislative pressure (Dam and Apeldoorn, 1996). Greener marketing took a more holistic view where companies take responsibility for the health of ecology and humanity in any marketing pursuit for stakeholders (Fuller, 1999; Charter, 1992) whilst sustainable (Dam and Apeldoorn, 1996) and sustainability (Belz and Peattie, 2009) marketing extended this further to encompass the notion of sustainable development crossing the economic, ecological and social dimensions. More recently Cronin et al. (2011) identified three main areas an organization may attach EM to strategy that services a range of external stakeholders, being green innovation, greening the organization, and green partnerships. With the first of these, firms now regularly attach EM claims to products that communicate credentials of ecological merit (Peattie and Crane, 2005), however it has been noted that more needs to be done in understanding the development process and marketing of such product innovation (Cronin et al., 2011).

There are opportunities now for marketers to influence ecological impact reductions through strategies such as creating default ecologically preferable product choices, creating awareness by educating stakeholders about ecological issues, convincing consumers of the merit ecologically based purchases, and leading by example in organizational business practice (Bocken and Allwood, 2012). Ecological impact reductions connected to such strategies are only clear if they are quantified across the product life cycle. Amongst the rise of EM claims connected to products developed through the new product development process, marketing outputs, or material of a range of mediums produced by a marketing department for marketing purposes in a particular market or markets, linked to the technically oriented life cycle assessment (LCA) method use to quantify ecological impacts is not yet widespread and needs further investigation.

The current International Standards Organization definition of LCA is “[A] Compilation and evaluation of the inputs, outputs and the potential ecological impacts of a product system throughout its lifecycle” (International Organization for Standardization, 2006b pp. 2). LCA can in turn be used to make ecological improvements to products in a transparent and objective manner, thus going some way to help contribute to issues affecting the Earth’s ecological system (Lockrey, 2011). Ecodesign and the new product development process have been connected to LCA for some time through technical functions such as research and development engaging in the principles of Ecodesign (Brezet et al., 1997), however EM has had tenuous links to LCA. Marketing processes that take core elements however from LCA throughout and following new product development is a relatively new area, and is referred to as life cycle marketing strategy (Verghese et al., 2012). A connection to LCA has the potential to provide the marketing process with more systemic ecological relevance. It has, however, been previously noted that very little has been defined as to a marketer’s role, or indeed that there is a lack marketing departmental engagement or understanding in regard to ecological issues (Charter and Clarke, 2008; Petala et al., 2010), a phenomenon that indeed needs more
Firms can view life cycle marketing strategy as a promising procedure in assisting in decreasing the impact of their products on the environment. The contribution of this paper is the identification of key aspects not previously investigated in the emerging area of life cycle marketing strategy. The reason to do this is to create an understanding of life cycle marketing strategy currently, and explore the extent of issues facing marketers and companies embarking on such strategies. Such work is important in that there is sparse information available in describing how marketing departments interact and implement tasks in relation to life cycle marketing strategy. A lack of definition has implications for firms running such strategies, with the potential for adverse outcomes from well-meaning projects ranging from incorrect claims to the market place, through to products that actually contribute more to, rather than mitigate, ecological impacts. Investigations presented in this paper are not merely a description of literature sources. Another contribution of this paper is that life cycle marketing strategy is analyzed critically in the context of where it may fit within organizational environments where new product development processes are conducted. Key insights meaningful to current managerial and functional practices and strategies aimed at mitigating the ecological impacts in the development of products, as well as future directions for research, are derived. It is envisioned that the insights and further research proposed in this paper will contribute to firms engaging in global efforts to reduce the ecological impacts of products.

2. Approach

A model for life cycle based EM connected to the new product development process organizations is visualized in Fig. 1, in order to explore the research question ‘what is critical to life cycle marketing strategy?’ Fig. 1 is a pre-theoretical inductive framework rather than deductive (Sekaran, 2000; Gray, 2004) and is used to help organize the research conducted used throughout this investigation. In being inductive the model is flexible and adaptive, and may change when further knowledge is uncovered. Fig. 1 is designed to help investigate the questions; who has influence within organizations to affect new product development processes; who is involved when LCA is being applied within the new product development process; and how and why LCA is implemented within new product development processes and more specifically connected to EM.

Elements connected to the new product development process within Fig. 1 are mapped within the organizational environment including dependent and independent variables and any moderating or intervening variables. Dashed lines indicate the interconnected variables identified as critical to life cycle marketing strategy, and contribute to how data is compartmentalized throughout this paper.

To understand the logic of life cycle marketing strategy elements within this framework, we must begin with the organizational environment, the context where strategies are developed. A strategy (i.e. to be ecologically responsible) is given to managers of functional departments within an organization (e.g. research and development and marketing departments) to implement. One means of implementing this EM strategy is through the new product development process in which marketing departments generally have a role (amongst other actors such as the research and development department). Functional departments can use LCA as a new product development process to base this ecologically responsible strategy upon, with life cycle marketing strategy an emergent practice of executing EM as a focus.

Summing up, each lens connected to new product development identified to frame investigations of life cycle marketing strategy throughout this paper is as follows:

A. Organizational environment (the context of life cycle marketing strategy, investigated in relation to market orientation, functional departmental influence and departmental collaboration)
B. LCA (the key process used in life cycle marketing strategy, investigated in relation to complexity and focus, tools and products)
C. EM (the focus of life cycle marketing strategy, investigated in relation to organizations, products, consumers and life cycles)

The research in this paper focuses upon the organizational environment, which can be considered according to a social-
cultural-ecological systems model (Brennan et al., 2014) adapted from Bronfenbrenner’s ecological systems model (Bronfenbrenner, 1986, 1992, 2000; Bronfenbrenner and Morris, 1998), as a meso level of investigation. This is rather than a micro (such as the consumer), exo (such as industries or governments), or macro (such as culture, ideology or rituals) level existing in the environment external to a company. Individual actors do interact at all levels of this model, and it is acknowledged that micro, exo and macro influences could affect the way that the perceptions of new product development actors may be framed in planning and implementing life cycle marketing strategy. The aim of this paper is to elucidate development actors may be framed in planning and implementing life cycle marketing strategy. The aim of this paper is to elucidate development actors may be framed in planning and implementing life cycle marketing strategy. The aim of this paper is to elucidate development actors may be framed in planning and implementing life cycle marketing strategy. The aim of this paper is to elucidate development actors may be framed in planning and implementing life cycle marketing strategy. The aim of this paper is to elucidate development actors may be framed in planning and implementing life cycle marketing strategy. The aim of this paper is to elucidate development actors may be framed in planning and implementing life cycle marketing strategy. The aim of this paper is to elucidate development actors may be framed in planning and implementing life cycle marketing strategy. The aim of this paper is to elucidate development actors may be framed in planning and implementing life cycle marketing strategy. The aim of this paper is to elucidate development actors may be framed in planning and implementing life cycle marketing strategy. The aim of this paper is to elucidate development actors may be framed in planning and implementing life cycle marketing strategy. The aim of this paper is to elucidate development actors may be framed in planning and implementing life cycle marketing strategy. The aim of this paper is to elucidate development actors may be framed in planning and implementing life cycle marketing strategy. The aim of this paper is to elucidate development actors may be framed in planning and implementing life cycle marketing strategy. The aim of this paper is to elucidate development actors may be framed in planning and implementing life cycle marketing strategy. The aim of this paper is to elucidate development actors may be framed in planning and implementing life cycle marketing strategy. The aim of this paper is to elucidate development actors may be framed in planning and implementing life cycle marketing strategy. The aim of this paper is to elucidate development actors may be framed in planning and implementing life cycle marketing strategy. The aim of this paper is to elucidate development actors may be framed in planning and implementing life cycle marketing strategy. The aim of this paper is to elucidate development actors may be framed in planning and implementing life cycle marketing strategy. The aim of this paper is to elucidate development actors may be framed in planning and implementing life cycle marketing strategy. The aim of this paper is to elucidate development actors may be framed in planning and implementing life cycle marketing strategy.

3. Data collection

In this paper life cycle marketing strategy was investigated via an extensive review of relevant theories and practice generated by a search of literature sources. Literature research was required to firstly accumulate existing data relevant to this emerging area, and secondly through evaluation of this data to develop new insights and meaning to inform new product development theory and practise. A qualitative and descriptive analysis identifying and summarising life cycle marketing strategy elements has been selected to draw out deeper meaning from the literature as argued by Macinnis (2011). By using the lenses of the organizational environment, EM, and LCA, the commonalities and differences of how firms approach life cycle marketing strategy within the new product development process could be organized and analyzed effectively. Each of these areas have mostly specialized literature and some unique databases, including: ProQuest ABI/INFORM Global, EBSCO Business Source Complete, Informit Business Collection, ProQuest Science Journals, ProQuest Environmental Science & Pollution Management, Informit Engineering, Knovel Environment & Environmental Engineering, Google Scholar, Scopus & Science Direct (Elsevier), Wiley Online Library (Wiley), and Emerald Management Xtra (Emerald). Database searches were complemented by some specialized library searches. Although some databases extended as far back as the 1880s, searches were conducted from 1990 onwards when both LCA and EM started to become specifically prominent, examined and cited in literature sources.

Table 1 details the search terms employed within these databases and libraries, developed to find relevant literature applicable to life cycle marketing strategy, starting with common terms, and following with lens-specific terms. Generated prior to searching, these terms were either direct descriptions of each lens from Section 2, or variations or subsets of these terms. Terms were devised in order to search for texts that had the most relevance to the life cycle marketing strategy. Alternatives to terms in Table 1, with words which had a similar meaning to the ones listed, were also used in the search. Examples of words of similar meaning included instances such as ‘green’, ‘eco’ or ‘environmental’ considered similar to ‘ecological’, or ‘firm’, ‘corporate’ and ‘company’ considered similar to ‘organizational’. Some terms were transferable across databases; while others were more relevant for one theme than another. An example of this is the term ‘marketing’strategy, which resulted in more relevant texts being identified in EM than life cycle’strategy for the LCA lens. In the case of the LCA lens, the term ‘ecological’product resulted in more relevant literature being attained than for ‘ecological’strategy for the organizational environment lens.

Once the databases were appropriately filtered (i.e. timeframes and key words), references of relevance were identified. Articles were determined as relevant to study further when words from key terms (or words of a similar meaning) from Table 1 appeared in either the article abstract or title. Further searches were made via the references contained in key articles, to identify any other relevant data sources for the review to glean more key articles. Some books and trade articles were also physically acquired in order to complement these key electronic articles. The number following the terms in Table 1 indicates the number of articles identified as relevant to that term in the search. There were 149 literature items identified through the search as relevant from 1990 onwards. Some sources were relevant to more than one term.

Literature sources were determined as relevant to either lens A, B or C as per Table 1 (or for some literature sources, more than one lens) in order to manage the data effectively. Each relevant article was then studied in more detail to determine if they indeed did contain substantial research and insights aligned to the lenses of life cycle marketing strategy from Section 2, and thus deemed key articles or not. An interesting component to this was that further material relating to another lens was sometimes uncovered under further examination. As an example of this, one paper by Baumann et al. (2002) was initially identified as relevant to the LCA lens after the title and abstract contained keywords ecological (as environmental), product, development and strategy. On further reading the same paper had relevance to the EM lens (with research on green marketing) and the organizational environment lens (with research on ecological strategy, functional departments, collaboration and stakeholders).

4. Results

In Section 4, life cycle marketing strategy is examined through the lens of the organizational environment, LCA and EM respectively, which covers context, process and focus respectively. Fig. 1

Table 1

<table>
<thead>
<tr>
<th>A. Organizational environment</th>
<th>B. EM</th>
<th>C. LCA</th>
</tr>
</thead>
<tbody>
<tr>
<td>New<em>product</em>development (27)</td>
<td>Life<em>cycle</em>assessment (12)</td>
<td>Ecological*marketing (39)</td>
</tr>
<tr>
<td>Life<em>cycle</em>strategy (2)</td>
<td>Marketing*research and development (5)</td>
<td>Life<em>cycle</em>marketing (5)</td>
</tr>
<tr>
<td>Life<em>cycle</em>strategy (2)</td>
<td>Marketing*strategy (21)</td>
<td>Life<em>cycle</em>strategy (2)</td>
</tr>
<tr>
<td>Ecological*strategy (17)</td>
<td></td>
<td>Ecological*product (26)</td>
</tr>
<tr>
<td>Organizational*strategy (15)</td>
<td>Ecological<em>product</em>perception (19)</td>
<td>Life<em>cycle</em>product*development (8)</td>
</tr>
<tr>
<td>Organizational*structure (13)</td>
<td></td>
<td>Ecological<em>product</em>development (22)</td>
</tr>
</tbody>
</table>

Note: The number in brackets ( ) following each term indicates the number of articles identified as relevant to that search term.
helped determine this lens group in order to investigate what life cycle marketing strategy is, and questions related to it. Overlaps exist between these areas of enquiry, evident where themes from one lens refers to concepts from another lens in the results described in this section.

4.1. Organizational environment as a context for life cycle marketing strategy

The first key lens identified to analyze Fig. 1 was the context of organizational environments where strategies such as life cycle marketing strategy are developed. These environments contain characteristics such as structure, culture, power and politics, which frame the nature of such activities tied to organizational goals and strategies (Pettigrew, 1979). Organizations work toward common goals by implementing strategies, generally at three levels within an organizational structure, being corporate, business and functional tiers, as firms engage with new product development processes (Varadarajan, 2010). A corporate level strategy defines the management of overall goals, objectives and resources required for processes (Varadarajan, 2010). One lens refers to concepts from another lens in the results described in this section.

4.1.2. Functional departmental influence

Over time, various types of market orientation have become a favoured approach across a wide range of business contexts (Goldman and Grinstein, 2010), leading to a rise in marketing departmental influence. As an example, a study of managers from 280 United States and 234 German firms (from a sample of 2610) producing electrical equipment, mechanical machinery and consumer packaged goods highlighted this in detail (Homburg et al., 1999). Marketing departments lead (sometimes with sales departments) in advertising, customer relations, pricing and distribution. With this context in mind, the marketing department would therefore have control of many external outputs if they related to ecological considerations in the context of life cycle marketing strategy. What is more interesting for life cycle marketing strategy is that the managers reviewed in this study regarded marketing departments as having the highest influence on new product development processes and the strategic direction of the business (Homburg et al., 1999). For operations, finance, sales and research and development departments, less new product development and strategic influence was apparent. Summing up, for the majority of the companies surveyed, determining strategy, running new product development and marketing externally, was controlled by the marketing department, and it would follow that the same would be the case related to ecological considerations.

Similarly a study of research and development departments in 128 new product development projects at 114 high technology firms (from a sample of 200) in China showed that research and development departments generally accepted that marketing and research and development departments had equivalent influence in production and technology market orientations. Production orientation is focused on developing products with scalability to mass production, including exploiting the refinement of past competencies (Calantone and Rubera, 2012), reducing costs and building production efficiencies (Deshpandé et al., 2012). Firms with a technology orientation on the other hand build capacity and competencies to innovate with new technology (Deshpandé et al., 2012), including exploratory new product development processes in creating new product options (Calantone and Rubera, 2012) independent of past offerings. Within production and technology orientations research and development departments theoretically have the major influence on the new product development processes as well as any decisions regarding ecological aspects implemented in the products developed.

Since the mid twentieth century, market orientation has covered various business contexts and global regions, giving rise to a growing influence of marketing departments within firms (Goldman and Grinstein, 2010), and on economic business performance (Verhoeven et al., 2011). Even in production or technology based market orientation, marketing departments have an important role to play. That said, the type of market orientation that firms adopt affects the interactions between marketing departments and other functional departments such as research and development, which is critical in determining who makes ecologically based decisions within the new product development process guided by subsequent life cycle marketing strategy.
over new product development processes (Atuahene-Gima and Li, 2003). High technology firms have constantly changing markets, technology turbulence, and a higher proportion of firms take a technology orientation to drive product innovation (Deshpandé et al., 2012). Even in a technology orientation, research and development departments in Chinese firms required on average similar input from marketing departments when running new product development processes (Deshpandé et al., 2012). Consideration of ecological aspects in technology based new product development may follow this departmental dynamic, where marketing and research and development share responsibility. Others have suggested that research and development and marketing departments have different perceptions about the other’s influence and participation in determining new product performance (Atuahene-Gima and Evangelista, 2000). Organizational strategy, product and personal considerations can affect this influence and participation (Atuahene-Gima and Evangelista, 2000). Research and development managers in Atuahene-Gima and Evangelista’s (2000) study considered a marketing department more often a participant in the new product development process when high in influence.

Market orientation appears to have helped elevate marketing departments as a major influence (Goldman and Grinstein, 2010) and lessened the influence of technical functions such as research and development in many activities within firms (Homburg et al., 1999). In a comprehensive study of managers in Germany and the United States (Homburg et al., 1999), a study of research and development perspectives at Chinese high technology firms (Atuahene-Gima and Li, 2003), and an exploration of perceptions regarding departmental influence on new product performance (Atuahene-Gima and Evangelista, 2000), equal if not more influence from marketing as opposed to research and development departments across different organizational activities becomes evident. Such studies demonstrate that marketing departments are an integral component of new product development processes and strategy, and as such must be a key player in life cycle marketing strategy planning and implementation.

4.1.3. Departmental collaboration

A mix of actors (such as marketing and research and development departments) collaborate in the new product development process. Kahn (1996) defines collaboration as a common or shared vision and strategy between groups. For the marketing discipline, cross functional coordination is one of three core principles of the ‘marketing concept’, as well as profitability and customer focus (Crittenden et al., 2011). More technically based disciplines (such as research and development, engineering, and architecture) identify the importance of interdisciplinary coordination in delivering successful projects (Emmitt, 2010; Liu et al., 2011). Potential collaboration advantages or disadvantages have been explored extensively within new product development literature in relation to; dissonance or resonance between collaborating departments, innovation drivers, MOs where collaboration is negative, product performance success, and connectedness to customer needs and/or wants (Calantone and Rubera, 2012; Griffin and Hauser, 1996; Gupta et al., 1986). Collaboration can also add value internally at a firm in tandem when involving external stakeholders in new product development processes (Mishra and Shah, 2009). Evidence of the critical nature of departmental collaboration makes it imperative to understand how it affects life cycle marketing strategy when departments such as marketing and research and development interact.

A study that looked at 96 (from a sample of 202) United States firms conducting new product development projects in heavy construction equipment, electrical equipment, and medical instruments, analyzed the value of collaboration. For firms involved in the study, overall organizational integration, internal coordination between functional departments, integration with external stakeholders (such as customers and suppliers) and proficiency are significantly related to new product market success (Millson and Willemen, 2002). The extent to which these benefits outweigh the costs in collaboration depends on the internal and external conditions in which the firm operates, and the products they procure to markets (Calantone and Rubera, 2012). With this logic, firms looking to market ecologically positioned products with life cycle marketing strategy would need to understand if their product, internal conditions, external market, costs of collaboration and projected return fostered an outcome that made business sense.

Another study highlighted collaborative advantages of 467 (from a sample of 643) completed new product development projects by United States high technology firms manufacturing electronics, appliances, pharmaceuticals, machinery, telecommunication equipment, instruments, air-conditioning, chemicals, and transportation equipment. By increasing marketing and manufacturing departmental integration, greater product competitive advantage and higher project return on investment was achieved, outweighing costs associated with a longer development commercialization time frame (Swink and Song, 2007). In summary, collaboration within a life cycle marketing strategy could potentially take longer and cost more up front, however create the potential to drive competitive advantage and generate greater revenue on an ecological basis, if the market were receptive to such a strategy.

When ecological concerns are included as part of new product development processes such as with Ecodesign, companies take a number of approaches to ecologically conscious new product development. Some look at improving products individually, whereas others look to build ecological consideration into the development process more systematically (Tingstrom and Karlsson, 2006). Approaches can encompass single issue projects, general ad hoc attention without a formal process, formalized attention with the use of tools, and the most comprehensive approach where strategy drives systemic attention of ecological issues (Alakeson and Sherwin, 2004). Whatever approach is taken, a lack of departmental cooperation or little common understanding can be detrimental to the process (Boks, 2006) such as in the use of LCA. Success often derives from collaboration in the use of a common language between departments, cross departmental common knowledge (Pascual et al., 2003), adequate tools to bridge these groups, management engagement, cross disciplinary participation and a well-defined process with milestones that everyone is cognizant of (Boks, 2006). Effective, comprehensive marketing combined with successful collaboration with research and development using systematic methods of delivering products with reduced ecological impacts should be part of a life cycle marketing strategy.

4.2. LCA, a process for life cycle marketing strategy

Second of lens to view life cycle marketing strategy through is LCA, a scientific method tracking ecological impacts throughout a product or service life cycle (Baumann and Tillman, 2004; Curran, 1993; Köpffer, 1997; Heijungs and Guinée, 1992). There are internationally accepted standards for LCA as a process, such as ISO14040:2006 (International Organization for Standardization, 2006b) and ISO14044:2006 (International Organization for Standardization, 2006a) which detail how a product LCA appropriately (Guinée, 2002). Ultimately through such ecological benchmarking, LCA has the potential to create opportunities for the marketing of ecologically preferable products through a life cycle marketing strategy.
4.2.1. LCA complexity and focus
Sustainability is a complex issue, and from a firm’s perspective, deals with multiple foci, such as triple bottom line, dealing with economic, environmental and social agendas. In measuring ecological impacts LCA is more concerned with ecological aspects of sustainability; however social and economic aspects of triple bottom line are often addressed by firms involved with new product development processes. Life cycle marketing strategy derives from an ecological perspective, but may end up covering social and economic issues through marketing outputs that align with aspects of the three pillars of triple bottom line a firm deals with.

LCA originated from being an energy efficiency or accounting method to a more complex multi criteria input and ecological impact analysis (Goedkoop et al., 2009). LCA is now used by firms to analyze anything from transport systems, packaging, appliances, food system, buildings, waste management, to energy grids (Horne et al., 2009; Vergheze et al., 2012; Guinee et al., 2010). LCA has also shifted from being retrospective, relating to known systems and products, to being prospective, in ideating how research and development can limit ecological burdens of products yet to be made.

By definition LCA is a platform to benchmark products to determine the ecologically preferable option, and thus could provide evidence for EM to focus on why a consumer might choose a product developed on ecological grounds. What can be difficult is to convert data from this complex and rigorous method into simple communication, without reducing the scientific credentials. Accounting inventories and the range of ecological impacts applicable to product life cycles makes LCA in a raw form data heavy and complex, something at odds with simple marketing outputs that resonate with consumers. On the other hand LCA data provides an opportunity for marketing departments to connect a complex system problem, being ecological issues, something that the discipline currently lacks the ability to address (Wilkinson and Young, 2013).

4.2.2. LCA as a tool
Technical disciplines such as research and development, design, and engineering at firms have traditionally been more connected to LCA (Pascual et al., 2003). Tasks utilizing LCA have ranged from the specification of products, continuous improvement, and compliance. Departments usually enact tasks utilizing LCA through life cycle based tools within the new product development process (Baumann et al., 2002). Life cycle tools allow a user to input product data, and together with background LCA data determine the ecological impacts of a product. Tools can range from simple life cycle mapping to understand the qualitative life cycle issues involved with a product, to streamlined tools that are quantitative yet use a large proportion of generic life cycle data to make internal decisions, to full peer reviewed LCAs that use mostly primary data and are rigorous enough to make claims to the marketplace (Vergheze and Lockrey, 2012). By simplifying the LCA process through streamlined tools in particular, LCA can become influence a firm’s milestones, key performance indicators, and new product development processes (Lockrey, 2011; Vergheze and Lockrey, 2012; Rio et al., 2013). Through the implementation of life cycle tools (generally within technical departments such as research and development) firms can also start embedding LCA within the organization. As such, marketing departments have an opportunity to use LCA tools independently, or with technical disciplines, in integrating LCA into new product development process within an overarching life cycle marketing strategy.

A range of examples exist where streamlined life cycle tools have helped to make internal decisions and strengthen brand based marketing messages. At Wal-Mart this extended to external parties in the supply chain regarding ecological requirements (ECRM, 2010). Ongoing initiatives by Wal-Mart are facilitated by a streamlined LCA based tool which is promoted broadly to consumers via supply chain transformations. SC Johnson has focused on continuous improvement which has led to reduction in social and ecological impacts in products over time. Subsequently top level messages and standards communicate these changes to consumers (SC Johnson, 2004; SC Johnson, 2010). For Toyota, the process started with a pilot project in relation to packaging, with agreement that there is the potential to broaden how streamlined LCA tools could be applied to other products or processes (Sterling, 2007). BASF integrated streamlined LCA into a broader suite of metrics forming SEEBALANCE®, an analysis examining triple bottom line. SEEBALANCE® is used internally at BASF, and triple bottom line successes are disseminated predominately in trade and academic literature, generally pitched at a business to business audience (Kölsch et al., 2008; Saling et al., 2002; Da Silva, 2008, Ulhiman and Saling, 2010). These four examples show global brands have embraced LCA within the technical functions of the new product development process. However the varying degrees of EM attached to this work is either to promote sustainability capacity, embedded in broader sustainability frameworks, all the way to corporate messages regarding brand. This is distinct from specific product based messages that life cycle marketing strategy would deliver led by a marketing department, generally with a full LCA base.

In another example, the 2000s saw Nestlé’s global team of packaging technologists, designers, and scientists build in-house capacity and understanding of ecological impacts related to new product development processes by incorporating a packaging LCA program called the Packaging Impact Quick Evaluation Tool. By formalizing this tool as a daily part of new product development evaluation, and as an escalation mechanism to higher management, life cycle awareness started to become embedded in the culture throughout Nestlé (Hughson, 2008; Lockrey and Vergheze, 2012). In the past, the organization relied on external expert consultants to explain the ecological sustainability credentials of a product or service, guided by clear protocols as to how to commission and interpret LCAs formulated globally out of the head office in Switzerland. The introduction of the Packaging Impact Quick Evaluation Tool started to shift this process, and build the firm’s internal capacity to incorporate LCA into new product development processes, including a life cycle marketing strategy based on full peer reviewed LCA with baby food packaging (Humbert et al., 2009), and the Nescafé Gold SMART Pack in 2012.

Marketing outputs using LCA are often at a corporate or brand level, or part of broader sustainability frameworks (ECRM, 2010; SC Johnson, 2004; SC Johnson, 2010; Sterling, 2007; Kölsch et al., 2008; Saling et al., 2002; Da Silva, 2008, Ulhiman and Saling, 2010). An opportunity is apparent for marketing departments to engage more with streamlined LCA tools to increase the viability and incidence of life cycle marketing strategy projects at a product level that ultimately then use a full LCA (Baumann et al., 2002; Lockrey, 2011; Vergheze and Lockrey, 2012; Rio et al., 2013). Life cycle marketing strategy could achieve for marketing departments both discrete ecological marketing outputs for consumers, as well as a connection back to the bigger, more complex problems related to ecological crises now evident to society.

4.2.3. LCA at a product level
Ecodesign has long included LCA a part of the new product development process at organizations. In the EcoIteDesign program funded through the Australian Government in the early 1990s, firms looked at how LCA could be used as a decision making tool for ecologically preferential new product development outcomes (Lewis et al., 2001; Gertsakis et al., 1997). The research outcomes
tended to focus the ecological analysis to design and engineering processes and the products they developed (Sweatman and Gertsakis, 1997; Lewis et al., 2002), rather than marketing departments and how they might engage with LCA within such projects. Further work saw Edodesign evolve to use LCA in an integrated form linking ecological, economic, and strategic considerations within new product development processes. Concepts linking these areas included internal and external value chains, managerial needs, research and development, customers, and policy makers (Pascual et al., 2003). Effective communication of LCA results to this varied stakeholder group was delivered via cost based product models (Wever and Vogtlander, 2013; Vogtlander et al., 2002). LCA has not only become a benchmarking tool for key product development stakeholders, but in one instance at Philips, a management benchmarking tool external to new product development informing decisions about product options compared to competitors (Wever et al., 2007). The role of marketing departments in relation to the ecological product development process, value chain considerations, and competitor benchmarking is not articulated in as much detail as technical or management implications in the extensive Edodesign work to date, and as such life cycle marketing strategy is somewhat detached from this work.

In an attempt to bridge this strategic gap, multinational Unilever has successfully built ecological framework within their strategy that has in turn influenced functional strategies that control new product development projects (Petala et al., 2010). Such strategies require managers running new product development projects to take responsibility for product environmental credentials, facilitated by tools such as Unilever's Brand Imprint which now includes ecological benchmarking capability using LCA. Interestingly in this context a large proportion of 112 innovation briefs analyzed for new products did not have the relevant section completed on ecological concerns (Petala et al., 2010). Briefs that were filled in to address ecological issues contained almost no benchmarking frameworks. As previously mentioned, marketing widens global organizational influence, so it is no surprise project leaders interviewed for these product projects at Unilever were from marketing departments. All interviewees considered the ecological issues section on innovation briefs as a role for technical departments. Organizational strategy demanded managerial responsibility for ecological concerns, while marketing engagement i.e. product development managers, had not shifted to align with this strategy (Petala et al., 2010). Moreover, LCA on new product development projects remained low and can explain the lack of product based life cycle marketing strategy projects at Unilever. More recently there is evidence that LCA is being trialled prior to a decision to start new product development at Unilever, so that ecological innovation can be scoped before a business case is built for a product (Bocken et al., 2012), which often utilizes the expertise of the marketing departments. This scoping process, along with clear ecological targets, and combined with successful implementation and use of Brand Imprint through marketing departments, may well lead to successful life cycle marketing strategy projects without the issues noted previously.

Another significant overlap between LCA attached to products and marketing does already exist when firms use ecological labels attached to ecological product declarations (usually defined as ‘environmental product declarations’) as defined by the standard ISO14025:2006. Ecological product declarations require an LCA of the product being labelled in line with agreed product category rules defining how the LCA is conducted (International Organization for Standardization, 2006b). Ecological product declarations have previously been voluntary, however France has now introduced mandatory labels on fast moving consumer goods, and other regions such as Japan and the European Union will shortly follow suit (Schenck, 2009). As a standalone label this provides consumers with ecological information much like a nutritional label or manufacturing label, output for marketing departments to utilize within a life cycle marketing strategy. As national legislation for ecological product declarations and associated LCA based eco labels increases, they could be used as part of more sophisticated marketing, with opportunities for a range of other outputs based on LCA data developed through a life cycle marketing strategy.

4.3. EM and a focus for life cycle marketing strategy

Finally the third lens through which to look at life cycle marketing strategy is that of EM. Focus by marketing departments has increasingly concentrated upon economic measures such as growth, profits, cost reduction and shareholder return, rather than social stakeholder metrics such as well-being, health, and biodiversity (Hastings, 2013). In contrast to this trend, firms using EM have tried to take an ecological angle and paid less attention to the social and economic components of triple bottom line (Simpson and Radford, 2012; Frame and Newton, 2007; McDonald et al., 2009; Tanner and Kast, 2003; Ritch et al., 2009). EM claims linked to new product development outcomes highlight the attributes of a product that are ecologically preferable to consumers (Peattie, 1992) and can lead to products with a competitive market advantage (Porter and Van Der Linde, 1995).

Alternatively, claims presented in support of ecologically marketed products can be - on the other hand - be unsubstantiated or spurious (Davis, 1992), disconnected from improvements needed for global ecological problems (Brennan and Binney, 2008; Peattie and Peattie, 2009; Schaefer and Crane, 2005), or even void of marketing or ecological philosophy (Peattie and Crane, 2005). Such issues with EM can lead to various levels of ‘greenwashing’ which drives consumer confusion, a lack of trust, some consumers looking beyond EM for validity, with others not believing claims at all (Simpson and Radford, 2012).

The importance of key stakeholders, such as marketers, understanding ecological information has been identified as key to supporting successful ecologically conscious new product development processes (Aschehoug et al., 2012). Previously firms may have neglected including the right stakeholders in developing this information leading to ineffective decisions with regard to ecological impact mitigation (Polonsky and Ottman, 1998). Life cycle marketing strategy can help focus marketing departments in turning best intentions into substantiated and trust worthy marketing outputs that connect to consumer and societal mandates for such ecological improvements.

4.3.1. EM from an organizational level

EM can combine anything from LCA, eco labels, environmental product declarations, pollutant release/transfer registries and macro-evaluations of industry sectors (Kaenzig et al., 2011). Integrated, consistent ecological evaluation frameworks catering for macro level issues such as firm operations, to micro level issues such as products, can help to create a consolidated market message (Kaenzig et al., 2011; Rahman and Post, 2011). Life cycle marketing strategy is one such mechanism with which marketing departments can use sophisticated marketing methods linked to credible ecological data from LCA for a credible market message, and help in the need to align with broader organizational sustainability strategy (Peattie, 2001).

A recent example exploring organizational approaches to EM in the German food industry identified four ecological sustainability marketing strategies, being performers, followers, indecisives and passives. Of 384 respondents (from a sample of 3585), 27% were identified as performers, incorporating very high social and
ecological quality attributes to strategy, including the integration of life cycle considerations. 40% were found to be followers, and 23% were indecisives, incorporating some or little ecological and social attention within marketing strategy (Belz and Schmidt-Riediger, 2010). The question remains why only a limited number looked at life cycle issues. It could be related to the fact that the research identified various external stakeholders such as consumers, retailers, competitors and legislators, brand profiles, as well as the beliefs, attitudes, perceptions and expectations of internal stakeholders as playing the decisive role in marketing outputs in this sector (Belz and Schmidt-Riediger, 2010). Performers and followers perceived a higher pressure from these issues and stakeholders than the indecisives and passive, with consumers and management having the highest influence on strategic decisions. Based on similar market conditions the researchers believe the four ecological sustainability marketing strategies may apply to non-food sectors (Belz and Schmidt-Riediger, 2010). Summing up, firms instigating life cycle marketing strategy could well do so because of pressure from and ideas of various internal and external stakeholders, with brand alignment forming a key component of that strategy also.

4.3.2. EM delivered to consumers
Insights discussed previously from the German firms producing food products show some consistency with the perspectives of 6498 United States consumers buying grocery products in a Deloitte (2009) study. Only a small proportion of these consumers actively and consciously buy ecologically (22%), far less than those looking for (63%) or aware of (75%) ecologically conscious products (Deloitte, 2009, p. 7). For both German firms and United States consumers, there are indications that both have similar interactions with ecologically conscious products. A small proportion actively buys or develops ecologically conscious products, even with a large proportion aware of or looking to engage with ecologically preferable products. Such evidence demonstrates a gap between activity and intent, which presents an opportunity for life cycle marketing strategy to encourage firms and consumers alike in increasing the uptake of ecologically conscious products.

Another piece of research suggests that, that pro-environmental and pro-social purchasing decisions may indeed evoke a desire for status, often reserved for selfish rather than altruistic purposes (Griskevicius et al., 2010). Such counter intuitive findings make it clear that marketers need to understand the motives with which consumers look to purchase products developed through life cycle marketing strategy, and cater for these needs accordingly. According to even more recent research, valid product information and credible delivery of such data is paramount to winning the trust of consumers (Chan and Coulthard, 2012). When an ecological element is part of product offering, evidence based ecological information is also important to consumers (Ottman et al., 2006). LCA has the potential to provide this valid base for marketers to objectively quantify the ecological credentials of a product. In doing so life cycle marketing strategy could deliver outputs from the marketing fraternity that provide consumers with piece of mind that their purchasing decisions reduce environmental impacts.

4.3.3. EM at a product level
Top level ecological evaluation frameworks can lack specific marketing outputs attached to products that connect with consumers. Product level marketing outputs can affect a customer exchange at the point of product purchase, affecting sales, cash flow and firm stock value (Ataman et al., 2010; Vorhies et al., 2009). Deloitte (2009) recommended in a study for the Grocery Manufacturers Association in the United States that defining product value as aligned to brand promises is still critical to EM, as previously mentioned for the German food industry. Additionally, an integrated marketing plan with every important marketing output is imperative in reaching ecologically aware consumers according to Deloitte. The target consumer for EM has tended to be limited to socio-ecological ‘actives’, highly engaged with ecological issues (Schmidt-Riediger, 2008). Deloitte suggests however that consumers who have the intention to buy often do not buy ecologically preferable products. Life cycle marketing strategy could help bridge this gap with product specific marketing outputs aligned with brand value that resonate with such consumers, so that buying intention for ecologically conscious products is realized. Moreover life cycle marketing strategy could convert follower, indecisive and passive firms into product sustainability marketing strategy performers, as identified by Belz and Schmidt-Riediger (2010).

Product based EM can be positioned to engage a range of target audiences, such as consumers, business, government or technical specifiers and designers. ‘On product’ EM remains predominantly left to eco labels including ecological product declarations, self-declarations, and other third party labels that form the core marketing outputs for ecologically conscious products (Res and Baumann, 2007). Few eco labels are LCA based, although with the rise of ecological product declarations this is set to change. As previously stated, stand-alone eco labels remain a single marketing output. Without other marketing outputs, labels could be considered one dimensional from an EM perspective. Life cycle marketing strategy can fix this problem by addressing complex ecological issues with multiple marketing outputs that are linked to brand value.

4.3.4. Life cycle as a basis for EM
Life cycle tools can embed sophisticated ecological sustainability understanding and process capability within organizations. Such capacity opens the possibility of innovative EM projects beyond eco labels. As an example, Nestlé Oceania (Nestlé), users of the LCA based Packaging Impact Quick Evaluation Tool started to understand that the tool provided the bridge for technical people to talk to marketers. Conversations ensued in regards to how to implement the technical details of LCA into marketing outputs. Conversations with upper management in turn led to a project where marketing strategy informed the new product development decision making (Lockrey and Verghese, 2012; Lockrey, 2012) beyond the eco label approach in a rare example of product based life cycle marketing strategy with the Nescafé Gold SMART Pack in 2012.

Following an analysis with the Packaging Impact Quick Evaluation Tool, an integrated marketing and procurement program for Nestlé’s Nescafé Gold SMART Pack was planned including a LCA project with the Centre for Design and Society at RMIT University in Melbourne, Australia. The Centre for Design and Society is a research group that often collaborates with industry to provide comprehensive ecological sustainability analysis, tool development, Ecodesign advice and strategy underpinned by various forms of LCA (Verghese and Hes, 2007). Nestlé’s commissioning of the project signalled the first time Centre for Design and Society had been actively included in such a sophisticated life cycle marketing strategy. In order to understand the ecological impacts of two packaging formats and substantiate marketing claims, Nestlé commissioned the Centre for Design and Society to compare the product life cycle of a glass jar and laminate pouch packaging system. Reporting was independently peer-reviewed and compliant with the ISO14040:2006 and ISO14044:2006 LCA standards. Marketing and procurement strategies ran prior, in parallel and following the LCA research.

Marketing personnel from Nestlé commissioned the project and developed a clear plan on what tasks were required to align with
make about Fig. 2 is that from the results in Section 4, it is clear that the link between research and development and new product development with an ecological agenda is well known, covered extensively in the Ecodesign literature over a long period of time. This is indicated by the link reverting to a solid line in Fig. 2. It also became clear through Section 4 that actors external to the organization required attention in regards to their influence on life cycle marketing strategy, namely suppliers, government, and consumers, represented by the numbered points next to links between these actors and marketing departments.

Most of the insights derived from Section 4 that appear in Fig. 2 do however revolve around the marketing department and their links to management, other functional departments, or processes. These insights are detailed below in regards to where each point relates in practise within the organisational environment using Fig. 2, as well as any links to the external environment, with discussion as to where future research may be focussed for each insight. The contribution of this paper can be summarised as the following insights relating to the practise of, and further research into life cycle marketing strategy:

A1. Organizational and managerial ecological proactivity and competency
A2. Market orientation influencing ecologically conscious product development
A3. Marketing influence within firms
A4. Organizational approaches to ecological conscious new product development
A5. Collaboration as an enabler
B1. Simplification of LCA data for increased internal adoption
B2. LCA as a basis for marketing solutions for complex problems
B3. LCA autonomy or outsourcing by marketing departments
B4. LCA tools and the functional requirements for marketers
B5. Ecological product declaration data synergy to a range of marketing outputs
C1. The role of internal and external validity of ecological data
C2. Alignment of marketing and brand strategy regarding ecological issues
C3. EM as multi marketing outputs
C4. Closing the gap between intention and initiation of ecologically based purchasing
C5. Key components of successful strategies

From a corporate and business management perspective, firms are often at different levels of sustainability competency and proactivity at all levels vertically down Fig. 2. As such new product development processes linked to EM will have different management and departmental influences in how a life cycle marketing strategy may be set up. Further research should document how engaged, proactive and competent managers at an organization need to be to implement life cycle marketing strategy, and whether there is a difference of these elements generally between companies that do and do not use life cycle marketing strategy (A1). Likewise, organizational approaches to new product development linked to ecology range from single issues, general ad hoc attention, formalized attention, to systemic strategic attention. Future research would be helpful in examining what approach company management engaged with life cycle marketing strategy take, if there is a progression between of level of approach needed before life cycle marketing strategy is possible, and if the more sophisticated approaches require the simpler approaches first (A4).

When considering the link between corporate or business managers and the marketing department, the market orientation of a firm can determine the way that business processes critical to life cycle marketing strategy are run, and the power of functional
departments involved in such processes. Researchers need identify which orientations are more likely to foster or limit LCA based marketing in relation to orientation affecting new product development processes, determined by corporate strategy and departmental power as represented in connections between management and various functional departments in Fig. 2 (A2). Firms have also devoted considerable effort in aligning with consumer interest in sustainability through frameworks at a brand level, something life cycle marketing strategy would likely need to compliment in order to be part of a holistic ecological agenda. Investigations are suggested to identify how alignment of ecological strategies are planned, implemented, and then reviewed to measure success through vertical tiers represented in Fig. 2. Such work would help organizations link brand to product life cycle marketing strategy through a life cycle marketing strategy, essentially a vertical alignment with product-based ecologically marketed outputs (A1, A2, C1, C2, C4, C5). Furthermore, research into the perceptions of stakeholders, from scientific credentials, something LCA can assist marketers in doing with more effectively (C2).

Moreover, EM positions products with regard to ecological credentials, something LCA can assist marketers in doing with scientific validity, along with valid delivery and/or understanding (both internal and external of firms) to increase consumer trust. More specific research into the perceptions of stakeholders, from management through to the consumer, as to the validity, preferred delivery mode and general understanding of LCA connected to products would formalize what marketers need to include in life cycle marketing strategy, and how to deliver it (C1). There still remains a gap however between both consumers seeking to actively buying ecologically conscious products, and firms uncommitted to those producing them. In order to encourage more uptake of ecologically conscious products, firms could start to combine brand alignment with product-based ecologically marketed outputs through a life cycle marketing strategy, essentially a vertical alignment between strategies of the tiers in Fig. 2. Where this has been done successfully, or not, research should be commissioned to explore the way that companies attempted to exploit this opportunity, as well as the key steps in this process (C5). Consumer research should explore how life cycle marketing strategy may shift purchasing decisions, or not, in regard to whether marketing connected to brand, product or a combination are the strongest drivers of such a shift (C4).

Point A2 also relates to the link between corporate or business managers and the research and development department, as do points C1 and C5 to any collaboration between marketing and research and development departments, so cross departmental research is most likely required in these instances for the future. Moreover points C1, C4 and C5 also have a relationship with actors in the external environment, and as such require participants in further research external to organizations, such as consumers, suppliers and government. The latter two of these insights also link to the marketing department administering parts of the new product development process, and as such require further examination of the tasks that are carried out.

In the case of the marketing department discreetly, complexity and the scientific nature of LCA are difficult concepts, particularly as simplicity is often an objective of marketing outputs. Investigations as to the ways in which companies have simplified LCA data has been done, particularly in the Ecodesign field, however more research is required at companies implementing life cycle marketing strategy to identify how this is done when a marketing department is involved (B1). Although LCA is complex there is an opportunity through life cycle marketing strategy for marketing departments to connect to complex problems such as ecological crises, something that they currently lack the capacity to do. Again in the instance where marketing departments are engaged in life cycle marketing strategy, research should be conducted as to how these groups find a connection to complex problems compared to when they are not using life cycle marketing strategy. Moreover, research should tackle the level of redundancy departments not engaged with life cycle marketing strategy feel when tackling such issues, compared to those that are using life cycle marketing strategy. There is the potential to expand this to explore external actor's perceptions of such organizations regarding their ability to engage with complex problems (B2). There are also suggestions that an integrated marketing strategy hitting a range of marketing outputs on ecological grounds could engage consumers more effectively than the traditional output of eco labels. The mix of such marketing outputs should be measured and compared by researching various firms using life cycle marketing strategy, to contribute to a common framework/s in planning life cycle marketing strategy as per the organizational environment in Fig. 2 to be successful externally with stakeholders (C3).
On top of points C1 and C5 already discussed regarding collaboration, departments involved with new product development processes interact collaboratively or operate disconnectedly as represented by the horizontal connections at a functional level in Fig. 2. Collaboration will influence how the new product development process linked to EM is run under a life cycle marketing strategy, affected by product, internal, external, and collaboration cost conditions. Collaboration should be further scrutinised where life cycle marketing strategy is being implemented, to determine if cross departmental common language, common knowledge, bridging tools, and participation can deliver competitive advantage, increase revenue, larger brand value along with reduced ecological impacts (A5). For instance technical disciplines traditionally conduct or engage with LCA, which can start to explain why there is a lack of life cycle marketing strategy currently. LCA has been a familiar component of new product development processes connected to Ecodesign, top level ecological reporting, and supply chain ecological continuous Research into companies that are running life cycle marketing strategy should be conducted to see whether marketing departmental alignment with other LCA capable departments or autonomous marketing departmental LCA is preferred, and how a transition to either of these options or a combination be achieved. In Fig. 2 this would see LCA tools stay with research and development and a link to marketed used, a combination, or the tools moving from research and development to marketing completely. Research into the success of tools that get marketing ‘buy in’, such LCA in project scoping and business case development is also warranted, in regards to how these add value to a life cycle marketing strategy (B3).

EM has overlaps with LCA, and with the rise of ecological product declarations, is considered an LCA based eco label in isolation. However, with the uptake of these labels there is an opportunity for marketing departments to combine the scientific understanding behind these labels into broader life cycle marketing strategy with a range of outputs to engage consumers. Research as to the synergies between ecological product declaration information, usually generated within research and development, and other types of marketing outputs is warranted. Further research as to the requirements for such information to be utilized in processes used by marketers is also required (B5). Point B5 is also linked to the marketing department administering parts of the new product development process, so the further research discussed would also need to examine how these tasks operated in conjunction with the research and development collaborative dynamic.

As well as insights B5, C2, C4 and C5, marketing departments can often influence a business day to day more than the technical disciplines who generally manage LCA (such as research and development departments), whether in the customer orientation, or even more technical production or technology orientations. As such marketing departments must play a key role in life cycle marketing strategy, something that could be further investigated in relation to how marketing influence affects the uptake of LCA, and if a more or less powerful marketing department is positive for life cycle marketing strategy to be considered, implemented, and then successful (A3). Marketing departments must engage with LCA for life cycle marketing strategy to become more widespread. Streamlined life cycle tools utilized by technical disciplines to integrate LCA into business processes could provide marketing departments with a platform to include LCA more within EM and directly address ecological issues in the process. Streamlined LCA tools could be investigated further to understand what functionality is required by marketers, whether current tools are adequate or there needs to be customized solutions for marketers. LCA tools and full LCA should also be examined as to how they link to the processes marketers implement within marketing practise (B4).

The insights in Section 5 provide evidence that firms are starting to look at combining product-based EM with LCA using a sophisticated suite of marketing outputs. However this life cycle marketing strategy process is not yet well documented and needs to be examined further as the areas for further research suggest. Insights from each lens used in Section 4 contributed to create a better understanding of what is currently happening and required for the future of life cycle marketing strategy. Results and subsequent insights discussed in this review are limited to trends relevant to life cycle marketing strategy from current literature including examples of life cycle marketing strategy in practise. Through further investigations within organizational contexts exploring the insights articulated in Section 5, the refined framework in Fig. 2 will develop further to assist firms attempting to combine LCA with EM as part of life cycle marketing strategy linked to the new product development process, to consolidate or modify this theoretical framework.

More detailed and specific research suggested in Section 5 will further articulate how LCA can fit into marketing connected new product development effectively and successfully. Specifically these would need to be investigations in an organizational context relating to corporate or business management, the link between these management teams and marketing and research and development departments, marketing departments discretely, collaboration between marketing and research and development departments, and the processes marketing use through new product development. External actors such consumers, government and suppliers will also play a role in this research based upon their influence on life cycle marketing strategy. One way to start doing this is through the exploration of organizational case studies (Woodside and Wilson, 2003; Yin, 2003; Woodside, 2010b; Gillham, 2000) based upon the suggested further research in Section 5. Mapping industry case studies could extend the research of this paper, by highlighting any commonalities, differences, or patterns related to life cycle marketing strategy, with the aim of developing theories or conclusions containing accuracy and complexity, and potentially generality (Woodside, 2010a). The core aim should be to develop a consolidated theoretical framework for life cycle marketing strategy (or a contribution developed identifying areas for further research in anticipation of developing such a model), something in which Fig. 2 has progressed towards. By investigating life cycle marketing strategy in this way, it is envisioned that such a model for intelligent practice will help marketing departments mitigate the ecological impacts in the process of delivering products they help develop and then market.

6. Conclusion

The current lack of definition of life cycle marketing strategy has implications for firms with potential for adverse outcomes from well-meaning projects ranging from incorrect claims to the market place, through to products that actually contribute to, rather than mitigate ecological impacts. On that basis, the review conducted in this paper is timely in mapping life cycle marketing strategy as having a connection to new product development processes and requiring an understanding of and links between (A) organizational environments, (B) LCA, and (C) EM. The contribution of this paper is the identification of key aspects of life cycle marketing strategy when organizations conduct life cycle based EM within new product development process, where these insights relate internally and externally to an organization, and where further research must be conducted to consolidate these insights into a formalized articulation of life cycle marketing strategy as a way of embedding LCA into marketing outputs (Lockrey and Verghese, 2012) connected to the new product development process. The insights in this paper
were developed in order to assist marketers and companies embarking on such strategies. By commencing organizational research proposed in this paper, outcomes will further assist managers at firms to better plan and implement life cycle marketing strategy activities within their given context. Insights will in turn contribute to organizational strategies aimed both to further progress the ecological sustainability of products, and global efforts to reduce ecological impacts.

Acknowledgements

The author would like to thank Professor Linda Brennan, Associate Professor Karli Verghese, Andrew Carre and Nguyen Hong Hai Dang of RMIT University for their advice, reviews and support in the development of this paper.

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CHAPTER 7: ARTICLE 4 - OUTCOMES AND AFTER-EFFECTS OF ES (PAGES 42-50)

At the time of the inception of the Centre for Design in 1989, the world was changing when it came to approaching sustainability.

Global sustainable development: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" was gaining momentum off the back of the Brundtland Report, "Our Common Future". The formative musings of Papanek about the role of designers in environmental sustainability started to shape the propositions of influential thinkers such as Whiteley and later Hawken, Lovins, and Lovins. Academia began to incorporate programs that addressed the sustainability issues relevant to design. Universities and research institutions in Europe, such as TU Delft, Danmarks Tekniske Højskole, Technische Universitat, and Netherlands Organisation for Applied Scientific Research, led the way with integrated tools, methods and resources in combating environmental issues through design. However there was much to be done in practice, with a lack of industry based projects aimed at redefining the influence of design on sustainability problems.

One of the cornerstones of the research that was undertaken by the Centre for Design concerned a hands-on approach to product design, underpinned by life cycle approaches. Original projects facilitated through the EcoReDesign program from 1994 to 1997 were heavily focused upon the redesign of existing consumer products, whereby material and/or energy efficient outcomes were delivered to the market place. More recent research at the Centre adapted the life cycle modelling and thinking developed during EcoReDesign to strategic and service decision-making, marketing, and tool-based outcomes that informed or complemented product development.

A multi-disciplinary team formed the backbone of expertise required for EcoReDesign projects, working in partnership with manufacturers, to reduce the environmental intensity of their products, processes and/or services. Approaches were developed, insights gained and lessons were learnt from these projects. This paper presents personal reflections by those who have all played critical roles over the 24 years of research undertaken by the Centre. It details how the EcoReDesign program went on to inform subsequent projects and research, influence Government policy, and affect product design and manufacturing more widely, both in the short and longer term.

**EcoReDesign – The Fundamentals**

Funded through the Australian Commonwealth Government, the EcoReDesign program brought together interdisciplinary 'EcoDesign' teams comprising designers, environmental researchers, engineers, social scientists, marketing experts and other related professionals. Teams worked together to research, develop and design products with leading manufacturers that improved environmental design and economic performance. Industry partners included Australian household names such as Blackmores, Schiavello, Caroma, Southcorp (Dishlex), and Kambrook. Teams produced prototypes through to commercialised products such as vending machines, office workstations, packaging, printer cartridge recycling kiosks, shower heads, dishwashers and kettles. The main objectives of these designs were to improve energy efficiency; minimise waste and conserve resources; use recycled material; design for recyclability; educate and engage consumers; reduce greenhouse gases; and, produce commercial outcomes.

Importantly, the key method of analysis used to verify environmental benefits of EcoReDesign designs was life cycle assessment (LCA). LCA, an objective scientific method to identify environmental impacts of products, services and systems, is now a widely accepted methodology adopted within the corporate sector. However, at the time, LCA was only just being considered by organisations. The method originated in analysing product systems retrospectively; once a product had come into being LCA was used to make claims about its environmental credibility. The problem here was that a product had already been manufactured or procured, with environmental impacts designed in. The design stage is often considered the best time to consider environmental aspects, designers “locking in” up to 70% of the environmental impacts of a product. EcoReDesign was one of the first programs where LCA shifted to the design stage, to make informed decisions about the environmental...
The processes we developed would bring up technical issues that may not have been discussed previously. Cross-disciplinary perspectives were considered. Fundamental were models reflecting the physics and chemistry of a context, and the use of benchmarking. There was a great deal of respect for each other, and a process by which you drew out the fundamentals of what was happening environmentally. This meant that teams didn’t jump to conclusions too early. There is a rigour in this process, and an ability to take on the challenge. It is the embracing of these processes that drove the innovation.

This demonstrates how EcoReDesign combined LCA with a multitude of other design techniques, including the exploration and application of fundamental physics, product design, laboratory testing and field measurements, alongside multidisciplinary workshops and market analysis. Fundamentally, LCA helped develop an understanding of the life cycle of products and how to reduce their environmental impact. At the same time teams created commercially viable outcomes. Mathematical analysis allowed participants to understand the fundamentals prior to prototyping, laboratory analysis allowed the products to be benchmarked, and field work allowed for measurements and testing of the prototype product, to see what happened in reality. Moreover, this suite of techniques ensured that the program’s main objectives could be met. We will later discuss elements of these other techniques as they relate to the products that were included in the EcoReDesign program.

Commercial Wins
In the late 1980s, the Dishlex dishwasher manufactured by Southcorp sold at a low price and also had a poor reputation for performance. Dishlex faced a challenge: should they design a new product, or just rebadge an imported product? The organisation chose to work with Centre for Design through the EcoReDesign program to design a new product, along with Mark Armstrong and the team at Blue Sky Design. The result, according to Pears, “was a very exciting and challenging project that delivered Australia’s first 6 Star energy, AAA water efficiency rated dishwasher”.

This result was achieved through a variety of mechanisms and approaches that took into consideration acoustic, energy and water performance. As Pears recalls:

I was asked to look at the energy and water performance. I measured and calculated the volumes of reservoirs, pipes and fittings, looked at flow restrictions, then developed a computer model to simulate its performance minute by minute. I was very pleased when the model closely matched the actual performance of a reference machine.

The computer models that Pears developed were based in excel spreadsheets, covering the energy use of products, minute by minute. Dishlex used these
Excel models to help optimise their appliance. This streamlined the previous practice of making prototypes of the product and testing performance, without the prior input of systemic performance modelling. The team also created an understanding of the design specifications of the dishwasher (e.g. size of pipes, connections, spray arm, etc). By using the specification and fundamental physics to measure where water flowed, they were able to identify flow resistance, length and sizing of pipes that could be changed to increase water efficiency.

Noise was also an issue for the dishwasher. Pears’ energy modelling combined nicely with an acoustic analysis. Noise in a dishwasher is generally generated through connections (e.g. thermal bridges), the location where most heat loss also occurs. Working together the team investigated different soundproofing materials and how they could reduce noise and energy simultaneously.

With this design approach, supported by comprehensive marketing, the Dishlex dishwasher went from being a very basic, low cost option, to enjoying long-lasting commercial success at a price premium. Dishlex became an example of the “Samsung effect” in local terms, being a capitalisation of the combination of superior technology and sophisticated marketing.15 Many will remember the now famous “Disssshlex” television commercial tag line, reflecting the quietness of the product to families around the dinner table at prime time television advertising slots. With massive market share increase and various acquisitions, Dishlex has enjoyed longevity. The brand is now owned by Electrolux as one of their high volume performers in a successful stable of dishwasher brands. Moreover, the Dishlex dishwasher should be considered the crown jewel of the EcoReDesign program from a commercial, environmental, and design perspective.

Success or Failure?
Clearly the Dishlex case demonstrates the commercial impact of federal funding for innovation and environmental design; something quite poignant on which to reflect in the current political climate.16 However, not all projects enjoyed such commercial success, and as such, may provide lessons for future programs. For instance, some projects only reached a concept or prototype stage, with very few of the industry partners following through to a mass-produced commercially beneficial outcome.

Of the projects that are considered a success globally, the Kambrook Axis kettle is certainly held in high regard for its contribution to design, to sustainability, behavioural change; in practice, and, regarding collaboration.17 It was the first kettle to include a petrol gauge-like indicator to communicate water level and reduce double boiling; a corded hub to render the kettle cordless; double walls to reduce heat loss; smart control systems; more elegant aesthetics; design for disassembly; and better grade of polymers.18 These innovations derived from market research, thermal modelling, LCA, and clever design, with Kambrook teaming up with Centre for Design, Millard for production computer-aided design, and the design team at Form consisting of Gerry Mussett, Paul Taylor and Scott Ballis. The Axis kettle thus provided a platform for both technical efficiency and prompts for consumer behavioural change and it was lauded as an exemplary EcoDesign outcome for years afterwards.

However, these innovations translated to extra cost for the Axis kettle, which created a problematic commercial context. Complications derived from Kambrook requiring a “boat” style petrol gauge to indicate water level. This added a costly metal component, along with additional polymer mouldings, and increased assembly time. The design team had some smarter options, but they were rejected. To the manufacturer’s credit, the ease of reading the water level via this system was a big step forward over all mainstream kettles at the time. Other issues that affected the Axis included the use of component choices outside of the design specification, leading to high return rates and compromises in manufacturing forcing design changes at the cost of ergonomics and aesthetics.

At the time, Kambrook was competing at the bottom end of the market in the highly competitive category of staple household appliances - low cost kettles and toasters. Price is a key consideration in these markets, and cost is often stripped out of products to remain
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CONTINUED

Top
Paul Taylor for Form Australia, Green Heating Quest Workshop hand rendering, 1995, RMIT Design Archives collection

Bottom Left
Paul Taylor for Form Australia, Caroma shower head concept hand renderings, 1995, RMIT Design Archives collection

Bottom Right
Paul Taylor for Form Australia, Kambrook toaster concept hand rendering, 1995, RMIT Design Archives collection
competitive. Although the Axis innovations were revolutionary for performance, the final product was more suited to sales channels Kambrook was not familiar with. As Paul Taylor recalls:

Big box stores of K-Mart and Target didn’t stock the Axis kettle. To Kambrook’s credit, they found a new avenue for Axis through David Jones, a first for them. The problem though was that David Jones didn’t have the volume of sales Kambrook were used to, and Kambrook didn’t have the reputation for high-end retailers.

Kambrook was asking its customer base to pay nearly double that of their successful budget kettle, the K300, in exchange for Axis’ innovative features and a saving on electricity. To complicate matters, at the time, competitor Sunbeam had a long-standing reputation as the “go to” quality brand at an acceptable price. Breville fitted somewhere in-between. Taylor reflects:

Sunbeam had always delivered more progressive designs with better components and quality of usability, therefore it was a big leap of faith for a budget consumer to purchase a more premium product in a budget store, and even bigger for a traditional, wealthier David Jones customer to accept what they had always considered an inferior brand to Sunbeam.

This leads to another aspect of disruptive product commercialisation. Education through marketing can be the key to success when pushing against the status quo but there was no substantial supporting marketing for Axis to counteract the ingrained reputations of its market competitors. Taylor recalls there was a distinct lack of in-store point-of-sale material, or television advertising for the kettle. This was in contrast to the work done by Dishlex for their dishwasher.

Ultimately, the cost of the kettle was revised and it was discontinued in its original form. Kambrook continues to sell the modified version of Axis into contexts where consumers are price-sensitive, which somewhat continues the legacy and success of the project. In short, the kettle reverted to budget retailers with which Kambrook was familiar. Things may well have been different with marketing support and a different consumer context as Taylor notes:

As a nation we’re more savvy shoppers these days and our brands are less ignorant of their customers, realising they can’t just put products on a shelf without a supporting deeper value story and communicating meaning through various channels.

Kambrook lost momentum during the later development of Axis mostly due to the hidden financial pressures, a “fish out of water” product, and the fact that much of the development was done outside their organisation. While their design team embraced the sustainability angle internally, there did not appear to be company-wide commitment. Kambrook needed a top-down belief in sustainability to change culture, together with a proactive management. Instead, the organisation looked externally for these things, and used the project for publicity and investment in exploratory research and development. Another issue here was that multiple organisational changes of management, corporate takeover and restructuring occurred as the incarnations of Axis were sold. For all this, the design of Axis exceeded expectations for environmental improvements and affected kettle design for many years.

**Lasting Industry Benefits and Dissonance**

Centre for Design changed over time with different funding sources, industry partners, research projects, and researchers, which meant a range of diverse initiatives and trends developed from the EcoReDesign program. But was design the right focus? As Liam Fennessy puts it:

The Centre for Design produced some excellent thinking, tools and projects, yet much of it may have been misdirected by targeting industrial design education and practice as a way of getting traction. This was a misreading of the situation in that in mass manufacturing and the concurrent implementation of environmental management systems, total quality management, and life cycle management, the responsibility for lean production and environmental standards became an engineering domain. This meant that industrial designers could suggest or press for
Moreover, the EcoReDesign program did not make industry-wide change to the culture of environmental responsibility across the Australian manufacturing sector. This may have been a combination of Australian manufacturing at that time being cost and product driven (rather than human-centred and brand oriented) and locally focussed (apart from the automotive sector and a handful of other brands in different sectors). Policy failure to continue the momentum of the program, and the lost knowledge at various organisations when Centre for Design staff and industry personnel moved on, did not help. Industry wide change may well have been an ambitious objective.

As Fennessy posited, maybe LCA was not aimed at the right disciplines. Indeed, power could have played a key role here. The most powerful departments in new product development are often not design disciplines, and as such, other organisational stakeholders may be better situated to drive environmentally based decisions. In a more recent study of multinational Unilever, power relations were identified as critical to EcoDesign failures. Even with a top-down mandate from management to implement environmental strategies, people in disciplines other than design, delegate environmental actions to design teams, without those design teams adequately empowered to act. Palmer et al take this further, and question the value of LCA to business at all, suggesting we should not “expect them [organisations] to know what to eventually do with a completed LCA study (experience has shown this to be rarely the case)”. This may also been the case for organisations involved with EcoReDesign, lacking the adequate resources or expertise to use LCA effectively after taking part in the program. At the very least, industry needed to be given a chance to innovate, and should be applauded for doing so. More than this, pockets of lasting change did occur.

Some organisations implemented processes in environmental measurement and reporting that remain today. For instance, Schiavello may not have widely commercialised designs from the program, yet they benefitted from the implementation of life cycle and environmental reporting through the support of Director, Peter Schiavello, and the leadership of environmental manager, Michael Pitcher. As the local green building movement grew in the 2000s, compliance activities shifted to environmental credentials becoming a market differentiator, a phenomenon on which Schiavello capitalised. Some organisations benefited and carried through, whether with process implementation like Schiavello, or through commercial product success like the Dishlex dishwasher.

Many of the personnel who worked on EcoReDesign projects continued to apply the learning from EcoReDesign in their careers. For example, the insights gained and the methods employed from EcoReDesign were adapted by Pears in a series of energy efficiency projects. Pears continued to operate with these methods for a long time, for projects in industrial contexts (i.e. production facilities, factories and corporate buildings), residential developments, product design, policy development, and regulated information programs. Of the last, Pears pioneered product energy efficiency labelling nationally, prior to EcoReDesign commencing. That work underpinned some of the EcoReDesign approaches, and continued on well after the projects concluded with water also included in the labelling mix. This could have been too late for the Axis kettle, where commercial success may well have been achieved if energy and water labelling were more recognisable and widespread.

Labelling opened opportunities for organisations to promote the environmental attributes of products more overtly, so that efficiency features that were previously difficult to convince manufacturers to include (for cost reasons), started to proliferate. Suddenly highly efficient products across whole categories had an advantage in a highly visible, legislated system.

Pears innovated for the environment, from product through to policy, receiving an AM in 2009. However he laments: “Regulators and policy makers don’t create policies that are open ended enough to reward...”
more innovation. Policy ends up blocking progress and undermining the opportunities for people to be recognised for the innovations they bring”.

Design innovation still gets stifled by the very mechanism that enabled EcoReDesign: Government bureaucracy.

For all that, in terms of design, EcoReDesign projects did enable designers to use many of their existing technical skills and develop new ones. As Taylor notes: “we could co-create, collaborate with best in field specialists and to work from ground up first principles rather than deal with legacy and re-style flawed ideas or just a different version of the same old thing”.

EcoReDesign allowed designers to do what they were trained for, to question, explore, research, make, reimagine, validate, and educate, to deliver real value. Although it may not have created broad change for industry, EcoReDesign represents a period of time when design disciplines were given purpose and meaning in the environmental context where they had not had such agency previously. Many aspects of the program have continued to this day, and as such the EcoReDesign legacy continues to contribute to society’s quest for environmental sustainability.

Endnotes Continued


15 Samsung, DVM catalogue, “imagination lives” (Suwon, Korea: Samsung, 2009).


18 Sweatman and Gertsakis “Mainstream appliance meets eco-design”.


CHAPTER 8: BOOK CHAPTER 1 – AGENCY AND STRUCTURE SHAPING ES
(PAGES 313-345)

15. Enabling employees and breaking down barriers: behavioural infrastructure for pro-environmental behaviour

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15.1 INTRODUCTION

This chapter addresses the development of environmental sustainability strategies in organisations. Ongoing problems are evident as organisations continue to seek environmentally sustainable outcomes (Wittneben et al. 2012). The strategies that organisations apply to environmental concerns involve employee behaviours and their interactions with social structures that facilitate or inhibit employee actions (Lockrey 2016). Social structures incorporate resources (i.e. infrastructure and technologies); and rules (i.e. policies and procedures), that affect employees when they think and act (Giddens 1984). Understanding the interplay between employees and the structures they encounter is crucial to determining what strategic problems exist, and what we can do about them.

Research has provided insights into the structural issues at play when organisations strategise for environmental sustainability. Resource-based theory (Wernerfelt 1984), institutional theory (DiMaggio 1988) and stakeholder theory (Freeman 1984) provide explanations of the structural problems organisations encounter. Resource-based challenges include: realigning processes for strategic efforts (Pullman et al. 2009); driving competitive advantage by resourcing stakeholder concerns (Markley and Davis 2007); or linking familiar performance measures (e.g. economic goals) (Zhu and Sarkis 2004) to environmental action. Institutional theory suggests that legitimisation requires: the navigation of strategy adoption (Campbell 2007); internal/external communications (Pérez-Batres et al. 2010); reporting (Jensen and Berg 2012); and innovation implementation (Aguilera-Caracuel and Ortiz-de-Mandojana 2013). Finally, stakeholders such as public policymakers (Doh and Guay 2006), communities (Kassinis and Vafeas 2006), markets (Preuss 2009), and investors (Neubaum and Zahra 2006) influence organisations seeking to reduce environmental impact. These macro perspectives have not examined employees and...
their behaviours within their (micro) organisational setting. Thus the link between employees and their structural influences is not well understood. We do not know how employee behaviours and social structures help or hinder organisational environmental impact reduction.

In this chapter we address organisational environmental sustainability by drawing on Giddens’ (1984) structuration theory and the ‘Nine Ps’ framework by Brennan et al. (2015), to analyse two case studies. The case studies focus on the use of life cycle assessment (LCA) to develop and procure organisational sustainability strategy. LCA is a resource used in organisational processes aimed at reducing the environmental impacts of products, services, and systems (Baumann and Tillman 2004). As such, these cases provide a context where environmental impact reduction is a core strategic aim, revealing related, novel insights about employees, their behaviours, and the social structures in which they operate. We use structuration to determine if employees have the power to change organisational contexts for better environmental sustainability outcomes. By that we refer to Giddens’ (1984) original notion of structuration being the reciprocal relationship between people, their actions, and the social structures in which they act. Power to change is necessary when employees are faced with barriers to action, or capitulation may result in light of the social structures they encounter. We explore whether employees establish agency by using resources and navigating rules to drive environmental sustainability within organisations. Based on the insights developed in the cases, the chapter concludes how our conceptual model, built upon the link between agency and social structure, can be used by employees to identify and navigate barriers when implementing environmental sustainability within organisations.

15.2 EMPLOYEES AND ENVIRONMENTAL STRATEGIES

Reducing the environmental impact of organisational outcomes (e.g. products, services, and activities) requires planning and deployment of resources (i.e. strategy). Ideally, both strategic planning and implementation is undertaken to achieve common organisational goals (Varadarajan 2010). The goal of strategy for the environment is to protect the Earth’s biosphere. However, we currently lack an understanding of the role of social structures in reducing environmental impact within organisations. Further, understanding the influence of employee actions on strategic outcomes is essential knowledge for those seeking to enhance organisational sustainability. As such, research has emerged focusing on employee
Enabling employees and breaking down barriers

attitudes (Davis et al. 2009) and intentions (Greaves et al. 2013). Likewise, the cognitive frames applied by employees (Hahn et al. 2014) and the identities they adopt (Wright et al. 2012) have been examined in relation to organisational sustainability. Each of these studies builds our understanding of employees, be that how they think, the personas they project, or the resources and power they employ in environmentally sustainable practice. However, individuals do not operate alone when it comes to organisations. They are interrelated in a system of actions and interactions. For example, while we know that an individual’s attitudes are important, unless they have power when strategy is developed, their attitudes may be irrelevant. Additionally, the gap between attitudes and behaviours is well known, such as for purchasing behaviours related to sustainability (Deloitte 2009). As a consequence, it is critical to have a more comprehensive understanding of the barriers and facilitators of environmental sustainability within organisations.

There is an emerging strand of studies that links employee behaviour to institutional and structural considerations. Gond et al. (2015) found that behaviours that seem environmentally unsustainable to outside observers are considered reasonable by employees within the oil and gas industry. In Gond et al.’s research, employees believed that as leaders in their professional disciplines, their actions were legitimate even when the result of their actions had a negative influence on curbing environmental impacts. Research into executive expectations has shown that employees can be at odds with the actions required in delivering environmental strategies. Petala et al. (2010) found that brand managers were not taking seriously environmental strategy directives from an executive level across product categories. Bocken et al. (2012) then show how that same organisation changed structures to enable environmental innovation in new product development. These studies highlight how employees and their behaviour have an influence on organisational sustainability, but that structural considerations shape their behaviour. However, work of this nature is sparse at this stage. New perspectives are required to develop the field.

In the next sections we explore structuration theory and the ‘Nine Ps’ framework that provides new ways of thinking about employee behaviour. In doing so we show how these concepts can also assist in linking back to structural aspects in an organisational and institutional context. Both aspects are imperative to consider if we are to stand a greater chance of addressing the environmental issues when strategic projects are enacted by employees within organisations.
15.3 ORGANISATIONAL STRUCTURE AND EMPLOYEE AGENCY

Giddens (1984) described the relationship between social structures and agency (see Figure 15.1). For organisational strategy, ‘agency’ is defined as the ability of the employee to act in support of the outcomes sought. The term ‘structure’ consists of systems of signification, legitimation, and domination. Structure is made up of the various rules and resources that contribute to individuals’ interpretations of communication as meaning, application of norms (descriptive and injunctive), and levels of power. Giddens (1984) proposed that social structures were twofold and consist of rules (e.g. policies) and resources (e.g. infrastructure and technologies). These structures are drawn upon by agents and applied using the agent’s cognition. Thus, structures are instantiated when the agent acts. Further, a duality of structure is pertinent to determining the influence of employee thought and action in using rules and resources, and vice versa.

Employees within organisations (agents in Figure 15.1), have varying levels of agency. Consciously purposeful or not, these actions consist of: communication, moral sanctioning, or mastery over material resources and/or other people. In Figure 15.1 structure and agency is mediated by social modalities, which link employees and their actions to social structures when they utilise rules and resources embodied in these structures.

Employees reproduce social structures, or create/change structures through their actions. For instance, structures can either control employees and the outcomes they set out to achieve, or enable them in changing existing conditions. Structure is both the result of and medium of action, instantiated by employee’s use, or encountering the effect, of rules and resources. This is represented by the double-ended arrows in Figure 15.1. By considering structuration in instances of strategising for environmental sustainability, we focus on whether employees can work toward beneficial outcomes, or are beholden to circumstances driving less than favourable environmental results. Structuration issues overarch investigations examining employees as ‘agents for change’ to influence strategic processes designed to increase environmental sustainability within organisations. It therefore provides a lens for considering whether organisational employees can (and do) behave in a way that can contribute to protecting Earth’s ecology. The instruments required to examine structuration are well advanced since Giddens’ proposal in 1984. However, implementation is not as well advanced. To this end, we propose the use of a practical toolkit: the Nine P’s Framework (Brennan et al. 2015) to assess behavioural infrastructures for sustainability within organisations.
15.4 STRUCTURE, EMPLOYEE AGENCY AND ENVIRONMENTAL STRATEGY

Brennan et al. (2015) assessed the performance of Australian Universities in tackling environmental sustainability and proposed a framework to explain the issues that exist in such contexts. This framework (see Figure 15.2) describes behavioural infrastructure and includes various elements of an agency–structure relationship (e.g. people, rules, and resources) relating to work practices associated with strategies for environmental sustainability. By applying the ‘Nine Ps’, we can demonstrate that the framework can be used to operationalise structuration based on an understanding of problems in relation to environmental strategies. We...
now describe how this can be achieved by linking the framework to key concepts from Giddens.

The ‘Nine Ps’ framework suggests that systems of social structure are underpinned by philosophy and policies that guide organisations in environmental sustainability strategies. These may be either formalised (e.g. written documents, explicit) or instantiated through employee memory traces (tacit). Brennan et al. (2015) describe a philosophy as the core set of beliefs guiding behaviour, and a policy as a statement of principles to guide decision-making, implemented using a process or procedure. These overarching organisational level rules set the conditions in which employees at all levels are expected to behave. Therefore, philosophy and policies relate to domination and control of employee behaviour, signification in terms of their related meaning to employees, as well as any sanctioning cultivated as employees seek legitimacy in strategic action. As such, explicit philosophies and policies are how the social structures of an organisation are arranged. These rules enable or constrain the actions of employees.

Source: Adapted from Brennan et al. (2015: 313).

**Figure 15.2 ‘Nine Ps’ with structuration elements**
Employees may draw upon processes, procedures, and promotional activities as resources in strategising for environmental outcomes. Resources may limit effective action, or alternatively they may enable agency with resource use whilst navigating related rules. For instance, with the right strategic processes, employees have the tools to reduce the environmental impacts of organisations. Strategic processes are collections of related activities that are designed to achieve a goal (Brennan et al. 2015). Structures of domination can be reoriented to facilitate effective actions through these processes. Processes can again be both explicit and tacit. As such, more formal guidance may be required when it comes to enhancing strategic performance. Procedures, being the written guidance for navigating processes (Brennan et al. 2015), can help in ensuring that strategic actions are undertaken with effect. Procedures are approved documentation that communicates what needs to be done. Thus, procedures act in signifying legitimate action. If guidelines are aligned with favourable environmental outcomes, success comes easily when strategic action is taken.

Promotion refers to the communication of plans and actions and builds the signification structures that facilitate conditions in which favourable outcomes can occur. By communication we refer to any material conveyed to or by employees, by way of mediums such as verbal, audio-visual, email, print, and written, that they may interpret into meaning. As such, promotion can contribute to the series of internal marketing actions aimed at disseminating multi-level aspects to employees about what is being done, including how employees will benefit, and what (individual and group) contributions are necessary for achieving environmental sustainability. This planned effort using promotional activities can be considered a marketing approach to overcome resistance to change and to align, motivate and coordinate employee behaviours (Rafiq and Ahmed 2000). Internal marketing is useful in the co-creation of value (Russell-Bennett et al. 2013), where a range of stakeholders, including employees, is required to participate in tackling the issues at hand. The importance of co-creation in change settings is that outcomes are accepted by the participants as being shared decisions and not prescriptions by management. Transformative contexts, such as environmental sustainability strategies, are inherently caught up with power and domination structures, so co-creation can help to break associated tensions.

Promotion can also aid in legitimising strategic activities by making plans and actions visible to employees as endorsed by the organisation. The desired behaviours may then align to corporate and functional actions and be designed to deliver improved environmental outcomes. Power may also be enhanced for those involved in strategies when compelling arguments
to act for environmental reasons are articulated. As such, promotion may be key to enabling employee’s action, thereby creating the ‘right’ set of structural circumstances for enhanced environmental outcomes.

The central platform of behavioural infrastructure envisaged in the ‘Nine Ps’ is that of people within organisations. The agency of employees is pivotal to driving environmentally sustainable outcomes. This is represented by the action arrows in Figure 15.2, where actions emanate from employees or affects them by way of the actions of others and the social structure they encounter. In our conceptualisation, people include all participants in the organisation, regardless of profession, role, level, or status (e.g. service staff, management, customers).

Behaviour is explicitly embodied in the ‘Nine Ps’ framework through perseverance, policing and phollow-up actions of employees. Perseverance comprises links to the inherent domination structures present, where employees either capitulate, or break through perceived barriers to environmental sustainability even in the face of adverse conditions. For the former they reproduce domination structures, for the latter they re-imagine and contribute to structural realignment. Another component of the framework is that of policing, which creates a sanctioning context that either affects, or is affected by, legitimation structures. Where policing of the environmental sustainability strategy is weak, the status quo remains, even if it is a requirement of organisational philosophical and policy guidance. When policing is implemented effectively, action and behaviours are directed towards preferable environmental sustainability outcomes. What this means is that the behavioural infrastructure must include mechanisms by which behaviours are monitored and determined to be effective (or not) when it comes to achieving organisational goals. Policing, to be effective, must be evident to all actors in the system in terms of action and consequence (Moisander and Pesonen 2002). That is, any action, positive or negative, will have a consistently applied consequence associated with it.

A critical action-based element of the ‘Nine Ps’ is that of phollow-up, which is the organisational efforts designed to close the loop on, and provide continuous enhancement of, actions aimed at building environmental sustainability programmes. If phollow-up actions are present, the ability of employees to critically reflect either tacitly (practical consciousness) or knowingly (discursive consciousness) is facilitated (Giddens 1984). These reflective actions can determine what needs to remain the same, or be adjusted, in continually improving the performance of an organisation’s approach to environmental sustainability. Without such thoughtful practice, the effectiveness of environmental strategies is at risk. Circumstances change and organisations need to be responsive, not reactive.

We have used the ‘Nine Ps’ to understand structural and agency-based
issues of organisational strategy dealing with environmental sustainability. It can uncover structural problems in implementing environmental sustainability strategy through employee actions. The following section outlines the use of the framework as an analytical tool to explore planning and implementation of environmental sustainability strategy within two case study organisations.

15.5  CASE: PLANNING FOR SUSTAINABLE ACTION IN AGED CARE

The first case study examines a planning process for a context-specific environmental sustainability in a major aged care organisation in Australia, operating currently as Uniting Agewell (hereafter UA). UA is a network of facilities and personnel across Victoria and Tasmania that aims to support the health and well-being of older people through the services that they deliver (Uniting Agewell 2016). As part of that vision, the UA board planned an environmental impact reduction strategy (hereafter the strategy). The strategy was designed to maintain the well-being of residents, while addressing environmental impacts associated with service delivery. Streamlined LCAs and design-thinking processes, known as the Double Diamond method (Clune and Lockrey 2014) were employed to help UA to develop their strategy. LCAs help benchmark the current aged care context in terms of environmental impacts. Design processes were used as tools by employees to conceptualise problems within aged care, and workshop solutions based on LCA data and cross-disciplinary experiences/expertise. LCA then helped verify if proposed changes would result in reduced environmental impacts. Hence, a range of conditions of action was evident.

UA employees from various disciplines at multiple levels within the organisation participated in an action research process (Swann 2002) over six months. Participants ranged from members of the executive, nurses, chefs, accountants, and operations managers, all working collaboratively with external experts and university academics (researchers) in developing a new strategic plan. The strategic plan was developed through a series of site visits; LCA modelling of current environmental impacts; stakeholder design workshops; and reporting of current and future scenarios. These actions resulted in the development of the strategy and revealed influential elements of structure and agency. The development of an environmental sustainability strategy was a new initiative for UA. As such we were able to consider the structural characteristics and actions associated from a low base, as well as any changes to this context over time as the strategy...
developed. Data gathered from the case included: strategic reports, observations throughout the strategic planning process, field notes, researcher insights, and publicly available organisational reports and websites. Data were examined in relation to the ‘Nine Ps’ and structuration to generate the results in relation to the strategy and the underlying processes (see Appendix 15.1 for tabulated results).

The following three themes became apparent from our analysis of strategic planning at UA:

1. Employees drew on key enabling rules and resources to enact the strategy;
2. Communication reduced resistance and enabled planning;
3. Employee ‘buy-in’ derived from co-creation and shared value.

15.5.1 Employees Drew on Key Enabling Rules and Resources to Enact the Strategy

In the pre-strategic planning context, formal environmental actions were not evident at UA. Environmentally focused philosophies, policies, processes, and procedures were not formalised, except for compliance reasons (e.g. government regulations). A cross-disciplinary team within the organisation progressed through the planning processes to formulate a strategy based on their own unique perspectives and contributions. As such, UA demonstrated how new rules and resources can represent opportunities for employees to develop effective strategy. Technical, creative, and social processes helped the team shape an emergent organisational philosophy for environmental impact reduction. UA employees created a low environmental impact vision for the organisation, thereby embracing new ways of working. Without seizing the opportunity to design such new rules and resources, that vision, and the pathway to reach it, may not have been possible.

LCA was the process that enabled communication and promotion (i.e. internal social marketing) of environmental opportunities to be exploited by UA. Further, LCA communicated the benefits of the emerging strategy to a range of stakeholders from various disciplines. LCA helped reveal environmental issues so that employees could contribute potential options to solve them. Ultimately this helped the team to develop a common philosophical goal of environmental impact reduction across organisational personnel and departments, and a set of reoriented structures for this development.

Communication flowed throughout a series of workshops facilitated by practitioners and academics. Employees engaged with signification structures aimed at an open and discursive environment for all involved, which included design processes such as (Clune and Lockrey 2014):
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1. Brainstorming and mind maps of problems and practices;
2. A ‘five whys’ discussion (IDEO 2002) of current problems and practices;
3. Group sketching of barriers and options on UA site maps;
4. Discussion of ‘world’s best practice’ in environmental sustainability;
5. Discussion of feasible interventions regarding current practices;
7. Discussion of ‘solutions as problems’ to be solved.

These processes allowed a deep exploration of strategic options available in addressing the environmental problems revealed by LCA. The design processes represented resources that allowed for the navigation of complex and seemingly separate issues of food service and waste, as well as resident thermal comfort and general energy consumption across UA’s sites. These nodes of environmental impact affected multiple UA employees and departments that traditionally did not have much contact with one another. As such, personnel had to interact with and reflect on different perspectives, agendas, values, and vocational experiences and their language of ‘business’. Interaction and reflection was between and by traditionally powerful people (CEO, managers, etc.), and newly empowered employees (various departments). This meant that the planning was inclusive and participatory. Hence planning involved an opening of the domination structures to employees not necessarily used to being enabled with power.

15.5.2 Communication Reduced Resistance and Enabled Planning

Once employees considered the LCA data generated, planning occurred in spite of some structural resistance. Consistent with the ‘Nine Ps’ framework, resistance derived from some employees being concerned about participating in planning. Initially some employees’ had reservations about being questioned as a department in terms of their (lack of) addressing environmental issues highlighted by LCA. Planning prevailed and collective conversations tempered anxiety regarding stakeholder issues. These conversations continued throughout the process and concerns were eventually assuaged and participation enhanced. Importantly, concerns were settled at any point they emerged, as discussions progressed between various employees as to how developing strategies could work toward a ‘shared value’ model of impact reduction. These actions helped shape legitimation and signification structures between organisational personnel that enabled them to navigate tensions by communicating the options,
working out any differences, and planning to address environmental issues together. Employees were required to consider their individual issues, listen to the perspectives of others, and then contribute to a collective strategy to lower energy use and greenhouse gases; for example, an early brainstorming session about the ‘current context’ for UA involved writing, sketching, and listening to each other’s ideas. In this session, operations personnel described barriers to propositions of replacing infrastructure outside of the organisational procurement policies currently in place for electrical appliances. However, in listening to this, the financial representative suggested that, through a new set of replacement procedures currently under consideration, there could be an opportunity to create rules in a hire-purchasing list more informed by energy consumption. By creating this new set of rules and resources, superior environmental decisions could be made taking into account financial and operational perspectives. Without this open dialogue and reflection on multiple alternatives, opportunities may not have been revealed and exploited. Through engaging in this way, employees demonstrated perseverance in considering the options and negotiating solutions, even when some suggestions may have been at odds with their point of view. This also represented signification structures evolving to be inclusive, from being previously siloed. Without this structural shift, planning may not have garnered dialogue, negotiation, and resultant strategy.

In a session following the ‘current context’ brainstorm, employees were provided with a range of examples of global best practice environmental sustainability projects from outside the aged care industry. A ‘round table’ discussion between university participants, external consultants, and UA employees then developed. The group conceptualised ‘what if’ the best practice insights were applied to food, energy and thermal comfort at UA’s sites. An example of one such discussion occurred when an interactive menu planning website was revealed, which prompted a discussion about the food practices of the organisation. What followed resembled the previous exchange between the operations and financial employees about electrical appliances, along with suggestions from participants:

- Food services personnel disclosed that they had direct discussion with residents and their families on what food would be provided, in planning for seasonal menus. This was a promotional opportunity for stakeholder engagement on environmental issues.
- Food services personnel had already conducted plate waste review processes and portioning meal-planning processes, and had produced procedures for both. This gave them existing rules and
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resources to plan environmental impact reductions with the right people, on points such as meal portioning and ingredients i.e. meat or vegetarian.

- Management employees felt that as different generations progressed into aged care, lower environmental impact cuisines would be easier to prepare. This opportunity derived from broader food experiences for those incoming generations.

- Nursing staff contributed the point that community gardening activities were popular with residents to create social interactions and a stronger connection to their food. From a thermal comfort perspective the physical component of gardening was favourable too, by way of residents exercising and keeping active.

- Operational staff noted that there was room to compost food waste, which was also seen as a way of dealing with a problem not completely addressed by better menu planning.

Strategic solutions such as the five described above required deliberation on current and future conditions, as connected to the environmental issues the team wished to solve. Through these types of multi perspective discussions, the team collectively identified what rules and resources could work in the current UA structure, that is, people working with people to envisage new ways of being and creating new behavioural structures that achieve organisational goals. Further, participant suggestions led to what was feasible to change by realigning structural contexts over time. Discussions of this kind were repeated for other food, thermal comfort and energy issues throughout the strategising process, and linked back to the problems identified by the LCA process. In turn, employees mapped the solution because it could be put into effect through back-casting techniques, where the idealistic solution was visualised along with a pragmatic pathway to get there over time. They also inverted the proposed solutions into new problems to be solved. In this way they identified structural elements to exploit or be reoriented to enable the right behaviours to occur. For example, in food practices, current stakeholder engagement via promotion and meal planning and plate waste processes were to be retained and exploited as part of signification and domination structures for environmental purposes. Demographic shifts also meant that domination and legitimation structures could evolve naturally over time, enabling an opportunity for adjustment to less environmental impactful diets, as new generations became aged care residents. This happened as a result of favoured cuisines of growing stakeholder groups, such as Baby Boomers, eating recipes originating from Asian nations that consist of smaller portions of meat and higher portions of vegetables. Finally,
infrastructure opportunities were viewed as possibilities to generate interest from employees and aged care residents in regard to gardening and food waste remediation initiatives. These new legitimation and significance structures, in the form of the promotion of food as an environmental sustainability focus, could help enable employee and resident action for environmental impact reduction.

15.5.3 Employee ‘Buy-in’ Derived from Co-creation and Shared Value

Through the participative design processes, employees collectively helped shape the strategy with all their perspectives considered and embedded in the outcome. Key personnel used a suite of processes, including internal social marketing, to create a strategy for collective ownership, thus developing a ‘shared value’. This meant the strategy held meaning for, and could be actionable by, all involved. This was important in empowering as many employees through domination structures as were feasible. Important to this was collective empowerment through participation in strategy and planning; taking on a broad range of contributions from participants; and embedding ongoing actions in the strategic plan that was developed. An action plan emerged, sharing responsibility across departments, including:

- Finance managing a reinvestment model that worked in collaboration with operations, starting from a low economic base with early energy efficiency measures, using compounding monetary savings over time to fund for more expensive off-grid renewable energy over the long term;
- Residential care employees collectively managing local thermal comfort for residents, that is, heaters/fans/clothing/bedding/exercise (including gardening!), as well as improved spatial temperature zoning scenarios in collaboration with operations; and
- Food service personnel managing new purchasing options with finance, and meal planning practices by leveraging the existing relationships with residents and extended families on portioning and cuisine choice, with residential care employees.

These strategic actions incorporated economic, social, and environmental aspects, and cut across functional areas within UA. To help a wide range of employees persevere with the strategy, short-, medium-, and long-term goals were provided. Goals were considered feasible, in that the various employees who developed the solution deemed outcomes possible, had a role in its implementation, and a stake in the outcome. Investment support through a reinvestment-financing model acted as an incentive and was
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considered central to employees continuing with the strategy in achieving set goals. Thus the planning team believed that through these structural conditions proposed for the strategy, they would enable employees to persevere in achieving the goals.

One department acting alone could not have created the environmental strategy summarised above. If the existing domination structures were retained, only executive personnel would have strategised top-down; the result, therefore, would be devoid of the range of expertise that contributed. Instead, strategising progressed more inclusively, and with collective intelligence and power. This case could then be interpreted as a shift in the domination structures of the aged care organisation in helping to reduce the barriers traditionally present, so that more employees and their perspectives could contribute to the development of the strategy. The planning team persevered with multiple perspectives on the environmental issues raised, to plan actions toward a strategic outcome that catered for those perspectives and retained ‘shared value’ for all stakeholders. As a result, people, their beliefs, and actions connected directly to the strategy through their participation, contribution, and ongoing actions that the strategy would require. Consequently a change in structural conditions enabled an organisational strategy to be developed that would be actionable by a greater range of employees and departments, in the hope to drive better environmental behaviour more broadly. Importantly, the ‘Nine Ps’ framework, while demonstrating that all Ps are required for environmental programme implementation, transformed throughout the action research process and different aspects reappeared at different stages. The dialogic nature of the process highlighted the need for phollow-up as the process of building a sustainable organisation is iterative. However, the case also demonstrates the benefit of starting an environmentally oriented philosophy, as well as taking the time to unearth tacit and explicit structures before designing any of the Ps for internal marketing purposes. Five of the Ps – people, processes, procedures, promotion and perseverance were evident in employees being enabled to develop this strategy. Having a philosophical position on which to implement strategy for environmental impact reduction was viewed as important by participants moving forward.

15.6 CASE: IMPLEMENTING SUSTAINABLE ACTION IN ECO-DESIGN

In our second case, we investigated the next phases of environmental strategy, examining implementation and refinement for eco-design in
a university educational setting – a university course (subject or unit of study) in a product design engineering (PDE) undergraduate programme. The course was delivered over four years to separate student cohorts. The eco-design case was selected as it involved people collaborating in a formally constructed but bounded setting where various interventions could be trialled and discarded or refined. The case participants were student designers and engineers, managing academic staff, and various industry partner (IP) employees from engineering and business (Lockrey and Bissett-Johnson 2013). Specific elements under examination related to operationalising a strategy for the design process, building the capacity of students with tools they used in the subsequent design process, engagement with industry, and designers being empowered as ‘change agents’ in the learning environment.

The course required students to work through a brief, using a number of design tools to produce outcomes that demonstrated environmental impact reduction. Students were educated in design and environmental sustainability skills. Interactions occurred between the employees from the IP and students, as well as within the university context where the engagement was mediated by academic staff. As such, the case provided a site to investigate employee agency with various structural influences (e.g. environmental, pedagogical, and commercial) in producing positive environmental outcomes from both a design and skills perspective. The case was also chosen as environmental sustainability strategy was an ongoing initiative, so we were able to consider structural characteristics and refinements as it evolved. Sources of data included design projects developed by the students; observations by researchers throughout the implementation process; formal collation of insights from academic staff; course surveys results from the students; and feedback from the IP. The data were reviewed for links to the ‘Nine Ps’ and structuration theory with information coded as it related to those concepts (see Appendix 15.2 for tabulated results).

The following three themes emerged from the analysis of the university eco-design strategy implementation and refinement:

1. Philosophy, policies, and procedures helped define rules and structural clarity;
2. Key resources enabled student reflection and eco-design agency;
3. Course reflection allowed strategic changes to better enable students.
15.6.1 Philosophy, Policies and Procedures Helped Define Rules and Structural Clarity

The case study reported that academic staff delivering the eco-design course developed and applied an overarching philosophy: environmental impact reduction is critical to business and the future of the planet. In doing so, they aligned course, university and IP philosophies to create a coherent platform from which other actions could be launched. Another key philosophical dimension was that of higher order student learning requirements for students to be both challenged and challenging: they should be challenged by the task and the learning environment and they should be able to challenge and redesign where and when required. IPs had to subscribe to those values in order to participate. Combining these philosophical dimensions contributed to legitimation structures in shaping the minds and actions of student designers, to be proficient in reducing environmental impacts through their design practice. With this philosophical position in place, a clear documented policy platform was devised by university staff, with student guidance on external regulatory requirements to be addressed; university requirements for learning outcomes and submission; IP expectations; and associated project actions.

A key component of these policies was to address environmental issues by producing designs with lower impact, required by fulfilling a design brief. A set of policies and procedures guided the actions intended to deliver university and IP expectations, deriving from university policy through to university and IP employee briefing of students. These included:

- University expectations for novelty of design outcomes;
- A timeline set for the project and associated tasks, as linked to the assessment schedule;
- A number of formal critical reviews;
- Final course assessment rubrics defining expectations of academic performance in key areas; and
- IP input, where they were provided with a design brief so they could understand the student tasks and their role in the learning process.

These rules were detailed in a number of resources, such as the design brief and course guides. As such, policy-based components of structure were explicit, easily understood and accessible by all participants. Hence, a clear structure helped define student expectations, supported by actions that policed their work throughout the course. Academic staff set domination and legitimation structures aimed at enabling student project and learning outcomes.
15.6.2 Key Resources Enabled Student Reflection and Eco-design Agency

Resources were drawn upon by multiple people throughout the course to navigate and, at times transform, the structure. For example, LCA tools and data provided by academics were made accessible to individual student designers in order to enact the set brief in implementing a design strategy. Students used LCA to identify environmental impact hot spots in their designs, and propose reduced impacts as they further refined their designs. Along with other tools, such as whole systems design and calculation of energy use, LCA was used through Sheppard’s characterisation of ‘what engineers do’ (Dym et al. 2005), in scoping, generating, evaluating, and realising ideas. This meant that students reviewed their work so that their designs could be reflected on at multiple stages in the design process. These reflections were used to refine their designs to achieve an optimal environmental outcome.

Design processes enabled students to persevere, even when a particular option may not have succeeded, and improve design propositions as the eco-design strategy unfolded. Their perseverance was supported by ongoing feedback from academics, through in-class guidance and email correspondence. This helped in training students as to how they might use the resources provided to deliver superior environmental outcomes, contributing to their skill development and resilience in the face of barriers. It was also a form of reflective policing from both academic staff and students in determining what design decisions may be appropriate. Hence as processes were put to use, and support by staff continued over time, students further developed more compelling design outcomes as well as associated eco-design skills through the process. This resulted in students and academic staff maintaining key aspects of the domination structures present in addressing environmental issues. Importantly, the design iteration process permitted IPs, staff, and students to experiment and co-create preferable outcomes. Hence, while dominance structures were in place the locus of power shifted between participants throughout the design process.

Design and engineering processes were not the only tools used to enable the student designers. Students completing the course were regularly engaged in reflection about their eco-design efforts at key communication (promotion) points, including:

- University processes such as in-class consultation and critical reviews of their work, emails, online management portals, web forums, and content lectures;
- Student awards from the IP for the best final outcomes that drove
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engagement. Monetary prizes were offered for some years of the IP awards;
● Reporting of successes and key learning through academic journals and conferences were provided as set readings; and
● Promoting benefits of undertaking the eco-design course to newer cohorts of students.

Industry participation with students has previously been explored as a key activity to heighten student engagement (Boks and Diehl 2006). Student survey data, assessment results, participation, design outcomes and IP feedback demonstrated that this, indeed, occurred. Promotion in turn contributed to signification structures that encouraged environmentally preferable designs by students, year on year.

15.6.3 Course Reflection Allowed Strategic Changes to Better Enable Students

When resources were restrictive, such as unwieldy tools used in the design process, students’ power in designing environmentally focused outcomes noticeably diminished. This was until course refinement was enacted by academic staff to introduce better LCA tools, based on student and IP phollow-up, as resource-based problems became apparent. Students and the IP used phollow-up processes to suggest improvements to benefit future students in delivering preferable environmental outcomes. This feedback was also a resource drawn upon by staff to aid in course modification, effectively another layer of phollow-up agency. Changes included (Lockrey and Bissett-Johnson 2013):

● Scenario consolidation to create focus for the eco-design projects;
● Removal of design drawings, as they were covered in other courses;
● Room to review changes to aid IP and student collaboration and feedback;
● Identification of more time and new resources to support impact reductions; and
● Development of a marking rubric to make expectations clearer.

In terms of the new resources implemented, a user-friendly, streamlined LCA tool, Greenfly, was embedded in the course. This improvement replaced cumbersome hand calculations introduced at the inception of the course, which had been identified as problematic by students in efficiently delivering outcomes (i.e. too long spent on hand calculations). The new
resource enabled student designs to be adapted effectively and quickly, leading to better managed and delivered enhanced environmental design propositions.

Policing and phollow-up processes were present, as dictated by policy. Course reflection by students was a university requirement designed to aid pedagogical improvements. In other words, the university level domination structure legitimised academic staff agency in changing the course for the better, based on student feedback. It also enhanced student agency as designers and IPs agency as co-creators of eco-design outcomes. As this occurred over a number of years of course delivery, the perseverance of university staff was evident. University employees accepted critical feedback from student designers, and acted to improve the eco-design learning outcomes.

Throughout this eco-design case, the importance of providing structural guidance to enable agency, and improving structures reflexively through agency over time is highlighted. Actions were bound in both practical and discursive consciousness (Giddens 1984), through the tacit expertise and considered reflection applied respectively by students. These two features are common elements of agency evident throughout the eco-design case, whether that be navigation of rules/structures, student mastery of resources, structural modifications initiated for improved student outcomes, or communicative interactions. Employees strategising for environmental sustainability may indeed need to keep these components of agency in mind. Expertise, reflection, or other combinations of knowledge, skill, and awareness may provide them with the agency to enact behaviours that reduce environmental impacts.

If behaviours demonstrated by students are retained beyond the learning process, in time the eco-design course could contribute to broader professional practice. It follows that the course has the potential to affect structures outside the course, as former students progress to contexts such as industry, government and civil society. In these roles their actions could make a significant difference to reducing environmental impacts in the projects with which they are involved.

15.7 CONCLUSIONS: BREAKING DOWN STRUCTURAL BARRIERS AND ENABLING OF EMPLOYEE ACTION

The two case studies have demonstrated important aspects of social structures that may enable employees and empower them to act in addressing environmental impacts within organisations.
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The aged care case reveals that employees of different disciplines can draw on key enabling rules and resources to plan a strategy effectively. In this context, communication is pivotal in reducing barriers and resistance whilst fostering an environment where various options can be refined collectively from a multi-perspective view. A shared value approach ensures that employees have a stake in the strategy, by co-creating it and, in time, by co-managing it.

The eco-design case study demonstrates that, by setting up the right structures initially, strategies can run smoothly. This includes creating rules that guide employees to improve their approach to environmental problems, and in providing key resources that enable their reflection and agency. When the settings do not work, reflexivity was shown to be critical in ensuring ongoing strategic success over time. This relates to sensitivity to problems that are evident and responsiveness to feedback, leading to modifications to plans and actions.

Both cases illustrate that with appropriate and thoughtful design, organisations and stakeholders can co-create behavioural infrastructures to provide agency to participants that results in environmental outcomes. In future research, analytical frameworks such as the ‘Nine Ps’ could provide parameters to test for actionable change environments, rather than having large-scale problems that may remain unaddressed because of complexity. Second, structuration provides a theoretical lens by which we may view the development of strategy for environmentally sustainable outcomes. Understanding the interplay between social structures and employee applications of rules, resources, norms and their interpretive schemes in further applied research could allow internal marketers to design apposite behavioural infrastructures. Such infrastructures may enable people to actively co-create environmentally sound organisations. If patterns emerge through further research, scholars could then provide managers with confidence in the general rules to be applied to reach environmental goals. In other words, such research may provide a ‘toolbox’ for best practice success in environmental strategy. Creating organisational environments where human agency is welcomed, and exploited, means overcoming systemic barriers to action. This is the first step in the process of change to pivot to ongoing strategic success in addressing environmental impacts.

NOTES

* The authors would like to acknowledge the assistance of the following people for their help in the formative stages of research and providing advice and support on the
case study components of this chapter: Kate Bissett-Johnson (Swinburne University), Stephen Clune (Lancaster University), Carol Fountain (Uniting Agewell) and Cedric Israelson (MicroHeat).

1. By legitimate, Gond et al. (2015) demonstrate that employees felt their actions were warranted based on beliefs drawn from institutions dictating their professional (engineering) discipline.

2. Systems of signification determine how people make sense of information and help them communicate; systems of legitimation determine socially accepted behaviours; and systems of domination determine how people wield power or are controlled (Giddens 1984).

3. By ‘phollow-up’ we mean ‘follow up’. We phrase it as ‘phollow-up’ to fit with the ‘P’ convention of the ‘Nine Ps’.

REFERENCES


Davis, G., F. O’Callaghan and K. Knox (2009), ‘Sustainable attitudes and behaviours amongst a sample of non-academic staff: A case study from an Information Services Department, Griffith University, Brisbane’, International Journal of Sustainability in Higher Education, 10 (2), 136–151.


Enabling employees and breaking down barriers


### Appendix 15.1 Structure/agency characteristics of strategic planning aged care case data

<table>
<thead>
<tr>
<th>‘Nine Ps’*</th>
<th>‘Nine Ps’ and structural characteristics pre-strategic planning*</th>
<th>‘Nine Ps’ structural change/agency observed during strategic planning*</th>
</tr>
</thead>
</table>
| **Philosophy** | 1.01 CEO committed to developing strategic environmental action.  
1.02 Funding supplied for external experts/employee time for planning.  
1.03 No philosophical statement was apparent publicly prior to strategic planning.  
1.04 Domination/signification/legitimation structure did not aid environmental action. | 1.05 Objectives to address energy/greenhouse gas reduction were made clear.  
1.06 Employees generally approached planning as if environmental issues should be solved.  
1.07 Techniques new to the organisation, namely LCA and design-thinking, were embraced in strategising. This helped reveal opportunities to exploit for better environmental outcomes. |
| **Policy** | 2.01 Management demonstrated support by initiation of planning.  
2.02 Planning was initiated to correct policy deficiencies guiding environmental action.  
2.03 No apparent environmental policies/action plans (except regulatory compliance).  
2.04 A lack of rules left structures for environmental action deficient. | 2.05 Some employee/departmental concerns surfaced as to environmental action.  
2.06 Internal/external teams collaborated to produce short/long-term actions.  
2.07 Policy did not result from the planning process, so remains a structural deficiency that needs to be addressed as part of strategic implementation. |
| **Process** | 3.01 Management, finance, risk assessment, operations, food service, care and stakeholder engagement processes existed, yet not focused on environmental impact.  
3.02 Operational practice, divergent innovation methods, risk-taking, measures of effectiveness, clear initiatives, and expected behaviours directly related to environmental issues were not previous organisational processes. | 3.04 Planning actions designed operational shifts for sustainable outcomes.  
3.05 LCA revealed environmental hot spots and design-thinking methods revealed viable opportunities (contemplated risk/divergent design).  
3.06 Realigned resources were identified to drive strategic success e.g. procurement tendering for food/appliances, plate food waste studies, resident consultation, community gardening and space heating/cooling zoning. |
3.03 A lack of resources inhibited environmental action, with structural influences enabling other sorts of actions e.g. economic, resident needs, cultural.

Procedure
4.01 Procedures were not apparent in relation to environmental sustainability.
4.02 An environmental management system e.g. set of processes and procedures, new staff environmental sustainability inductions, or sets of steps to achieve environmental outcomes were not apparent pre-planning.
4.03 Limited resources and rules again inhibited environmental action.
4.04 Employees planned clear steps/processes, designed to achieve environmental aims.
4.05 Collaboration helped reveal how policies/procedures may guide actions.
4.06 More needed to be done post planning and in subsequent implementation in defining guiding procedures, for domination/signification/legitimation structures enabling action.

Promotion
5.01 Environmental sustainability was not broadly embedded in daily practices.
5.02 By reaching out to external experts the aged care organisation looked to professionals for support on this.
5.03 By communicating support for employee participation in planning, internal social marketing helped form the planning process.
5.04 Regular internal communication: external reporting, and advertising of the successes in dealing with environmental issues were not apparent pre-planning.
5.05 Signification/legitimation structures remained weak due to a lack of resources.
5.06 Broad content that could be used for promotional activities in strategic implementation was developed in the planning process, regarding external and internal communications.
5.07 More work was needed in confirming the plan for: internal communication e.g. email, web, and e-news to staff, from philosophy down to initiatives; reporting initiatives to residents, regulators and broader community; and advertising success e.g. print, posters, and digital, in dealing with environmental issues.

3.07 New resources were identified to help strategic success, e.g. reinvestment of energy efficiency savings, and tools to measure environmental choices.
### Appendix 15.1 (continued)

<table>
<thead>
<tr>
<th>‘Nine Ps’*</th>
<th>‘Nine Ps’ and structural characteristics pre-strategic planning*</th>
<th>‘Nine Ps’ structural change/agency observed during strategic planning*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>People</strong></td>
<td>6.01 The CEO drove strategic planning, a powerful central champion structurally.</td>
<td>6.08 Executive through to middle management engaged with the planning project, and supported lower-level employee involvement.</td>
</tr>
<tr>
<td></td>
<td>6.02 A culture existed in supporting and rewarding savings in financial costs.</td>
<td>6.09 Actions for people were identified to drive strategic success, e.g. engagement processes with residents and families for thermal comfort and food outcomes.</td>
</tr>
<tr>
<td></td>
<td>6.03 Individuals saving energy could be treated likewise, although being indirect environmental support, as it is economically focused.</td>
<td>6.10 Subsequent work on empowering mechanisms and related resources such as: rewards for individual action; positive activism; training; time off; or monetary reimbursement, is required for any implementation.</td>
</tr>
<tr>
<td></td>
<td>6.04 Potentially important partnerships existed between key stakeholders such as departments, procurement partners, residents and their relatives.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6.05 No formal direct reward/recognition of individual’s environmental actions existed.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6.06 There were no empowering mechanisms for individual action for environmental outcomes, although the planning process could signify the inaugural one.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6.07 Structures were subsequently limited in communications, enabling of power, and legitimisation of effective environmental actions by employees.</td>
<td></td>
</tr>
<tr>
<td><strong>Policing</strong></td>
<td>7.01 Policing extended only as far as environmental compliance e.g. waste and</td>
<td>7.04 Assessment through LCA for impact hot spots became strategically critical as employees worked through the pertinent issues.</td>
</tr>
<tr>
<td></td>
<td>7.02 Assessment through LCA for impact hot spots became strategically critical as employees worked through the pertinent issues.</td>
<td></td>
</tr>
</tbody>
</table>
energy, to regulation prior to strategic planning.

7.02 Strong rules and resources to sanction employee behaviour counter environmental sustainability were not present.

7.03 Domination/legitimation structures did not provide deterrents to drive substantial environmental impact reduction.

7.05 Measureable goals/objectives were mapped in strategic planning.

7.06 Development of rules and resources such as: regular audits; enforcement of policy breaches; and employee complaint protection, were still required to guide policing action.

Phollow-up

8.01 Not previously initiated in connection to environmental sustainability strategy at the aged care organisation. As such, structure and agency in day-to-day practices at the organisation as related to environmental sustainability strategy and outcomes are insignificant.

8.02 Executive involvement in planning paved the way for closed-loop reporting e.g. issues addressed are reported to executive.

8.03 The reinvestment financing model for energy resolved to be iterative over time through planning actions.

8.04 Cross-disciplinary participation in strategic planning initiated organisational learning.

8.05 More work was required pre-strategic implementation to ensure: closed-loop reporting; strategic development from previous strategic outcomes; employee development; continuous improvement; and organisational learning.

8.06 Employee access of such resources, structures could be aligned to enable better environmental outcomes.
### Appendix 15.1 (continued)

<table>
<thead>
<tr>
<th>‘Nine Ps’*</th>
<th>‘Nine Ps’ and structural characteristics pre-strategic planning*</th>
<th>‘Nine Ps’ structural change/agency observed during strategic planning*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Persevere</td>
<td>9.01 Not previously initiated in connection to an environmental sustainability strategy at the aged care organisation. As such, structure and agency in day-to-day practices at the organisation as related to environmental sustainability strategy and outcomes are insignificant.</td>
<td>9.02 Long-term (&gt;5 years) goals and strategies in relation to environmental issues were developed through planning actions e.g. energy financing short to long term, relying on implementation. 9.03 The planning team persevered with multiple perspectives, to make pragmatic actions towards a strategic outcome that catered for those perspectives and retained ‘shared value’ for all stakeholders. 9.04 Investment was deemed central to strategic implementation. 9.05 Further work on: staff deployment, secondments, departmental budgets, and openness to prototype-failure-refinement cycles will allow resilient action.</td>
</tr>
</tbody>
</table>

### Appendix 15.2 Structure/agency characteristics of eco-design strategic implementation case data

<table>
<thead>
<tr>
<th>‘Nine Ps’</th>
<th>‘Nine Ps’ initial structural characteristics for strategic implementation</th>
<th>‘Nine Ps’ structural change/agency observed during strategic implementation/refinement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Philosophy</td>
<td>1.01 University/IP had executive/board support to address environmental issues.</td>
<td>1.06 Students approached strategic implementation in terms of reducing environmental impacts, as well as other design requirements.</td>
</tr>
<tr>
<td></td>
<td>1.02 Funding allowed external experts and employee time to deliver strategy.</td>
<td>1.07 New techniques for student design projects, namely whole systems design, engineering calculations and LCA and design-thinking, were used to help reveal opportunities to exploit, and whether designs achieved strategic success.</td>
</tr>
<tr>
<td></td>
<td>1.03 Objectives to reduce energy use, greenhouse gas reduction, water and solid waste were the aim of the eco-design projects.</td>
<td>1.08 University staff used environmental impact savings as the overarching philosophy to create clear structural conditions for actions in eco-design projects.</td>
</tr>
<tr>
<td></td>
<td>1.04 Philosophical statements existed for the university and IP during the design project.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.05 As such, clear domination, signification, and legitimation structure in aiding environmental action was present.</td>
<td></td>
</tr>
<tr>
<td>Policy</td>
<td>2.01 University staff created a policy platform for the eco-design strategy, with regulatory/university/IP expectations, and associated projects.</td>
<td>2.04 Students, university staff, and the IP used the design brief over time to produce eco-design outcomes.</td>
</tr>
<tr>
<td></td>
<td>2.02 Students accessed an easily understood/readily available project brief with relevant environmental/product issues, and pedagogical expectations in course outlines/assessment guidance. Clear project plans/actions accompanied the policy summary.</td>
<td>2.05 Some student and IP concerns surfaced as to environmental action, based on some of the rules and resources included in the first few years of the course.</td>
</tr>
<tr>
<td></td>
<td>2.03 These rules set domination/legitimation structure for environmental action through design.</td>
<td>2.06 Policy refinement was actioned e.g. structures changed in light of shifting tasks, tools to be used, and outcome requirements written in the project brief.</td>
</tr>
<tr>
<td>Process</td>
<td>3.01 Clear processes were provided for the design of products through the strategy.</td>
<td>3.05 Streamlined LCA revealed environmental hot spots.</td>
</tr>
<tr>
<td></td>
<td>3.06 Engineering calculation/whole systems analysis tracked product performance.</td>
<td></td>
</tr>
</tbody>
</table>
### Appendix 15.2 (continued)

<table>
<thead>
<tr>
<th>'Nine Ps' *</th>
<th>'Nine Ps' initial structural characteristics for strategic implementation *</th>
<th>'Nine Ps' structural change/agency observed during strategic implementation/refinement *</th>
</tr>
</thead>
</table>
| Process     | 3.02 A clear set of processes for feedback on/ refinement of the strategy over time existed.  
3.03 Design/engineering practice; tools/methods; divergent innovation/risk-taking in design-thinking; measures of effectiveness through streamlined LCA; engineering calculation and critical design review sessions; and policies driving expected environmental outcomes were key processes drawn upon by student designers in a 'scaffolded learning' course structure.  
3.04 Resources enabled action in creating structure central to environmental outcomes. | 3.07 Design methods revealed opportunities for eco-design outcomes e.g. divergent design and contemplated risk, which were viable.  
3.08 Feedback from IP and university staff during critical design reviews led students to refined eco-design outcomes over the eco-design project.  
3.09 Feedback from IP and students led to impact assessment/design process changes, so domination structures shifted in order to better enable students to reduce the environmental impacts of their designs. |
| Procedures  | 4.01 Clear guidance/resources were provided students, explaining how to use the design/environmental sustainability tools and methods they needed to fulfil the eco-design projects.  
4.02 Clear guidance as to university expectations on academic conduct was available, distributed physically and reinforced verbally through marking rubrics, time management by way of key milestones, and progressive formative/summative assessment.  
4.03 Project management, training in design/environmental sustainability concepts, and preferred actions for environmental outcomes were provided prior and throughout to students. | 4.05 The strategy helped students work through a clear set of steps designed to reduce environmental impacts through a brief and online course management system.  
4.06 Training was delivered through lectures and online resources.  
4.07 In class guidance, feedback, and ongoing email correspondence also helped form the real-time training and guidance.  
4.08 Marking rubrics were developed in later years of the course for clarity of the task required for the course, which represented a shift in signification structures e.g. better visibility for students on what was required; and |
4.04 Guiding rules and resources enabled effective use of tools, even with structures also related to other actions e.g. user needs, manufacturability, robustness, or university policy.

Promotion 5.01 Environmental sustainability was embedded in practices involved in the eco-design course.
5.02 Through the IP, university staff pitched a real-world problem to be solved by students.
5.03 By promoting an authentic problem and participation/stake of the IP, student engagement was enhanced and internal social marketing dimension realised.
5.04 Communication points between IP, staff, and students; student awards; external reporting; and promoting course benefits were resources used by staff to engage students.
5.05 This had particular relevance in that signification and legitimation structures remained strong as these resources were utilised.

People 6.01 University staff initiated eco-design strategy, a powerful position as central champions.
6.02 Support and reward for student engagement in the eco-design strategy was evident.
6.03 Key partnerships were brokered between staff, IP personnel and students.
6.04 Direct reward and recognition of environmental actions taken by students were embedded in course domination structures e.g. more formalised requirements for action.
5.06 Students completing the course were regularly engaged as to benefits of eco-design, and key communication points with the IP.
5.07 Student awards from the IP for the best student outcomes drove engagement.
5.08 Reporting of successes/learning through academic journals/conferences were actioned by staff post course delivery. This added to the legitimacy of the techniques applied with peer review scrutiny and approval.
5.09 Promoting benefits of the eco-design course to new cohorts of students was a practice initiated in time, strengthening signification structure.
6.09 Staff managed the eco-design project to support student actions.
6.10 Engagement processes for students were included throughout.
6.11 Student training in design methods, whole systems-thinking, LCA and energy calculations provided resources to shape designs/student skills.
6.12 IP monetary prizes were dropped, as tangible feedback
### Appendix 15.2 (continued)

<table>
<thead>
<tr>
<th>People</th>
<th>'Nine Ps’ initial structural characteristics for strategic implementation*</th>
<th>'Nine Ps’ structural change/agency observed during strategic implementation/refinement*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>marking structure. IP awards for the best outcomes were another reward.</td>
<td>on commercial aspects of designs was considered more important.</td>
</tr>
<tr>
<td></td>
<td>6.05 Processes/tools empowering student action were explicitly part of the strategy.</td>
<td>6.13 Certainly the continued engagement of the IP added legitimacy to the course, based on verbal and written feedback from students.</td>
</tr>
<tr>
<td></td>
<td>6.06 Structures subsequently enabled communications, engendered power, and bore legitimacy for effective environmental actions by students.</td>
<td>6.14 In later years, more time was allocated for environmental impact reduction. Raised in student feedback, the change created enabling domination structures.</td>
</tr>
<tr>
<td></td>
<td>6.07 Time was specifically allocated for student focus on environmental impact reduction.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6.08 Monetary prizes were offered for early years of the IP awards.</td>
<td></td>
</tr>
</tbody>
</table>

| Policing | 7.01 Policing was inherent in a timeline set for project tasks, linked to the marking schedule. | 7.05 Policing actions were described in university/PDE policy and the course brief. |
|          | 7.02 Rules to penalise outcomes counter environmental sustainability were in place. | 7.06 Measureable goals and objectives were in the course brief/assessment rubric. |
|          | 7.03 Domination and legitimation structures were conducive to driving substantial environmental impact reduction through deterrent to not complying with the requirements of the course. | 7.07 LCA/engineering calculations allowed auditing/environmental impact assessment |
|          | 7.04 Task deadlines were clearly communicated in the project brief in order to signify the conditions for acceptable project management. | 7.08 Environmental impact reductions were checked in critical reviews/final marks. |
| Phollow-up | 8.01 A clear set of processes for feedback on, and refinement of, the strategy existed. | 7.10 A more understandable/readily available rubric helped student clarity on requirements, signification/domination structures for action on environmental impacts. |

| Phollow-up | 8.05 Ongoing IP relationship management by university staff facilitated IP feedback. |                                                                                 |
8.02 University policies in relation to course reflection/improvement enabled closed-loop reporting e.g. strategic issues reported by students/IP to university staff, and acted upon.
8.03 Strategy changes and continuous improvement from previous outcomes followed.
8.04 Formative/summative reflection within, and post, strategy enabled better outcomes.

Persevere
9.01 Clear processes were provided for design refinement of products through the strategy.
9.02 A clear set of processes for the feedback on strategic implementation failure existed.
9.03 Lasting university/IP support (>12 months) was evident in commitment over years.
9.04 Time investment devoted to environmental issues and refinement of the course occurred.
9.05 Legitimation structures therefore enabled perseverance to flourish.

8.06 Reflective tools during and in refining strategy enabled organisational learning.
8.07 Realigned and new resources were identified to drive further strategic success, thus adding to domination structures in enabling student action.

9.06 Long term (>5 years) product life-cycle goals developed through eco-design.
9.07 Design and engineering techniques allowed for prototype-failure-refinement, leading to better environmental outcomes, and student learning.
9.08 Strategic implementation concerns from IP/students led to strategy refinement over time to help improve components of the course.

CHAPTER 9: DISCUSSION
9.0 INTRODUCTION

In this chapter I discuss the collective findings of my research. My findings centre on people, their agency, and how the social structures they encounter affect environmental strategy (ES) they enact. Findings were generated in a series of artefacts consisting of four published journal articles and one edited book chapter, contained in Chapters 4-8. Figure 4 outlines the conceptual elements of agency and structure that each individual artefact explores (overlayed Figure 3 from Chapter 2, page 48).

![Figure 4](image)

*Figure 4 – Where my research artefacts address aspects of my conceptual model of ES*
By investigating the contexts Figure 4 represents, I answered the research questions:

Who within organisations is needed to enact ES?

What rules assist people to enact ES within organisations?

What resources assist people to enact ES within organisations?

Why are structure and agency important when people enact ES?

In studying these questions my research artefacts revealed insights regarding the role of agency, social structure and people when enacting ES. Thus my findings collectively addressed the overarching research question:

How do people within organisations enact environmental strategy?

I discuss how my findings derived from the questions above extend theory, and add new practical implications of agency and social structure for people enacting ES. Specifically I highlight the importance of rules, resources, norms and information that people create, persevere with and change. In particular, I explain how these aspects of social structure enable or guide people to protect the environment from within their organisational contexts.

9.1 DIMENSIONS OF STRUCTURE AND AGENCY

The analysis conducted for my discussion is organised using the three step process advocated by Gioia et al. (2013) The full data structure, moving from first order data, to second order themes, to aggregate dimensions is tabulated in Appendix 1 by way of a systematic process (Currie and Spyridonidis, 2016). First order data used for my research artefacts framed emerging second order themes as my research progressed (Gioia et al., 2013). See Appendix 1 for a full list of second order themes. By considering second order themes collectively, they
led to a series of structure-agency characteristics by the way of aggregate dimensions abstracted from those themes (Gioia et al., 2013). My aggregate dimensions, summarised in Table 8, characterise how people enact ES with agency whilst interacting with social structures as described by Giddens (1984).

### Table 9 - Outline of aggregate dimensions from findings from my research artefacts

<table>
<thead>
<tr>
<th>Artefact</th>
<th>Aggregate dimensions of ES agency and structure</th>
</tr>
</thead>
</table>
| **Article 1 (Lockrey and Bissett-Johnson, 2013)** | - Interacting legitimation and domination structures  
- Familiarity enabling action  
- Power afforded through signification |
| **Article 2 (Clune and Lockrey, 2014)** | - Interacting legitimation and domination structures  
- Reoriented structures enhancing agency |
| **Article 3 (Lockrey, 2015)** | - People using domination structures they are embedded within  
- Power afforded through signification |
| **Article 4 (Lockrey et al., 2016)** | - Signification structures enable meaningful action  
- Reoriented structures enhancing agency  
- Entire strategy supporting structures |
| **Book chapter 1 (Lockrey et al., 2018)** | - Power afforded through signification  
- Interacting legitimation and domination structures  
- Reflection for judgements on action  
- Social structures enable or constrain agency |

A discussion of the nine aggregate dimensions outlined in Table 8 follows.

#### 9.1.1 Interacting legitimation and domination structures

The first aggregate dimension identified how social structures interact when ES is implemented. Interactions amongst social structures in turn influence how people apply their agency (Giddens, 1984). In particular my research showed that domination and legitimation structures intermingle to affect agency. Specifically, people in a number of cases sought legitimacy and permission to enact ES. Once they received legitimacy they simultaneously wielded legitimate power to act. Related insights from my research answered the question;  

*Why are structure and agency important when people enact ES?*
When social structures interacted, there were implications for what rules and resources people used in enacting ES. For instance, for students in the eco-design case the interaction of domination and legitimation structures simultaneously normalised their actions and empowered them. A brief was a resource provided to students that explained environmental issues, such as climate change (Lockrey et al., 2018). The brief also showed them how to use a relatively new technology for such issues, whilst an industry partner (IP) guided them in applying the technology in design contexts. Thus, rules were created about environmental issues to address, and technology to use, prescribing routines that guided student behaviours when using resources.

I also showed that rules open access to resources, whilst also bestowing permission for people to apply their skills. A student noted of the course structure, in a survey response:

“It [course structure] allowed us to bring more of our engineering knowledge into our projects”

Rules from the brief not only dictated actions students should take, but empowered them to apply agency with skills at their disposal. In contrast, previous research of ES has not documented how social structure interactions can be beneficial, focussing instead on the effect of specific structures in isolation. For example, rules such as external legislation implemented by governments can limit organisational activities aimed at the environment, like actions directed at climate change (Falke, 2011). Alternatively the findings showed that guidance provided by rules can empower people too. Rules contained in the brief prescribed tasks students were to perform and resources to use. However students subsequently applied agency with these directions, with engineering and design tools they has access to in order to reduce the environmental impacts of their products. Social structures are not always independent in affecting people and their actions. In contrast, the findings showed interacting
domination and legitimation structures simultaneously guided and then empowered students in their action to protect the environment. That echoes what Jarzabkowski (2008 p. 623) noted about relationships people have with social structures that can shape what they think is legitimate, as well as provide settings for what they can achieve.

The interaction of domination and legitimation structures was also shown to determine who becomes involved when ES is implemented by organisations. In aged care, a new routine was implemented, in the form of an open forum approach to planning (Lockrey et al., 2018). Subsequently, the routine legitimised people from all levels of the aged care organisation to work together on ES. As such senior aged care management engaged with employees from nursing, finance, and operations in a series of workshops. Previous research at Unilever showed idea generation for environmentally sensitive products resulted from cross disciplines working together co-operatively and collaboratively (Bocken et al., 2011). In contrast to simply legitimising a right to contribute ideas at Unilever, my findings revealed how aged care staff were also afforded the power to take action on their ideas by way of collaboration (Clune and Lockrey, 2014). They did so by wielding legitimate power in influencing how they would contribute to how ES was to be implemented. Collaboration helped identify the engagement processes nursing staff used with residents, to leverage for thermal comfort and food solutions reducing environmental impacts. Moreover, collaboration helped finance personnel commit to reorient procurement policies with external partners, so purchasing practices included environmental considerations. By adjusting power structures and legitimising their collaboration between people and their roles in aged care, they were enabled to act and deliver what needed to achieved. This extends understanding beyond external actor groups influence setting the conditions to implement strategy (Clifton and Amran, 2011). It shows how internal structure legitimising broader participation can have
positive outcomes for ES by affording internal individuals power, making them crucial to how ES goals are achieved.

These findings make a contribution to theory by demonstrating that domination and legitimation structures interact to shape how people apply agency in their organisational contexts (Jarzabkowski, 2008). For ES, this occurs when rules guide people in ways that afford them power through resources. People in the cases I examined were legitimised by rules to perform tasks and collaborate, which in turn empowered them to enact ES through tools and skills. This finding has implications for practice, in that organisations must consider social structures in an integrated way, when planning an ES. Such insights are new, my research showing for the first time what happens when social structures interact for ES deployed by organisations. I discuss how social structures enable and constrain agency next.

### 9.1.2 Social structures enable or constrain agency

Another aggregate dimension that emerged from my analysis is that social structures enable and/ or constrain the agency people aim to apply. Providing people with resources and/ or guiding actions with rules and norms can assist them to enact ES. Examining social structures enabling and constraining people enacting ES helps to address the question:

*Why are structure and agency important when people enact ES?*

The eco-design case showed that resources empowered students to apply agency to achieve goals stipulated by an ES (Lockrey et al., 2018). For instance tools, such as life cycle assessment (LCA) enabled students to make judgements about what designs achieved better environmental outcomes. Students measured water and energy performance of their designs with engineering techniques that they were proficient in, the results from which were used as inputs for use with LCA tools. LCA then enabled students to quantify environmental impact
reductions for their product designs, against competitor product benchmarks. By building on their engineering skills in this way the LCA tool became a normal part of their practice. This is consistent with the work of Rio et al. (2013), who demonstrated that design routines that have LCA embedded within them, can assist in achieving environmental outcomes.

In the aged care context, LCA was a resource that enabled action beyond product contexts prevalent in literature about LCA applications. New LCA tools and design methods enabled personnel to plan ES for the aged care services they provide (Clune and Lockrey, 2014). LCA provided the knowledge that informed judgements about aged care activities that delivered environmental savings. Design methods enabled idea generation and a framework to make judgements about those propositions. The methods were particularly useful for generating solutions and making decisions about food, thermal comfort and energy practices. Hence new resources, LCA and design methods, had enabled previously unknown opportunities to be considered and then acted upon. New resources, such as LCA tools, generate knowledge that can prompt people to think of fresh ideas when planning an ES, as staff at Unilever did for product designs (Bocken et al., 2011). However my research broadens the scope of such resources, in that resources such as LCA is useful for ‘whole of organisation’ ES. Beyond just those who conducted LCA, the tool was crucial to other people across the organisation as a basis upon which to justify decisions about aged care activities on environmental grounds.

By constraining people sometimes, organisations can also achieve positive outcomes for the environment. That may be somewhat counter intuitive, in that rules and norms affecting organisations have been shown to limit how ES is implemented (Wright et al., 2012). Rules such as external legislation can be a barrier to environmental action (Falke, 2011), whilst internal organisational procedures may not mandate significant action (Steurer et al., 2005). Alternatively, in the eco-design case policies and procedures helped students to be effective
by guiding them as to how to enact ES (Lockrey et al., 2018). University staff created a policy platform incorporating university and IP expectations for student projects, as well as external regulations product design must adhere to. Key processes for students to use were detailed within the course outline. Students also accessed pedagogical expectations in their assessment guidance, as a part of a normalised university routine. Examples of this included guidance about tasks to be completed in a brief, and the way they would be judged against a marking rubric. Rules and norms were therefore used in a practical way to constrain students, albeit to achieve favourable outcomes for the ES. In contrast to rules and norms being a limiting, my findings provide some insight into how organisations can apply them as mechanisms to direct actions that improve how an ES is achieved.

Social structures both enable and constrain agency as ES is implemented. Resources inform and empower people, whilst rules and norms guide them so that they know how impact reductions can be achieved. The practical implication is that by understanding which combinations work well in practice, managers can influence the conditions i.e. resources, rules, norms and information, to achieve ES outcomes. Taken together, these findings show knowledge derived from rules and resources inform action, whilst tools facilitate action required for people to enact ES. Procedures can prescribe how to act, whilst policies can limit certain actions from occurring as organisations implement ES. By achieving the right combination, people can then be both empowered and guided to achieve environmental impact reductions. Next I discuss how making rules and resources familiar to people can also assist in their enacting ES.

9.1.3 Familiarity enabling action

My research revealed how making social structures familiar to people increasingly enabled actions that led to environmental protection. When people already understand the rules and
resources available, enacting ES with them becomes easier. Thus familiar rules and resources enabling ES implementation helps address the questions;

*What rules assist people to enact ES within organisations?*

*What resources assist people to enact ES within organisations?*

Students used familiar rules and resources in the routines they performed during their eco-design projects (Lockrey and Bissett-Johnson, 2013). Routines were legitimised and guided by clear policies and procedures respectively, about outcomes to be achieved for the environment. That contrasts previous theorising, like when business case cognitive frames predicate managers maximising of profit, over environmental goals (Hahn et al., 2014b). Courses of action for environmental impact reductions are then compromised because more dominant economic drivers define what people attribute to normal workplace behaviour. However the opposite can also occur where particular rules exist that mandate environmental goals that become routinised. For instance, marking rubrics were used to define and communicate expected environmental impact reductions for students. Impact reductions were normalised and rewarded, by connecting reductions to the how student performance was assessed. Marking rubrics were also made accessible prior to the course commencing via web, paper documents and email. Hence assessment procedures were easily understood, normalised and accessible. This finding is consistent with Bocken et al. (2012), where environmental assessment was aligned to stage gate procedures familiar to personnel in new product development (NPD) at Unilever. My research then strengthens the case for organisations to leverage existing rules and norms to guide people in their ES routines, and reward them when they do so effectively.
In addition to being guided by rules and norms, students also used familiar resources and skills to design low environmental impact products. An LCA tool, Greenfly, helped them make sense of what they were achieving, through engineering metrics they were familiar with. This was similar to the way Unilever connected LCA to tasks staff performed, albeit to develop business cases for products they managed (Bocken et al., 2012). Alternatively, Greenfly provided a basis for students to make design decisions beyond establishing a business case. The tool also provided embedded tips linked to familiar student knowledge, such as user centred considerations and production insights. Students then were afforded agency through tips that they could understand based on knowledge and skills they already possessed. The eco-design case adds credence to the argument that common knowledge and understanding underpinning social structures can lead to ES success (Boks, 2006, Pascual et al., 2003). In robust action research that notion is defined as situations where many stakeholders understand what is required to achieve environmental goals (Etzion et al., 2017). Beyond robust action examples of groups’ shared understanding, my findings reveal that individuals are also pivotal to familiar knowledge being translated to environmental savings. For students, clear rules, LCA tools and design tips combined to form social structures that were connected to their current competencies, knowledge and skills. What resulted was that students understood what to do for ES, and how to do it. The implication for managers is that rules and resources need to be connected to current competencies, knowledge and skills of people enacting ES. They need to also help people deal with the unfamiliar. In the next section I discuss instances where reorienting social structures is necessary, in order to help people enact ES.
9.1.4 Reoriented structures enhancing agency

The findings on occasion showed that social structures need to be reoriented, so that people can apply agency to enact ES. As previously discussed, social structures can enable or constrain people as ES is implemented by organisations. However, that is not always beneficial to them achieving environmental goals. By examining an aggregate dimension of reoriented social structures I further resolve the questions;

*What rules assist people to enact ES within organisations?*

*What resources assist people to enact ES within organisations?*

In aged care, a recalibration of social structures created impetus for people to work effectively to enact ES (Clune and Lockrey, 2014). In contrast, rules that are not mandated can make implementing ES a low priority. For example product managers at Unilever disregarded the importance of ES initiatives in the face of a lack of organisational guidance to act pro-environmentally (Petalà et al., 2010). Voluntary corporate social responsibility procedures are another example where ES can fall short because people have discretion as to how to act (Steurer et al., 2005). Conversely my research showed rules can remedy such issues with actions taken. Aged care executive, finance, operations, nursing, managerial, and catering personnel were introduced to new rules requiring they collaborate to plan ES together. Thus they worked with disciplines they would not normally interact with. Aged care planning interactions then mirrored the way groups at Unilever worked together when assessing environmental initiatives (Bocken et al., 2011). Unilever staff pitched ideas from across functional areas, using rules requiring they be free from premature criticism to encourage collaboration and limit constraints to their thinking. For aged care staff, similar rules applied. Subsequently new knowledge was developed and shared from collaboration, producing promising ideas for ES.
To assist in planning the aged care ES, new resources were also provided to staff to use as they collaborated. LCA tools were used by external experts, resulting data introduced to help people catalogue environmental impacts associated with material and energy flows of aged care activities. Internal staff and external consultants also visited an aged care facility to ensure LCA work remained grounded in real issues in the field. Staff considered knowledge beyond their own perspectives by comparing LCA results to practices on site, to make judgements about options for the ES. As one external participant observed:

“At the outset of the project the organisation’s environmental concerns were highly visual, such as paper use and the high number of incontinent (sic) pads used. The process shifted the thinking of the organisation from the visual to the embodied”

The combination of new resources enabled new knowledge to be generated and shift norms people referenced from their preconceptions, to help advance the ES. Alternatively, norms, such as those related to maximising organisational profits, can lead to actions that stymie outcomes that ES requires (Supran and Oreskes, 2017). Developing a business case is one routine managers participate in that where economic drivers can block them enacting ES (Hahn et al., 2014b). Conversely the findings showed aged care personnel could navigate influences that ordinarily constrain them, using LCA data to justify action on more pertinent environment issues. LCA went beyond the traditional role of benchmarking tool (Hellweg and Canals, 2014), to being a resource that enabled people to excerpt their agency.

The EcoRedesign case also illustrated how evolving resources can lead to improved environmental outcomes when ES is implemented (Lockrey et al., 2016). Individual participants in the EcoRedesign program were involved in creating tools to solve problems during NPD. Those tools then assisted them enact ES. As one participant noted:
“The processes we developed [for NPD] would bring up technical issues that may have not been discussed previously…It is the embracing of these processes that drove the innovation”

Success in achieving project goals was attributed by participants to new tools used to verify environmental credentials, resulting in innovative products being developed. Knowledge generated from the tools enabled judgements about actions subsequently taken during the design process. As the same participant elaborated:

“Fundamental [to NPD] were models reflecting the physics and chemistry of a context, and the use of benchmarking… and a process by which you drew out the fundamentals of what was happening environmentally. This meant that teams didn’t jump to conclusions too early.”

New tools provided knowledge that informed design routines as impact reductions were achieved as a result. One participant expressed how new tools made them confident in decisions made when designing a prototype with environmentally superior features:

“I was asked to look at the energy and water performance [of the product designs]. I measured and calculated the volumes of reservoirs, pipes and fittings, looked at flow restrictions, then developed a computer model to simulate its performance minute by minute. I was very pleased when the model closely matched the actual performance of a reference machine”

In this way new resources provided confidence by equipping EcoRedesign participants with knowledge, so that they could excerpt agency to innovate. Success is not a given when eco-design is used by organisations to achieve goals set by an ES (Pascual et al., 2003). Petala et
al. (2010) found Unilever staff were provided neither rules nor resources to adequately address environmental concerns. In contrast, both the aged care and EcoRedesign cases showed reduced environmental impacts can be achieved when social structures are reoriented to assist people to apply their agency. By providing explicit time and space for those responsible for either managing or enacting ES to reflect, changes required to social structure become more achievable. Next I discuss further how reflection helped managers reorient social structures to increase agency of employees tasked to enact ES.

9.1.5 Reflection for judgements and action

In order to apply their agency effectively, or change social contexts to do so, space and time for people to reflect is required. It is also crucial that people are conscious about how they can make good decisions, as they reflect on their situations (Winch, 1990). Cognitive frames research captures the initial stage of reflection, cataloguing the content and structure of thoughts used by people to make decisions about enacting ES (Hockerts, 2015). I enrich cognitive research about decisions made, by illuminating cases of how and why actions are then taken. With processes set up that provide people space and time to reflect, they can more adequately judge what is required and then enact ES accordingly. Subsequently the findings show when people use reflection to inform their actions, it helps to answer the question;

*Why are structure and agency important when people enact ES?*

During the eco-design course, reflective processes helped students apply agency to use or change social structures (Lockrey et al., 2018). Resources such as LCA tools were provided, which enabled students to reflect on and refine their designs according to environmental performance data the tools provided. Also, students were forced to reflect on verbal and written feedback provided in structured design review sessions, ad hoc class feedback, and
email correspondence. Subsequently, feedback to students forced them into a mode of deliberation that caused them to make better judgments to reduce environmental impacts

Significantly, students and the IP used feedback processes to reflect on the eco-design course as a whole. Suggestions were made about aspects of the course that had not worked, and ways in which to improve to benefit future students. For instance, feedback was used to adjust the tools students used, to improve their ability to implement environmental benefits and achieve better learning outcomes. LCA tools that were initially deployed were hard to use, and had led to some students struggling to achieve good and timely environmental outcomes with their designs. In response to feedback a user-friendly LCA tool, Greenfly, was adopted. Subsequently students evaluated environmental impacts of their designs more effectively and efficiently. A key finding then was that reflective processes allowed students change to social structures to better enable them to apply their agency, their feedback leading to better tools. Concerns were also raised by students about assessment tasks not focussed on creating environmental savings, and doubled up in courses elsewhere. Staff commented course changes that resulted from student concerns:

“More traditional engineering drawings was (sic) less relevant in the current environment of digital 3D CAD files. Exploded and sectional views….allow for more effective use of time …and clearer communication of resulting designs and systems”

Thus processes enabling reflective feedback led to course modifications allowing students to focus more on implementing environmental outcomes. Providing the right information to students was also noted by the IP:

“A strong understanding of the scope for the application of the technology enhances the search for creative applications”
Subsequently clear information about technology increased the students’ agency in designing better products. Research acknowledges that ES inherently requires reflection, as organisations and their stakeholders consider what they must shift to address environmental challenges (Steurer et al., 2005). The findings show that ES requires organisational personnel to reflect and potentially to adjust their own practices too. University staff required time and space to reflect on student feedback, to consider and deploy course changes. As part of their normal university routines staff were provided written reports summarising collective feedback from students, and time at the end of semester to reflect and act on them. Student reflections were used to acknowledge success and problems, and change the course for students to take future action more effectively.

A key implication of reflective processes is that feedback data, and time to consider it, can empower employees to alleviate issues they face. Those managing ES, university staff, and those enacting it, the students, shared the agency to have power in enacting changes require for the eco-design course. Empowerment is discussed next, as to how people are embedded in ES domination structures.

9.1.6 People using domination structures they are embedded within

Giddens (1984) proposed that power derives from the domination structures that shape how organisations operate. People are embedded within domination structures within organisations, a relationship which determines the power they wield when enacting ES. My research articulated the importance of the relationship between people and power. The relationship is key to who can achieve environmental impact reductions, or not, due to their capacity to apply agency. Hence it addresses the question;

*Who within organisations is needed to enact ES?*
In my review of the NPD context (Lockrey, 2015), marketers were identified as wielding significant power within organisations engaged in NPD (Goldman and Grinstein, 2010). This is due to marketing activities influencing operations as organisations take steps to service market needs and desires (Atuahene–Gima and Li, 2003). As a result people from other disciplines, such as design and production, are limited in the action they can take in NPD projects (Atuahene-Gima and Evangelista, 2000). However it is these other disciplines who often have expertise to apply resources needed to enact ES, such as LCA (Pascual et al., 2003, Verghese and Lockrey, 2012, Rio et al., 2013). Thus my research showed that because expertise can sit outside of disciplines wielding power, such as marketing, implementing ES can become difficult. That is, agency is dictated by domination structures that people are embedded within, such as their discipline and where it is placed within organisations. For example agency can be apparent for ES, but for the wrong reasons (Lockrey, 2015). Petala et al. (2010) found that Unilever product managers demonstrated problematic attitudes when they reflected on their NPD projects, with comments including:

“We generally do not fill this (sustainability) section”, and

“Sustainability is not yet integrated as a parameter in the whole [NPD] process”, and

“I feel that I need to do it [sustainability], but it is not a working practice”

Unilever managers’ low priority for ES reflected in their comments above, combined with power afforded by their marketing discipline, led to inaction. Alternatively, when helpful resources are embedded into the routines of powerful disciplines, beneficial outcomes emerge when organisations implement ES. Research on Unilever showed benefits to trialling a life cycle based tool that scoped the viability of ES for new products whilst being embedded in the process of business case development (Bocken et al., 2012). Environmental considerations were assessed alongside other drivers of NPD, making ES easier as a part of
managers’ normal routines. My findings therefore highlight that embedding resources with the normal practices of people, such as life cycle tools into business analysis, can work as a practical approach to assist in enacting ES. Environmental issues are then a part of normal job functions, when previously domination structures may have required other priorities or tasks to take precedence. In practice resources, such as LCA, can then be used to enact new domination structures, where routinised action on ES can be enabled.

Collaboration is another mechanism by which powerful disciplines enact ES. Collaboration is akin to ‘participatory architecture’ in robust action research (Ferraro et al., 2015), where organisations working together and interact with external groups to implement ES. My research reiterates the value of external collaboration covered in robust action research (Etzion et al., 2017, Ferraro et al., 2015), however in contrast focusses on individuals interacting internally to enact ES. Bocken et al. (2011) identified where ideas about environmental issues developed at Unilever through collaboration. Staff with from sustainability, NPD, engineering, and supply chain disciplines worked together, proposing solutions that would continue collaboration within Unilever. Likewise in the aged care case, personnel collaborated to secure commitments, including by people with power from executive management, in implementing ES with their future actions. Both examples illustrate the key finding that domination structures that allow people to collaborate from differing power levels, help them tackle ES collectively, and effectively. Information that enables such collaboration is discussed in more detail next.

9.1.7 Power afforded through signification structures

People can apply power through the signification structures they interact with, and this was evident in the aged care case, eco-design course, and my review of life cycle marketing in NPD (Lockrey, 2015, Lockrey and Bissett-Johnson, 2013, Lockrey et al., 2018). More
specifically people used information to inform effective actions, wielding power in the process. The relationship between information and power is another example of how social structures interact, this time domination and signification structures. Etzion et al. (2017) showed that such structural interactions existed between Danish organisations, where shared information helped them develop the national wind power industry effectively. Said collaborations afforded organisations in Denmark the power to drive technological changes required. Additionally to this, my findings demonstrated if people can access good information they can wield power within organisations, further addressing the question;

*Why are structure and agency important when people enact ES?*

Information flowing between people enabled informed judgements to be made when the eco-design course ran (Lockrey and Bissett-Johnson, 2013). Students showed project progress using verbal, visual, physical modelling, computer generated or calculation based communication modes. University staff and the IP communicated feedback progressively to students, and when they formally judged students at the course conclusion. One student commented on this communication;

“They [staff] were interested in our work and gave good feedback responding quickly to emails”

In contrast, good communication is not always the case when ES is implemented. Petala et al. (2010) showed Unilever managers lamenting internal ES information flows;

“It [ES] is not efficiently communicated among employees,” and

“Global teams should communicate sustainability more efficiently among employees”
In spite of organisational directives, Unilever managers’ inaction on ES was exacerbated when required information was not well communicated to them by executive management. In contrast, my research showed that by enabling information flow, effective judgements were made by students on implementing environmental savings. Communication did not just empower students to design for the environment. As previously noted, feedback from student and IP reviews helped university staff enact improvements to the course. Signification structures then afforded power to staff, as feedback information was used to justify changes to social structures to enable students to design superior products in the future. Thus individuals, who are provided good information and the ability to communicate, have more power to enact ES, or change conditions to do so.

The aged care case provided further examples of how information can afford people power to solve instances where resistance to ES occurs (Lockrey et al., 2018). Antipathy to action for the aged care ES arose when some participants took issue with ideas pitched by personnel from other disciplines. Figure 5 shows ideas that developed by people planning the aged care ES, which were written in black text. Resistance about actions is demonstrated by red comments, which denote where counter points were made to proposed changes in aged care practice. Aged care staff from a variety of disciplines made counter points; based on barriers they perceived to aged care practice changes.

![Figure 5 – Red comments written in planning to negate ideas](image-url)
The aged care case provides evidence of how such barriers to enacting ES can be overcome by way of information sharing. Anxieties held by planning personnel about ideas posed for the ES were eased as they engaged in discussion. For instance, initially some planning participants identified procurement policies for electrical appliances as inhibitors to energy efficiency improvements. To negotiate these concerns, consensus building exercises were performed, illustrated in Figure 6. Red dots indicate preferred options to aged care staff from a variety of disciplines, overlayed on ideas developed for the ES. In this case consensus developed as information was shared about electrical appliances. External consultants participating in planning contributed knowledge about appliance efficiency. Additionally, internal knowledge about purchasing protocols for appliances was given by financial personnel, information that was normally less accessible to other disciplines involved with aged care. Also day to day appliance use was detailed by nursing and operations staff, work flows less familiar to some of the other aged care staff present in planning. Thus the value of outside expertise and knowledge, whether facilitated by external consultants or unfamiliar staff disciplines, must be acknowledged for managers considering ES. Facilitating outside expertise empowered aged care staff with new ways to view their practices.

Figure 6 – Red dots acknowledging agreement on ES planning options

As information was shared, new rules for aged care were formulated. An example of this was existing, centralised hire-purchasing policy for electrical appliances being adapted to have
energy consumption performance data added to it. Managers were then made aware of environmental consequences of appliances they were responsible for purchasing. As such the planning team had devised a new procedure for energy savings that were compatible with existing aged care practices. The aged care case then supports research from Unilever showing the importance of matching actions for environmental issues with established business functions, such as business case development with information (Bocken et al., 2012). Tasks for an ES can then be scoped as compatible with the organisational context, as it was for aged care as participants communicated and collaborated. Further existing opportunities in aged care to leverage across the organisation included procurement tendering for food services and appliances; plate food waste studies; resident consultation; community gardening; and space heating and cooling zoning. It follows that good information and communication helps to bridge resistance and empower people to enact ES effectively. In the next section I look at signification structures further, in how they bring meaning to people enacting ES.

9.1.8 Signification structures enable meaningful action

Signification structures provide information that can result in people developing meaningful connection to actions that they take. People sometimes enact ES because it means something significantly personal to them. My findings then strengthens calls to consider the concerns people within organisations hold about the environment, and how to translate their concerns into action (Bansal, 2003). Personally constructed characteristics of action relate to my overarching research question;

*How do people within organisations enact environmental strategy?*
Firstly, the EcoRedesign case revealed that people acted on environmental purposes that they felt had merit (Lockrey et al., 2016). An engineer that participated in EcoRedesign was interviewed, and expressed what it meant to be a part of a project that was;

“A very exciting and challenging project that implemented Australia’s first 6 energy star, AAA water efficiency rated dishwasher.”

The participant valued both the challenge of the project, and the goal of achieving outstanding environmental outcomes in designing energy and water efficient products. Hence, they were highly engaged in the purposes they were tasked to fulfil for the ES. An alignment of their personal values to what they were trying to achieve was evident.

EcoRedesign participants also echoed ‘multivocal inscription’ from robust action research, as the ES resonated to the range of stakeholder perspectives. EcoRedesign projects goals were set and understood like they were amongst the many Danish organisations that built a successful wind power industry (Etzion et al., 2017). However for the case of EcoRedesign, personal, rather than only organisational, perspectives were shown to align.

Further, commitment to enact ES grew by way of interactions between people participating in EcoRedesign. Interviewees attributed their success at solving problems during EcoRedesign to open and free-flowing communication, both with people within and between organisations. Thus signification structures in EcoRedesign mirrored those that allowed organisations to collaborate successfully to deploy Danish wind power through robust action (Etzion et al., 2017). Findings from the EcoRedesign case went further that an ability to collaborate, in that goodwill between individuals was also shown to play a role. The engineer interviewed commented on the team dynamic;
“Cross disciplinary perspectives were considered…. There was a great deal of respect for each other.”

EcoRedesign brought together interdisciplinary teams consisting of design, engineering, social science, marketing and environmental expertise. The collective expertise of teams meant they worked together productively. Such collaborations contrast what many managers experience when enacting ES, who face resistance to implement positive action. For instance the identities and narratives managers are required to adopt to satisfy their collaborators on ES can compromise any action they take (Wright et al., 2012). For EcoRedesign the opposite was the case, where respect between design, engineering, social science, marketing and environmental personnel, and their respective capabilities, drove positive outcomes. As one industrial design manager recalled;

“We could co-create, collaborate with the best in field specialists.”

The people and expertise, as per the disciplines listed above, strengthened participants’ commitment to the ES they were enacting. Granted, participants were initially passionate in achieving goals by an ES purpose they believed in. Yet commitment to projects developed further, because good expertise was available and mutual respect was evident in the way they described their experiences. Therefore a key finding was that people can feel more capable because of interactions with colleagues from disciplines other than their own. Collegial characteristics born from collaboration can in turn enhance the meaning that enacting ES holds for them individually. Such collegial characteristics are not always evident for ES, as has been shown when people face resistance from other disciplines within organisations (Wright et al., 2012). In my final section I acknowledge the importance of people being supported over an entire ES, to overcome barriers they encounter.
9.1.9 Entire strategy supporting structures

Support should be provided to employees over an entire ES, through rules and resources organisations supply. Personnel then have the best chance to achieve environmental impact reduction. Yet even if some tasks are successful, environmental goals are not guaranteed if support is not consistent over an entire ES. Giddens’ (1984) concept of the interplay between structure and agency applies continuously over time as an ES is implemented. The findings highlighted the importance of social structures that organisations provide, to support people to apply agency throughout an ES. Such considerations relate to the questions;

*What rules assist people to enact ES within organisations?*

*What resources assist people to enact ES within organisations?*

EcoRedesign teams exhibited their agency in the design phase by means of resources they used to develop environmentally conscious products (Lockrey et al., 2016). Specifically they were empowered by tools such as LCA, so that they could justify good environmental product credentials. This is consistent to the way in which organisations traditionally apply LCA, for NPD activities (Hellweg and Canals, 2014). For the Kambrook Axis kettle designed during the EcoRedesign program, designers used LCA to incorporate features capable of driving environmental savings in the water heating category. The findings reveal that agency applied successfully during one ES task, such as using LCA when designing, is not always enough. This contrasts research that generally focusses on how resources such as LCA is applied to tasks at hand, like developing a business case (Bocken et al., 2012), or making NPD decisions (Rio et al., 2013). Rather tasks that follow the use of helpful resources like LCA should be considered too. For all the eco-design success Kambrook achieved through
LCA, market problems ensued as management and marketing personnel engaged unfamiliar sales channels. As one design manager involved in EcoRedesign put it:

“Big box stores of K-Mart and Target didn’t stock the Axis kettle. To Kambrook’s credit, they found a new avenue for Axis through David Jones, a first for them. The problem though was that David Jones didn’t have the volume of sales Kambrook were used to, and Kambrook didn’t have the reputation for high end retailers”

Kambrook were more familiar with a sales strategy for high volume and low cost kettles, which did not apply to their new sales channels. The new experience likely led to Kambrook defaulting to their normal focus on low price. Other features, such as functionality and high quality, may have resonated more with customers in the new, premium channels. The manager also compared Kambrook to other brands:

“Sunbeam had always implemented more progressive designs with better components and quality of usability, therefore it was a big leap of faith … for a traditional, wealthier David Jones customer to accept what they had been educated as to an inferior brand to Sunbeam”

A disconnect between the actions taken by those launching the kettle, and new unfamiliar markets, was apparent. At the same time low management support for the kettle was observed by external personnel on the project, and evidenced in the light touch approach to marketing. They exhibited similar behaviour to that of product managers at Unilever, who demonstrated a disinterest in supporting an ES for products they managed (Petala et al., 2010). Kambrook management acted counter to the aim that was the focus of the design phase, in fact approving features to be stripped out of the kettle to address environmental impacts for cost reasons. Therefore the Kambrook example in the EcoRedesign case suggests that without
supporting all tasks needed across an ES, people struggle to enact what is required or in fact act counter to them. Resources such as LCA tools do help people validate environmental savings. However organisations should also consider other resources that help people make those savings become a reality over an entire ES.

In contrast another EcoRedesign project achieved the opposite result to the kettle, when market success was realised for a dishwasher. The Dishlex dishwasher was designed with superior environmental performance to competitors with the help of LCA tools, whilst remaining quieter and cheaper to run. As well as these favourable selling features, management supported ongoing promotion of the dishwasher by providing marketing resources to do so. Subsequently the Dishlex was successful with consumers for many years up unto this day, and environmental savings realised through that success. Unlike the Kambrook kettle, the Dishlex case demonstrates that success is more likely by providing supporting social structures to people over the entirety of an ES.

9.2 DISCUSSION SUMMARY

Collectively, the discussion of my findings in this chapter identified nuanced aspects of how people can enact ES within organisations. I did so by enriching cognitive frames research by showing actions people take from decisions they make cognitively; and by extending robust action and stakeholder research by highlighting the role of individuals. I also contributed by revealing problems they face in enacting ES, and ways in which they negotiate issues to use resources such as design techniques and LCA to be more effective. My contribution provided a contrast to previous institutional research by identifying how rules and norms can be helpful to individuals achieving environmental goals, not only a hindrance. Managers may organise ES to enable personnel to achieve set environmental goals, whether that be through policies to guide them or good information to make decisions from. The way in which interactions
between social structures in turn affect people enacting ES was also identified as crucial. In the next chapter I articulate the implications of the contributions my research has made. I summarise limitations to my research. Finally, I conclude my PhD by explaining where new research could focus to extend what I have found.
10.0 INTRODUCTION

In this chapter I conclude my PhD. I start by discussing the implications of my research contributions in answering my research questions. I conclude by proposing a few ways in which my research could be built upon in the future.

10.1 IMPLICATIONS OF MY RESEARCH

My PhD revealed how and why agency and social structure shape environmental strategy (ES) enacted by people within organisations. I achieved this by answering the question.

*How do people act within organisations to benefit the environment?*

I showed that social structures enable and constrain people, a relationship that could be used to achieve results required when ES is enacted. In this section I summarise what my findings contribute to theory and the practice of ES.

10.1.1 New theoretical application for ES

The interplay between social structures and agency has had little attention in the context of ES. However some studies are enlightening in revealing how people take action in strategic contexts other than ES. Coopey et al. (1998) compared three managers applying enacting strategy to achieve innovations in separate cases. Managers either used consensus building with stakeholders; resources; new work practices; or ensured outcomes were compatible with existing work practices to innovate. The same goal of innovation was achieved, yet with different ways of applying agency one case to another. Jarzabkowski (2008) revealed that managers have different capacities to apply agency when enacting strategy within Universities, depending on their role or existing social structures they encountered. Some had freedom to take deliberate actions they choose; whilst others were dominated by existing work contexts. In a rare instance where the environmental was the focus, structuration was
used to examine how Canadian paper organisations used power, information and symbolism to report on environmental aspects of their operations (Buhr, 2002). I extend structuration conceptualisations organisational action for the environment, with a focus on strategy rather than reporting. For instance my findings highlighted agency people use when enacting ES, such as design actions enabled by LCA tools used by students (Lockrey and Bissett-Johnson, 2013), or purchasing policies used by staff to enable change to aged care practices (Clune and Lockrey, 2014). They also demonstrate how agency is affected by the social structures in which people enact ES, such as the brief that scripted how students used resources or performed tasks (Lockrey and Bissett-Johnson, 2013). Therefore through my research I answered the question;

Why are structure and agency important when people enact ES?

Drawing on a structuration lens enabled me to demonstrate the importance of social structures interacting in affording people agency when enacting ES. Giddens (1984) noted that this is what occurs as rules, resources, norms and information intermingle as people take action. Previous examples show where such interplay between structures has been pivotal to what occurs within organisations, though not in the context of ES. Coopey et al. (1998) showed social structures interacting in an investigation of innovations delivered by individuals within three organisations. Power, sanctioning and interpretive schemes interacted when managers took action across the three cases of innovation. Thus the research highlighted the importance interacting social structures to the agency people apply.

Interactions between social structures have not previously been conceptualised by scholars deploying structuration to organisational efforts on environmental improvement. Domination, legitimation and signification structures were considered independently when environmental reporting was examined by Buhr (2002). In contrast, my research showed how domination
and legitimation structures interact to both guide and empower people to enact ES. The rules in a brief helped legitimise students to take particular actions on eco-design projects (Lockrey et al., 2018). For aged care, rules such as purchasing policy were reoriented to change how electrical appliances were to be procured (Clune and Lockrey, 2014). Staff then used design tools to workshop the best ideas for appliance purchasing. In both cases rules in turn provided people power to apply agency with resources at their disposal, to design outcomes reducing environmental impacts.

Information also can provide knowledge that affords some people power to enact ES effectively, due to the interplay of signification and domination structures. Collaboration helped to bridge resistance in aged care, as information was shared through communication to empower people to plan an ES (Lockrey et al., 2018). Consensus building enabled the collective resolution of issues that might have constrained ES, so that it was compatible with aged care practices and had clear steps to reduce impacts.

Thus my research nuances the argument that social structures interacting are important. Insights that resulted from examining interacting social structures explained how structure relationships can assist people succeed when enacting ES. The structure-agency relationship is key, however, structure-structure relationships are also important.

10.1.2 Articulation of the role of people and their agency on ES

My research identified how people influence ES, by explicitly focussing on their agency. The majority of previous research, both theoretical and empirical, has explored stakeholders, institutions or resources influencing ES (Montiel and Delgado-Ceballos, 2014, Touboulic and Walker, 2015). For instance research at Unilever explicates rules and resources used for ES, but not how they affect agency people apply (Bocken et al., 2012, Petala et al., 2010). A
contribution I make then is detailing how people enact good environmental outcomes, or otherwise, through their agency. Focussing on the agency of individuals and their role is new for ES. By focussing on people, I addressed the question;

*Who within organisations is needed to enact ES?*

Subsequently, I showed how individuals enact ES; influencing the outcomes delivered. For aged care staff engaged in ES planning, life cycle data and design tools, both new resources, were used to empower them to generate an ES plan (Clune and Lockrey, 2014). In another case, students conducting eco-design also applied their agency by using a suite of resources at their disposal such as LCA and engineering calculations (Lockrey and Bissett-Johnson, 2013). Finally, individuals involved in EcoRedesign had the flexibility of developing their own tools to verify environmental credentials, which resulted in very successful product outcomes (Lockrey et al., 2016). Resource based research has previously missed these types of individual aspects of how ES is enacted, by not focussing on individuals and their agency (Aragón-Correa and Sharma, 2003, Touboulic and Walker, 2015). Thus I articulated how fit for purpose resources, enable agency so beneficial environmental outcomes may become easier for people using them.

Further, reflective agency was crucial for practice. Students conducting eco-design reflected on their designs, and the eco-design course as a whole (Lockrey et al., 2018). Cognitive frames research has previously captured reflection through the way managers consider a series of options to make decisions about environmental issues (Hockerts, 2015). Yet my research looked beyond decisions, to how and why agency is applied from reflection. Reflection enabled students to modify designs, and the course, to assist environmental impact reductions being achieved now and in the future.
People were also encouraged to collaborate in my cases, which enabled their agency. Staff at an aged care organisation interacted with external expertise, and a broad range of internal staff disciplines (Lockrey et al., 2018). Personnel of various functional disciplines also collaborated in NPD projects during the EcoRedesign program (Lockrey et al., 2016). By detailing the importance of these relationships, I extend stakeholder research previously lacking individual stakeholder interactions with a focus on internal people. In robust action research, success comes when many stakeholders work toward a common understanding what is required to achieve environmental goals. For instance organisational stakeholders interacted successfully to develop a wind power in industry in Denmark (Etzion et al., 2017). Yet unlike what previous robust action examples have revealed, I showed internal stakeholders are also important as they work together when ES is implemented. Their ability to exert their agency is enhanced as they collaborate, when shared understanding is translated to environmental savings through their actions. Interactions with others can enable good outcomes derived from insightful information, reflected in both my aged care and EcoRedesign cases.

My research provided new knowledge about how resources; reflection; and internal stakeholder interactions assist agency applied by people to ES. I did so by illustrating how they use new tools, space to think, and collaboration in addressing environmental issues.

10.1.3 Clarity on social structures influencing actions when ES is implemented

My research provides a nuanced account of how social structures affect people enacting ES. Conversely, previous research has focussed primarily on social structures that influence organisations as they implement ES (Montiel and Delgado-Ceballos, 2014, Touboulic and Walker, 2015). As per the section above, structuration helped me connect people and their actions to social structures that exist for ES. In that regard, people succeed or experience
difficulties when social structures enhance or limit how they apply their agency, which has managerial implications.

Firstly my study showed that people use resources to be effective in their routines, or decisions made for ES. LCA and design methods were new resources that enabled aged care staff to identify environmental opportunities to be acted upon (Clune and Lockrey, 2014). LCA was then useful to more people and more broadly applied across the organisation than has been shown for single functions such as NPD (Bocken et al., 2011). My research identified that LCA tools helped students to quantify environmental impact reductions during their design practice (Lockrey and Bissett-Johnson, 2013). I echoed the value of embedding tools into routines, so that people understand how they can be effective in reducing impacts (Rio et al., 2013). When individuals have access to tools and information that inform them, and align to their routines, their actions are supported so that better outcomes result. Hence I answered the question;

*What resources assist people to enact ES within organisations?*

People also refer to rules to guide their action when enacting ES. For instance existing rules were identified, and new rules were proposed that could be beneficial for the ES in the aged care case study (Lockrey et al., 2018). Subsequently, new routines for food, energy and thermal comfort were guided by institutions both new and existing, to reduce environmental impacts for aged care. For students participating in an eco-design course, policies and procedures helped guide their actions (Lockrey et al., 2018). Guidance included how to use tools on tasks to be completed; technology options to apply; and the way they would be judged on their projects. Institutions were then mechanisms to direct beneficial actions for ES. That contrasts rules previously shown to limit organisations improving environmental problems, such as external legislation blocking action on climate change (Falke, 2011), or
corporate social responsibility procedures lacking priority for action (Steurer et al., 2005). Alternatively, I showed rules can prescribe actions and limit detrimental behaviours, and also guide people to enact ES effectively. Similar approaches have been suggested for organisations to adopt, where rules guide those tasked to achieve goals set by an ES (Brennan et al., 2015). Thus I reiterated that institutions can be used to direct people, and answered the following question;

\[
\text{What rules assist people to enact ES within organisations?}
\]

Social structures can both help people seek guidance, as well enable them the freedom to act or change situations so ES is delivered effectively. Collectively, I have then contributed a nuanced account of how social structures combine and interact to constrain people as well as give them choices about how to apply their agency, answering the question;

\[
\text{Why are structure and agency important when people enact ES?}
\]

Without knowing beliefs and commitments people bring, organisations cannot provide the conditions under which ES can be delivered effectively. Subsequently, managers can face challenging decisions when planning for ES. My research provides findings that have practical implications for managers. In particular they should consider the right people to enact ES, the resources to enable their action, and rules to keep them on course.

It will now be the task of new research to assess if insights from my research are relevant and applicable to more organisations considering ES. I explore some the options for future research next.
10.2 DIRECTIONS FOR FURTHER RESEARCH

In my PhD I revealed the importance of people and their role enacting ES. To extend my work, opportunities exist to understand the structure-agency relationship more profoundly when ES is implemented by organisations. Research could be focussed on refining theoretical insights that developed, such as the concepts of power, reflection and familiarity when ES is enacted. Research could also be designed to test those dimensions more broadly in practice across a greater volume of scenarios. I detail the scope of some of those options now. Aggregate dimensions I developed addressed the overarching the research question;

*How do people act within organisations to benefit the environment?*

However, I provided little detail of the mental component of agency people use to make decisions before enacting ES. Cognitive frames research links managers’ thought patterns to choices made prior to enacting ES (Hahn et al., 2014b). Mental decisions which manager’s use help explain their thinking behind how they deploy ES processes. Beyond judgements, cognitive frames research lacks the connection to resultant actions. It may be pertinent to conduct parallel cognitive and action based research to capture how managerial judgements translate into action. By linking managerial decisions to resultant action, beneficial extensions of both cognitive frames and action based investigations would be achieved respectively. Such work will identify the types of managers that succeed or otherwise with ES, and further address the question;

*Who within organisations is needed to enact ES?*

By determining thoughts and actions people use, a more complete understanding of how they enact ES will result. Related research may be of an embedded form much like the action research used in my PhD. Researchers could then intervene when decisions and actions occur
that are not aligned with goals set to achieve ES, as active participants (Gaziulusoy et al., 2016). Future research of this nature would then be applied, to give managers access to influence the ES process as research proceeds.

My research identified rules and resources that helped enable or constrain people when enacting ES, such as LCA informing people on environmental impacts, or organisational policies scripting their action. A combination of constraint and empowerment was shown to be beneficial. By identifying the importance of what social structures consist of to assist with ES implementation, I addressed the questions;

*What resources assist people to enact ES within organisations?*

*What rules assist people to enact ES within organisations?*

*Why are structure and agency important when people enact ES?*

Authors citing my work have started to further investigate these questions, as to the resources, tools and processes needed to enable people to act in ES (Lofthouse et al., 2015, Souza and Borsato, 2016, Liao et al., 2016); as well as the rules and norms that can guide action for the environment (Vallet et al., 2014, Wang et al., 2013, Wu and Shen, 2016, Matinheikki et al., 2016). How social structures are designed for ES success needs further refinement, and could be addressed with more research. Behavioural infrastructure research could be used to investigate the resources, rules, and norms that concurrently enable ES to be implemented effectively (Brennan et al., 2015). Also, an interesting part of my findings showed the power of marketing discipline within organisations, as well as the value of collaborations between disciplines enacting ES. It would be interesting to determine what professions and disciplines carry agency, for what reasons, and how embedding resources could help them as practical approach to assist in enacting ES. The relative importance of
particular resources for specific types of people to enact ES, such as LCA versus design methods, or designers versus engineers, must be determined. Then the empowerment or otherwise of people involved, depending upon resources at their disposal and the disciplines they belong to, will be more clear. The benefit of rules, such as organisational policies for behaviour and procedures for taking action, could also be compared to how resources enable action on ES. By identifying beneficial combinations of rules and resources, scholars will then be able to theorise what mix of both helps individuals enact ES. Measures managers could then apply may include changing the tools available or introducing rules that direct use of tools, such as LCA, that assist in achieving goals associated with ES.

New research of general approaches that enable ES to be enacted may require a shift from the predominantly qualitative research that has culminated in my PhD contribution. Such investigations may require hypotheses, quantitative measurements over many cases such as surveys of key people and environmental impact reduction results (Lampard and Pole, 2015). Those enquiries may develop general applicability of tested relationships within sectors or industries. For instance such an approach could be applied for interactions between domination structures with legitimation and signification structures respectively, relationships demonstrated as empowering people across my specific ES cases. Results could provide confidence to managers to set general characteristics of social structure that positively affect how ES is implemented. The result would be a ‘toolbox’ of sorts, of preferred resources, rules and norms organisations could provide or promote to people use for ES.

It is hoped my agenda for further research may steer scholars to clarify, consolidate and extend my contributions in the future. The agenda is aimed at fostering work to help guide managers in understanding the practices of individual people they manage, and the social structures they need. In doing so managers may be able to set up favourable conditions within
organisations so that ES is achievable. They may then provide the best mix of enabling resources and rules that guide their people respectively. In turn, people will be empowered to take actions aimed at reducing environmental impacts. Organisations will then be able to participate more purposefully in ensuring the future sustainability of the planet.
REFERENCES
(For Chapters 1-3 and 9-10, References for Chapters 4-8 listed after each research artefact)


MATINHEIKKI, J., RAJALA, R. & PELTOKORPI, A. 2016. From the profit of one toward benefitting many-Crafting a vision of shared value creation. *Journal of Cleaner Production*, In Press.


### APPENDIX 1 – DATA, SECOND ORDER THEMES TO AGGREGATE DIMENSIONS

*Table 10 – Data, second order themes, and aggregate dimensions for Article 1*

<table>
<thead>
<tr>
<th>First Order (data)</th>
<th>Second Order (Findings, themes from data)</th>
<th>Third order (aggregate structure-agency dimensions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impending environmental issues, such as climate change, were communicated verbally and through documentation to students by university staff and the industry partner.</td>
<td>A connection between the industry technology/ markets and environmental problems provided a purpose and pathway for judgements to be made in ES action.</td>
<td>Interacting legitimation and domination structures</td>
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<tr>
<td>Guidance in the brief explained the new industry technology provided for opportunities to design for environmental savings.</td>
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<tr>
<td>Simplifying the scenario definitions year to year by reducing the markets students would design for, meant students had more focus from the start of the ES.</td>
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<td>The industry partner provided consultation times to discuss how their technology could address environmental issues in various design contexts.</td>
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<tr>
<td>Tasks required for the ES strategy aimed at implementing eco-designs were laid out in a design brief.</td>
<td>Rules governing the ES in what tools and skills could be used, normalised design routines in doing so, enabling successful actions with those resources on environmental issues.</td>
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<tr>
<td>88% of student respondents stated eco-design projects offered them the opportunity to apply their learning</td>
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<td>Student survey response - “I also thought this was a good step … expecting us to make our products manufacturable and looking into all aspects in their life, from energy consumption to where we were going to get all the parts form. It allowed us to bring more of our engineering knowledge into our projects.”</td>
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<tr>
<td>Industry partner feedback documented outcomes exceeding their expectations through the design work.</td>
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<td>First Order (data)</td>
<td>Second Order (Findings, themes from data)</td>
<td>Third order (aggregate structure-agency dimensions)</td>
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<td>Students had agency by being proficient at design sketching, computer aided design (CAD), engineering calculation, and whole systems design, to produce viable outcomes.</td>
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<td>Familiar skills and user friendly tools embedded within routine made environmental savings and design viability easy to achieve.</td>
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<td>Greenfly software provided embedded design tips.</td>
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<tr>
<td>Students were observed to prefer using Greenfly as more user friendly than generating environmental impact calculations by hand.</td>
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<td>Design strategy and an educational scaffold intersected iteratively through structured phases and set assessable tasks at the end of each phase, including both design and evaluative tasks.</td>
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<td>Familiarity enabling action</td>
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<td>Marking rubrics were provided prior to the commencement of the eco-design course for clarity of what outcomes were to be evaluated.</td>
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<td>Tools allowed designers to understand what they were achieving in the judgements they made for actions taken, resulting in environmental savings.</td>
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<tr>
<td>Students used Greenfly to generate results that communicated the life cycle impacts for water, energy, greenhouse gases and solid waste.</td>
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<td>Engineering calculations confirmed the amount of energy and water designs would use.</td>
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<td>Design propositions showed improvements in energy and water compared to competitors over a 10-year period, demonstrating knowledge had been applied to the project outcome.</td>
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<tr>
<td>Student survey response - “They (staff) were interested in our work and gave good feedback responding quickly to emails.”</td>
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<tr>
<td>Interacting flows of knowledge between disciplines, facilities by routines of communication, allowed good judgements to be made for environmental design credential and skills.</td>
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<tr>
<td>The industry partner provided progressive feedback and formally judged each project quantitatively at the end of the course.</td>
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<td>Power afforded through signification</td>
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<td>Industry partner feedback – “A strong understanding of the scope for the application of the technology enhances the search for creative applications.”</td>
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<td>Student survey feedback - 100% of respondents agreed that the assessment tasks assisted their learning.</td>
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<tr>
<td>Students communicated project progress using appropriate design language being verbal,</td>
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<tr>
<td>First Order (data)</td>
<td>Second Order (Findings, themes from data)</td>
<td>Third order (aggregate structure-agency dimensions)</td>
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<tr>
<td>visual, physical modelling, computer generated or calculations</td>
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<tr>
<td>Annual staff reviews of the curriculum and student feedback, particularly in response to time management and workload concerns, has led to modified tasks and timing for the project</td>
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<tr>
<td>Changes to the curriculum have included assessment procedures and changes to tasks, improving time spent on tasks considered as core to environmental improvements. “More traditional engineering drawings was (sic) less relevant in the current environment of digital 3D CAD files. Exploded and sectional views….allow for more effective use of time …and clearer communication of resulting designs and systems”</td>
<td>Information from feedback processes led to agency to enacting ES improvements to rules, resources and routines, for each new ES iteration.</td>
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<tr>
<td>The industry partner provided correspondence with university staff on their perceptions on successes, and potential improvements</td>
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<tr>
<td>The environmental impact assessment was streamlined in the verification phase by shifting from calculating the carbon equivalent impacts of the artefact outcomes to utilising the streamlined LCA tool Greenfly.</td>
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</table>
Table 11 – Data, second order themes, and aggregate dimensions for Article 2

<table>
<thead>
<tr>
<th>First Order (data)</th>
<th>Second Order (Findings, themes from data)</th>
<th>Third order (aggregate structure-agency dimensions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal expertise, about processes of aged care, was central to framing problems and solutions in the workshops.</td>
<td>Internal and external knowledge provided information with which to make judgements on ES options based on known routines as well as normalised global alternatives to routines</td>
<td>Interacting legitimation and domination structures</td>
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<tr>
<td>External experts on sustainability, economics and engineering provided answers ‘at hand’, to inform discussion and ideation concepts in the workshops.</td>
<td>Participant collaboration, in sharing of knowledge and joint judgment making, defined what routines to retain.</td>
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<tr>
<td>World’s best practice examples were drawn upon to base new routines upon e.g. Woking City Council financing strategy (Thompson, 2007), Bon Appétit Catering Company low carbon food strategy (York, 2009), Japanese Government’s cool biz campaigns for thermal comfort (Lakeridou et al., 2012), etc.</td>
<td>Participant collaboration, in sharing knowledge and joint judgments, defined routines to reorient, or where to leverage changes that were</td>
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<tr>
<td>Discussion between workshop participants identified where the organisations were achieving good outcomes already e.g. “From a group discussion surrounding upgrading and retrofitting existing cases, precedents were identified that replaced and upgraded items on cases when they were not operating effectively. For example, air-conditioners were relocated to improve air-flow. Glare on west facing windows was reduced through the installation of blinds, which by default makes the environment more comfortable and reduced energy needs.” A process for consultation with residents and families for menu planning already exists, with strong relationships with suppliers (to the extent that they may change serving size to reduce waste). In addition, the facilities have run food themed days and are currently in the process of completing a ‘plate waste’ study.</td>
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<tr>
<td>Discussion between workshop participants facilitated ideas around feasible changes to process and procedures to achieve better outcomes e.g. “From the discussion surrounding procurement, a decentralised purchasing strategy exists at present, in that each case is autonomously responsible for purchases. A shift</td>
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</table>
### First Order (data)

- is occurring on items that were previously purchased by patients, to be purchased centrally by the care provider. The desire is to move to a more centralised procurement policy, which could attach an efficiency agenda to purchasing."

Efficiency improvement opportunities regarding present financing for e.g. insulation, glazing, curtains, reflective roofing or shading was not formalised and unlikely to be achieved in the existing framework, and identified as a practice to reorient.

Life cycle assessment provided visibility of environmental impacts associated with material and energy flows that manifest both ‘upstream’ and ‘downstream’ from aged care facilities.

A case visit was undertaken to review obvious areas for potential improvement by way of an ES, particularly in the area of energy consumption. This visit sought to ensure that the LCA study remained grounded in real issues facing aged care cases.

The application of social practice theory was observed as assisting in framing the LCA results in themes to enable discussion with the aged care personnel, to then enabling sociotechnical solutions to be developed (rather than simply techno-centric, i.e. lighting, air-conditioning, etc.). Those themes were capital purchasing decisions, thermal comfort, and food and diet.

“At the outset of the project the organisations environmental concerns were highly visual, such as paper use and the high number of incontinent pads used. The process shifted the thinking of the organisation from the visual to the embodied.”

New creative processes and tools were introduced to aged care personnel to plan the ES, by combining brainstorming, mind maps, prompting ‘what if’ questions identifying interventions, group sketching of uncomfortably hot and cold areas on select case maps, identifying preferred futures, back-casting, and inverting the solution in to the problem: how could we realise a specified solution is often more important than identifying the solution itself.

### Second Order (Findings, themes from data)

- already at hand.

New resources for benchmarking and measuring proposed reductions of environmental impacts were operationalized.

A new focus on routines that involve people, rather than solely on materials and technology, was central to the ES purpose that captured key stakeholders.

### Third order (aggregate structure-agency dimensions)

- Reoriented structures enhancing agency

Novel resources and rules for ES planning were provided through a routine consisting of a series of problem solving tools not previously applied by the aged care personnel.
<table>
<thead>
<tr>
<th>First Order (data)</th>
<th>Second Order (Findings, themes from data)</th>
<th>Third order (aggregate structure-agency dimensions)</th>
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<tbody>
<tr>
<td>Organizational and managerial ecological proactivity and awareness vary (Hunt and Auster, 1990, Bansal and Roth, 2000, Sharma, 2000, Banerjee, 2001, Spar and La Mure, 2003, Benn et al., 2006, Nidumolu et al., 2009, Willard, 2005). Marketing influence within firms is high (Homburg et al., 1999, Atuahene–Gima and Li, 2003, Atuahene-Gima and Evangelista, 2000), “‘‘We generally do not fill this section”, “sustainability is not yet integrated as a parameter in the whole process”, “I feel that I need to do it, but it is not a working practice”, “sustainability is not a scope, it only now comes as a scope for projects that we prepare for 2010”, Unilever managers, in spite of organisational directives to apply ES (Petala et al., 2010). Market orientation is prevalent, thus influential in ecologically conscious product development (Deshpandé et al., 2012, Goldman and Grinstein, 2010, Verhoef et al., 2011) Environmental tools could be a basis for marketing solutions for complex problems (Wilkinson and Young, 2013) Tools need to align to the functional requirements for marketers (Aschehoug et al., 2012, Polonsky and Ottman, 1998). ES innovation can be scoped before a business case is built for a product (Bocken et al., 2012). LCA autonomy or outsourcing by marketing departments is not settled (Pascual et al., 2003, Verghese and Lockrey, 2012). Collaboration as an enabler (Boks, 2006, Pascual et al., 2003, Millson and Wilemon, 2002, Swink and Song, 2007, Calantone and Rubera, 2012). Closing the gap between intention and initiation of ecologically based purchasing is a problem still (Deloitte, 2009)</td>
<td>Consideration of positions of power is pivotal if people are to have the space and capacity to make judgements required for ES action. ES resources embedded in the routines of powerful disciplines could lead to beneficial judgements for action, or else the purposes of said ES may not be achieved (as is currently being observed).</td>
<td>People using domination structures they are embedded within</td>
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<tr>
<td>First Order (data)</td>
<td>Second Order (Findings, themes from data)</td>
<td>Third order (aggregate structure-agency dimensions)</td>
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<tr>
<td>Simplification of LCA data could increase adoption internally within organisations (Verghese and Hes, 2007, Lockrey and Verghese, 2012, Lockrey, 2012).</td>
<td>Valid, clear information that allows for effective communication must support actions required for ES.</td>
<td>Power afforded through signification</td>
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<tr>
<td>“it is not efficiently communicated among employees”, “global teams should communicate more efficiently sustainability among employees”, Unilever managers, in spite of organisational directives to apply ES (Petala et al., 2010).</td>
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<tr>
<td>Alignment of marketing and brand strategy regarding ecological issues are imperative (Kaenzig et al., 2011, Rahman and Post, 2011, Peattie, 2001, Deloitte, 2009).</td>
<td>Existing interpretive schemes through which information can be communicated are an opportunity for ES action.</td>
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<td>Product declaration data should have a synergy to a range of marketing outputs (Rex and Baumann, 2007, Schenck, 2009).</td>
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<td>Ecological marketing as multi marketing outputs are an opportunity (Lockrey and Verghese, 2012, Lockrey, 2012).</td>
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**Table 13 – Data, second order themes, and aggregate dimensions for Article 4**

<table>
<thead>
<tr>
<th>First Order (data)</th>
<th>Second Order (Findings, themes from data)</th>
<th>Third order (aggregate structure-agency dimensions)</th>
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<tbody>
<tr>
<td>“A very exciting and challenging project that implemented Australia’s first 6 energy star, AAA water efficiency rated dishwasher”. (Alan Pears, 2015)</td>
<td>The purposes that drew people to participate in the ES held meaning for them, empowering their action.</td>
<td>Signification structures enable meaningful action</td>
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<tr>
<td>“It was exciting and had real meaning for us” (Paul Taylor, 2015)</td>
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<tr>
<td>Funded through the Australian Commonwealth Government, the EcoReDesign program brought together interdisciplinary teams comprising designers, environmental researchers, engineers, social scientists, marketing experts and other related professionals.</td>
<td>The expertise brought by people to the ES empowered them through drawing on the collective skills set through collaborative action.</td>
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<tr>
<td>“Cross disciplinary perspectives were considered. … There was a great deal of respect for each other…..” (Alan Pears, 2015)</td>
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<tr>
<td>“We could co-create, collaborate with best in field specialists.” (Paul Taylor, 2015)</td>
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<td>“The processes we developed would bring up technical issues that may have not been discussed previously.” (Alan Pears, 2015)</td>
<td>New routines were embedded with novel rules and resources, considered the driver that enabled ES success by the people involved.</td>
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<tr>
<td>“Fundamental were models reflecting the physics and chemistry of a context, and the use of benchmarking.” (Alan Pears, 2015)</td>
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<tr>
<td>“It is the embracing of these processes that drove the innovation.” (Alan Pears, 2015)</td>
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<td>“Work from ground up first principles rather than deal with legacy and re-style flawed ideas or just a different version of the same old thing.” (Paul Taylor, 2015)</td>
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<td>Reoriented structures enhancing agency</td>
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<tr>
<td>First Order (data)</td>
<td>Second Order (Findings, themes from data)</td>
<td>Third order (aggregate structure-agency dimensions)</td>
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<tr>
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</tr>
<tr>
<td>“… and a process by which you drew out the fundamentals of what was happening environmentally. This meant that teams didn’t jump to conclusions too early. There is a rigour in this process, and an ability to take on the challenge.” (Alan Pears, 2015)</td>
<td>New ES resources provided knowledge so that people made informed judgements that empowered their action.</td>
<td></td>
</tr>
<tr>
<td>“I was asked to look at the energy and water performance. I measured and calculated the volumes of reservoirs, pipes and fittings, looked at flow restrictions, then developed a computer model to simulate its performance minute by minute. I was very pleased when the model closely matched the actual performance of a reference machine”. (Alan Pears, 2015)</td>
<td></td>
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</tr>
<tr>
<td>Schiavello benefitted, implementing life cycle and environmental reporting through leadership of environmental manager Michael Pitcher. As the local green building movement grew in the 2000s, compliance activities shifted to environmental credentials becoming a market differentiator, a phenomenon on which Schiavello capitalised. The insights gained and the methods employed from EcoReDesign were adapted by Alan Pears over a string of energy efficiency projects. Pears continued to operate with these methods for decades, for projects in industrial contexts. Pears innovated for the environment, from product through to policy, and was elevated to Member of the Order of Australia for his efforts.</td>
<td>Beyond the completion of the ES, people and organisations applied associated rules and resources in future ES.</td>
<td></td>
</tr>
</tbody>
</table>
First Order (data)

| “Big box stores of K-Mart and Target didn’t stock the Axis kettle.” (Paul Taylor, 2015) |
| “To Kambrook’s credit, they found a new avenue for Axis through David Jones, a first for them. The problem though was that David Jones didn’t have the volume of sales Kambrook were used to, and Kambrook didn’t have the reputation for high end retailers.” (Paul Taylor, 2015) |
| “Sunbeam had always implemented more progressive designs with better components and quality of usability, therefore, it was a big leap of faith for a budget consumer to purchase a more premium product in a budget store, and even bigger for a traditional, wealthier David Jones customer to accept what they had been educated as to an inferior brand to Sunbeam.” (Paul Taylor, 2015) |
| Multiple organisational changes of management, corporate takeover, and restructuring occurred as the incarnations of Axis were sold. |

Second Order (Findings, themes from data)

| Even if certain strategic stages succeed e.g. design, failure to identify rules, resources and actions affecting/required for all ES stages e.g. marketing, commercialisation, and management, can be detrimental. |

Third order (aggregate structure-agency dimensions)

| Rules applied by one discipline can provide barriers to what other discipline understand is required for ES. |
| A focus on particular disciplines of ES stages may be misguided, especially if there are people outside of that focus that could act to benefit ES. |
| Entire strategy supporting structures |
Table 14 – Data, second order themes, and aggregate dimensions for Book Chapter 1

<table>
<thead>
<tr>
<th>First Order (data)</th>
<th>Second Order (Findings, themes from data)</th>
<th>Third order (aggregate structure-agency dimensions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Some employee/departmental concerns surfaced as to environmental action. e.g. body</td>
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<tr>
<td>language observed, points negating ideas in discussions or opportunities identified in</td>
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<tr>
<td>brainstorming (shown below, red comments)</td>
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<tr>
<td>Collaboration between internal and external planning participants helped reduced</td>
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<tr>
<td>resistance, and revealed how policies/procedures may guide feasible courses of</td>
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<tr>
<td>actions on food, capital expenditure and thermal comfort proposals for ES</td>
<td></td>
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<tr>
<td>(shown below, red dots in areas of consensus in solution mapping)</td>
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<td></td>
</tr>
<tr>
<td>Existing internal rules and resources were identified to drive future ES actions</td>
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<tr>
<td>in reducing environmental impacts e.g. procurement tendering for food/appliances,</td>
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<tr>
<td>plate food waste studies, resident consultation, community gardening and space</td>
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<tr>
<td>heating/cooling zoning.</td>
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<tr>
<td>New resources were identified by planning participants to help strategic success,</td>
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<tr>
<td>e.g. reinvestment of energy efficiency savings; and tools to measure environmental</td>
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<tr>
<td>choices.</td>
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<tr>
<td>Engaging external experts incorporated new knowledge and perspectives to support</td>
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<td></td>
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<tr>
<td>planning ES.</td>
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<td></td>
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<tr>
<td>Communication between people with critical knowledge reduced resistance so that</td>
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<td></td>
</tr>
<tr>
<td>collective judgements could be made for ES planning.</td>
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<td></td>
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<tr>
<td>Power afforded through signification</td>
<td></td>
<td></td>
</tr>
<tr>
<td>First Order (data)</td>
<td>Second Order (Findings, themes from data)</td>
<td>Third order (aggregate structure-agency dimensions)</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------</td>
<td>----------------------------------------------------</td>
</tr>
<tr>
<td>People from inside and external to the aged care organisation, with specific expertise, were situated in the planning process to determine informed short/long term ES actions.</td>
<td>entwined with people provided their knowledge as a resource for action.</td>
<td></td>
</tr>
<tr>
<td>People from all levels of the aged care organisation were encouraged to work together on ES, where executive/ middle management engaged with employees from nursing, finance, etc. A flat hierarchy was created by the CEO pre-planning, and observed throughout ES workshops.</td>
<td>Employee ES participation in planning was normalised independent of previous organisational hierarchy.</td>
<td></td>
</tr>
<tr>
<td>The planning team persevered with each of their perspectives together, working toward strategic outcomes that catered for those perspectives as consensus based actions. Actions for people were identified to drive strategic success, e.g. engagement processes with residents and families for thermal comfort and food outcomes, finance reorienting procurement policies with external partners, etc. Short through long term (&gt; 5 years) goals were developed through planning e.g. energy financing short to long term initiatives (see climate change savings vs. financing proposal below).</td>
<td>Employee co-creation of the ES plan toward commonly agreed purposes, facilitated by way of normalising their participation and empowering their input, resulted in future action that they collectively planned as feasible, and for which they were tasked to participate in</td>
<td>Interacting legitimation and domination structures</td>
</tr>
</tbody>
</table>
Aged care management legitimised new planning tools, and supporting external experts, in the planning process.

Tools new to the organisation, namely LCA and design thinking, were embraced in strategising, as they revealed previously unknown opportunities that were readily used by people involved in planning environmental outcomes.

LCA revealed environmental hot spots/ viable alternatives. Design thinking methods revealed viable opportunities. Both were then observed to allow the space for informed judgements to be made by people during ES planning.

<table>
<thead>
<tr>
<th>First Order (data)</th>
<th>Second Order (Findings, themes from data)</th>
<th>Third order (aggregate structure-agency dimensions)</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image.png" alt="Image of data analysis graphs" /></td>
<td>through their routines.</td>
<td>Social structures enable or constrain agency</td>
</tr>
</tbody>
</table>

People drew on key new resources to enable judgements in planning and implementing ES.
<table>
<thead>
<tr>
<th>First Order (data)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processes were provided for the design of products through the strategy, by way of the student brief and supporting instructional material on particular tasks. Design/ engineering routines consisted of divergent innovation/ risk taking and convergent solution refinement (double diamond method). Students accessed an easily understood/ readily available project brief with relevant environmental/ product issues e.g. design for (1) Hot water systems servicing low volume user multiple dwelling/ amenities, (2) Hot water domestic systems using solar, and boosted by electric hot water heater, or (3) Hot water appliance.</td>
</tr>
</tbody>
</table>

| University/ industry partners (IP) had policy support for environmental issues e.g. “Swinburne has a longstanding commitment to sustainability. We recognise that as a leading university we have an important role to play in preparing tomorrow’s leaders and decision-makers to contribute to a sustainable future. At Swinburne, we apply sustainability thinking in our strategic planning and to the initiatives that we pursue.” (Swinburne University 2017) The purpose of the eco-design course was consistent with institutional directives to reduce energy use, greenhouse gas reduction, water and solid waste e.g. product proposals were to reduce impacts when compared to products produced by competitors over a 10-year period. |

| University staff created a policy platform for the eco-design strategy, with regulatory/ university/ IP expectations for associated projects. These policies defined environmental expectations. Students accessed pedagogical expectations in course outlines/ assessment guidance e.g. tasks, marking rubric, etc. Clear project plans/ actions accompanied the policy summary, with key processes drawn upon by students in a ‘scaffolded learning’ course structure. |

<table>
<thead>
<tr>
<th>Second Order (Findings, themes from data)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Legitimation structures from institutions aligned to specific eco-design tasks, and thus normalised student action addressing the purpose of the course.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Third order (aggregate structure-agency dimensions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domination/ legitimation structures defined normal expectations and resources for students, so staff agency both constrained and empowered student action.</td>
</tr>
<tr>
<td>First Order (data)</td>
</tr>
<tr>
<td>---------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Measures of ES effectiveness were used in streamlined LCA, engineering calculation and design review sessions.</td>
</tr>
<tr>
<td>The strategy helped students work through a clear set of steps designed to reduce environmental impacts through a brief and online course management system.</td>
</tr>
<tr>
<td>Training was implemented through pre-determined lectures and online resources throughout the eco-design course, as well as less structured in class guidance, feedback, and ongoing email correspondence to form real-time training and guidance as it was required by student designers.</td>
</tr>
<tr>
<td>Ongoing IP relationship management by university staff facilitated IP feedback.</td>
</tr>
<tr>
<td>Processes for feedback on/ refinement of the strategy over time existed, by way of student and industry partner survey at the conclusion of the course.</td>
</tr>
<tr>
<td>Once concluded, realigned and new resources were identified from reflective surveys to drive future ES success. This provided students, university and the IP alike with a mechanism for action when changes were required.</td>
</tr>
<tr>
<td>Strategic implementation concerns from IP/ students led to strategy refinement over time to help improve components of the course.</td>
</tr>
<tr>
<td>Funding allowed the resources for university staff time to implement and refine ES.</td>
</tr>
</tbody>
</table>
## APPENDIX 2 – RESEARCH ARTEFACT AUTHOR CONTRIBUTIONS

### Table 15 - Authors majority contributions for Article 1

<table>
<thead>
<tr>
<th>Author</th>
<th>Conceptualizing refining/crystalizing research idea</th>
<th>Research design – selection of data, instruments + analysis</th>
<th>Data collection + analysis</th>
<th>Interpretation</th>
<th>Writing introduction + literature</th>
<th>Writing methods</th>
<th>Writing results</th>
<th>Writing discussion</th>
<th>Writing limitations, future directions + conclusions</th>
<th>Review management + responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lockrey</td>
<td>✔ Life cycle assessment (LCA)¹ and sustainability strategy</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
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<td>✔️</td>
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<tr>
<td>Bissett-Johnson</td>
<td>✔ Pedagogy and learning</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
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</table>

¹ Life cycle assessment (LCA) is a best practice tool often used in organisational processes aimed at identifying the potential environmental impacts of products or services (Baumann and Tillman 2004)

### Table 16 - Authors majority contributions for Article 2

<table>
<thead>
<tr>
<th>Author</th>
<th>Conceptualizing refining/crystalizing research idea</th>
<th>Research design – selection of data, instruments + analysis</th>
<th>Data collection + analysis</th>
<th>Interpretation</th>
<th>Writing introduction + literature</th>
<th>Writing methods</th>
<th>Writing results</th>
<th>Writing discussion</th>
<th>Writing limitations, future directions + conclusions</th>
<th>Review management + responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clune</td>
<td>✔ Design thinking/ techniques</td>
<td>✔️</td>
<td>✔️</td>
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<td>✔️</td>
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<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Lockrey</td>
<td>✔ LCA and sustainability strategy</td>
<td>✔️</td>
<td>✔️</td>
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</tbody>
</table>

### Table 17 - Authors majority contributions for Article 3

<table>
<thead>
<tr>
<th>Author</th>
<th>Conceptualizing refining/crystalizing research idea</th>
<th>Research design – selection of data, instruments + analysis</th>
<th>Data collection + analysis</th>
<th>Interpretation</th>
<th>Writing introduction + literature</th>
<th>Writing methods</th>
<th>Writing results</th>
<th>Writing discussion</th>
<th>Writing limitations, future directions + conclusions</th>
<th>Review management + responses</th>
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<tbody>
<tr>
<td>Lockrey</td>
<td>✔</td>
<td>✔️</td>
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### Table 18 - Authors majority contributions for Article 4

<table>
<thead>
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<th>Author</th>
<th>Conceptualizing/refining/ crystallizing research idea</th>
<th>Research design - selection of data, instruments + analysis</th>
<th>Data collection + analysis</th>
<th>Interpretation</th>
<th>Writing introduction + literature</th>
<th>Writing methods</th>
<th>Writing results</th>
<th>Writing discussion</th>
<th>Writing limitations, future directions + conclusions</th>
<th>Review management + responses</th>
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<tr>
<td>Lockrey</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Verghese</td>
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<td>Pears</td>
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<td>Taylor</td>
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<td>Fennessy</td>
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</table>

### Table 19 - Authors majority contributions for Book Chapter 1

<table>
<thead>
<tr>
<th>Author</th>
<th>Conceptualizing/refining/ crystallizing research idea</th>
<th>Research design - selection of data, instruments + analysis</th>
<th>Data collection + analysis</th>
<th>Interpretation</th>
<th>Writing introduction + literature</th>
<th>Writing methods</th>
<th>Writing results</th>
<th>Writing discussion</th>
<th>Writing limitations, future directions + conclusions</th>
<th>Review management + responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lockrey</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
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<td>✓</td>
<td>✓</td>
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<tr>
<td>Brennan</td>
<td>✓</td>
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<tr>
<td>Verghese</td>
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<td>Staples</td>
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<td>Binney</td>
<td>✓</td>
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</table>
APPENDIX 3 – RESEARCH ETHICS APPROVALS

RMIT UNIVERSITY Design and Social Context College Human Ethics Advisory Network (CHEAN) Sub-committee of the RMIT Human Research Ethics Committee (HREC)

Notice of Approval

Date: 11 November 2014
Project number: CHEAN 8 0000018975-10/14
Project title: Beyond eco dogma - Organisational relationships and processes in the framing of strategies linked to ecology using lifecycle assessment
Risk classification: Low Risk
Investigator: Professor Linda Brennan and Mr Simon Lockrey
Approved: From: 11 November 2014 To: 05 January 2016

I am pleased to advise that your application has been granted ethics approval by the Design and Social Context College Human Ethics Advisory Network as a sub-committee of the RMIT Human Research Ethics Committee (HREC).

Terms of approval:
1. Responsibilities of investigator
   It is the responsibility of the above investigator/s to ensure that all other investigators and staff on a project are aware of the terms of approval and to ensure that the project is conducted as approved by the CHEAN. Approval is only valid whilst the investigator/s holds a position at RMIT University.
2. Amendments
   Approval must be sought from the CHEAN to amend any aspect of a project including approved documents. To apply for an amendment please use the ‘Request for Amendment Form’ that is available on the RMIT website. Amendments must not be implemented without first gaining approval from CHEAN.
3. Adverse events
   You should notify HREC immediately of any serious or unexpected adverse effects on participants or unforeseen events affecting the ethical acceptability of the project.
4. Participant Information and Consent Form (PICF)
   The PICF and any other material used to recruit and inform participants of the project must include the RMIT university logo. The PICF must contain a complaints clause including the project number.
5. Annual reports
   Continued approval of this project is dependent on the submission of an annual report. This form can be located online on the human research ethics web page on the RMIT website.
6. Final report
   A final report must be provided at the conclusion of the project. CHEAN must be notified if the project is discontinued before the expected date of completion.
7. Monitoring
   Projects may be subject to an audit or any other form of monitoring by HREC at any time.
8. Retention and storage of data
   The investigator is responsible for the storage and retention of original data pertaining to a project for a minimum period of five years.

In any future correspondence please quote the project number and project title.

On behalf of the DSC College Human Ethics Advisory Network I wish you well in your research.

Suzana Kovacevic
Research and Ethics Officer
College of Design and Social Context
Notice of Approval

Date: 17 November 2015
Project number: CHEAN B 0000019696-10/15
Project title: Design Archives Journal - Centre for Design Special Issue
Risk classification: Low risk
Chief investigator: A/Professor Karii Vergheese
Status: Approved
Approval period: From: 17 November 2015 To: 30 November 2016

The following documents have been reviewed and approved:

<table>
<thead>
<tr>
<th>Title</th>
<th>Version</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk Assessment and Application form</td>
<td>2</td>
<td>17.11.2015</td>
</tr>
<tr>
<td>Participant Information and Consent Form</td>
<td>2</td>
<td>17.11.2015</td>
</tr>
</tbody>
</table>

The above application has been approved by the RMIT University CHEAN as it meets the requirements of the National statement on ethical conduct in human research (NH&MRC, 2007).

Terms of approval:
1. Responsibilities of chief investigator
   It is the responsibility of the above chief investigator to ensure that all other investigators and staff on a project are aware of the terms of approval and to ensure that the project is conducted as approved by CHEAN. Approval is valid only whilst the chief investigator holds a position at RMIT University.

2. Amendments
   Approval must be sought from CHEAN to amend any aspect of a project. To apply for an amendment use the request for amendment form, which is available on the HREC website and submitted to the CHEAN secretary. Amendments must not be implemented without first gaining approval from CHEAN.

3. Adverse events
   You should notify the CHEAN immediately (within 24 hours) of any serious or unanticipated adverse effects of their research on participants, and unforeseen events that might affect the ethical acceptability of the project.

4. Annual reports
   Continued approval of this project is dependent on the submission of an annual report. Annual reports must be submitted by the anniversary of approval of the project for each full year of the project. If the project is of less than 12 months duration then a final report only is required.

5. Final report
   A final report must be provided within six months of the end of the project. CHEAN must be notified if the project is discontinued before the expected date of completion.

6. Monitoring
   Projects may be subject to an audit or any other form of monitoring by the CHEAN at any time.

7. Retention and storage of data
   The investigator is responsible for the storage and retention of original data according to the requirements of the Australian code for the responsible conduct of research (section 2) and relevant RMIT policies.

8. Special conditions of approval
   Nil.

In any future correspondence please quote the project number and project title above.

A/Professor Suellen Murray
Chairperson
RMIT DSC CHEAN B

cc: Ms Suzana Kovacevic (Ethics Officer/CHEAN secretary), Mr Simon Lockrey.