Understanding Design Impact:

A new framework for understanding the potential of design and enhancing future professional practice

A thesis submitted for the degree of Doctor of Philosophy

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Working on this topic and producing the final Thesis has been a major six year undertaking and has had, and hopefully will continue to have, many positive reverberations in my career as a designer and academic for at least as many years to come. In many ways it has necessarily been a very single minded and solitary activity, but here is the place to thank all the people along the journey that have generously supported me with their time and interest.

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Abstract

Understanding Design Impact: A new framework for understanding the potential of design and enhancing future professional practice.

Design is widely recognised as an important driver for economic performance. However, the value of design has proved resistant to quantification despite research attention since the early 1980s. Correlation between design investment and impact has been demonstrated, but not causation. There is considerable interest from policy and professional bodies in what is described here as 'Design Impact'. Impact can be measured, for example, by return on investment, increases in profitability or cost reductions. However this only crudely captures the economic impact of a design ingredient. Increasingly, social and environmental impacts are also of interest. The design profession sees the potential for better articulation of design impact as a means to increase their influence.

The context has been explored through a series of descriptive and prescriptive studies including analysis of 45 DBA Design Effectiveness Award case studies, 304 undergraduate design projects from two institutions over a three year period together with interviews and workshops with senior design professionals and design academics.

A new *Understanding Design Impact framework* is the overall outcome and contribution to knowledge from the work. This bridges between theory and practice and is a powerful basis for placing consideration of design impact at the heart of design activity. A *design impact ontology* has been developed as a robust foundation to the framework which resolves issues with underlying concepts. An initial version of this ontology is published in *The Design Journal* and is claimed as a supporting contribution to new knowledge. So too are new ontological classifications of factors which have considerable influence on design impact: Design *Influences and Authority* and *Motivation and Path*. These provide fresh perspectives and are worthy of further research consideration. A number of routes are identified for the further development and dissemination of the framework.

List of Publications

Journals

Green S, Southee D & Boult J, (2014), Towards a design process ontology, *The Design Journal*, Volume 17, Number 4, pp 515-537

Conference papers

Green S, Young M & Boult, J (2012), Mapping Design Process and Radar Analysis of Design Activities, paper in: Design Education for Future Wellbeing- Proceedings of the 14th Engineering and Product Design Education Conference, Buck L, Frateur G, Ion W, McMahon C, Baelus C, De Grande G, Verwulgen S, (Eds), Institution of Engineering Designers

Green S, (2013), An Exploration of Design Project Output Factors & Metrics, paper in Brunel University School of Engineering and Design – ResCon13

Green S, (2014), What we DON'T know about design impact, paper in Brunel University School of Engineering and Design – ResCon14

Other publications

Green S, (2010), Enhancing entrepreneurship in design major projects, report for the Higher Education Entrepreneurship Group, available at: https://brad.brunel.ac.uk/repository/files/?rep=1&pub=112547&file-url=http%3A%2F%2Fbura.brunel.ac.uk%2Frt4ds%2Ffile%2F52953%2FEnhancing%2BEnterprise%2Bin%2BDesign%2BMajor%2BProjects_Final%2Breport_Jan-2010.pdf

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Chapter One

Introduction

1.1 The context for exploring Design Impact

Design is rapidly changing. Evidenced by the stupendous performance of Apple, the impact of design is intuitively recognised by many: well known design commentator John Maeda, speaking at the TED2014 conference, suggested that: “Right now is a golden age where the economic impact of design is going to be true” (Jacobs & Walters, 2014). ‘Tech companies, and investors, are increasingly seeing the value of designers who know how to work with and within the constraints of the tech industry’ (Maeda, 2015).

It was not too long ago that one of the very early studies of design impact (Roy & Potter (1993) reported a company participant saying: “I get the designer’s sketchbook out when I want a laugh”(p189) and 40% of the design projects in their study made a loss. But as recently as the founding of the phenomenally successful Airbnb ($13bn valuation according to the Wall St Journal, 2014) one of the founders claimed: ‘Being designers they thought we were people that worked for people that ran companies ....they didn’t think a designer could build and run a company’ (Chesky, 2014).

The evolution of design from an often derided craft industry to indispensible ingredient amongst some of the world’s most successful companies is also a story about the impact of design. But the *why* (should we invest in design?)and *how* (impact is achieved?) remains unclear, at best, to many. The term *Understanding Design Impact* (UDI) is used throughout this thesis to signify the need to understand the factors which will lead to more effective answers.

Design and Impact

The concept of impact can be found in many fields, for example in research (research impact), policy (social impact) and environment (environmental impact). Business and performance management typically focuses on economic impact, but increasingly recognises 'triple bottom line' impact (Elkington, 1999). Within the design field there is increasing interest in the social and environmental effects derived from design (Madano Partnership, 2012). Whilst much of the body of work exploring design impact has an economic focus, the wider 'triple bottom line' of potential impact is accommodated within the scope of this study.

The economic success of design-led companies such as Apple is a driving factor behind increased awareness of the potential for design impact (Micheli, 2013). But notwithstanding the high profile of such success and empirical evidence of the correlation between design and firm performance since 1993 (Roy & Potter, 1993), there remain substantial challenges with the profile of design, typically with managers only having an intuitive and anecdotal sense of design's value (Hertenstein et al, 2005) and only 3% of firms reliably evaluating design impact (Design Council, 2005a).

The design community has increasing interest in the idea explored by the 2012 *Measuring the Impact of Design forum* that: 'Better evidence of the impact of design will drive up demand' (Montgomery, 2012). But developing a deeper understanding of design impact is widely seen as problematic, with some seeing virtually any attempt to quantify design impact as counter-productive to the creative essence of design (Micheli, 2013), compounded by problems with defining 'success' or 'good design' (from Black & Baker, 1983, to Rae, 2014).

Research motivation

Whilst there is often scepticism about the topic within the design community (Micheli, 2013) and a desire for a single indicator of design impact (Bovea & Gallardo, 2006) is highly unlikely to be practical, there would appear to be considerable potential to enhance the current situation. A range of beneficiaries are envisaged for the outcomes of the overall study. The founding motivation for the research derives from extensive experience within the design consultancy profession where, historically, designers have faced barriers to the adoption of design and full realisation of design's potential. However enhancing the current situation is undoubtedly more complex than simply providing more effective evidence of design impact (as debated by the *Measuring the Impact of Design forum* (Montgomery, 2012). But a wider focus on enhancing the professional activities of designers through an improved understanding of design impact factors should benefit the profession. For example by providing a more robust basis for designers to articulate the value of their contributions in a variety of professional scenarios. The research outcomes have the potential to add to the growing body of design research, particularly in relation to underpinning design process and the identification of gaps, through this study, in current theory, therefore benefiting the design research community. Conducting the design research within a design higher education context also allows the processes and outcomes of the study to be integrated into the learning and teaching of future generations of designers.

Due to the widely reported complexity of the topic (e.g. Tether, 2005 or Verganti, 2008) there is seen to be the need to review first principles to create a robust foundation as a basis for understanding design impact. Hence the idea embodied within the overall aim and research question of the potential of a framework for understanding design impact.

1.2 Research scope

This study is firmly placed in the design domain. New Product Development (NPD), Innovation, the creative industries, engineering and business management are considered as related fields. Each has a much more substantial body of research associated with it which, considered where needed, is judged to have limited relevance to drawing out the core ‘designerly’ (Cross, 2001) aspects of the topic. The need for better understanding of design, the potential for an enhanced role for design and the design profession and the challenges of recognising design impact are overarching themes.

To provide a structure for the initial investigation, five further themes are identified from an initial review of literature in the general design domain. The scope and rationale for identifying these themes is summarised as follows:

- **The role of design**: Explores the evolving context for professional design activity and the potential for enhancement within this context

- **Design process**: Widely recognised as the core differentiator of design activity and therefore of central importance to any links between context and impact
- **Design impact:** Recognising links, but also distinct from other fields of impact study, exploration of the distinctive *design* ingredient of impact whether economic, social or environmental
- **Models and Metrics:** This theme acknowledges and explores the potential for deriving operational approaches from various related fields as well as current design practice
- **Design research:** Exploration to place this work within the context of the body of design research and ultimately to demonstrate the development of new knowledge.

1.3 Research aim and objectives

Aim

To define a new framework as a basis to effectively explore, understand and communicate design impact.

Objectives

- **Research Objective A**–Review of current situation: To carry out a thorough investigation of current theory and practice for understanding design impact within relevant research literature to provide a foundation of understanding for subsequent studies.
- **Research Objective B –**Analysis of professional practice: To conduct descriptive studies of design practice to understand relationships between design practice and impact and identify gaps in current understanding.
- **Research Objective C –** Developing a new framework: To follow a process to create a framework to represent the factors which lead to design impact which, in turn, can contribute to improved understanding of design impact
- **Research Objective D–**Evaluating the new framework**:** To evaluate the framework, including its potential as a basis for new working methods for understanding and communicating design impact.

Overall Research Question

> Can a new framework for understanding design impact encompass relevant factors and be of practical benefit to the design profession together with contributing to contexts for designing, design theory and the underpinning of design pedagogy?

1.4 Thesis Structure

The thesis is organised into eight chapters with summary content as shown in *Table 1.1* and summarised below.

Chapter 1: Introduction
Provides an overall introduction to the topic, scope of the work and introduces the study aim, objectives, key research question and the thesis structure.

Chapter 2: Literature review
Reports on the review, analysis and synthesis of literature covering design impact literature and related fields. The synthesis includes the definition of a number of initial models and a prototype framework for understanding design impact.

Chapter 3: Methodology
Describes the analysis and selection of a research methodology, research structure and related methods. This concludes with a matrix of the overall objectives and research questions for each study.

Chapter 4: Impact and design process in tertiary design education
Reports on the first of five studies: a pilot investigation of how a range of factors relating to the emerging context for design can be evaluated with new approaches.

Chapter 5: Design process foundations
The report of the second study explores core design process concepts leading to the definition of robust, process based, foundations for developing a framework for understanding design impact.

Chapter 6: Studies of professional design practice and impact factors
Describes the two main industry based empirical studies conducted: a detailed exploration of Design Business Association Design Effectiveness Awards case studies and a triangulating series of semi-structured interviews with leading practitioners.

Chapter 7: Developing a new framework for UDI

Reporting on the final study in the sequence: the development and evaluation of the framework for UDI including two workshops with design professionals and academics.

Chapter 8: Conclusions and further work

Table 1.1 *Chapter outcomes*

Chapter	Outcome
1 Introduction	Identification of five research themes
2 Literature Review	*S*ynthesis of findings into models and prototype framework for UDI
3 Research Methodology	Rationale for methodology and methods, overview of research studies and methods and matrix of study objectives and questions
4 Impact and design process in tertiary design education	Report of initial research findings from the first study Review of findings in relation to objectives and research questions
5 Design Process Foundations	Reporting of core UDI framework foundations resulting from the second study Review of findings in relation to objectives and research questions
6 Studies of professional design practice and impact factors	Reporting of research findings from the two main industry based studies Review of findings in relation to objectives and research questions
7 Developing a new framework for UDI	Reporting development of the final UDI framework Review of findings in relation to objectives and research questions Discussion of the overall study outcomes and considerations of application
8 Conclusions and further work	An updated model of the study impact, definition of contributions to new knowledge and suggestions for further work

The reporting of each study incorporates a tabulated summary of the main findings based on a matrix of the objectives and research questions.

Appendices

The first section of the appendices (Appendix A) is a matrix showing the main research studies together the associated research questions and study objectives.

Appendix B is a an expanded literature review which provides more extensive background theory and references which have informed the focused literature review reported in Chapter 2. This expanded material is considered of value to establishing an overview of related literature for future scholars of design impact. Notable elements of the expanded literature review are a chronology of significant economic studies of design impact (*Table B.6*) and a table of UK grey literature reports covering design impact (*Table B.19*). The remaining appendices provide further background evidence of the study processes and associated research papers.

Chapter Two

Literature Review

Chapter content Page

2.1 The Literature Review Scope

The need for better understanding of design, the potential for a greater role for design and the design profession, and the challenges of recognising design impact were identified in the Introduction as overarching themes for this study. These are outlined in the first section of the literature review. This leads to the rationalisation of the five identified research themes into an *Initial Reference Model* (*Figure 2.1*) following the principles of Design Research Methodology (Blessing & Chakrabarti, 2009) and reporting on the related literature analysis. The literature review is further synthesised in the final section of the chapter. Firstly the *Initial Reference Model* is updated. Secondly, the main findings of the literature review are mapped to the research objectives, in particular Research Objective A which directly references the need to clarify what theory and practice exists as a foundation for subsequent studies. Thirdly, a number of research models are defined including an initial *Impact*

Model (Blessing & Chakrabarti, 2009) and a prototype framework for understanding design impact. This schematic distillation of literature review findings is subsequently updated as a consistent reference point through the remainder of the thesis.

2.1.1 Understanding Design

These are recurring themes which design research has not necessarily contributed to resolving (Love, 2000). Amongst many design researchers, Tether (2005) discusses how 'design is difficult to define'(p2), and that business has no consensus on the meaning of design. Kootstra (2009) states: 'Practically every single study that focuses on design has to cope with the complex nature of the subject and the relative ignorance about the subject among respondents. In practice, people have highly divergent notions of design; an unequivocal conceptual basis and clear definitions are lacking' (p56). Verganti (2008) makes similar points about ignorance of design and complexity amongst the design research community.

An important element of the complexity issue is the evolving nature of design and the design profession. Sudjic (2014) links the evolution and definition challenges stating; '...design keeps changing shape, which is why it matters. The clearest, but still not entirely satisfactory way to define design is through its relationship with mass production' (p139). Jones and VanPatter (2009) report: 'We recognized that it is impossible to have a meaningful conversation about the changing nature of design today without some kind of sense making framework' (p3).

We can see that defining design is a problematic but important foundation to any in-depth consideration of design issues (e.g. Tether, 2005; Kootstra, 2009; Love, 2000). Design has tended to be defined by chronological evolution, design activities, specialisms (e.g. Walker cited in Cooper & Press, 1995, Rawsthorne, 2013 and Sudjic, 2014), but these approaches may be insufficient.

Many writers on design have commented that confusion over terminology is an issue (e.g. Love 2000, Blessing & Chakrabarti, 2009). This is compounded by the word 'design' itself, which can have multiple meanings, both as a verb and a noun. Simon (1981) and Heskett (2008) make the distinction between design*ING*, the activity of design, and design*ED* outcomes, to emphasise the point that the added value of design is accrued through design*ING***.** Yet the popular perception of design is of designed things. It is often associated with the famous designers who have contributed to creating them, such as design 'superstars' Jonathan Ive or Philippe Starck. Tether (2005) describes the need to delimit design. Therefore a simple three point clarification of design consisting of: 1)Design*ERS*; 2) Design*ING* things; which have therefore been 3) Design*ED*, may be a useful contribution.

2.1.2 An Enhanced Role for Design?

Government initiatives promoting the value of design in the twentieth century can be traced to the 1943 Weir report and formation of the UK's Council for Industrial Design (CoID) in 1944 and the Britain Can Make It exhibition in 1946 (Woodham, 1996). The Government funded successor to the CoID, the Design Council, has continued ever since with varying foci for promoting the role of design as a socio-economic good.

More recently the *Cox review of Creativity in business* (2005) is widely seen as a significant catalyst for interest in the positive influence of creativity and design on the economy (Bakhshi & McVittee, 2009). For example Cox states: 'Steps should be taken to get greater understanding of creativity and innovation into the boardroom...' (op.cit., p16). Implicit in the involvement of policy level initiatives in the UK and beyond is the presence of both opportunities and barriers to adoption of design. The European Commission supports the periodic survey, Global Design Watch (Immonen et al., 2011) which provides a survey of Innovation and design promotion initiatives and a 'top 20' ranking of global creativity and design.

Professional design bodies have a vested interest in promoting the role of their members, notably in the UK by the Design Business Association through their long running Design Business Association Design Effectiveness Awards (Dawton, 2011). The US based Design Management Institute with a global membership has a range of initiatives including its *Design Value Index*(Rae, 2014) aimed at promoting the role of design. Most of this professional activity is linked to the role of design to enhance economic performance.

Much, if not all, design research activity can be seen to have the ultimate objective of enhancing the impact of design in a broad, not exclusively economic, sense (Blessing & Chakrabarti, 2009). A proportion of this research activity is concerned with promoting the idea of an enhanced role for the design profession. In the new product development field Noble's (2011) research review sets out with the aim to; '... help *elevate* design to the status of other essential, managerially oriented sub-disciplines that are tightly linked to marketing, such as sales, services, and relationship marketing. This more strategic focus will also enforce the notion that design is not just a stage in the product development process but a critical culture, capability, and asset for the firm' (p389). And in another study: 'how can we help to promote research on product design in order to increase the visibility and impact of efforts by researchers currently focused in this area, as well as to *elevate* its perceived importance within marketing academia?' (Swan & Luchs, 2011, p321).

However, despite the goals of design policy, design bodies and design researchers, 'companies are not convinced of design management's ability to generate added value. Despite the fact that investing in design can indeed provide great benefit. Apart from costs, knowledge factors and cultural factors are also listed as stumbling blocks. A culture change can be brought about by convincing companies of the added value of design' (Kootstra, 2009, p54).

Therefore, integral to enhancing design, are the common themes of design value and impact concepts. However policy, professional and research stakeholders also face the challenge identified by Koostra of 'convincing companies' – A fourth critical stakeholder group.

2.1.3 Recognition of Design Impact

With the Cox review (2005) acting as a catalyst, UK interest in the impact of design reached a crescendo with the 2012 Measuring the Impact of Design forum. This debated the motion 'better evidence of the impact of design will drive up demand', with 86% of the audience agreeing with the statement, declining to 75% at the end of the debate (Montgomery, 2012). The speakers confirm the frequently identified challenges inherent in attempts to measure design impact. For example: 'In a business world largely driven by the quantifiable assessments of success, the contribution of industrial design to a specific business's financial performance has stubbornly resisted measurement.' (Hertenstein, 2005, p5) And in Europe: 'There is a lack of reliable, comparable statistical evidence demonstrating design's contribution to the economy and its impact on return on investment.' (European Commission, 2013, p7)

The research community confirms this lack of impact data and sceptical reaction to the topic, for example: 'Also evident...is a continuous search for the measure and metrics of design that we can use to assess its contribution to business, society and the environment in general or to social media and brands in particular' (Cooper & Junginger, 2011, p10) and '...measurement of design has hitherto received little critical attention and many attempts to do so have been criticised by those who believe it is unquantifiable' (p21 op. cit.)

In summary, the measurement or assessment of design impact is seen by many as a necessary part of making a case for an enhanced role for design, but there is considerable scepticism about the practicality of defining and quantifying design impact.

2.1.4 Boundaries of the literature review

Studies of impact tend to be tied to professional domains. The number of design related studies is much fewer than that in other fields, e.g. the 233 studies reviewed in Evanschitzky et al.'s (2012) study in the new product development field, or the whole body of social or environmental impact analysis research. Within these broader fields of impact analysis large data sets and complex statistical analysis techniques are typically used. The €Design: Measuring Design Value initiative(Barcelona Design Centre, 2014a) will potentially lead to the availability of large data sets for policy level analysis. But the difficulties of obtaining large data sets in design (Swan et al., 2005) and the firm level focus of this work are judged to preclude exploring detailed statistical analysis. Concepts such as 'designerly' approaches (Cross, 2001), design driven innovation (Verganti, 2003) and design thinking (Brown, 2009) all recognise the divergent nature of designing, but also the distinctiveness of design. Therefore the principle of focusing on the distinctive elements of professional design activity helps to define boundaries for the review within the field of professional design activity.

2.2 Five *reference model* themes

Following initial review of the five research themes and the principles of Design Research Methodology (Blessing & Chakrabarti, 2009), the themes have been arranged into an *Initial Reference Model* (*Figure 2.1*). Within this reference model *Design Process* is shown as the core aspect of design activity which leads to design impact. The nature of the design process is influenced by many factors, but in this simplified diagram *The Role of Design* theme is shown as the overall input or influence on Design process which leads to *Design Impact*. The *Design Research* theme is shown having links to all three core themes and *Models and Metrics*. The *Models and Metrics* theme has a direct link to design impact, but there are also potential links with all the other three themes.

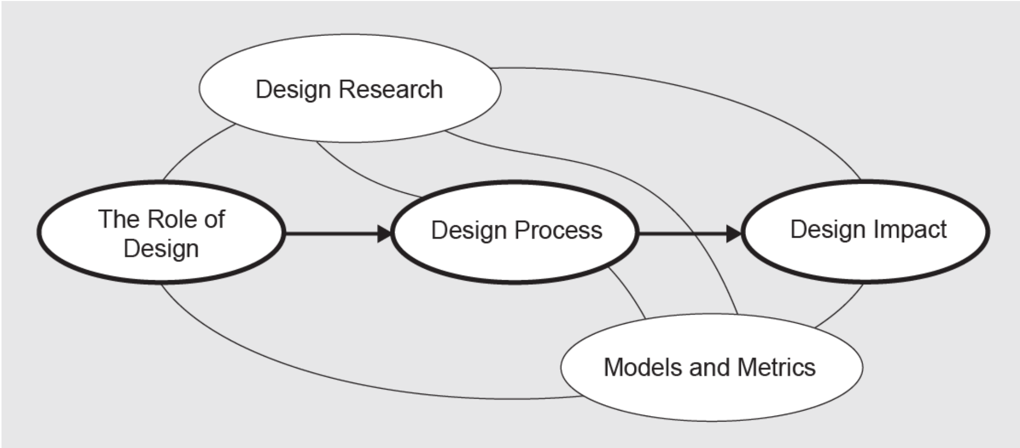

Figure 2.1 *Initial reference model for research themes*

For additional reference, Appendix B is an extended descriptive report and analysis of these factors.

2.2.1 Design Impact

The fact that there has only been limited research into design impact is widely reported throughout the history of studies on this the topic (e.g. Tether, 2005 and, chronologically, from Moody, 1980 through to Micheli, 2013), or as evidenced by Candi & Gemser's (2010) significant review of 18 available studies compared to 233 in the Evanschitzky et al. (2012) review of success factors in the broader subject of New Product Development. However, the general connection between the use of design and a positive impact on financial performance has now been demonstrated in a number of empirical studies dating back to 1980 (Moody) and notably in the UK by Roy and Potter (1990).

Hertenstein et al., (2005), Cooper et al., (2011), Madano Partnership, (2012), Micheli (2013) and others highlight the complexity of measuring impact, especially in relation to a 'triple bottom line' (Elkington, 1999) of potential impacts. As early as 1987, Black & Baker state: 'The operationalisation of such performance concepts is problematic' and 'as no single agreed definition of success exists, study comparisons are difficult' (p210). This complexity or lack of operationalisation is a factor in the Design Council (2005) survey showing that only 3% of their sample could reliably evaluate design impact. Micheli's study (2013) makes the point that professionals involved are reluctant to engage with the topic and he identifies a ‘paradox’ whereby it is felt that consideration of impact results in more conservative design approaches.

To an extent, attempts have been made to reduce the complexity by offering models to delimit design activity, such as Whicher et al., (2011) or Tether (2005).

A Chronological review of impact studies (Reference Appendix B, *Table B.6* for an overview of 39 studies from 1980 to 2013) demonstrates that the concerns of these studies mirror the overall evolution of design practice as summarised in overviews such as Borja de Mozota & Kim’s 2009 work shown in *Table 2.1*.

Table 2.1 *Historical development of design and design management (Borja de Mozota & Kim, 2009)*

Period	Main Perspective: Design as -	Design Role	Design Management focus	Cases
1940s to 1950s	Function	Product Quality	None	AEG, Olivetti
1960s to 1970s	Style	Quality communication	Project management	Alessi, Braun
1980s to 1990s	Process	Innovation	NPD/Innovation management	Philips, Sony
1990s to 2000s	Leadership	Creativity strategy	Brand	Apple
2000 onwards	Thinking	New Business model	Creative organisation	IDEO

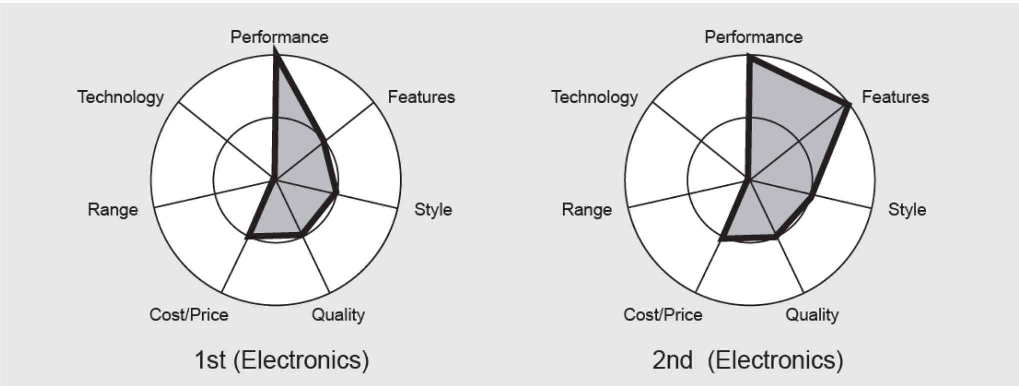

Figure 2.2 *Roy & Riedel’s (1997) Polar maps of success factors for the highest ranked products in their sample*

In the 1990s, and building on earlier work (Roy & Potter, 1990, 1993), Roy & Riedel (1997) demonstrated a finer grain understanding of the contribution of design to impact (*Figure 2.2*), showing that design impact is created by more than simply adding ‘style’. By the time of Candi & Gemser’s (2010) review of 18 notable studies a more comprehensive model of links between design and performance is demonstrated (*Figure 2.3*).

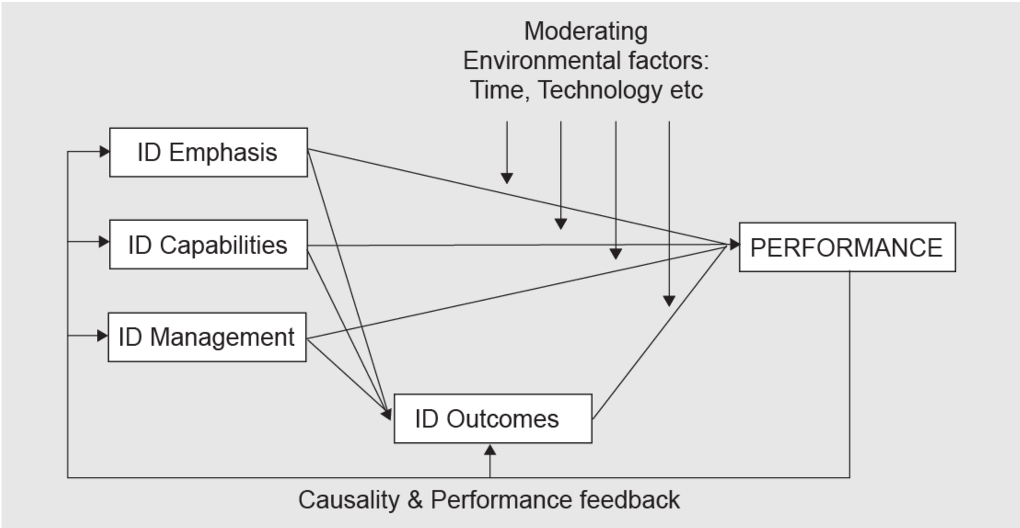

Figure 2.3 *Candi & Gemser's (2010) model of relationships between Industrial Design (ID) & Performance*

Candi & Gemser's (2010) review, together with Noble (2011), Madano Partnership, (2012) and Nomen et al., (2012) each identified a series of questions which impact research needs to address. These have been rationalised and this demonstrates five areas where design impact research is lacking *(Table 2.2).* The expanded details of the questions and synthesis are included within Appendix B.

Table 2.2 *Synthesis of design impact research agendas from macro-economic/policy and NPD/Innovation fields*

Theme	Candi & Gemser, (2010)	Noble, (2011)	Madano Partnership, (2012)	Nomen et al. (2012)
1 Need for a sound theoretical basis for design impact analysis	Q1, Q3	Q1	Q1	Q1
2 Need for means of operationalising design impact analysis			Q1	Q2, Q3
3 Need for empirical evidence of design impact	Q4, Q7, Q8	Q2	Q3, Q4	
4 Need for effective dissemination of design impact analysis	Q2			Q4
5 Need for building a case for integrating design in firms	Q5, Q6	Q3, Q4	Q2	

In general it can be seen that professions have a vested interest in promoting the value of their own professional input. For example in sectors related to design: studies in human factors (Dul, 2012), architecture and the built environment, (MacMillan, 2006) or advertising (UK Advertising Association, 2013). Parallel issues can be seen such as 'a widely acknowledged difficulty with many of the benefits associated with good design is that they are hard to measure, or intangible' (MacMillan, 2006, p264). Gann et al.'s (2003) Design Quality Indicator*,* in parallel with Roy & Riedel (1997) demonstrates the communicative value of polar maps for multi-variate analysis, and The Advertising Pays report (UK Advertising Association, 2013) indicates a variation of Candi & Gemser's (2010)causality and performance feedback loop, described as 'reverse causality'.

Increasingly there is interest in broader design impact, for example beyond economic impact to social and environmental impact (Choi et al., 2014). A comprehensive understanding of design impact needs to accommodate recognition of the complete 'triple bottom line' (Elkington, 2009)

2.2.2 Design Process

The origins of research into design process, dating back to 1962 and the origins of design research itself (Bayazit, 2004), is inextricably linked to design impact with the general goal of enhancing design outcomes. Design process has been extensively reviewed (e.g. Dubberly's (2004) 'compendium' of 131 design process models, Gericke & Blessing's (2011) 142 models and Wynn and Clarkson's 2005 study). The Design Council's study (2007a) and in the NDP and Innovation fields (Koen et al, 2001 & 1988, Baxter 1995) all advocate early intervention of design and staged processes for improving impact. However this emphasis on design process has its critics, who express concerns that abstraction to process models leads to reductionism and important omissions(e.g. Birkhofer, et al., 2005, Lawson, 2004, Blackwell et al.,2009, Gericke & Blessing, 2011).

More significantly for this study, the comparatively long history of design process study contributes a more granular understanding and a rich resource for consideration of the component factors, such as creativity (Pahl & Beitz, 1995, Howard et al., 2008), 'moderating factors' (Candi & Gemser, 2010; Pugh, 1991) and the spectrum of approaches possible within the field from creative to scientific (Wynn & Clarkson, 2005, Howard et al., 2008). However, the links to design impact within this body of research tend to be implicit and not thoroughly evaluated.

2.2.3 The role of design

The design profession has progressed from its craft roots (Walker, 1989), through an emphasis on design process to making a more holistic contribution to added value when effectively *embedded* (Micheli, 2013; Rae, 2014) or *integrated* (Borja de

Mozota, 2003) within organisations. This transition from craft to strategic activities presents complexities that are compounded when practitioners are faced with new domains for design activity (McCullagh, 2010; Norman, 2010). Kimble (2009) cites examples of emerging specialisms including: interaction design, experience design, service design and transformation design.

Others, building on Schumpeter's (1934) work linking innovation to economic performance, make the connection to an enhanced role for design (Tether, 2005; Multu and Er, 2003; Verganti, 2003 and Utterback et al., 2006). Design thinking (Buchanan, 1992) is also held out as an important ingredient for added value. But, as in other aspects of the topic, it is noted by scholars that links between these claims for design and performance enhancement are not explicit (Candi & Gemser, 2010; Noble, 2011; Therrien et al., 2011; Kootstra, 2009).

To rationalise the various perspectives on the role of design and impact, a summary 6Ws analysis (Boeijen et al., 2013) has been used (*Table 2.3*). This is explored in further detail in Appendix B.

Table 2.3 *6Ws framework of design impact research and the role of design in creating impact*

6Ws	Concepts / terminology	Associated criteria/metrics
1 **WHY** invest in design?	*Price and Non price* factors (Rothwell & Gardiner, 1989),*The Power of Design*(e.g. 8 factors, Rae, 2014), *Design Currency* (Visocky O'Grady & Visocky O'Grady, 2013)	*Design Value Index*, six criteria for *design centric* companies (Rae, 2014)
2 **HOW** does design create impact?	Design *Conscious firms*(Roy & Walsh, 1983), Design *Orientation* (Black& Baker, 1987), Design *Effectiveness* (Hertenstein 2001), Design *Intensity* (Gemser & Leenders, 2001), *Emphasis*(Candi & Gemser, 2010), Design *Strength* & *Continuity* (Zec, 2011), *embeddedness* (Micheli, 2013); Design centric, (Rae, 2014) *Integration*(Borja de Mozota, 2003)	*Design Participation* (Black & Baker, 1987), *Danish Design Ladder* (Danish Design Centre, 2003),*Design Value* (Zec, 2011) *Design Management Staircase*, (Kootstra, 2009), *Four Powers* (Borja de Mozota, 2006)
3 WHEN & 4 **WHERE** does design add value?	Level of *Commoditization* (Candi & Saemundsen, 2011), *Moderating Factors* (Candi & Gemser, 2010)	34 categories of *Resource envelope* input *(*Pugh, 1991*)* *Design Newness*(Talke et al., 2009)
Design activity: 5 **WHO** is directly involved with designing which creates impact?	*Silent Design* (Gorb & Dumas, 1987), *Overt Design* (Candi, 2010), *Design Leaders* (Topalain, 2011, Miller & Moultrie, 2013a and 2013b)	Delimiting Design activity (Tether, 2005), Technical & Non-technical Design investment (Livesey & Moultrie, 2008)
6 **WHAT** design specialism and HOW is it deployed to create impact?	*The Design Tree* (Walker in Cooper & Press, 1995), Expressive – symbolic – Functional (Tether, 2005), Product–Logo-Web design (Kristensen and Gabrielsen, 2010), *Design Knowledge*(Tether, 2005) *Design Management* (e.g. in Swan et	*Technical – Non TechnicalDesign investments*, (Livesey & Moultrie, 2008), *'Good Design'* (Kristensen and Gabrielsen, 2010), *Capability*(Candi & Gemser, 2010),*Competency* (Kristensen and

6Ws	Concepts / terminology	Associated criteria/metrics
	al.,2005; Ravasi & Lojacono, 2005, Borja de Mozota, 2003), *Design Thinking*, (Brown, 2008)	Gabrielsen, 2010); *Design capabilities* (Swan et al., 2005),

Communicating design impact

The Design Council and the Design Business Associations' report (2005b) notably indicated that 42% of design consultancies were judged to communicate the value of design 'not well at all'. If designers and design impact are to 'elevate' the design profession, communication of impact is an integral part of this. Early studies of design impact were based on communicating favourable results at policy level, resulting in reports and grey literature (ref Appendix B, *Table B.6 and B.9*). Competitions run by bodies representing design such as the Design Business Association Design Effectiveness Awards (Dawton, 2011), Red Dot (Zec, 2011), and the European Design Management Award (Kootstra, 2009) are leading examples of design advocacy using case studies of design impact. Case studies would also appear to be the predominant basis for design impact communication by practitioners.

No research has been identified which directly focuses on the efficacy of professional communication of design impact. However, in the architecture and built environment field MacMillan (2006) cites Mulgan (2005) and Gann et al.,(2003) cite Tufte, (1983), in both cases advocating a visual approach to communicating impact data. More recent activity and publications such as Visocky O'Grady & Visocky O'Gradys' *Design Currency* (2013) or the Design Management Institute's *Design Value System* (DMI, 2014) are directly providing tools to enable practitioners to understand and communicate design impact.

The DBA Design Effectiveness Awards and the series of studies from the Design Council (2002, 2003, 2005a, 2007b) use datasets as a basis for communicating design value, but the objectivity of the data and analysis is open to criticism for bias and generally provides limited insight into causation between design and impact.

2.2.4 Models and Metrics

The design impact literature (ref Appendix B *Table B.6*) makes reference to, and adopts, a range of models and metrics to evaluate design impact. These are derived from business and management practice. More distinctively, the concept of design value is highlighted as a basis for understanding design impact (e.g. Borja de Mozota, 2006; Heskett, 2008, Nomen et al, 2012). Others (egLøvlie et al., 2010; Joziasse & Sleders, 2009; Zec, 2011; Rae, 2014;) adopt the term *design value* more loosely as a basis for differentiating *how* design creates impact (Ref *Tables 2.4 and Figure 2.4*).

Table 2.4 *Use of 'Value' terms in design and related literature*

Reference	Types of value discussed
Osterwalder (2004)	Defining the **Value Proposition** as a core pillar of business model design linked to analysis of how value is derived from the **Value Chain** and **Value Networks** with different categories of **Value Integration**
Borja de Mozota (2006)	Defines a **Value Model** for design referencing Porter's **Value Chain** model (2008)
Heskett (2008)	**Economic value** based on **Use Value** and **Exchange Value** (from Neo-classical economic theory) fails adequately to capture the potential of design
Joziasse & Selders (2009)	'Isolation' of 11 types of **value added by design,** 9 for organisations, 2 for society
Zec (2011)	The (loosely defined) identification of '**Design Value'** as the **Added Value** derived from design input
Nomen et al (2012)	**Economic Value** explained as the difference between Economic Cost and Perceived Utilities, in turn comprised of Functional, Emotional and Social Utilities
Rae (2014)	Higher stock market performance through **'Design-driven Value'** in 'Design-centric companies'
Barcelona Design Centre (2014)	A model for **Design Value Creation** as a basis for design impact evaluation (Ref Figure 2.4)

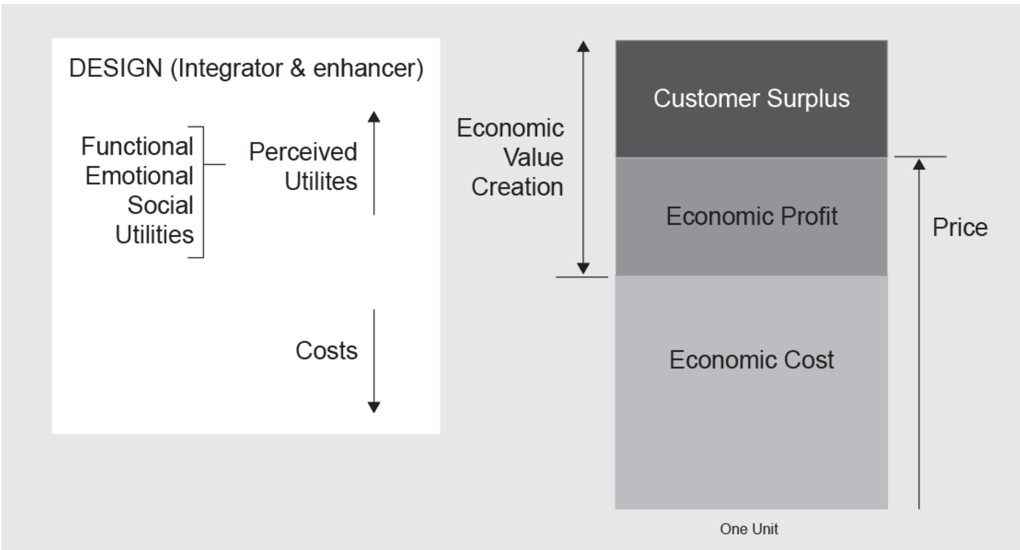

Figure 2.4 *Schematic of design's potential contribution to value creation (Barcelona Design Centre, 2014)*

From outside the design field, the Balanced Scorecard (Kaplan and Norton, 1992) concept has attributes useful for design impact analysis and communication (Hoque, 2014). Borja de Mozota (2006) adopts this approach in her *Four Powers of Design*

design value model (Design as differentiator, Design as integrator, Design as transformer and Design as good business)

Likewise Elkington's Triple Bottom Line (1999) offers a means to evaluate the social and environmental 'bottom lines' of design impact in addition to economic performance. However criticism of the approach, for example Norman and MacDonald (2004) or in the design field, Melles et al. (2011), is indicative of the challenges faced in the diffusion of any new approach (Birkerhoffer, 2011). This challenge is also highlighted by the 'proliferation' of models and methods related to environmental impact analysis shown in Glavic & Lukman's hierarchical model, (2007 ref *Figure 2.5*). This usefully indicates the potential meta-theoretical 'space' for the spectrum of potential interventions for aiding impact analysis.

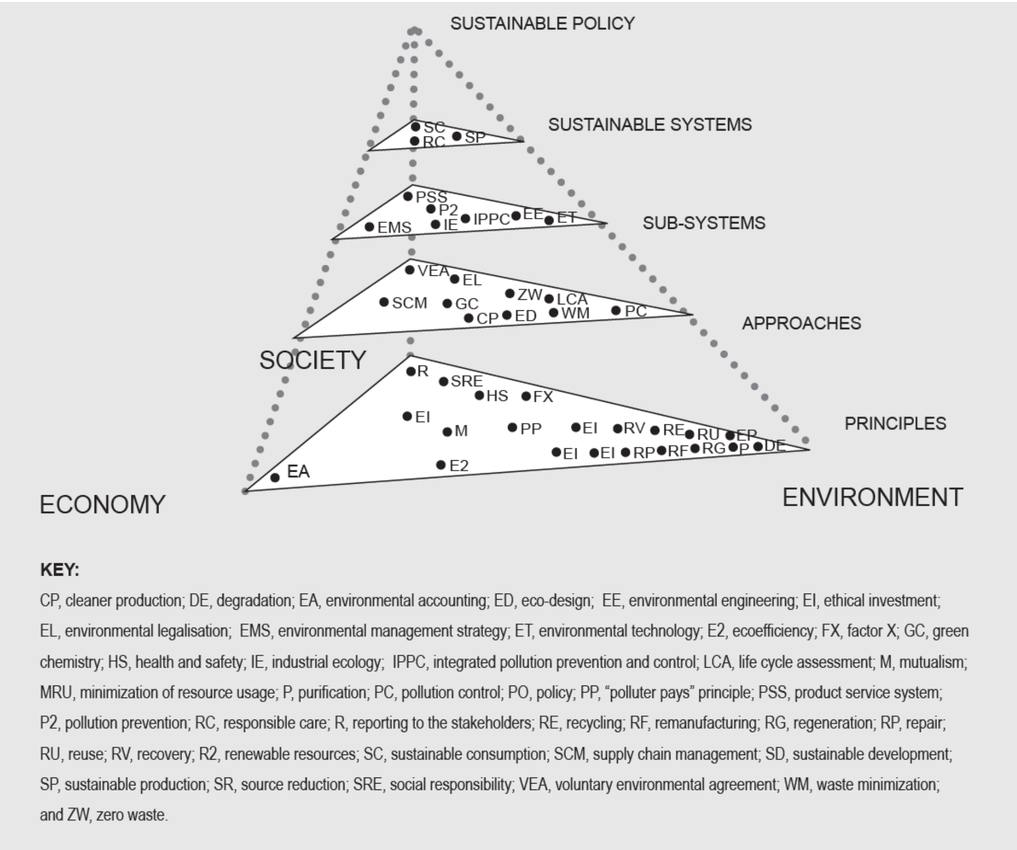

Figure 2.5 *Classification of sustainability oriented terms (Glavic & Lukman, 2007)*

In the Impact Assessment field Cashmore and Morgan (2014) identify a similar 'analytical arms race'. McCreless et al., (2014) propose an evolution of thinking about metrics (similar to Jones & Van Patter's (2009) software development metaphor) whereby Metrics 1.0 is the stage of recognition at company level of the need to identify impact; Metrics 2.0 is the stage where common sector standards become established and Metrics 3.0 (their recommendation) the stage where widespread recognition of standardised metrics leads to integration across stakeholders and a focus shifting to value enhancement rather than monitoring and auditing. The evidence from much of the design impact field is that much of the sector is not even reaching the Metrics 1.0 level.

RoI, KPIs and CSFs

Return on Investment (RoI), Key Performance Indicators (KPIs) and Critical Success Factors (CSFs), are all well established and well known performance management concepts. RoI is used within design (Whicher et.al., 2011), but Godin (2009) and Hertenstein et al., (2001), both highlight that this does not illuminate the relative contribution of design. The Design Council customises this approach to emphasise the value of design investment based on turnover rather than profit: 'For every £100 a design alert business spends on design, turnover increases by £225' (Design Council, 2007b, p4). This approach does little to demonstrate causation.

Rockart's (1979) Critical Success Factors concept, similarly to Key Performance Indicators and the Balanced Scorecard approach, aims to highlight the most relevant factors and associated metrics in order to streamline management functions. Koutsikouri et al.'s (2008) study of 63 CSF studies from the architecture-engineering-construction field correlates with Miller and Moultrie's (2013a, 2013b) study of design leadership – demonstrating that 'super soft' socio-cultural factors are Critical Success Factors, but that these factors are typically overlooked in the majority of studies.

Planning canvasses

The EU funded work exploring value creation by design (Barcelona Design Centre, 2014a) creates a 'canvas' as a basis for understanding design value and its potential. Whilst not referenced to the *Business Model Canvas* (Osterwalder, 2004), it can be seen that the concept derives from this and from Osterwalder's own references. Osterwalder highlights the *visualisation* goal of business models resulting in the *Business Model Canvas* (Osterwalder & Pigneur, 2010). This is of particular interest because: 1) its origins lie in a synthesis of thinking in these fields; 2) it considers ontological approaches as a means to rationalise knowledge; 3) it puts emphasis on the importance of visualisation and designerly approaches; and 4) the approach is concerned with business model innovation and working across sectors and scales of operation.

Summary of Models and Metrics

The following key points summarise the literature review findings related to the use of models and metrics and understanding design impact:

a) Need for recognition of how design operates within nested contexts from the general domain to the firm, business unit or project level.
b) That design is an ingredient within value propositions, value chains, etc., leading to impact.
c) Design activity (the process of designing) is core to creating (design) value, and this extends beyond conventional notions of economic value.
d) Many studies and approaches are focused on economic added value. But social and environmental added value factors should also be effectively integrated into a more complete understanding of design impact.
e) There are a considerable number of models and metrics which can be used as a basis for operationalising analysis of design impact. But there is considerable scope for improvement of these models and metrics throughout a theory to practice hierarchy.
f) Relating established models and metrics for understanding design impact to a core Input-Process-Output-Impact sequence helps to distinguish the underlying design activity.

2.2.5 Design research

Many researchers exploring design theory describe the inherent complexity of design and design process and its resistance to definition within universally agreed models (e.g. Lawson, 2004, Clarkson & Eckert, 2005). However, this complexity is acknowledged as a positive defining feature within concepts such as ‘wicked problems’ (Rittel, 1967 cited by Buchanan, 1992) and design thinking (Buchanan, 1992, Brown, 2009). A further consistent theme is the identification of, and associated problems with, the gap between academic development of conceptual models and the reality of commercial practice (e.g. Buijs, 2003 and Blessing & Chakrabarti, 2002). Design research can be placed on a theory – practice spectrum, for example with Buijs (1993) towards the practice end and with Love (2000) and Lawson (2004) exploring the theoretical end. Frayling’s (1993) Research FOR – THROUGH - INTO Design classification adopted by Philips Electronics (Kyffin, 2009) also reflects this spectrum (*Figure 2.6*). Cross (2001) identifies issues with the ‘scientising’ of design research and advocates recognition of the distinctive cross-cutting theme of ‘*designerly ways of knowing*‘.

Challenges for research INTO design

Love (2000 & 2002) identifies four ‘serious criticisms’ of design research summarised as: 1) *confusion* between theories, concepts and methods; 2) ‘unjustifiable’ *conflation* of concepts; 3) unnecessary *multiplicity* of concepts; and 4) confused and *imprecise terminology*. He aims to address these issues through a single coherent theory – a meta-theoretical hierarchy (*Figure 2.6*). Blackwell et al.(2009) and Dorst (2008) aim to re-conceptualise design. Blessing & Chakrabarti (2002) identify a three point critique of the body of design research and Dorst (2008) identifies five criticisms of research INTO design. Love (2000), Sim & Duffy (2003) and Wodehouse & Ion (2010) all consider knowledge structures as a basis for resolving these issues, the first two exploring the notion of an ontological approach. Wang & Ihan (2009) criticise Love’s approach on the basis that it omits certain dimensions. A summary review of ontology literature reveals that *expandability* is an underlying principle of ontological approaches (Gruber, 1995). Therefore omission is not necessarily a valid criticism of an ontological approach.

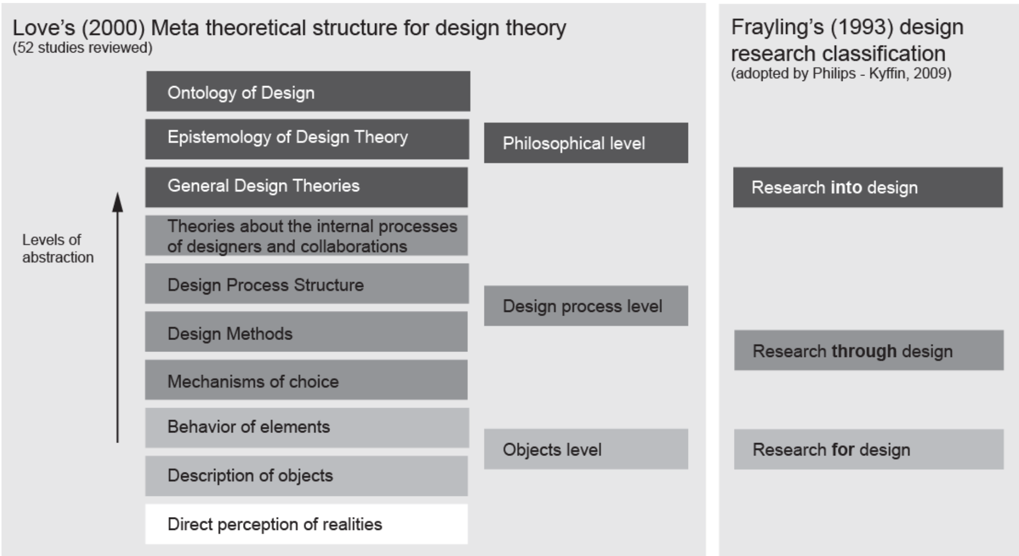

Figure 2.6 *A framework for exploring design theory and research derived from Love (2000) and Frayling (1993)*

Epistemological and Diffusion issues

Eckert & Stacey (2010) introduce their critique of epistemological factors in design process modelling by citing Lawson (2004, p28): ‘[it is]…about as much help in navigating a designer through his task as a diagram showing how to walk would be to a one year old child...Knowing that design consists of analysis, synthesis and evaluation will no more enable you to design than knowing the movements of breaststroke will prevent you from sinking in a swimming pool’.

In order to aid consideration of knowledge structures, for example, in the case of understanding design impact, and as a practical response to these complex challenges, Eckert& Stacey offer an alternative approach or set of criteria for considering design process models: 1) Selection (clarifying the purpose of the model); 2) Consideration of representational bias (e.g. Stage Gate process emphasises decision points); and 3) Modelling choices (e.g. how much detail is put into mapping a situation to the model).

Adopting the term here of *Diffusion (e.g.* from *Diffusion of Innovations*, Rogers, 2003), it is clearly important to consider the theory-practice spectrum and the *diffusion* of design research. Birkhofer (2005) provides a useful Venn diagram to consider these factors (*Figure 2.7*). Based on an industry interview study, scope for more effective diffusion is identified for three main elements: 1) Supply - Improve utilisation of design methods & productivity factors; 2) Application –Improve efficiency of existing industry practice; and 3) Demand - Improve identification of demand for new methods.

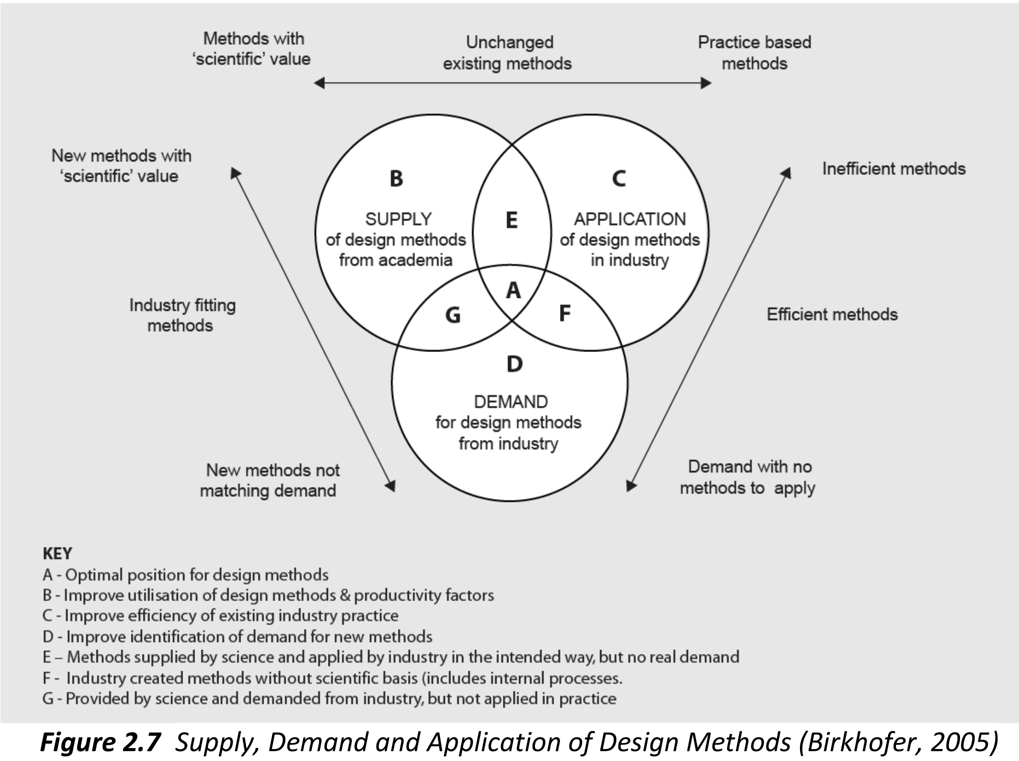

Figure 2.7 *Supply, Demand and Application of Design Methods (Birkhofer, 2005)*

2.3 Literature Review Synthesis

The synthesis of the literature review findings is organised into four sections. The first section, based on the initial *reference* model (*Figure 2.1*) provides a complete overview of findings in relation to the connections between the five main research themes. The second section maps the overall research objectives to pertinent findings. The third section of synthesis is based on an initial *Impact* model (Blessing and Chakrabarti, 2009)demonstrating the links between the anticipated *new knowledge* or 'support' and the synthesis of literature review findings. The fourth and final section is a further distillation of key analysis into a *prototype* framework for UDI which is subsequently updated through the thesis with the findings from each successive study.

2.3.1 Development of the Reference Model

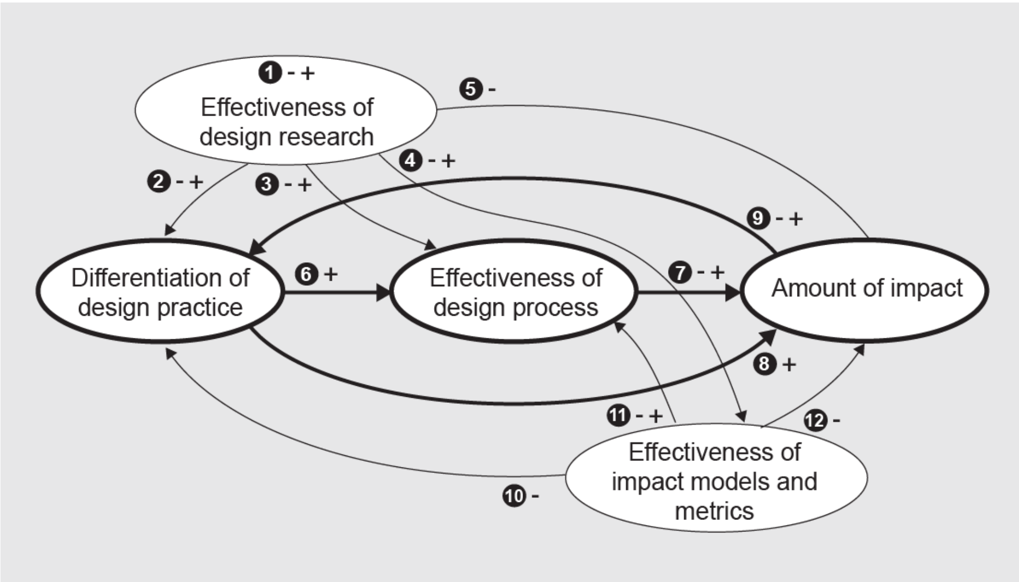

Figure 2.8 *Updated Reference Model*

The initial reference model is updated (*Figure 2.8*), in line with Blessing & Chakrabarti's (2009) recommendations, to show positive (+) and negative (-) influences on the links between themes. In the updated reference model each theme is now expressed as an attribute of an element. For example 'Design Impact' becomes *Amount* (attribute) *of Impact* (element). Additional links are added between Amount of impact and Differentiation of design practice and all the links on the reference model (*Figure 2.8*) are numbered from one to twelve. Summary literature review findings corresponding to this numbering are shown in *Table 2.5*.

Table 2.5 *Positive and negative influences on the links between the reference model themes*

Link	Negative (-) or positive (+) summary literature review finding
1	Effectiveness of design research
	Ref *Table 2.2* – synthesis of research challenges (Candi & Gemser, 2010; Noble, 2011; Madano Partnership, 2012; Nomen et al., 2012):
-	Need for a sound theoretical basis for design impact analysis
-	Need for effective dissemination of design impact analysis
+	Ref Figure 2.6 – Synthesised design research model (Love 2000; Frayling,1993). Need for a meta theoretical model as a basis for design research
2	Effectiveness of design research leading to Differentiation of design practice
-	Need for building a case for integrating design in firms (Ref *Table 2.2*)
-	Complexity and terminological issues (Love, 2000 & 2002)
-	Gap between theory & practice (Buijs, 2003, Blessing & Chakrabarti, 2009)
	Ref *Table 2.3*; 6Ws framework
+	The 'Power of design' determined by: emphasis, integration, capability continuity and moderating factors shown to create impact.
3	Effectiveness of design research leading to Effectiveness of design process
-	The topic is complex, models are never ideal (Alexiou et al., 2010; Lawson, 2004; Design Council 2007a; Clarkson &Eckert, 2005)
-	Existing models are incomplete (Dorst, 2008; Patterson et al., 2009; Lawson, 2004; Blackwell et al., 2009)
-	Models are less effective for creative process (Wynn & Clarkson, 2005)
-	Limited effectiveness of process research (Birkhofer et al., 2011)
-	Scarcity of empirical studies on Design management (Chiva & Alegra, 2009)
+	Process based approaches to enhanced practice predominate (Wynn & Clarkson, 2005; Gericke & Blessing 2011)
+	Process is core to adding value (Simon, 1981; Heskett, 2008)
4	Effectiveness of design research leading to Effectiveness of impact models and metrics
-	Need for means of operationalising design impact analysis (Ref Table 2.2)
-	No 'agreed framework' (Ramlau, 2004; Livesey & Moultrie, 2008)
-	'Search for metrics' (Hise et al, 1989; Tether, 2005; Cooper et al., 2011)
-	Frameworks are explored, but with limited operationalisation, (Joziasse & Selders, 2009)
+	Initial framework for delimiting design (Tether, 2005)
+	*European Design Manual* proposals for national economic evaluation (Barcelona Design Centre, 2014)
5	Effectiveness of design research linked to Amount of impact
-	Correlation demonstrated but not causation (Tether 2005)
-	Need for empirical evidence of design impact (Ref *Table 2.2*)
-	Limited work on design impact (Gemser & Leenders, 2001)
-	'Triple Bottom Line'impacts not generally recognised (Whicher et al., 2011; Madano, 2013)
-	Difficulties sourcing data for analysis (Swan et al., 2005)
6	Differentiation of design practice leading to Effectiveness of design process
+	Design evolution, (Borja de Mozota & Kim, 2009)
+	Emerging practice, (Kimble, 2009)
7	Effectiveness of design process leading to Design impact
-	Differences between 'Good & Bad' design are generally not explored (Blackwell et al., 2009)
	Ref Table 2.3; 6Ws framework:
+	The 'Power of design' determined by: emphasis, integration, capability continuity and moderating factors

Link Negative (-) or positive (+) summary literature review finding
8 Differentiation of design practice leading to Design impact - Need for empirical evidence of design impact (Ref *Table 2.2*) Ref *Table 2.3*; 6Ws framework + The 'Power of design' determined by: emphasis, integration, capability continuity and moderating factors
9 Amount of design impact leading to Differentiation of design practice - The need to convince companies of design value (Kootstra, 2009) - Designer weakness in communicating value (Design Council, 2005b) + Virtuous feedback loop (Chiva & Alegra, 2009; Candi & Gemser, 2010)
10 Effectiveness of design impact models and metrics leading to Differentiation of design practice - No empirical studies exploring a link between communicating design impact and increased differentiation have been identified.eg Design Council (2007b) or DBA Design Effectiveness Awards (Dawton, 2011) use examples of design effectiveness as design advocacy, but the impact of this advocacy does not appear to have been evaluated.
11 Effectiveness of design impact models and metrics leading to Effectiveness of design process - Industry concerns and Micheli's 'Paradox' (Micheli, 2013; Madano, 2012) - Difficulties interpreting results (Swan et al., 2005) - Policy level studies predominate in UK & Europe (Cox, 2005, Design Council 2007b, Tether 2009, Nomen et al., 2012) - Confusion & need to clarify terminology(Glavic & Lukman, 2007) - Methods 'competition' & 'analytical arms race' in the field of Impact Assessment (Robert et al., 2002; Cashmore & Morgan) - Lack of understanding of 'super soft factors' (Koutsikouri et al., 2008; Miller & Moultrie, 2013a, 2013b) + Value concepts (Ref Table 2.4) + Performance management models & planning canvasses: Balanced Scorecard (Kaplan & Norton, 1992); Value Proposition (Osterwalder, 2004); Triple Bottom Line (Elkington, 1999); Critical Success Factors (Rockart 1979)
12 Effectiveness of design impact models and metrics leading to Amount of impact - Causation is not demonstrated (Tether 2005, Hertenstein, 2005) - Very little evaluation of design impact by companies (Michalli, 2013) - Operationalisation is a challenge, (Black & Baker, 1987)

2.3.2 Mapping research objectives to literature review findings

Table 2.6 synthesises the literature review findings further by mapping key findings to the overall research objectives. This mapping omits the positive findings from the reference model and focuses on the negative factors which are the reference for the contribution to knowledge which the overall study aims to make.

Table 2.6 *Literature review – Mapping research questions to findings*

Research Objectives	Main literature review findings
Review of current situation RO A To carry out a thorough investigation of current theory and	- It is generally acknowledged that the correlation between design investment and performance uplift is proven, but not the detailed causation (Tether, 2005) - In the context of emerging practice (Kimble, 2009) and evolution (Borja de Mozota & Kim, 2009) professional design practice can be 'elevated' (Noble, 2011) by more effective communication of design value and impact (Kootstra, 2009)

Research Objectives	Main literature review findings
practice for understanding design impact within relevant research literature to provide a foundation of understanding for subsequent studies	- This can lead to a virtuous feedback loop for design (Chiva & Alegra, 2009; Candi & Gemser, 2010). However a sound theoretical basis for understanding design impact is lacking, resulting in limited empirical evidence (Candi & Gemser, 2010; Noble, 2011; Madano Partnership, 2012; Nomen et al., 2012) - This is compounded by a number of barriers to adoption such as: design industry concerns about the usefulness of understanding design impact (Micheli, 2013; Madano, 2012); difficulties sourcing data for analysis (Swan et al., 2005) and operationalisation (Candi & Gemser, 2010; Noble, 2011; Madano Partnership, 2012; Nomen et al., 2012); general confusion and the need to clarify terminology (Glavic & Lukman, 2007) - A stream of pan European research with roots tracing back to early studies by the UK Design Council is leading towards a Barcelona Design Manual (BCD, 2014). However this is focused on generating national economic data on the value of design rather than design practice and company level analysis, where there is currently very little evaluation (Michalli, 2013)
Analysis of professional practice RO B To conduct descriptive studies of design practice to understand relationships between design practice and impact and identify gaps in current understanding	- The value of integration of design into the early stages of NPD, Innovation and business management is generally acknowledged in the design field and to an extent in the NPD and Innovation fields (Hise et al., 1989, Design Council 2007a, Koen et al., 2001) - However the design profession is not judged to be effective in communicating the value of design in terms organisations understand (Design Council, 2005b) - There are a number of practical barriers to developing professional practice based around design impact concepts (ref above)
Developing a new framework RO C To follow a process to create a framework to represent the factors which lead to design impact which, in turn, can contribute to improved understanding of design impact	- Design process has been central to design research and to exploring the potential added value of design (Wynn & Clarkson, 2005; Gericke & Blessing 2011; Simon, 1981; Heskett, 2008) - Ref *Table 2.3;* The 'Power of design', determined by emphasis, integration, capability, continuity and moderating factors, has been demonstrated to contribute to design impact - However the core design process factor is complex and models are typically judged as incomplete, less than ideal and poor for deconstructing creative process (Alexiou et al., 2010; Lawson, 2004; Design Council 2007a; Clarkson &Eckert, 2005; Dorst, 2008; Patterson et al., 2009; Lawson, 2004; Blackwell et al., 2009; Wynn & Clarkson, 2005) - Design 'Value' concepts are important for disaggregating the nexus of the design ingredient in added value (Borja de Mozota, 2006; Joziasse & Selders, 2009; Rae, 2014) - But the majority of design impact research provides an incomplete picture of all the influencing factors (Candi & Gemser, 2010)
Evaluating the new framework RO D To evaluate the framework, including its potential as a basis for new working methods for understanding and communicating design impact	- A number of models and metrics have been used to explore design impact. It is not clear that these have been adopted within the profession, with the exception of ROI (Whicher et al., 2011). Direct links between models and specific working methods for detailed impact analysis do not exist in the design field - Given 'complexity & scepticism' and other factors, there are challenges with the diffusion of any proposed recommendations (Birkhofer et al., (2011) + Popular models used in general performance management may have utility in design impact evaluation e.g. Balanced Scorecard (Kaplan & Norton, 1992) adopted by Borja de Mozota (2006) and the Business Model canvas (Osterwalder & Pigneur, 2010)

2.3.3 Initial impact model

Figure 2.9 shows the core elements from the initial *reference* model within an initial *impact* model (Blessing and Chakrabarti, 2009). The literature review provides strong evidence of a lack of a theoretical foundation for exploring design impact. This shortfall in design theory can also be judged to extend beyond the design impact topic area. Therefore the proposition of a new framework for understanding design impact could have wider relevance, and is shown as a separate element. Links, or potential influences emanate from this element to *effectiveness of design research*, *effectiveness of design process* and *effectiveness of models and metrics.* In each case the aim is to address the lack of an effective underpinning theory or framework.

Methods and communication to understand and communicate design impact are shown as a second linked element, indicating a potential contribution to the *effectiveness of design process* and the *effectiveness of models and metrics.* A two way connection is shown between the hypothesised new UDI framework and new methods and communications. This is predicated on a co-evolution of a UDI framework with associated methods and communications.

Links are not shown to *Differentiating design practice* or *Amount of impact.* However, the literature review demonstrates these connections, and the schematic is intended to infer that a new UDI framework, methods and communications would potentially have an indirect impact on design practice, and ultimately on the resulting impact of professional design practice, for example as suggested by the concept of a virtuous feedback loop (Chiva & Alegra, 2009; Candi & Gemser, 2010)

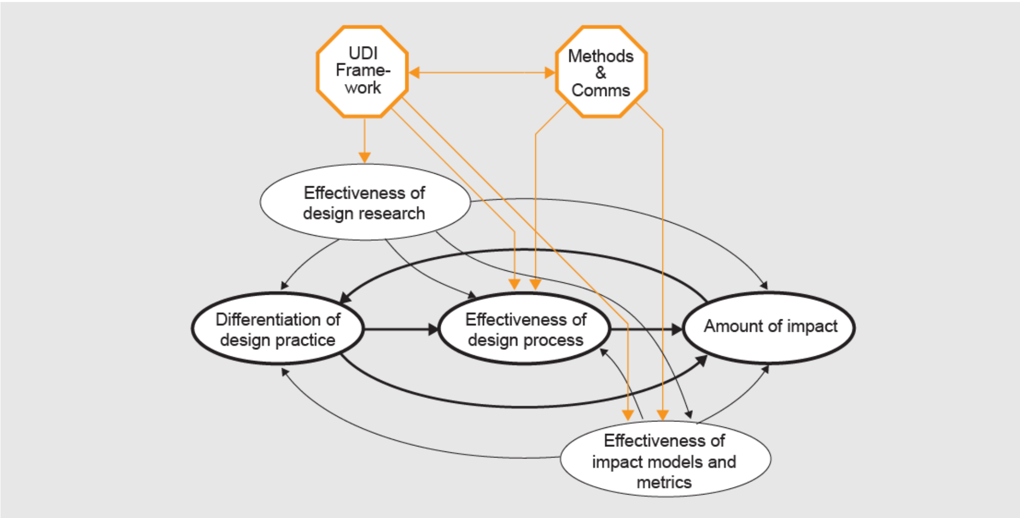

Figure 2.9 *Initial impact model*

The *Reference model* and *Initial impact model* have been used to synthesise and highlight gaps in existing design and related research. A further element of literature review synthesis is considered helpful here for clarifying and framing consideration of design impact. This is an overview of the range of scales for considering design impact (Figure 2.10). For example the € Design: Measuring Design Value initiative (Nomen et al., 2012) is clearly geared to a policy level audience within a pan-European economic context. The intended unit of analysis is firm level design impact. This is then extrapolated to a national or international level. In the DBA Effectiveness Awards (Dawton, 2011) the unit of analysis is the design project . This is then extrapolated to firm level and sector level, with business and design profession target audiences in mind. The focus of this study is on 'elevating' the role of design at a professional practitioner level. Therefore the unit of analysis is design activity at a project, business function or firm level. This analysis may then be extrapolated to other levels right up to national or international level.

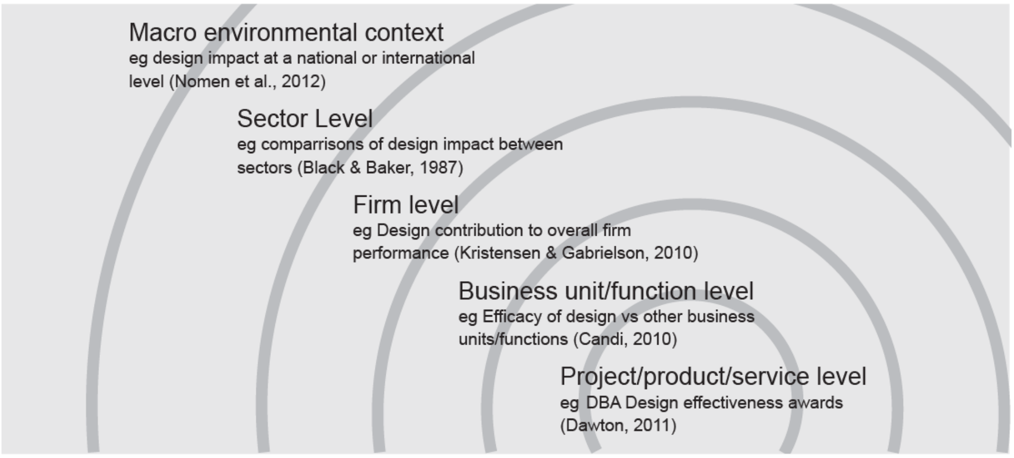

Figure 2.10 *Nested levels and units of analysis with associated Design Impact literature references*

2.3.4 Prototype framework for UDI

The prototype framework for UDI (*Figure 2.11*) is a consolidation of the key findings from the literature review demonstrating:

- A schematic representation of an *Input-Process-Output* sequence leading to *Impact* at the core of the framework. This highlights the significance of *Impact* to this study and the context for design.
- A rationalisation of the concentric levels of evaluation shown in *Figure 2.10* into three main areas: the *designing space* at the heart of the framework;

the broader *activity space or* operational context in which design activity takes place; and the wider macro environmental *domain* which encompasses all the factors which may influence impact.

– The key factors identified in Candi & Gemser's (2010) literature review: *Moderating factors, Design Emphasis, Design Management, Design Activity* and *Feedback.*
– A cross-cutting plane, indicating that design impact understanding and analysis needs to be considered across all the elements encompassed within the framework.

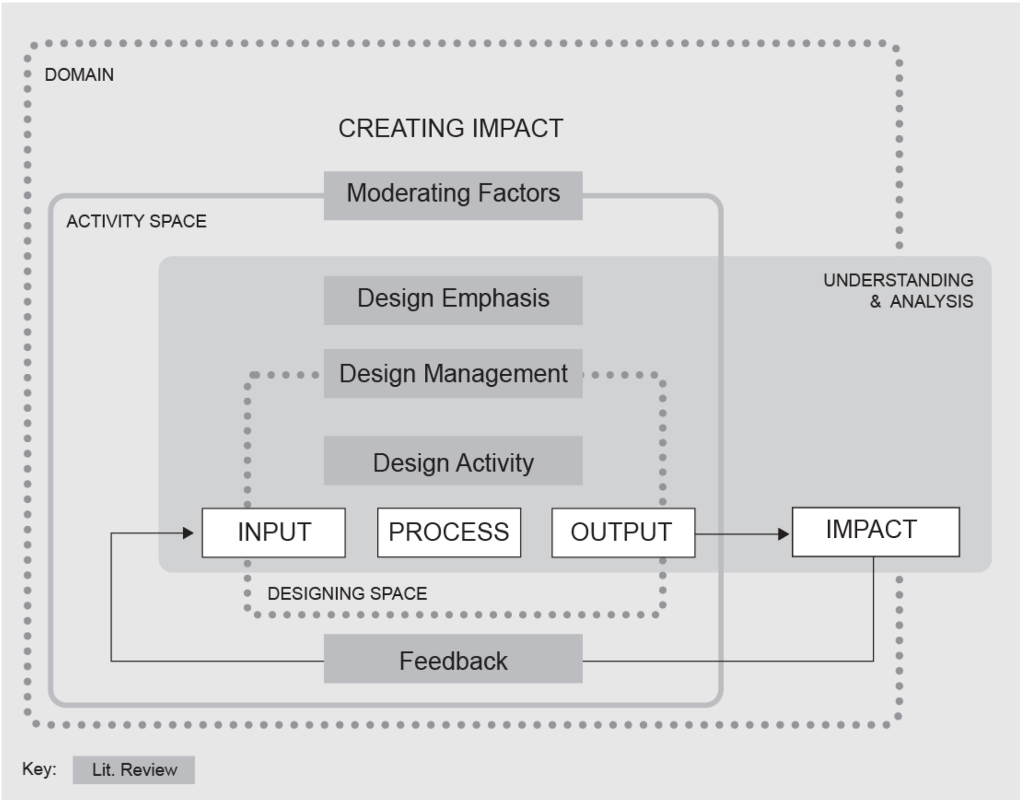

Figure 2.11 *Prototype framework for UDI (Version 1)*

Chapter Three

Research Methodology

Chapter content Page

3.1 Introduction

With origins only dating back to 1962, 'design' is a relatively new field for research (Bayazit,2004). Generally design research adopts research strategies and methods from other fields to enhance research quality, whilst needing to differentiate '*designerly way of knowing' (Cross, 2001)* through a distinctive selection of strategy and methods. Design research is frequently cited as highly complex (e.g. Alexiou et al., 2010) and intimately connected with its context (Laurel, 2003). A recurring theme in design research literature and methodological considerations is the need for increased understanding of the relationships between design, design practice, design research and scientific research.

Design is a broad and complex subject with many definitions, processes, stakeholders and subjects for design – from physical to virtual, and with a whole spectrum of scales from nano-engineering design to the very largest man-made structures and systems. Micro- and macro-contextual factors add an additional level of complexity to any research context. Blessing & Chakrabarti(2009)claim that this complexity has given rise to the need for greater consideration of the role of design research and methods. They reference Wallace and Blessing's (2000) design research phases (Experiential, Intellectual and Experimental) and cite 17 'notable attempts' at building theoretical frameworks for design research. But the authors conclude that 'a theoretical framework for design is still missing' (p3), and: 'To investigate the phenomenon of design, a much wider variety of research methods (than engineering – natural science- research methods), both qualitative and quantitative, from various disciplines has to be used to investigate the facts and aspects involved' (p32). Relevant to design research, Fox et al.(2007) and Robson (2002) from the field of social sciences refer to approaches which deal with research in the real world rather than a research laboratory. Derived from their work, *Figure 3.1* gives an overview of the main elements which need to be considered when planning or designing a research programme.

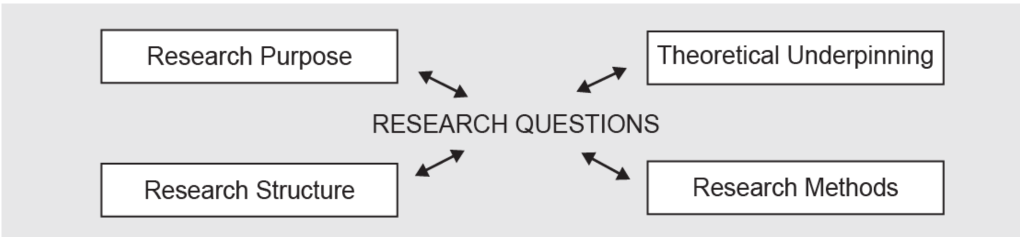

Figure 3.1 *Framework for Research Design (derived from Robson, 2002 & Fox et al, 2007)*

The structure of this chapter moves from a general introduction, including an overview of research concepts and methodologies (theoretical underpinning), through to the selection and application of a methodology, defining a research structure and selection of appropriate methods.

3.1.1 Design Research Models

The study is positioned as *Design Research*, and this provides a basis for exploring research concepts or theoretical underpinning through the lens of Design Research.

Frayling's seminal 1993 paper establishes his INTO-THROUGH-FOR taxonomy for design research, derived from a critical overview of the art, design and research context. He introduces the subject by describing a background of widespread confusion and ignorance about the characteristics of *research* in relation to art and design practice. As part of his conclusion Frayling states that the Royal College of Art (where Frayling taught at the time) would only grant PhDs for work which encompassed research INTO *and* THROUGH art and design rather than research solely FOR art and design.

Sanders (2006), reviewing the landscape for design research, notes that 'researchers and designers are getting into each other's domains and misinterpreting or misapplying the other's methods and tools for design research' (p4). She provides a map for navigating this 'landscape'.

Outlining the background rationale for their model of 'integrated' design research, Eckert et al. (2003) state: 'The methodological challenge of design research lies in finding ways to integrate a large number of small-scale research problems and activities to make cumulative progress' (p2). A 'spiral' model is proposed to accommodate factors including multi-disciplinarity, scales of activity and the need for scientific rigour in design research.

3.1.2 Research Terminology

In their review of *Doing Design Research*, Crouch & Pearce (2012) identify a number of key concepts which form a terminological foundation for considering the nature of, and planning of, *design* research. Therefore these concepts, derived from the more general field of natural and social science, summarise important foundations for understanding *design* research and provide a theoretical context for this study.

Crouch & Pearce strongly advocate the value of using the concept of *Praxis* as a framing element for design research, together with the need for designers to base their research work on social science research paradigms and a focus on the connection between theory and practice. They also favour the concept of *abductive* thinking over *inductive* or *deductive* approaches. This is in line with Cross's (2006) call for recognition of designerly approaches to research. Crouch & Pearce explore the *design* versus *science* divergence in tackling a phenomenon in terms of *Research Problem-Solution* versus *Research Question* approaches. They contend that a research question is designed to elicit enquiry and information, but designers don't necessarily use the concept of research questions in their work. However, citing Lawson (2004) and Cross (2006), they point out the common ground between design and science and the desirability of keeping problem and solution in co-evolution.

3.1.3 Research Purpose

Frayling's INTO-THROUGH-FOR categorisation provides one overview of the purposes of design research. In the social sciences, Neuman (2007) offers three alternate categories of research purpose (ref *Table 3.1*) and suggests that a study could have multiple purposes, but will tend to have a single dominant purpose. Cross (2006) is concerned that [design] researchers 'adhere to underlying paradigms of which they are only vaguely aware. We need to develop this intellectual awareness within our community' (p102). In the design field, research has historically had the overall objective of enhancing the processes of design (e.g. Bayazit, 2004, Clarkson et al., 2005).

Table 3.1 *Categories of Research Purpose, (Neuman, 2007, p15)*

Exploratory	Descriptive	Explanatory
Become familiar with the basic facts, setting and concerns	Provide a detailed, highly accurate picture	Test a theory's predictions or principle
Create a general mental picture of condition	Locate new data that contradict the past	Elaborate and enrich a theory's explanation
Formulate and focus questions for future research	Create a set of categories or classify types	Extend a theory to new issues or topic
Generate new ideas, conjectures or hypotheses	Clarify a sequence of steps or stages	Support or refute an explanation or prediction
Determine the feasibility of conducting research	Document a causal process or mechanism	Link issues or topics with a general principle
Develop techniques for measuring and locating future data	Report on the background or context of a situation	Determine which of several explanations is best

Blessing & Chakrabarti (2009), suggest that design research encompasses both *understanding* and *support* (*Figure 3.2*) stating that 'the term *support* is used to cover the possible means, aids and measures that can be used to improve design' (p4).

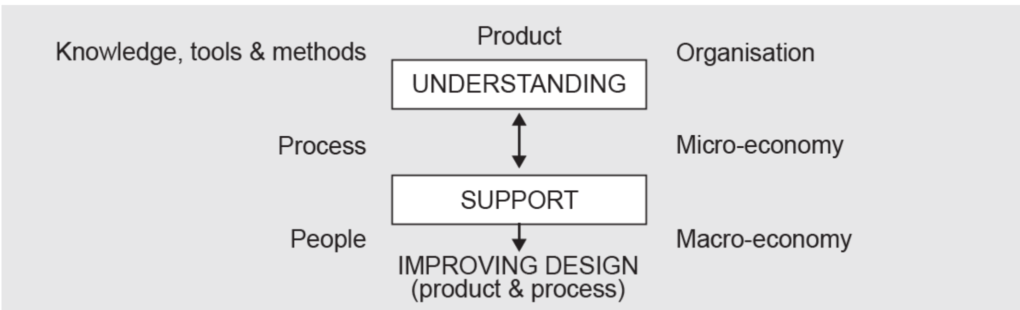

Figure 3.2 *Blessing & Chakrabarti's (2009) model of Design research aim, objectives and facets of design*

In summary, the positioning of this research study as *Design Research*, or Research INTO Design recognises the distinctive nature of a design approach in relation to established research paradigms, and is ultimately concerned with a designed outcome or *'support'* which will contribute to improving the practice of design.

3.2 Methodology

Considering the landscape of research, we can see that design research, and therefore the resulting methodologies, research structure and methods, might be derived from the precedents established by various perspectives. Therefore, in order to consider the methodology for the study, a spectrum of methodology options have been considered. These include a generic research methodology from the social sciences, through to the well recognised double diamond design process methodology (Design Council, 2007a), which could be adapted to a design research application.

Typically social science research explores the relationships between theory and phenomena using quantitative, qualitative or mixed method paradigms. These approaches can be applied to generic processes for conducting research as shown in *Table 3.2*. The significant difference between *Quantitative-Deductive* approaches and *Qualitative-Inductive* approaches is that the former starts with theory and proceeds to test phenomena in relation to existing theory, whilst the latter approach explores a phenomenon as a basis for building new theory. Mixed methods research (Creswell, 2002) supplements the quantitative – qualitative research dichotomy. This raises additional questions about how research methods from quantitative and qualitative paradigms might be deployed within an overall research exercise, for example sequentially or concurrently.

Table 3.2 *Overviews of research process derived from Bryman & Teevan (2005) & Robson (2002)*

General process of research (Robson, 2002)	Quantitative (Deductive) process (Bryman & Teevan, 2005)	Qualitative (Inductive) process (Bryman & Teevan, 2005)
1 Deciding on a focus	1 Theory(as a foundation)	
2 Developing research questions	2 Hypothesis	1 General research questions
3 Choosing a research design	3 Research Design	
4 Selecting the research methods	4 Operationalisation	
5 Arranging the practicalities	5 Select research sites	2 Select relevant sites and subjects
	6 Select research subjects	
6 Collecting data	7 Collect data	3 Collection of data

7 Preparing for analysis	8 Process data	
	9 Analyse data	4 Interpretation of data
	10 Findings/conclusions (could include revisions to original theory)	5 Conceptual and theoretical framework(as an outcome)
8 Reporting findings	11 Write up findings	6 Write up findings/conclusion

Cross, a leading advocate for design research, says: 'The underlying axiom of this discipline (design) is that there are forms of knowledge special to the awareness and ability of a designer, independent of the different professional domains of design practice' (2001, p54). He champions a distinct approach to research which acknowledges 'designerly ways of knowing': 'we must avoid swamping our design research with different cultures imported either from the sciences or the arts.' (p55). As noted by Frayling (1993) design research can be considered as a *process* for research (research THROUGH design).

The introductory sections to Blessing & Chakrabarti's book (2009) on their *Design Research Methodology* (DRM) proposition extensively explores the history of design research, the lack of scientific rigour in much design research and their rationale for a prescribed design research methodology. This historical context for an early version of DRM is confirmed by Eckert et al. (2003, p8): 'DRM is a response to too much research that is undertaken without a clear goal and methods and tools that are produced as solutions to problems that do not exist'.

In the wider research context, the notion of developing 'support' (Blessing & Chakrabarti's concept for the enhancement of design practice aim of much design research) has parallels with *Action Research*; 'designed to bridge the gap between research and practice' (Collins, 2010, p56) and *Practitioner Research* (research undertaken from a professional rather than academic perspective (Fox et al., 2007)

3.2.1 Methodology Selection

Neuman (2007) reports that some social scientists see multiple paradigms as hindrances to the 'growth of knowledge' (p42). Others accept multiple paradigms. Whilst the paradigms of quantitative, qualitative and mixed methods are well established in the research community, design research has a shorter history. However, there are clear arguments put forward, notably by Frayling (1993) and Cross (2006), for differentiating a design research paradigm. However, as noted by Blessing & Chakrabarti (2009), there has been limited success in consolidating a coherent, generally recognised and accepted design research paradigm. It might be argued that designerly approaches with abductive and creative thinking are inherently resistant to classification and conformity (Crouch and Pearce, 2012).

This overall study is firmly positioned both as research INTO design (Frayling, 1993), *and* research which exhibits designerly characteristics (Cross, 2006). Therefore it also has elements of research THROUGH design, and it can be considered to be positioned towards the design end of Sander's (2006) *Design Research Landscape*, as well as falling within Fallman's (2008) *Design Research Triangle.* Eckert et al's (2003) *Design Research Spiral* models how all design research should have interconnections between information and theory. This links well with Crouch and Pearce's (2012) strong advocacy for a Praxis focus within design research, together with Cross's (2006) fifth test for good design research, that it should be communicable.

Translating this overall *design research* positioning into decisions about methodology selection, Blessing & Chakrabarti'sDRM (2009) provides the most detailed, yet flexible framework for conducting design research available. It explicitly aims to address the numerous criticisms of much existing design research (e.g. Love, 2000 & 2002, Cross, 2006). Blessing & Chakrabarti's (2009) preface states a 'frustration about the lack of a common terminology, benchmarked research methods, and above all, a common research methodology in design'. DRM is introduced as 'a generic design research methodology that links the research questions together and provides support to address these in a systematic way' with an overall aim to 'help achieve more rigour in design research' (p9). Furthermore, 'DRM and its methods are intended to support a more rigorous research approach by helping to plan and implement design research' (p12). Blessing & Chakrabarti identify that the aim of much design research has been the improvement of practice (support), yet most of this work remains at conceptual level rather than being adopted and actually improving practice. (They cite Cantamessa's (2001) review of 331 conference papers in which only 37% had results applied in industry). Reich (1994 and 1995) is cited to support the claim that 'the objective of support, i.e. improvement rather than explanation and prediction, is largely absent, ignored, or given little emphasis in existing research methodologies' (Blessing & Chakrabarti, 2009, p10).

DRM has been widely adopted in design research, including Cifter (2011), who cites Ahmed (2000), Dong (2004), Cardoso (2005) and Gupta (2007) as other adoptees of

DRN. Therefore as a result of consideration of the spectrum of research paradigms and the design research positioning of this overall study, DRM is selected as a methodological basis for the following summary reasons:

- DRM is based on recognition of the distinctive nature of design research
- DRM aims to contribute to improving the overall quality and validity of design research
- DRM recognises the significance of research with overall aims of improving professional practice
- DRM provides a robust framework for research supported with specific recommendations for research techniques to be used
- There is a growing body of design research which has adopted the DRM

3.2.2 Research Structure

The selected DRM approach provides a detailed basis for structuring the research study. This includes a number of distinctive elements including at the early stages the creation of the initial *reference* and *impact* models. Main studies are categorised as *Descriptive* studies or *Prescriptive* studies whereby the Descriptive studies most closely mirror conventional empirical research approaches, and Prescriptive studies are where the abductive, creative and designerly aspects occur. *Table 3.3* gives an overview of a generic sequence of activity using the DRM.

Table 3.3 *Design Research Methodology (DRM) phases & outcomes (Blessing & Chakrabarti, 2009)*

Basic research means	Stages	Main outcomes/deliverables
Literature review	RESEARCH CLARIFICATION	Research definition/goals: Initial reference model Initial Impact model Primary criteria Overall research plan
Empirical data analysis	DESCRIPTIVE STUDY 1	Detailed Understanding: Reference model Success criteria Measurable success criteria
Assumption, Experience, Synthesis (e.g. developing 'support')	PRESCRIPTIVE STUDY	Developed support: Impact model Support design & development Support evaluation Outline evaluation plan
Empirical data analysis (e.g. testing the 'support')	DESCRIPTIVE STUDY 2	Evaluation: Evaluation plan

Basic research means	Stages	Main outcomes/deliverables
		Application evaluation Success evaluation Implications

Flexibility

Although presented as a sequence of four stages the DRM authors recommend that, as in design process, it is unhelpful to consider DRM as a linear process. Greater efficiency may well be achieved by conducting stages in parallel. Likewise they point out that research studies and subjects vary in scale, complexity, intended outcomes, the need for major iterative loops, etc. This is illustrated with seven example research 'types'. The overall DRM structure for this study (*Figure 3.3*) conforms to Blessing & Chakrabarti's designation of 'type 2' which they recognise as typical of PhD studies. A second block of descriptive study/ies, which might thoroughly research the impact of any support developed during the prescriptive phase, is not included due to the practical limitations of time, resources and the scope of a PhD study.

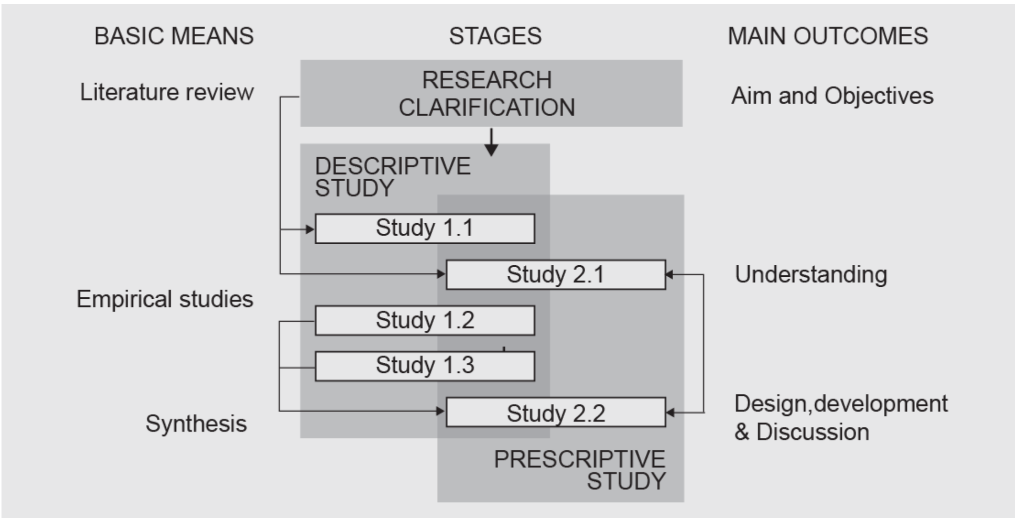

Figure 3.3 *Schematic view of DRM applied to the overall UDI study*

Figure 3.3 Shows the general sequence of the Research Clarification, Descriptive Study and Prescriptive Study phases. The Descriptive and Prescriptive work is further divided into a number of individual research studies. The arrowed links shown indicate the iterative and concurrent nature of the work.

The DRM concept of defining existing and desired situations in a *reference* and *impact* model, respectively, has been adopted in the literature review chapter. The DRM concept includes specific detail on how these models are developed. It is argued that much design research focuses on links between pairs of factors, but does not consider a wider network of factors and how these combine to influence success. Schematic representations of the *Reference* and *Impact* models include identifying themes or factors relevant to the situation, whereby each factor should consist of an element and an attribute to qualify the element as shown in *Figure 3.4.* Furthermore these factors can be considered nodes in a network of factors, with plusses and minuses added to the ends of the links between nodes to indicate the influences between factors. Potential 'support' concepts can be shown on the Impact model as a hexagon to differentiate it from a factor (oval in their example). At the Research Clarification stage the Impact model links may mainly consist of assumptions.

The DRM authors claim there are minimal examples in existing research of representations of networks of influencing factors. However, such models are proven amongst their PhD students for enhancing the identification of factors, clarifying thoughts, structuring understanding, revealing assumptions and more.

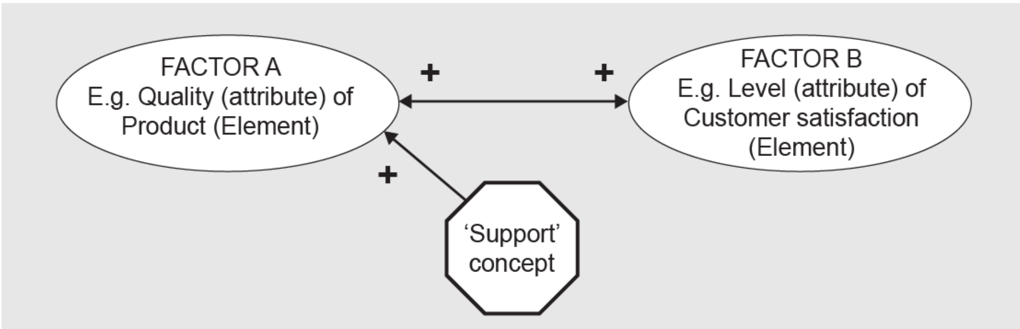

Figure 3.4 *DRM: Modelling reference and impact factors, (Blessing & Chakrabarti, 2009)*

3.3 Methods

From a general review of relevant literature across the science-design research landscape, it can be seen that certain methods are linked to research paradigms. For example, at the scientific research end of this landscape, quantitative methods are generally categorised within *Deductive*, *Positivist* paradigms. On the other hand, design research typically adopts a wide range of social science methods such as *Mixed Method*, flexible, *Inductive* and *Interpretivist* paradigms. More recently, distinct design research methods are being defined, such as design games, design probes, design documentaries, visualization and storytelling, playful triggers, designing with video, mobile diaries, situated make tools (Sanders, 2008). Therefore, particularly in a design research based study where the general paradigm involves a plurality of methods, consideration needs to be given to the selection of appropriate methods as well as the sequence of research activity.

A selection of published design based PhD theses (from the host institution and beyond) were also explored in order to draw general conclusions about the selection of appropriate methods. *Table 3.4* summarises the significant categories of research methods considered, together with the factors determining their potential selection in the research structure. Selected research methods are explored in further detail in section 3.3.2. The detailed selection and application of methods together with discussion about related data is discussed further within the reporting of each study. Refer to *Table 3.5* for a summary of the mapping of research methods to the selected methodology and research structure.

Table 3.4 *Summary of candidate research methods*

Primary Research Method	Selection factors
Quantitative methods	A broad category of methods associated with deductive approaches (and vice versa). But also relevant to mixed methods approaches. Operationalisation and then measurement of research factors is a key step in quantitative approaches. Quantitative data combined with good sample sizes can produce strong verification. Some quantitative methods will be applicable to aspects of the studies and the more specific methods listed below. However, as previously explored, aspects of design are notoriously difficult to quantify, therefore quantitative methods will only provide a partial picture of specific design phenomena, with limited validity (for this work).
Qualitative methods	A contrasting broad category of methods associated with inductive approaches. Systemising the process of moving from data collection through to analysis and findings to ensure reliability and validity of the findings. More direct methods for gathering data (for instance where quantitative data cannot easily be derived from the phenomena). Qualitative methods are strongly associated with social science and therefore design research methods. But qualitative data, and the processes for analysis, are more open to criticisms of subjectivity or other threats to validity. Scenarios researched through qualitative methods are often difficult to replicate e.g. weak reliability.
Surveys	Surveys can be relatively efficient to implement and reach a large number of participants. They can also generate data relatively simply as a basis for quantitative analysis. However recruiting suitable participants can be challenging (self selection bias), and the level of detail achievable in the data in relation to the research questions can be limited. In the adopted DRM methodology, use of surveys as part of research clarification and/or initial evaluation in the Prescriptive study were considered, but discounted for the above reasons.
Ethnographic methods (real time data)	Studying people in context to generate qualitative data is highly relevant to many design research methods, particularly in research FOR design and professional practice. The ultimate context for the UDI study is professional design practice, however considering resource (time) and ethical factors together with the research INTO design focus of the research leads to ethnographic methods being discounted
Content analysis (retrospective	Wherever significant data sets (longitudinal, quantity etc), in whatever form, are available, these can provide a valuable basis for both quantitative and

Primary Research Method	Selection factors
data)	qualitative analysis. Relevance to research questions/sub questions and quality of available data need to be considered along with research resource issues (sample size, data collection, coding, analysis). Content analysis methods are used in all three Descriptive studies.
Modelling	Process modelling and visual communication of models is crucial to this study, both as an aid to the synthesis and communication of research data, but also in the design of 'support'. There will be significant *External Validity* threats as evidenced by the existing research into design process models. These can be mitigated to an extent through the selection of methods and triangulation of findings. However, modelling can take many forms, and there is no clear alternative to modelling as a basis for synthesis and communication in this field. Modelling is adopted in some form in all the studies.
Semi-structured and unstructured interviews	Selection of participants relevant to the focused research issues is crucial, together with consideration of resource issues (availability of participants, time constraints, coding, analysis). Semi-structured interviews are used in STUDY 1.3.
Focus groups	Focus groups will generate similar data to interviews. Groups can considerably enhance the outcomes through brainstorming or 'piggy-backing' cross-fertilisation of comments and ideas. Gathering a number of participants together can be resource efficient and can facilitate additional dynamics through the interaction between selected participants. Managing the group dynamic can be a challenge, and there can be difficulties in achieving sufficient depth of understanding or abstract conceptualisation of factors within a potentially more complex social scenario. Focus groups are selected as an appropriate methodology for Prescriptive STUDY 2.2.
Action research	Characteristic of research THROUGH design and the DRM Prescriptive study stage. Elements of action research are fundamental to a practitioner research – design research approach. Reflexivity is a significant factor to consider in relation to the specific implementation of design methods, for example by adopting more participatory approaches Action research or design methods are used as part of mixed methods in Prescriptive STUDY 2.1 and 2.2.
Case studies	The case study method can potentially be used at various points within the adopted DRM process. Case studies are well established as a research method for generating qualitative data both within design research and more specifically in the field of evaluation. Selection of cases for study is significant and reflexivity factors need to be considered. Resource factors (time, availability of cases) also impact on the use of case studies in a mixed methods approach. Pre-existing case studies are used as a basis for content analysis in STUDY 1.2.
Pilot studies	In design terms these would be defined as prototypes and as such are an integral part of an iterative design research process. In DRM they are considered an essential part of Descriptive stage 1 (common to all DRM process) and also part of the Prescriptive stage. The DRM authors urge guarding against extending the scope of Pilot studies beyond the focused evaluation requirements. Likewise the design of Pilot studies needs to be managed within the study resources. Pilot studies are part of Descriptive STUDY 1.1 and Prescriptive study 2.2.

3.3.1 Design Research Quality

In the detailed rationale for their proposed Design Research Methodology (see 3.2.2 below), Blessing & Chakrabartistate that they 'have found very few publications that provide evidence of a link between stated goals and the actual focus of the research project' and that 'as a consequence little evidence exists that the goal has indeed been achieved' (2009, p29-30). As recently as 2011, Noble points out that 'despite the growing admonitions by practitioners and management thinkers to consider design as a powerful source of competitive advantage, the academic literature on design has largely avoided a strategic focus' (2011, p389).

In social sciences research *Reliability* and *Validity* are the most frequently cited terms for identifying quality. Bryman & Teevan (2005) also point out the philosophical differences in paradigms in relation to quality criteria and note that some qualitative researchers reject the *Reliability* and *Validity* terms, but that *External Validity* is relevant to both paradigms. They cite Lincoln & Guba's (1985) alternative *Trustworthiness* criteria for qualitative approaches.

For each of the three main quality criteria, *Reliability, Validity* and *Trustworthiness*, examples are explored below indicating how consideration of the criteria and sub-criteria may impact on the research structure and method selection. The term 'threats' is used to express issues with meeting criteria, for example 'threats to reliability'.

Reliability

Reliability in the research context means consistency or repeatability. For example, will the research or methods applied to a phenomenon generate the same results under the same conditions when repeated? *Reliability* is judged to be a less stringent test than validity, given that absolute validity is impossible (Neuman, 2007). In the case of the research structure and methods for this study, Reliability can be judged through consideration of how effectively the methods can be applied across time and by others. An example of threats to reliability would be the selection of esoteric methods applied to highly individual cases of design impact.

Validity

Validity, as noted, is a more demanding criterion. In general terms it means the truthfulness or correctness of the measurement (note how the concept of measurement is less in tune with qualitative approaches). Within *mixed methods*, the leading proponent, Creswell (2002), offers an eight point list of ways to enhance validity: triangulation (of findings); participant checking (participants review findings); detailed descriptions of findings; clarify potential bias; present negative findings; spend prolonged time in the field; peer de-briefing; external audit (of whole study) (p196).

The validity criteria can be sub-divided into four types (Blessing & Chakrabarti, 2009, citing Cook &Campbell 1979): 1) *Statistical validity* – robustness of the relationships between variables; 2) *Internal validity* – the plausibility of causal relationships; 3) *Construct validity* – the robustness of the construct used to generate findings; 4) *External validity* - Potential for generalisation to other cases or research. Therefore a commentary on this taxonomy and how it relates to the overall study's research structure and method(s) can be considered as follows:

– *Statistical validity*: Where design impact data is numerical, e.g. in Return on Investment (RoI), is the relationship between variables robust, e.g. between 'design investment' and the 'return' figure? In this example the statistical validity for design investment as a variable is likely to be weak because of difficulties in consistently defining and capturing design investment data.
– *Internal validity*: Causal relationships are fundamental to this research and also exhibit considerable scope for criticism of quality. For example designers have a generally poor reputation for over-claiming the impact of their input. It is vital to consider reflexivity issues in relation to internal validity.
– *Construct validity*: In this overall study there is no obvious and robust pre-existing construct to use as a basis for exploring design impact, only a multitude of constructs appropriated from related fields. For example the Return on Design Investment (RoDI) metric has many potential weaknesses in terms of statistical and internal validity. It is more likely that construct validity needs to be developed through development of new approaches.
– *External validity*: The applicability of the research outcomes to professional practice are another fundamental concern. Therefore strong potential external validity needs to be designed in at the outset. For example a design impact construct is likely to have stronger external validity if practicing designers have been involved in a participatory development process.

Trustworthiness

Trustworthiness(Lincoln &Guba, 1995) is an alternative to Reliability and Validity, particularly for qualitative research. It can also be further divided into sub-categories: 1) *Credibility* - how believable are the findings – similar to internal validity; 2) *Transferability* - applicability to other contexts – similar to external validity; 3) *Dependability* - are the findings consistent over time – similar to reliability; 4) *Confirmability* - will another researcher reach the same conclusions? – similar to *Replicability*).

The *Reliability – Validity* criteria for research quality would appear to provide the most universally recognisable concepts to be applied to the research design and methods selection process. The general paucity of quality considerations in design research literature does not negate the value of considering the quality perspective at the research design stage.

3.3.2 Research Studies and Methods

Table 3.5 provides an overview of each of the five studies. In each case the main methods used are indentified, along with the quantity of data sources or number of participants, and summary reliability and validity considerations. *Table 3.7* at the end of this chapter shows a matrix of the individual research studies and questions in combination with the four overall research objectives.

Table 3.5 *Research methods and quality considerations within the DRM structure*

Studies	Methods(Data source quantity)	Reliability & Validity considerations
RESEARCH CLARIFICATION	Literature review	
DESCRIPTIVE STUDY STUDY 1.1 Design process and impact in tertiary design education	Focus groups, pilot study of content analysis & modelling (304 student projects& 2 focus groups)	External validity has limited relevance for this study which is at an explorative stage. There are threats to the statistical validity in the content analysis. However this is also mitigated by the preliminary nature of this study.
PRESCRIPTIVE STUDY STUDY 2.1 Rationalising theoretical frameworks	Literature review and action research (ontology development process) (approx 150 sources)	Construct validity is key. Review and iteration of the construct through subsequent stages and triangulation will help to mitigate threats.
DESCRIPTIVE STUDY STUDY 1.2 Reviews of design impact from professional practice	Content analysis /case studies (45 case studies – DBA dataset)	Good levels of external validity are achieved through the 'external' data source. Analysis creates potential threats to validity. This is mitigated by triangulation with the other studies.
STUDY 1.3 Professional perspectives	Semi-structured interviews	This study is crucial for triangulating with the findings from STUDY 1.1, 1.2 and 2.1 and providing good validity as a foundation

Studies	Methods(Data source quantity)	Reliability & Validity considerations
on understanding and communicating design impact (UDI)	(10 professional and academic perspectives)	to STUDY 2.2.
PRESCRIPTIVE STUDY STUDY 2.2 Developing and evaluating an ontology and framework for UDI	Action research (design studies) pilot studies and focus groups (2 focus groups, 11 participants in total)	Reliability (repeatability & consistency) is inherent to the objectives of this study. Validity is determined through the quality of the earlier studies and the range/selection of participants for pilot studies. As an 'initial' study (ref DRM type 2) high levels of validity cannot be guaranteed.

3.3.3 Selected methods

The Chapters dealing with each study include more detailed exploration of the selection and application of methods, data sources and participants. Considerations for each of the main selected methods are summarised as follows:

Content analysis

Leading authority on content analysis, Krippendorff (2010), summarises the research method as 'a research technique for making replicable and valid inferences from texts (or other meaningful matter) to the context of their use' (p234). A key point is the stress on the relationship between content and context (Robson, 2002). Robson suggests a checklist of criteria in relation to the relevance of content for analysis summarised here as the need for thorough consideration of the validity of the content. Content analysis is typically associated with social science research and particularly for analysis of interview transcriptions (Robson, 2002). Content analysis is a process that involves reliable, repeatable and unbiased coding of the underlying data source as a basis for analysis.

The method is used for STUDY 1.1, analysis of a dataset of output from tertiary design education, STUDY 1.2, analysis of case studies of professional design practice and STUDY 1.3, analysis of interview transcripts. The well documented recognition of content analysis, adoption within research, and related coding research techniques since 1945 (Krippendorff, 2010) provides a robust basis for the selection.

Modelling

Jordaan & Lategan (2010), as discussed earlier in the chapter, propose that modelling can be considered a methodology. Considered as a method, it is highly relevant to design research as it can offer '...indispensable cognitive roles in science, providing a basis for scientific reasoning...' (Haig, 2010, p828). From a praxis perspective it can be seen that a considerable body of design process research has historically been based around the creation of models (e.g. Pugh, 1991). Modelling as a method is selected as an important element of the prescriptive STUDY 2.1 and STUDY 2.2. This approach to theoretical modelling, with a potential practice application, is further expanded in these studies through the adoption of ontology development processes, referencing the work of Noy & McGuinness (2001), Gruninger & Fox (1995) and Gruber (1995). Therefore modelling is appropriated as a development method and as a basis for praxis – activity spanning theory to professional design practice.

Case studies

Case studies of design impact are the basis for content analysis in STUDY 1.2. The case studies are pre-existing records demonstrating exemplary design impact. With origins in medical and legal fields, *case study* can be a broad portmanteau term which can be used without rigour and consideration of the significant issues around generalisation from individual cases (Robson, 2002). A leading reference for case study methods, Yin (2003), suggests that case studies can be a basis for quantitative and qualitative research, although in social science are mainly considered a qualitative method. Delimiting the factors to be studied and applying rigour to the analysis of case study material is important for achieving appropriate levels of reliability and validity.

Semi-structured interviews and focus groups

Interviewing as a basis for research findings can be traced to the early 1940s. Over the intervening period a considerable body of research into interview protocols and analysis of interview data has evolved (Platt, 2012). As a research method, interviewing is characterised as part of the social sciences field. Interviewing is typically defined by the degree of structure, for example fully structured, semi-structured and unstructured (Robson, 2002). A semi-structured approach is adopted for STUDY 1.3 based on the depth of findings this interview format can generate, combined with a degree of flexibility to help elicit the appropriate depth. To ensure reliability and validity, a process is followed to develop and refine the interview questions and interview protocols. Analysis of resulting interview transcripts follows a content analysis method based on three stages of coding (Richards 2005).

Focus groups are used in STUDY 1.1 and 2.2 as part of an action research approach to develop methods and models for understanding design impact. Relevant to the selection as a method for these studies, Robson (2011) identifies benefits including efficiency of gathering feedback/data from a number of people, 'natural' quality control from the participants, group dynamics, flexibility and efficiency. From the design research field Storvang et al. (2014) are referred to for protocols adopted in the final STUDY 2.2, focus group activities.

Action research

The social sciences concept of action research is important in the field of design research because it is concerned with adding 'promotion of change to the traditional purposes of description, understanding and explanation' (Robson, 2011, p188). Exploring the links with design activity, Swann (2002) cites Lewin (1952) as the originator of the concept of action research. In summary, action research is a problem solving process based on observing a phenomenon with the goal of instituting a positive change. Therefore it has very close parallels with the nature of design activity. Swann's (2002) synthesised action research protocol for design research includes the following elements: 1) data gathering; 2) participation in decision-making; 3) collaboration as a critical community; 4) self reflection; 5) self reflective learning; 6) reflection & communication in a wider context (p59). Design methods are the means to deliver these elements in the prescriptive STUDIES 2.1 and 2.2.

Pilot studies

In various forms of research, pilot study refers to small-scale 'try outs' of research activities in order that the protocol can be tested and iteratively improved (Robson, 2011). An indicative list of benefits of pilot studies is given by Persaud (2010): 'They are suitable for both quantitative and qualitative studies and are helpful for determining suitability of instruments, data collection procedures, and sample population, to name a few' (p1033). STUDY 1.1 and STUDY 2.2 both use the research concept of pilot studies to explore the potential of new methods for understanding design impact.

3.3.4 Ethical considerations

It is a universal principle of research that it should be carried out within the codes of ethical conduct of the organisation or institution and the professional field of practice. In this case the host institution (Brunel University) publishes a code of ethics which requires internal approval for any research involving human subjects (Brunel, 2010). This puts particular emphasis on consideration of the requirements for the research processes involving humans. Ethical considerations for research should be considered broadly and there is recognition that the governance frameworks became more robust in the late twentieth century (Fox et al, 2007). Ethical considerations can be considered from five perspectives: 1) organisational structures (ref Brunel,2010); 2) professional guidelines (e.g. any additional requirements defined by professional bodies for design); 3) conducting research ethically (e.g. considerations throughout the whole process); 4) ethical approvals; and 5) any need to pragmatically balance ethical considerations with contextual practicalities (adapted from Fox et al., 2007).

Creswell (2002) expands on the implications of ethical consideration throughout the research process by highlighting factors at each phase. At the definition stage consideration should be given to the communicability of the research purpose to potential participants. The Brunel code states: 'Research using human participants is only justified if there is a reasonable likelihood that the populations within which the research is carried out stand to benefit from the results of the research'. Therefore ethical considerations and the role of human participants need to be considered at the earliest planning stage (Robson, 2002). Where participants are involved in a research protocol there is the universal research ethics principle of the need for *informed consent*. Neuman (2007) summarises what the participant information should include:

- Research purpose
- Statement of any risks for the participant
- Guarantee of privacy, anonymity and confidentiality
- Access to information about the research
- Confirmation of voluntary nature and option to withdraw
- Statement of benefits
- Offer to receive summary findings

The Brunel code (2010) requires that: 'the researcher should then obtain the participant's freely-given informed consent, normally in writing. If the consent cannot be obtained in writing, the researcher must provide evidence that the potential participant has been appropriately informed'.

At the data analysis stage issues to consider include maintaining the anonymity of participants, data security, data ownership, and arrangements for verifying the data analysis including potential sharing results with participants (Creswell, 2002). During dissemination, ethical considerations include ongoing maintenance of participant anonymity, use of appropriate, unbiased terminology and reporting, consideration of any repercussions from publishing results, and allowing audiences for the research to determine the validity of the results (Creswell, 2002).

The UDI study includes participants, all of whom were provided with appropriate levels of information conforming with the relevant code and confirming their informed consent. The specific data gathering methods do not require completion of a full ethical approvals process, but include the signing off and logging of a 'Research ethics review checklist' (ref Appendix C).

Robson (2002) notes that in a traditional positivist approach, researchers are supposedly 'value free', but this view has been largely discredited. In reality value and moral judgements do play a part in research. Therefore researchers need to be aware of the range of influences that may impact on all stages of the research process, from defining a focus, through to analysis and publication. The Brunel code (2010) also makes the key point that 'the general principle of academic integrity should inform all research activities. Honesty should be central to the relationship between the researcher, the participant and other interested parties'.

Adopting Fox et al.'s (2007) general framework of considerations for conducting ethical research; the proposed UDI studies were reviewed for the necessary compliance with ethical considerations as follows.

a) Organisational structures: the proposed work complies with the Brunel Code of Research Ethics.
b) Professional guidelines: the work includes liaison with the design profession and one or more of the professional bodies for design, and therefore will comply with any guidelines and requirements identified by the professional bodies.

c) Conducting research ethically: in addition to compliance with the organisational and professional guidelines, where they exist, the principles and requirements of research ethics were considered and applied throughout the work (ref *Table 3.6*).

d) Ethical approvals: the Brunel ethical approval process, in this case, requires signing off and logging of a Research Ethics Review Checklist (Appendix C).

e) Any need to pragmatically balance ethical considerations with contextual practicalities?: it is anticipated that there may be occasions where primary research data is gathered in contexts where it is somewhat impractical to formally gather signed participant consent. In these situations, it is particularly important that the general principle of informed consent is met. For example there should be no question that participants are unknowingly providing information or data which is being used for research purposes within this overall study.

Table 3.6 *Research studies, methods and ethics considerations*

Studies	Methods(Data source quantity)	Ethics considerations
RESEARCH CLARIFICATION	Literature review	General principles of referencing and academic integrity apply (Robson, 2002)
DESCRIPTIVE STUDY STUDY 1.1 Design process and impact in tertiary design education	Focus groups, pilot study of content analysis & modelling (304 student projects& 2 focus groups)	Participants need to provide informed consent, based on appropriate briefing information evidenced by formal indications of approval if practical.
PRESCRIPTIVE STUDY STUDY 2.1 Rationalising theoretical frameworks	Literature review& action research (ontology development process) (approx 150 sources)	As above
DESCRIPTIVE STUDY STUDY 1.2 Reviews of design impact from professional practice	Content analysis /case studies (45 case studies – DBA dataset)	The majority of the dataset to be made available with approval by the DBA is in the public realm. Where additional data is made available by the DBA (with approval) and used in the results of the studies, this will be processed and anonymised, such that any DBA or member confidentialities are not breached.
STUDY 1.3 Professional perspectives on understanding and communicating design impact (UDI)	Semi-structured interviews (10 professional and academic perspectives)	Participants in these activities will receive full briefing covering data protection and anonymous reporting and will confirm participation consent in writing (ref participant information in Appendix)
PRESCRIPTIVE STUDY STUDY 2.2 Developing and	Action research (design studies) pilot studies and focus	As above

Studies	Methods(Data source quantity)	Ethics considerations
evaluating an ontology and framework for UDI	groups (2 focus groups, 11 participants in total)	

3.4 Summary

The relatively short history of design research can be traced back to 1962 (Bayazit, 2004). Various experts have commented on its limited theoretical foundations. Frayling (1993) proposes his notable *INTO-THROUGH-FOR* framework to aid clarification of the relationship between theory and practice. Cross (2006) proposes the recognition of distinctive designerly approaches to research. This is also recognised in Swann's (2002) identification of the links between designing and the social sciences concept of *action research*. Blessing & Chakrabarti(2009) propose their Design Research Methodology (DRM) as a way to address quality issues with design research and to operationalise design research. Action research methods and design research are both concerned with developing solutions to phenomena as an integral part of research.

DRM is selected as the overall methodology for this study based on its recognition of a distinctively designerly, solution focused approach, combined with being a robust basis for addressing the quality issues in design research identified by the DRM authors and others.

DRM provides a flexible basis for planning the research, as summarised graphically in *Figure 3.3*. The main elements of this include a *research clarification* component which is reported within the Literature review chapters. There are five individual research studies, which are classified as either *Descriptive* or *Prescriptive,* denoting whether the work within the study is predominately concerned with describing the context for UDI or prescribing potential 'support' for UDI. The research studies employ a combination of five groups of methods: 1) content analysis; 2) modelling; 3) case studies; 4) semi-structured interviews and focus groups; 5) action research; and 6) pilot studies.

Table 3.7 below summarises an overall objective and research questions for each study in a matrix with the overall study objectives.

Table 3.7 *Individual study objectives and research questions*

AIM / QUESTION / OBJECTIVES	OVERALL RESEARCH OBJECTIVES (RO) & STUDY QUESTIONS (RQ)			
OVERALL STUDY Aim: To define a new framework as a basis to effectively explore, understand and communicate design impact Question: Can a new framework for understanding design impact encompass relevant factors and be of practical benefit to the design profession together with contributing to contexts for designing, design theory and the underpinning of design pedagogy?	**Review of current situation** RO A To carry out a thorough investigation of current theory and practice for understanding design impact within relevant research literature to provide a foundation of understanding for subsequent studies.	**Analysis of professional practice** RO B To conduct descriptive studies of design practice to understand relationships between design practice and impact and identify gaps in current understanding	**Developing a new framework** ROC To follow a process to create a framework to represent the factors which lead to design impact which, in turn, can contribute to improved understanding of design impact	**Evaluating the new framework** ROD To evaluate the framework, including its potential as a basis for new working methods for understanding and communicating design impact
STUDY 1.1 (Descriptive) Modelling student design activity (304 student projects & 2 focus groups) Exploration using design process modelling concepts derived from the literature review as a basis for data collection, analysis and communication techniques (in a design education context)	RQ A1.1 What existing models and methods are there for capturing data about design activities? RQ A1.2 To what extent do existing models and methods accommodate a broader context (e.g. the FEI to IMPACT journey)	RQ B1 What issues and challenges are raised through process based data collection, analysis and communication?	RQ C1 How can design process based modelling and data collection concepts be used to capture attributes which lead to design impact?	RQ D1 How can the effectiveness of design process based modelling and data collection concepts for impact evaluation be judged?
STUDY 2.1 (Prescriptive) Rationalising theoretical foundations (approx 150 sources) To combine the literature review and initial study findings into a useful foundation which will serve as a robust basis for exploring impact throughout the FEI to IMPACT journey	RQ A2.1 To what extent do existing design process models accommodate a complete FEI to IMPACT journey? RQ A2.2 To what extent do existing process models make explicit links to FEI or IMPACT factors?	RQ B2 What issues and challenges do existing process models aim to address?	RQ C2 What foundations are needed as a robust basis for a framework to understand design impact?	RQ D2 What criteria do foundations for a UDI framework need to meet and can these be tested?
STUDY 1.2 (Descriptive) Reviews of design impact from professional practice (46 case studies – DBA dataset) To develop a detailed understanding of current best practice for describing and quantifying design impact and for the findings to contribute to a useful holistic model of the FEI to IMPACT journey	RQ A3.1 What impact metrics are used in design and related contexts? RQ A3.2 What types of criteria are applied in the selection of impact metrics? RQ A3.3 Are there clear relationships between impact metrics and processes at the early stages of projects?	RQB3.1 What are the issues and challenges associated with the use of impact metrics in design practice? RQ B3.2 To what extent can impact be attributable to design?	RQC3 Can current professional practice for defining design impact be translated into workable elements for a new framework for UDI?	RQD3 Will the translation of professional practice relating to design impact into new categories and a framework be recognisable and useful (e.g. for the design profession and professional contexts for design)?
STUDY 1.3 (Descriptive) Industry & Academic reviews of the design process and impact context (10 interviews) To develop a detailed understanding of current practice, experience and viewpoints about the role of design and how enhanced understanding and communication of design impact may play a part in enhancing practice, outcomes and impact	RQ A4 What individual experiences do participants have of discussing and communicating design impact?	RQ B4 What issues and challenges do the participants have with differentiating and enhancing the role of design?	RQ C4 Can verbatim professional experiences of design impact related factors be translated into workable elements for a new framework for UDI?	RQ D4 Will the translation of professional experiences relating to design impact into new categories and a framework be recognisable and useful (e.g. for the design profession, professional contexts for designing, the design research community and design pedagogy)?
STUDY 2.2 (Prescriptive) Developing and evaluating a framework for UDI (Ontology development exercise and 1 focus group) To combine the findings from the earlier studies into the development of a design ontology and new UDI framework with associated discussion of the possibilities for professional tools, applications and adoption	RQ A5 How do methods currently used in practice compare to the ideas being developed?	RQ B5 How do the ideas being developed respond to the issues and challenges identified?	RQ C5 What evidence can b e gathered to verify that a framework for UDI can have a positive effect on design impact (for example for the design profession, professional contexts for designing, the design research community and design pedagogy)?	RQ D5 What ideas for methods and communication tools emerge from the combined studies which could have potential for enhancing professional design practice??

Chapter Four

Design Process and Impact in Tertiary Design Education

Chapter content Page

4.1 Introduction

The first descriptive study of the planned series of three (STUDY 1.1, ref *Figure 4.1*) utilises the prototype *Input-Process-Output* framework emerging from the literature review and combines this with developing evaluation techniques to explore variables and outcomes in undergraduate design projects. The need to evaluate aspects of emerging pedagogical practice is considered analogous with the need to understand design impact in professional practice. Furthermore, many of the macro contextual factors impacting the design profession as a whole need to be considered within the evolution of design education (Melles et al. 2011).

The study is positioned as an early exploratory pilot study to develop understanding of the utility of evaluation frameworks and methods for impact analysis. The tertiary design education context provides a basis for data collection, content analysis and peer review.

The study also formed part of a wider project to develop and evaluate initiatives to encourage enterprise within design higher education (Green, 2012) sponsored by

HEEG (Higher Education Entrepreneurship Group). The documentation of the work within this UDI thesis focuses on the elements of the work relevant to STUDY 1.1.

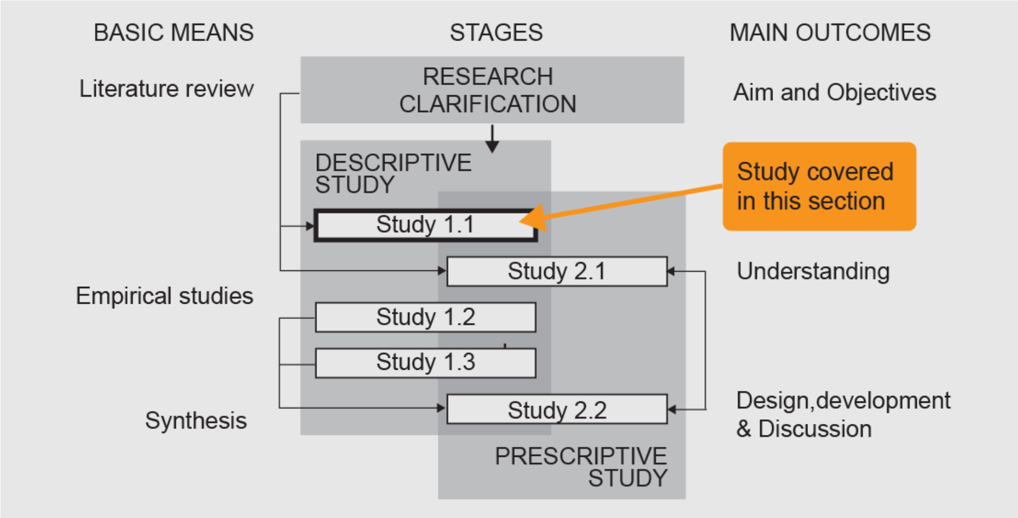

Figure 4.1 *Adopted DRM methodology highlighting STUDY 1.1*

4.2 STUDY 1.1 - Modelling Student Design Activity

This study has two main elements: Part 1) combines findings from the literature review with development and exploration of an evaluation technique which can be applied to undergraduate design projects, in order to enhance the understanding of multiple variables and their impact on outcomes; Part 2) uses the developed method in reviews of the students' design project outcomes.

Part 1, developing the evaluation technique, is explored in the methods section of this chapter, together with the specific pedagogical context for the study. Part 2, the evaluation of student design project outcomes, is summarily reported in the findings section.

4.2.1 Aim, Objectives and Research Questions

STUDY 1.1 Aim

To explore using design process modelling concepts derived from the literature review as a basis for data collection, analysis and communication techniques (in a design education context).

Table 4.1 *STUDY 1.1 Research Questions*

Overall Research Objectives	STUDY 1.1 Research Questions
Review of current situation RO A To carry out a thorough investigation of current theory and practice for understanding design impact within relevant research literature to provide a foundation of understanding for subsequent studies	RQ A1.1 What existing models and methods are there for capturing data about design activities? RQ A1.2 To what extent do existing models and methods accommodate a broader context (e.g. the FEI to IMPACT journey)?
Analysis of professional practice RO B To conduct descriptive studies of design practice to understand relationships between design practice and impact and identify gaps in current understanding	RQ B1 What issues and challenges are raised through process based data collection, analysis and communication?
Developing a new framework RO C To follow a process to create a framework to represent the factors which lead to design impact which, in turn, can contribute to improved understanding of design impact	RQ C1 How can design process based modelling and data collection concepts be used to capture attributes which lead to design impact?
Evaluating the new framework RO D To evaluate the framework, including its potential as a basis for new working methods for understanding and communicating design impact	RQ D1 How can the effectiveness of design process based modelling and data collection concepts for impact evaluation be judged?

4.2.2 Methods: Context and Development

The evolving professional context for design is undergoing a number of transformations (Rothwell, 1992,Jones & VanPatter, 2009,Borja de Mozota & Kim, 2009). This evolution has implications for design education (Melles et al., 2011). This provides a relevant context for the study of design impact. In this case by piloting design impact evaluation methods as a basis for consideration of emerging impact factors in design education. In turn, the findings can be relevant to the broader exploration of frameworks for design impact evaluation in professional contexts.

Design practice, education and entrepreneurship contexts

Networking is a growing theme within Rothwell's (1992) five generations of innovation models. Within design, Dykes et al., (2009) and Rogers & Bremner (2011) propose new frameworks to accommodate the *Discipline, Multidisciplinary, Cross-disciplinary, Interdisciplinary* and *Trans-disciplinary and Alterplinarity contexts for contemporary design practice.*

The Design Council (2010) reported that 51% of UK design businesses collaborate with other disciplines and Tom Kelley (2006) advocates 'T' shaped people or organisations as a practical response to the multi-disciplinary context of many contemporary design activities. However, there are considerable barriers to multidisciplinary practice (Buchanan, 2004; Neumeier, 2009 and Jones & VanPatter, 2009). McArthur, McIntyre and Watson (2007, p1) state: '...the contemporary context requires a shift in approach that encompasses diverse processes running in parallel. A challenge in this scenario is in defining the new skills and tools required by designers'.

There are strong overlapping interests amongst the design community, design higher education, business, and various government departments and agencies, all of which are seeking to develop individual, professional and national economic success and relevance in a rapidly changing global environment. Appendix B, *Table B.19* summarises the UK policy context for design. Developing understanding in enterprise factors is part of the response to this emerging context.

The HEA-ADM (2007), reviewing the creative industries' subject areas, reports from 80 institutional responses that 10% of entrepreneurship and enterprise teaching and learning is embedded within discrete projects or modules, with another 10% present in all activity, with the remainder split within this spectrum (*Table 4.2)*

Table 4.2 *Spectrum of approaches to integrating entrepreneurship in creative industry courses derived from a study of 80 responses from UK institutions (HEA-ADM & NESTA, 2007, pp38 & 95)*

Explicit Entrepreneurship			Not necessarily explicit
a) Free standing entrepreneurship modules	b) Entrepreneurship learning outcomes within certain practice based modules	c) Entrepreneurship qualities developed through engagement with industry and projects, placements etc	d) Pedagogies based on deep learning through project based learning
10%	80%		10%

Linking multi-disciplinarity, enterprise and design process

Enterprise and multi-disciplinarity within design have both been explored through pedagogical research studies with recommendations for enhancement (e.g. the HEA-ADM report, 2007 and the Design Council, 2010). However there is limited evidence of research which explores how these factors map onto core design process activity.

Design process literature includes a number of significant longitudinal reviews (e.g. Rothwell, 1992; Blessing, 1994; Wynn & Clarkson, 2005). A recurring feature of much of this work is the idea of using design process understanding as a basis for process improvement. The Design Council asserts that there is a correlation between business success and presence of a formalised process for design (Design Council, 2007a). The pedagogic aspect of this study is based on the hypothesis that exploring and making explicit the connections between design process, multi-disciplinarity and enterprise can lead to a robust foundation for developing teaching and learning. In turn there are potential benefits of an enhanced understanding of design impact.

Difficulties associated with design process theory as a basis for fully capturing the complexity and added value of design are noted (e.g. Lawson, 2004). Strickfaden et al.'s (2006) study develops the concept of the *Culture Medium,* which encompasses the intangible cultural factors surrounding design practitioners that ultimately influence design outcomes. *Figure 4.2* schematically represents how multi-disciplinarity and enterprise (a complex multi-stakeholder context) are part of the enveloping context for the core design process activity.

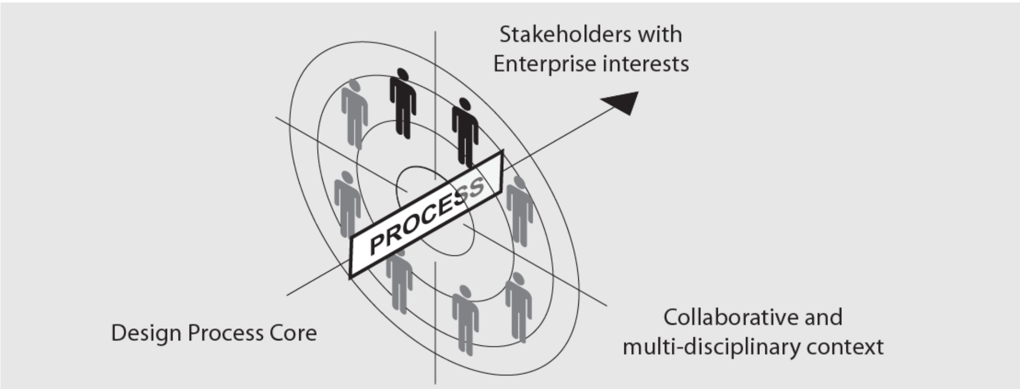

Figure 4.2 *The macro context for design: Linking Design process, Enterprise and Collaboration*

A Design Process based operationalisation

The eco-compass (Fussler and James, 1996), which uses recognised measures of eco-efficiency set out in relation to six poles of a radar chart or spider diagram, has become a widely accepted tool to condense and compare environmental information into a visual map as a basis for analysis of product or design variants. Roy & Riedel (1997) use equivalent polar maps to evaluate success factors in design. The method demonstrates benefits derived from allowing visual comparison of multiple metrics. These principles have been applied to the introduction and development of what is termed here as the *HEET radar chart* (*Figure 4.3*). This variation of a radar chart has evolved as a result of the need for a simplified method of evaluating and visualising relative values for a number of contextual or macro-environmental considerations affecting design projects.

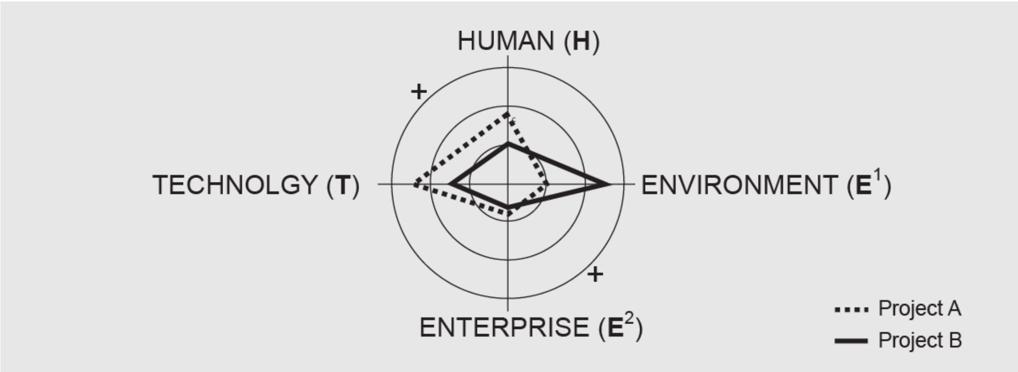

Figure 4.3 *HEET radar chart comparisons*

The developed HEET radar chart includes significant contextual factors derived from PESTEL type analysis. They are re-defined as: HUMAN factors, ENVIRONMENTAL factors, ENTERPRISE factors and TECHNOLOGY factors.

Relative weightings for these contextual factors, so far as they affect any given project, can be plotted onto the radar chart to indicate the 'area' covered by the project. This 360 degree overview of all the factors which may impact or be relevant to a design project has strong parallels with the principle of 'major primary specification elements'. These are 34 categories of factors identified by Pugh (1991) in his influential *Total Design* theory. Pugh depicts these factors (rationalised to four in the HEET model) as a circumscribing envelope for design projects, around a core of sequential design process stages. Pugh's approach advocates that the primary specification elements are analysed as a basis for establishing a Product Design Specification (detailed design brief) as a vital early step in a design process. The identification of a sequential design process is characteristic of a significant number of well-recognised models of design (Dubberly, 2004). As in the *Total Design* model, a visual depiction of design process stages can be combined with the 360 degree overview of contextual factors (*Figure 4.4*). This provides the potential to consider the weightings of contextual factors for a project as whole (for example at the point of outcomes), and at other individual points during the chronology of a design process or NPD scenario.

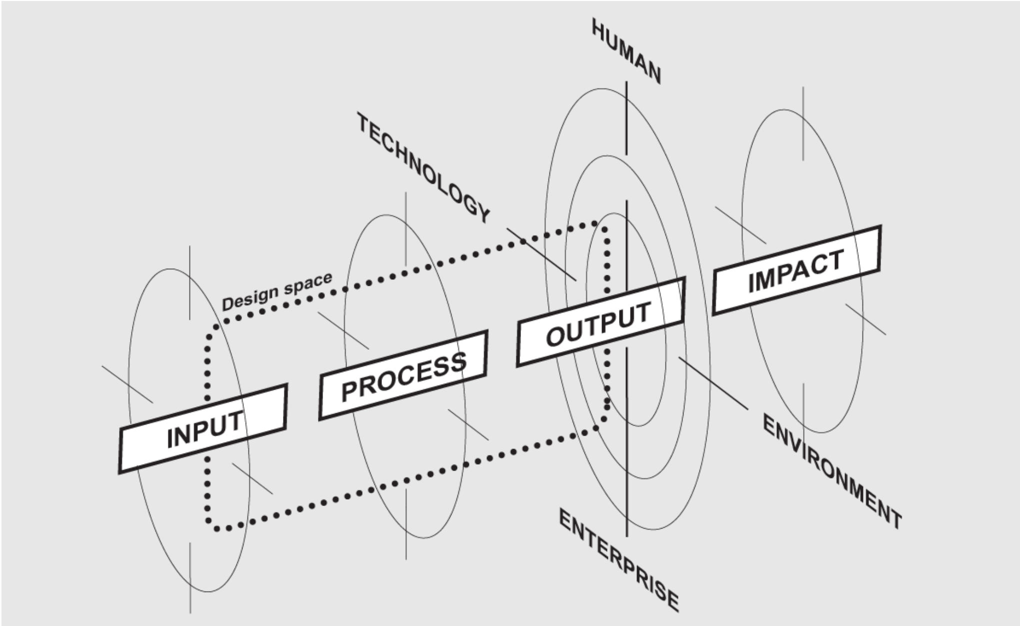

Figure 4.4 *Schematic visualisation of potential HEET radar sampling points in an NPD process*

In order to apply the HEET radar chart as an evaluative tool, meaningful values need to be attached to each pole. In STUDY 1.1 a simple zero to three scale with defined generic criteria has been used (*Table 4.3*). In further development sub-headings within each of the HEET poles (e.g. Pugh's (1990) 34 factors) could have been identified and quantitative metrics applied to each factor.

Table 4.3 *Summary of HEET factors and example of basic value descriptors*

Scale	**H** Human	$\mathbf{E^1}$Environment	$\mathbf{E^2}$ Enterprise	**T** Technology
	Physical and cognitive ergonomic, societal and social factors including context and trends	Life cycle analysis, environmental sustainability, environmental context and trends	Market factors, commercialisation, economic sustainability, innovation management	Materials and manufacturing, mechanical, electrical and electronic factors, technology context and trends
0	**No significant consideration** of the factors within this category is evident			
1	Some factors within this category have been considered and **reasonable-to-good** work has taken place as clear evidence of a response to the resulting issues			
2	A good range of factors within this category have been considered and **good-to-very good** work has been carried out on a number of these factors to a good-to-very good depth and is apparent in the outcomes			
3	Consideration of a comprehensive range of factors within this category is an integral part of the work and many have been considered to an **excellent-to-outstanding** depth as evidenced by the outcomes			

Study sample

The study involved working with data derived from final year undergraduate product and industrial design student projects at two leading UK design schools. Samples were taken from three academic year cohorts: 2008-9, 2009-10 and 2010-11. This data provided a basis for a comparative analysis between schools A and B. The longitudinal effects of introducing a *Collaborative Project* Initiative at design school 'A', which addressed multi-disciplinarity and enterprise, is also reviewed.

Major Projects and Collaborative Projects

The *Major Project* is a typical feature of most final year undergraduate courses in the UK Art and Design sector. It represents a culmination of all the skills, knowledge and understanding acquired earlier, within the underlying project based pedagogy. The proportion of the final year time commitment and assessment weighting that the Major Project represents across the UK tertiary design sector varies to an extent. However, in all cases the proportion is significant (*Table 4.4*).

The defining feature of a *Collaborative Project* in this context is the involvement of an external organisation or individual, who introduces a project brief and who can provide enhanced access to the project environment, together with additional support and feedback throughout the project. These generic qualities are typical of the 'live projects' historically undertaken by groups within Art and Design tertiary education (ref *Table 4.1 c*) although in this case on a one to one basis.

Table 4.4 *Overall statistics for the Product/Industrial design courses in study 1.1*

2010 -11 Graduating cohort	School A	School B	Comment
Cohort population	Circa**100**	Circa **40**	
Time spent on the major project and % proportion of the final year of the course	**400**hours (33%)	**300**hours (25%)	This variation between institutions is typical
Number of collaborative projects and % of cohort	**24** (21%)	NA	This is up from around 5% in previous years

A summary review of the existing academic evaluation methods and resulting data at the two design schools revealed that any existing data would not provide a basis for evaluating the disciplinary and enterprise factors. This supports the potential for a new design process based evaluation method.

Data coding and analysis

For the comparative study between major project outputs at design schools A and B, the image and text records of each individual project were reviewed and a value was assigned to each of the HEET factors (ref *Table4.3*) by post-graduate researchers. For the longitudinal study the values were generated by the Major Project supervisors at design school 'A'. Data reliability was enhanced through pilot coding and double blind coding of projects by both the 1st and 2nd supervisors.

Research quality considerations

Whilst the radar chart method of communicating data points for multiple variables is well established, the specific application in design pedagogy and design impact studies is new. Therefore it is worth reviewing the quality considerations against Cook & Campbell's (1979) categories of threats to validity, as follows.

– *Statistical validity* – There are norm-referencing influences on the criterion based approach. However a more significant threat is the reductionism of factors which can overlook the relative 'real-world' contextual significance of these factors. It is argued that threats to validity are limited in this study as the purpose of the methodology is to provide a general 'picture' of relationships between factors, rather than absolute values.
– *Internal validity* –There is the distinct possibility that, whether or not positive trends are shown, the HEET Radar method cannot reliably demonstrate causality. This threat is mitigated, firstly by awareness of this issue, and secondly due to the exploratory, pilot nature, of the study method, e.g. the outcomes of the study are not dependent on the validity of the HEET Radar method.
– *Construct validity* – A key question in this exploratory study is whether the HEET Radar operationalisation is the most effective approach to evaluation of design impact factors (ref Table 4.1 - RQ C1 and RQ D1). Or, put another way, if the construct validity is found to be seriously flawed, this is a useful finding.
– *External validity*–It is envisaged that the HEET Radar approach is highly flexible, and it is conceived as an approach which can be developed and adapted to exploring design impact in professional practice if appropriate. As a pilot for the approach, threats to validity are mitigated by the potential to either develop or reject the HEET Radar approach.

4.2.3 Findings

Findings from the data analysis are summarily reported as these are of limited direct relevance to the overall Understanding Design Impact study.

Comparative study

The coded data from a total of 141 projects at School 'A' and 55 projects at School 'B' completed during the academic years 2008-9 and 2009-10 formed the basis for the summary HEET Radar charts shown in *Figure 4.5.*The results are surprisingly similar between the two institutions with average values for all the projects indicating a strong focus on both HUMAN and TECHNOLOGY factors, especially when considering the averages for School 'A' over the longer three year period. But the individual and distribution results show that a significant number of students have zero scores for ENVIRONMENT and ENTERPRISE factors. It is proposed that in view of the importance of the complete 360° of factors, students should be able to demonstrate at least a baseline consideration of ENTERPRISE and ENVIRONMENT factors within their major projects.

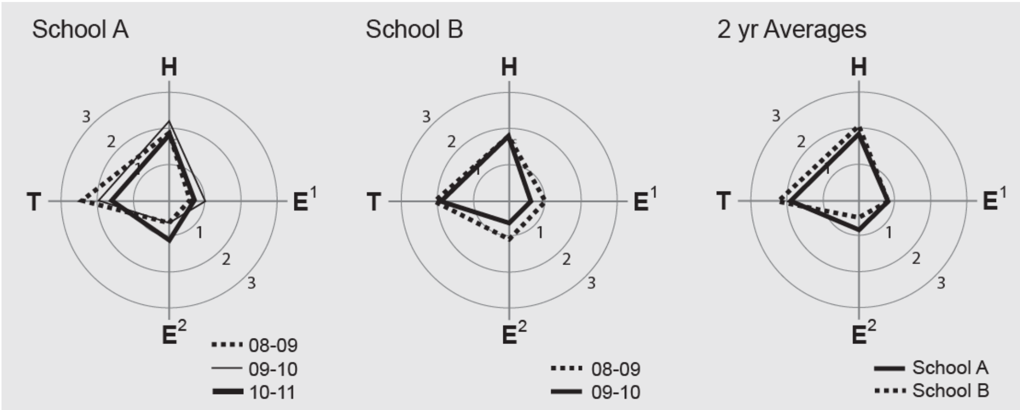

Figure 4.5 *HEET Radar charts for School 'A'&'B' Major Projects*

Longitudinal study

A second phase of the study added to the original two years of data with data from a further 108 projects completed at School 'A' during 2010/11. The overall longitudinal results shown in *Figure 4.6* demonstrate that over the three year period there is a noticeable uplift in both the average values for ENTERPRISE (0.5 to 1.1), plus the overall distribution indicates that within the standard deviation, the ENTERPRISE value had risen from zero to 0.2.

The HEET radar charts generated from this data can provide a visual overview of the distribution of the projects each tutor supervised and how individual supervision may be a significant influence. *Figure 4.7* (left hand chart) shows two divergent examples from amongst the 13 staff involved. The average results from a member of staff with an engineering background (Tutor A) indicate a strong orientation towards

TECHNOLOGY factors. Likewise, a member of staff (Tutor B) with a background in inclusive design results in averages with a marked orientation towards HUMAN factors.

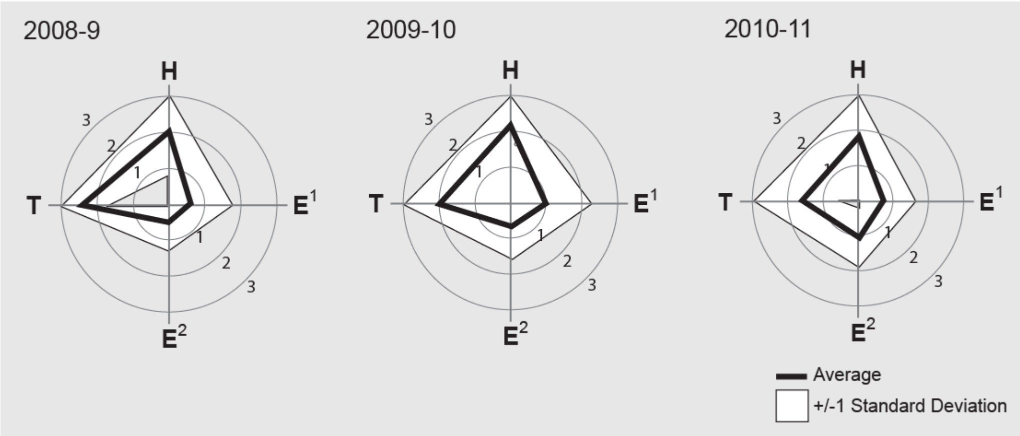

Figure 4.6 *HEET Radar Charts for School 'A': Distributions over three years*

Consideration of ENTERPRISE factors has increased overall for final year students at School 'A' between 2009/10 and 2010/11. However, the averages for the collaborative project initiative (*Figure 4.7* centre chart) counter-intuitively show only a very small increase compared to the overall average. This highlights a limitation in the capacity of the HEET radar graph and the ENTERPRISE criteria and values to capture the full complexity of the influencing factors. *Figure 4.7* (right hand chart) shows the average and complete distribution of values within the Collaborative project sub-set. Note that all of the Collaborative projects demonstrated some level of consideration of ENTERPRISE factors.

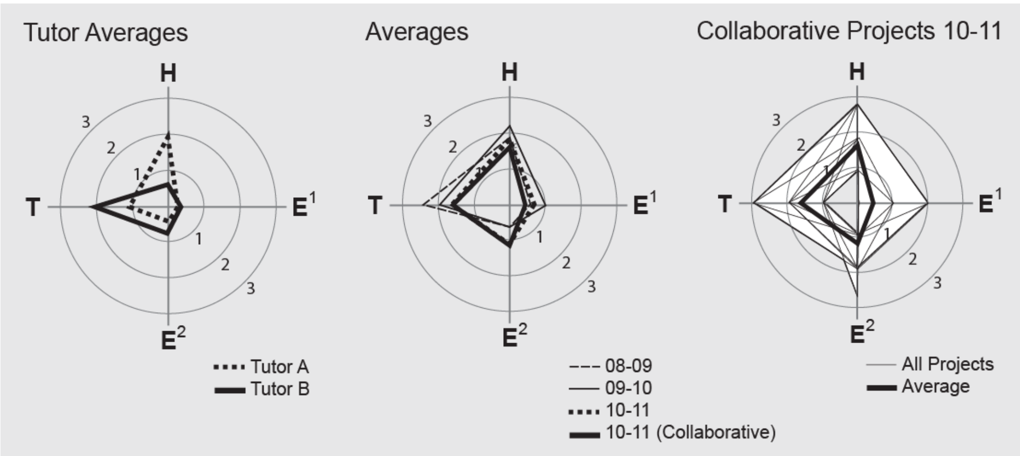

Figure 4.7 *HEET radar charts for School A: divergent results from two different tutors (Left), collaborative projects in comparison to overall averages(centre) and distribution of 2010/11 collaborative Major Projects(right)*

Within the 2010-11 data set, 24 collaborative projects were undertaken, representing 21% of the cohort, compared with a historic percentage of around 5%. Evaluation of the final academic assessments of the collaborative projects, in comparison to non-collaborative projects, provided the basis for further evaluation of the impact of the initiatives to enhance multi-disciplinary and collaborative factors. This additional evaluation and findings do not link directly to the research questions within this study, but do demonstrate the tactical benefits of being able to use pre-existing data sets to support analysis and triangulation of findings. For summary reference, these key additional findings are shown in *Table 4.5.*

Table 4.5 *2010-11 Collaborative Major Projects compared to non-collaborative projects*

Factor	Results	Comment
Rank position in the overall final degree assessments for students undertaking collaborative projects	8 out of the top 14 students undertook a Collaborative Major project, a much higher proportion than for the whole cohort	Stronger students have greater confidence to take on Collaborative projects. Taking on greater challenges results in learning and improved results
Degree grades of students undertaking collaborative projects	Amongst those doing collaborative projects 33% achieved 1sts versus 24% for the cohort as a whole	Underlines the average higher performance of students doing collaborative projects, but causation is not proven
Average % difference between Major project result and degree result	Average for Collaborative project students is 2%, average for the whole cohort is 1.4%	The major project shows a close correlation with the overall degree grade result. But the collaborative project students achieve slightly higher values
Capacity for improvement in relation to the whole cohort	Improvements in marks from 1st year to final year average 6%, compared to 1% for the whole cohort	Students undertaking a collaborative project are on a steeper learning trajectory

4.2.4 Review

STUDY 1.1 review: Pedagogical context

The HEET radar method has facilitated a range of evaluations based on the underlying data and provides simple visual communication of the results. The results indicate that on average ENTERPRISE and ENVIRONMENTAL considerations are less significant in Design major projects than HUMAN or TECHNOLOGY factors. The introduction of Collaborative projects, as an initiative to promote attention to important emerging themes in the professional design context, does appear to have resulted in some uplift in values for ENTERPRISE factors, although the causation is not reliably proven.

The results provide a benchmark for consideration of the impact of introducing the collaborative project initiative and may have some value for informing future pedagogy. Impact on student graduation destinations and longer term ENTERPRISE orientation can only be surmised. This highlights a simple but fundamental point, which is common to many attempts at design impact assessment, that the wider *desired impact* cannot be assumed from outcome data. However it may be informative to have an approach which allows impact evaluation data to be consistently referenced back to longitudinal HEET radar 'snap-shots'.

STUDY 1.1 review: Implications for the UDI study

Although linked to a design process model, the study did not exploit the potential for longitudinal evaluations of influencing factors. However, combining the *Input-Process-Output* model emerging from the literature review and the HEET radar chart method enables a clear conceptual link to be made between process and outcome. Availability of suitable data and resources for data collection were, as they are in virtually any context, a consideration or constraint which informed the adopted methodology.

Complexity of the emerging context

Design Higher Education is an interesting and relevant exemplar of the complexity challenges faced by the design profession and the related evaluation of impact. Even at a basic level there are many more factors to consider than the simple four pole HEET radar accommodates. It was suggested earlier that a wider range of factors (such as the 34 proposed by Pugh, 1991) could be included within the 360˚ of the radar, but the question of how a more complex range of factors and interrelationships can be accommodated remains to be explored.

What impact?

Despite its critics (e.g. Norman & MacDonald, 2004), the Triple Bottom Line (Elkington, 1999) approach suggests a benefit in considering a broader range of 'bottom line' outcomes or impacts. The key point of the impact assessment methodology used in this pilot study is that it considers *Outcome* evaluation as a time based, cross sectional, view of a complete sequence of design activity. Evaluation of the 360˚ of factors affecting impact could be considered at any cross-sectional sampling point from the *Input-Process-Output-Impact* continuum, not just at the point of designed outcomes. This literally adds another whole dimension to the complexity of evaluating impact.

We could consider the *Outcomes* data point used in this study as a 'pre-impact' indicator. For example if we use a baking metaphor, the method allows evaluation of the proportions of ingredients in the outcome as an *indication of potential impact.*

Challenges with definition and terminology

Evidence from the impact assessment field, with a burgeoning academic literature and proliferation of terms, highlights the barriers to adoption created by definition and terminology issues (e.g. Caschili et al. 2014; Cashmore and Morgan, 2014). Within this study this was exemplified by discussion around the use of the word *Entrepreneurship* versus *Enterprise* – and the generic term *Economic* in PEST or TBL evaluations. This confirms that the UDI study should explore and adopt an approach to 'translating' terminology to specific contexts. For example, it might be concluded that the terminology adopted in any impact evaluation should remain flexible and be informed by a participative approach to defining terms.

Research quality

As mentioned earlier (section 4.2.2), this study has many potential issues in relation to reliability and validity, but this is mitigated to an extent by its exploratory, pilot nature. However it is worth revisiting the *Construct* and *External validity* criteria: The *construct* proposed by the HEET radar evaluation is that, in other applications, HEET radar data sampling could be carried out at a number of points in the *Input-Process-Output-Impact* continuum. This study tested the HEET radar at one point only (Output). Therefore at this stage, only limited conclusions can be drawn about the potential of the construct to be useful in broader evaluations with more than a single sampling point. *External validity* (generalisation to other cases) is proven to an extent by sampling from two design schools and involving a number of people in the coding phase. However, for resulting approaches to be useful in design practice, stakeholders will need to be persuaded of their value. Therefore - to adopt a term from innovation studies - the conditions for *diffusion* need to be considered.

STUDY 1.1 review: Mapping research questions to findings and review

Table 4.6 maps the study research questions to the main findings of the study together with references to relevant design impact literature.

Table 4.6 *STUDY 1.1 – Mapping research questions to findings and review*

STUDY 1.3 Research Questions	STUDY 1.3 Findings	Literature review references
RQ A1.1 What existing models and methods are there for capturing data about design activities?	Conventional assessment/evaluation of design projects in HE do not focus on the complete spectrum of factors which determine design impact, for example emerging factors. Factors of emerging importance (e.g. Enterprise and Environmental considerations) are notably absent or only implied in existing evaluations of the core 'Major' or final project practice of the two design schools reviewed.	Integrating sustainability into design activity puts emphasis on the need for evaluation/assessment of impacts (Waage, 2007) Total Design (Pugh, 1991)
RQ A1.2 To what extent do existing models and methods accommodate a broader context (e.g. the FEI to IMPACT journey)	249 Major projects from 3 years reviewed at Design School A and 55 Major projects from 2 years reviewed at Design School B were coded and reviewed. In the absence of methods to capture a complete 360˚ of factors affecting impact the **HEET radar** method was developed based on radar/polar charts and PEST and TBL type factors. The study did not explore a complete FEI to IMPACT journey, but a cross section at the **PROJECT OUTCOME** stage but HEET radar could potentially be applied at any point within this.	Generic approaches adopted such as the pillars of TBL (Elkington, 1999) Some links are emerging between design process and Sustainability (Sutcliffe, 2009; Waage, 2007) and Economics (Veryzer & Borja de Mozota, 2005)
RQ B1 What issues and challenges are raised through process based data collection, analysis and communication?	**Scope restricted by resources and availability of data**: The study was driven by the practical need to gain insights into an aspect of HE design practice **Complexity of impact assessments is confirmed**: only a limited number of factors at a single sampling point in relation to the I-P-O-Impact continuum were evaluated **Definitions and Terminology**: Bringing concepts together to operationalise design impact assessments requires approaches to resolve barriers created by multiple terms **External Validity**: Not tested in this study, but diffusion of any new design impact assessment method is identified as a significant challenge	*Aggregation* issues (Norman & MacDonald, 2004) Dangers in the proliferation of concepts and approaches in the IA field (Cashmore and Morgan, 2014) The need to recognise 'power' factors in the adoption of approaches (Cashmore and Morgan, 2014)
RQ C1 How can design process based modelling and data collection concepts be used to capture attributes which lead to design impact?	The HEET Radar / IPO-I continuum combination adds to the prototype framework as a potentially useful basis for impact assessment. Comparative evaluations had limited effectiveness for impact considerations Longitudinal evaluations were more effective	Frameworks of evaluation / assessment approaches can be useful as a first step in understanding what might be effective (framework of sustainability terms – Glavic & Lukman, 2007; Ontologies - Sim& Duffy, 2003)
RQ D1 How can the effectiveness of design process based modelling and data collection concepts for impact evaluation be judged?	Ref External Validity point above: Not tested in this study, but addressing this factor needs to be explored in subsequent studies	Key literature reviews (Wynn & Clarkson, 2005; Gericke & Blessing, 2011) identify gaps and frameworks for considering the efficacy of design process literature. The literature on design impact analysis could be considered as emergent. Design value (Borja de Mozota, 2006) and Design emphasis concepts (Candi & Gemser, 2010) are significant.

4.2.5 Development of the prototype framework for UDI

The initial *Input-Process-Output-Impact* (IPOI) based prototype framework emerging from the literature review is updated here to show the relationship of the work conducted in STUDY 1.1 (*Figure 4.8*). In this instance the 'Design Domain' is tertiary design education. Collaborative projects are an additional *'Input'* responding to the evolving context for professional design practice. *Figure 4.8* indicates the sampling point (based on *Output* from undergraduate design major projects). This does not aim to evaluate Impact directly, but can provide insights into the ingredients of potential impact. Operationalisation challenges and the use of 'HEET radar' are highlighted as other notable features of this study.

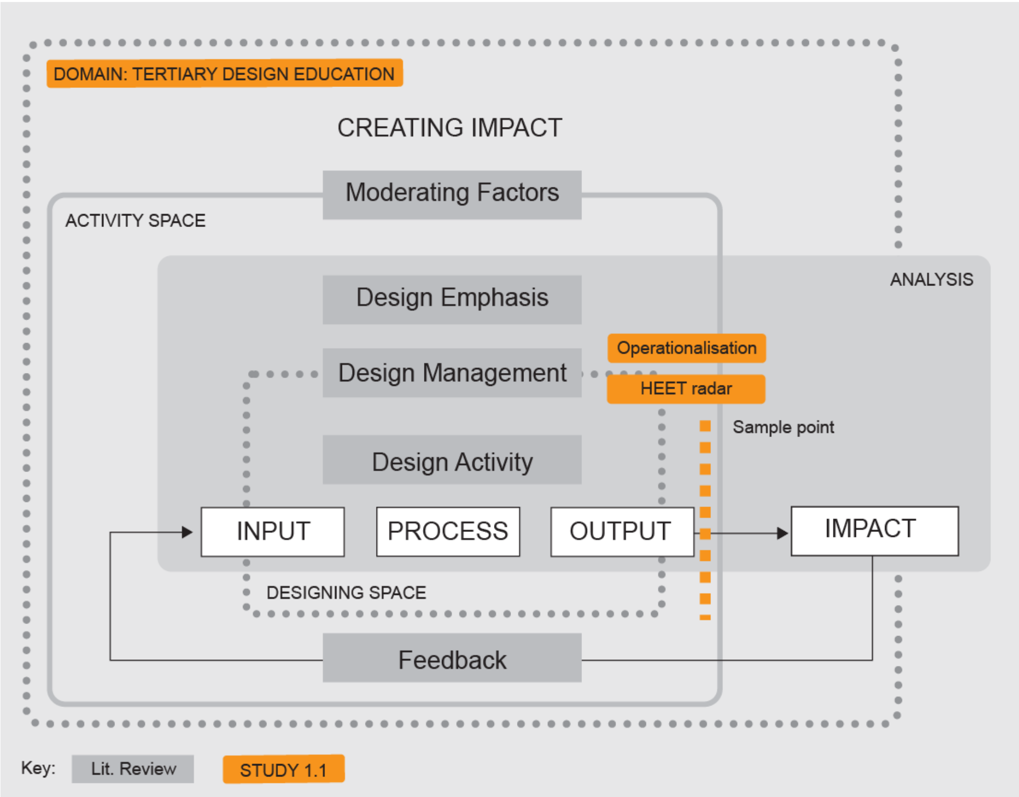

Figure 4.8 *Prototype Framework for UDI (version 2)- with outcomes from STUDY 1.1 added*

4.2.6 Summary

The tertiary design education domain was used as a basis for this pilot study, to explore how emerging or overlooked factors which ultimately effect impact might be operationalised and evaluated. The pedagogic aspect of the work focused on the importance of consideration of enterprise factors and related multidisciplinary working.

A development of the popular radar chart data visualisation technique was adapted as a basis for making simple to review representations of relevant data. Four primary poles relating to human, environmental, enterprise and technology factors were defined, hence the acronym HEET radar.

The HEET radar chart technique was then applied to a comparative and longitudinal study of data from a total of 304 final year 'major projects' at two leading design schools over a period of three years. The sampling point was based on design<u>ed</u> outcomes. The approach facilitated a range of analysis and communication of findings which were reported as part of a related research project (Green, 2012)

The point is made that the HEET radar chart principle could be applied at any point on an *Input-Process-Output-Input* continuum. This adds an additional dimension to design impact analysis which typically focuses only on outcomes.

4.3 Evaluation

The study was conceived as a pilot study to empirically explore issues identified within the literature review and within a readily accessible context (tertiary design education). This evaluation section considers the study findings and summary in the wider context of the complete UDI study.

The HEET radar approach used to sample data at points on the *I-P-O- Impact* continuum is demonstrated to be an effective operationalisation to evaluate overlooked factors in current evaluation within the context. However significant challenges with operationalisation for design impact analysis are also confirmed and highlighted. The availability of data, especially for more complex multi-factor analysis, is highly likely to be a barrier to UDI.

A limited number of factors were explored within the study. These only cover a small proportion of the complete range of factors which might be significant in any instance of design impact. Therefore the identification and prioritisation of factors for analysis appears significant. The study also highlights issues with any potential adoption or diffusion of any operationalisation for design impact analysis, even if there is data available, and factors for analysis have been accurately identified and prioritised.

Chapter Five

Design Process Foundations

Chapter content Page

5.1 Introduction

As highlighted in the literature review, the professional practice of design is evolving (e.g. Kimble, 2009; Melles et al., 2011). This results in a number of areas where design research has identified the need for practice to develop to meet the challenges and opportunities. These include, for example, multi-disciplinary working, design thinking at the front end of innovation, participative design and, not least, the subject of this overall study, the challenge of understanding design impact. Design research is identifying and responding to these challenges and opportunities. However, as noted by Love (2000 & 2002) there are many issues with the coherence of the theoretical underpinning of design research. In turn Candi & Gemser (2010) have identified issues with the status of design impact studies.

The second study within the planned sequence of studies (STUDY 2.1, ref Figure 5.1) takes the design methods/process foundations of the historical development of design research as the basis for building a coherent framework. It is proposed that this is a necessary prerequisite and will act as a robust foundation for the subsequent studies in the series.

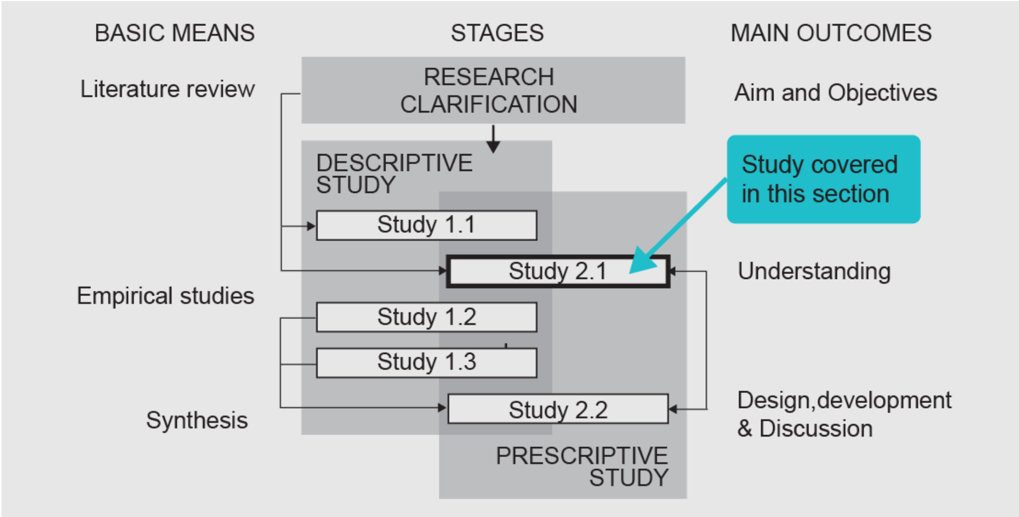

Figure 5.1 *Adopted DRM methodology highlighting STUDY 2.1*

Within the overall topic of *Understanding Design Impact,* the various impacts resulting from design *might* originate from the *Output* of design activity. However, using anestablished model from Information systems, we can also consider how these outputs are derived from *Inputs* and *Process* in an *Input-Process-Output*(IPO)model (e.g. Lederer & Salmola, 1996). NESTA's work (2009) identifies *Input* factors as a basis for measurement of innovation. Livesley& Moultrie (2008) develop a model for delimiting design investments (a design input)as a basis for evaluating design impact.

Within the professional practice of design any instance of IPO is likely to be very complex, and adoption of this linear model may be confused with criticisms of design process models (e.g. Lawson, 2004). However, in order to develop a better understanding of design impact, there is a need for better understanding of the elements and inter relationships in instances of IPO. Typically, the design profession uses case studies (descriptions of input, process and output) as a means to communicate potential design impact (Dawton, 2011), but this oversimplifies the complexity of the specific instances of IPO. There is a tendency to substitute the nearest matches of case study within a designer's repertoire or portfolio.

This study is the first prescriptive study in the series. It aims to develop the foundations for a framework which can make a contribution to what Dorst (2008) describes in his paper 'Design Research - a revolution waiting to happen':the need to better understand the interrelationships of a 'constellation' (Wang &Ilhan, 2009, p20) of factors within design activity.

5.2 STUDY 2.1 - Rationalising theoretical foundations

The study presented in this chapter is an integral part of the synthesis of the literature review findings. However the work described here also has a prescriptive, action research element, establishing foundations using principles of ontology development. The methods section of this chapter describes the background to the adoption of the ontological approach and the specific ontology development process. The Findings section reports on the development of the framework and the significant factors identified and integrated into this. The Evaluation section considers the overall results of the study - the ontological foundations and prototype framework- as a basis for the remaining studies within the overall DRM methodology.

5.2.1 Aim, Objectives and Research Questions

STUDY 2.1 Aim

To combine the literature review and initial study findings into a useful foundation which will serve as a robust basis for exploring impact throughout the Front End of Innovation (FEI) to IMPACT journey.

Table 5.1 *STUDY2.1 Research Questions*

Overall Research Objectives	STUDY 2.1 Research Questions
Review of current situation RO A To carry out a thorough investigation of current theory and practice for understanding design impact within relevant research literature to provide a foundation of understanding for subsequent studies	RQA2.1 To what extent do existing design process models accommodate a complete FEI to IMPACT journey? RQA.2 To what extent do existing process models make explicit links to FEI or IMPACT factors?
Analysis of professional practice RO B To conduct descriptive studies of design practice to understand relationships between design practice and impact and identify gaps in current understanding	RQB2 What issues and challenges do existing process models aim to address?
Developing a new framework RO C To follow a process to create a framework to represent the factors which lead to design impact which, in turn, can contribute to improved understanding of design impact	RQC2 What foundations are needed as a robust basis for a framework to understand design impact?
Evaluating the new framework RO D To evaluate the framework, including its potential	RQD2 What criteria do foundations for a UDI framework need to meet and can these be tested?

Overall Research Objectives	STUDY 2.1 Research Questions
as a basis for new working methods for understanding and communicating design impact	

5.2.2 Methods

Design Process Context

Design process is at the core of design activity and was the basis for the emergence of the field of design research (Bayazit, 2004). Subsequently it has formed the basis for a considerable body of design research, as evidenced by major academic reviews by Wynn & Clarkson (2005), Howard et al. (2008) and Gericke& Blessing (2011). These reviews summarise a spectrum of approaches from ‘creative – romantic’ to ‘engineering – scientific’ (Wynn & Clarkson, 2005; Howard et al., 2008) and demonstrate considerable consistency in the presentation of sequential stages of activities (Howard et al., 2008; Gericke& Blessing, 2011). Design process has also been reviewed and identified as central to the practice of design from a commercial perspective by the UK Design Council (2007a) and Dubberly (2004). From commercial practice, Newman’s ‘Squiggle’ (2006) is perhaps at the more ‘creative – romantic’ end of the spectrum, but it also very effectively demonstrates the random, diverse and complex nature of design process. Reconciling creativity and randomness has contributed not only to the proliferation of process models, but has also generated considerable criticism of design process studies (e.g. Lawson, 2004; Dorst, 2008; Birkhofer, 2005 & 2011). There are parallels between these criticisms and criticisms of design research (Love, 2000 &2002). Therefore, whilst on the one hand design process is central to all design activity, and in turn the core of an *Input-Process-Output-Impact* model, there is scope to address the criticisms with a more robust framework, which could also accommodate emerging factors relevant to design practice.

The Potential of Ontologies

Ontological principles are judged to have the potential for structuring and rationalising the ‘constellation’ of factors (Wang & Ilhan, 2009, p20) affecting design process and impact in a manner which both accommodates the many variables within existing process models and helps to address the criticisms of design process models and design research (Sim & Duffy, 2003).

As identified by Love (2002), the ontology concept could represent the highest level of philosophical abstraction of design theory (*Figure 5.2*).Love's use of the term ontology draws on the meaning of ontology from philosophy; 'a systematic account of existence' (Gruber, 1993, p1). Love uses examples to demonstrate that this level of philosophical critical analysis would be needed to answer complex questions which encompass human values and the values and assumptions of design researchers (Love, 2000, p306). Galle (2009, p324) concurs and states that 'a meta-theoretical philosophical approach to design may improve the clarity of our thinking about design and design methodology' (Galle, 2009). Sim& Duffy (2003, p200) propose an ontology of generic engineering activities to help resolve issues such as 'no shared understanding' of design process and process models 'not reflecting the reality' of design and 'no consensus and widespread application of theory in industry'.

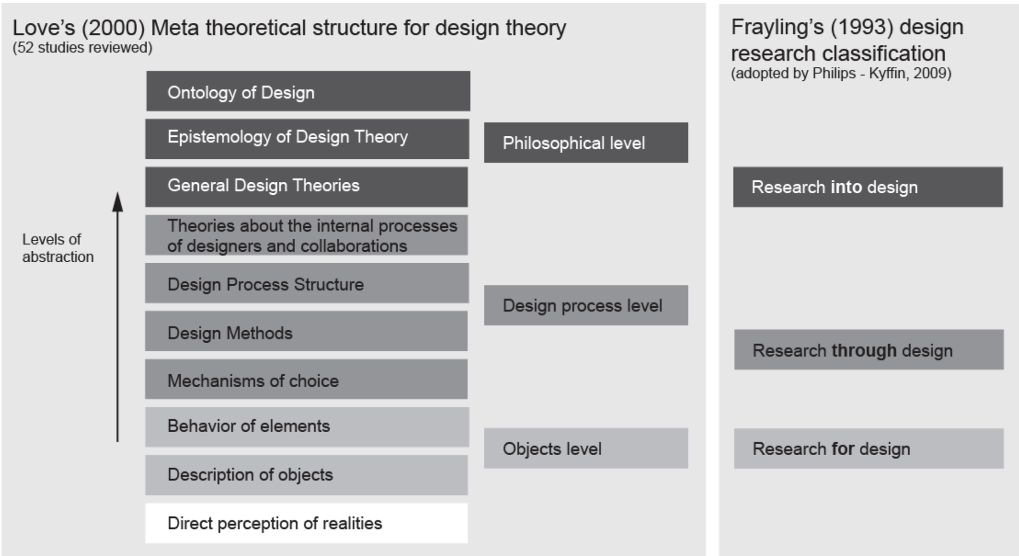

Figure 5.2 *Rationalising a structure for design theory and research*

Also widely used within the development of Artificial Intelligence, the concept of ontologies has broadened into the domain of computer and information science (Noy & McGuinness, 2001), often with the objective of building digital knowledge management applications. Bullinger (2008) reviews the use of ontologies across a range of domains as a basis for her proposal for an ontology to support decision making at the Fuzzy Front End (FFE) of innovation. The link between Love's and Galles' use of ontology (philosophy) and the information science use of ontologies (Bullinger) is the idea of creating a hierarchical framework of concepts and knowledge as a basis for sharing understanding of concepts and the relationships between them. This objective for developing ontologies is summarised by Noy and McGuinness (2001, p1) as:

- ‘to share common understanding of the structure of information among people or software agents;
- to enable reuse of domain knowledge;
- to make domain assumptions explicit;
- to separate domain knowledge from the operational knowledge.
- to analyse domain knowledge’.

These objectives make for a strong fit with this study’s aim. Thereforethe concept of developing an interim ontology was explored. The Noy and McGuinness paper goes on to describe fundamental principles and first steps for creating ontologies. According to these principles there is no right or wrong ontology, and ontology development is an iterative and ongoing activity. This equates to the definition of the work reported here as an *interim* design process ontology (subsequently referred to without the interim prefix).

Creating an ontology requires assessment of the scope and intended application, establishing ‘competency questions’ (Gruninger & Fox, 1995) which the ontology should be able to provide answers to. Gruber (1995) additionally recommends a set of five generic criteria for the design of ontologies. These criteria are revisited in the review section (2.4.2) as part of the evaluation of the initial ontology:

- CLARITY: Using objective terminology which is widely understood
- COHERENCE: The relationships or inferences between elements should be logical and consistent
- EXTENDIBILITY: The ontology should allow for continuous expansion (also ref iterative nature of ontology development – Noy and Mc Guinness, 2001)
- MINIMAL ENCODING BIAS: meaning limiting the use of more abstract or restrictive concepts to aid encoding (Gruber uses the example of encoding bias such as restricting the format for expressing dates in a bibliographic ontology)

– MINIMAL ONTOLOGICAL COMMITMENT: At a basic level this means that if the ontology is too complex for the intended application it will be less likely to be adopted, therefore contrary to the aim of knowledge sharing

Ontology development process

A summary, simplified process for creating an ontology is defined by Noy and McGuinness (2001) as:

1) Determine the domain and the scope of the ontology (e.g. by considering competency questions and generic criteria)
2) Consider re-use of existing ontologies
3) Identify key terminology to be used within the planned ontology
4) Define classes and class hierarchy ('concepts' is also used as a synonym for classes. Typically classes might be collections of things or instances)
5) Define the properties of the classes (also referred to as slots)
6) Define the permissible or allowed values for the properties (or facets, e.g. the facets of the slots)
7) Populate the classes with instances.

Steps one to four of the Noy and McGuinness recommendations are followed here to generate an initial design process ontology. This activity has the additional ontology development aim - in line with the established generic objective of ontologies within information science – of creating a hierarchical structure of design process concepts and knowledge as a basis for a shared understanding of significant concepts within the domain of design and design process.

Research quality considerations

The overall threats to the validity of STUDY 2.1 are mitigated by the identification of the output as an *Interim Design Process Ontology*, in keeping with the iterative nature of ontologies (Noy& McGuinness, 2001). Adopting terminology from Cook &Campbell's (1979) validity criteria, further more detailed observations are made. Threats to *Internal* and *Construct Validity* are mitigated by the ontology development process advocated by Noy& McGuinness. However, the thoroughness of steps three and four could be compromised by the depth of work possible within the timescale and any analytical bias in the process. These potential threats are, in turn, mitigated by the ontological principle whereby*External validity* evolves through an iterative process (*Extendibility*). For example, in relation to step three and the adoption of terminology, the specific terminology can evolve if needed within the overall hierarchical structure, without compromising the underlying principles.

Ultimately, *External Validity*of an ontological approach is threatened by the degree to which the principles are externally adopted. This issue is encompassed with the term *Ontological commitment*. However, it can also be argued that this is mitigated by the interim nature of the work at this point.

5.2.3 Findings

Ontology Development Process

The findings of this study are reported following the structure of the first four steps of Noy& McGuinness's (2001) recommended development process.

Step 1: Domain and Scope

The overall domain is defined as *the professional practice of designing*. Although this defines the overall scope, it should be emphasised that ontologies are organic and should be designed to allow for ongoing development (Noy and Mc Guinness', 2001, Extendibility criteria). This is appropriate within the design domain, as professional design is continuously evolving and often encompasses the practices and bodies of knowledge from related professions (Wang & Ilhan, 2009).Competency questions - examples of questions which the ontology should be able to provide answers to - are important tests for the work. These design ontology competency questions (DOCQs) are defined as:

DOCQ 1 (design research based) How does any specific existing design process model or methodology fit within this ontology? Eg. can existing models such as FBS (Gero & Kannengiesser, 2004) be easily mapped onto the ontology?

DOCQ 2 (professional practice based) How does this ontology relate to either a specific design project or the general design practice of an organisation? Eg. can projects or practice such as 'Web design' be mapped onto the ontology as instances?

DOCQ 3 (usefulness to predicting design impact) Can the ontology encompass all the elements which may determine the impact of design practice? Eg.

can case studies of 'good' or 'bad' design be mapped onto the ontology and does this to help clarify what constitutes the good or bad quality?

A supplementary competency question in line with the overall study objectives can be added as **DOCQ4**: Can the ontology be presented in a form which can be quickly and simply understood by design practitioners and design researchers alike (eg. as a framework for UDI)?

Step 2: Re-use of existing ontologies?

Various sources are identified in the literature for ontology libraries and fields of application. Gruber (1995) refers to ontology developments in relation to engineering models, planning, problem solving and models of expertise. Noy and McGuinness (2001) refer to ontology libraries such as the *Ontolingua Ontology Library* based at the AI lab at Stanford University or the *DAML ontology library* which - at the time of writing (2011)- included 283 ontologies. However, much of this activity is focused on AI applications and the management of knowledge bases, rather than as a means to share high level concepts and knowledge. Anexample is the work in the engineering domain by Tomiyama et al. (1992) to develop Intelligent CAD systems. This work classifies design process within a knowledge hierarchy, but at the design process level does not have the granularity which is found either within design process literature or within design practice. However, Tomiyama et al.'s work does correlate with Love's (2000) general hierarchy of abstraction (ref Fig 4.2) in identifying a '*process level'* class of design knowledge distinct from '*object level'* design knowledge (Tomiyama et al., 1992, p241). Sim& Duffy's (2003) work confirms the principle of hierarchical levels combined with an *Input-Activity-Output* model. This work explicitly explores granularity, taking27 designing activities in detail and placing them in categories of *Definition, Evaluation* and *Management*. Kumar (2008) explicitly builds on Sim & Duffy's work with the *Design Activity Ontology*(DAO) and this further validates a general hierarchical structure. The DAO models 25 design activities and 82 'information flows', where an information flow is the passage of information between activities in a complete process. Bullinger's (2009) ontology in the Innovation domain aims to enhance decision making in the FFE of innovation by systemising and unifying aspects of the processes involved. Therefore it is concluded that existing ontologies can help to establish and validate the purpose and some general principles for a design process ontology, but there is currently limited scope for direct re-use of ontology structures and components.

Step 3: Key terminology

'The very word 'design' is the first problem we must confront...' (Lawson, 2004). 'Design' can be used as a noun, verb and adjective; the specific meaning is usually clarified to an extent by its context, prefix or suffix. For example 'product design' or 'design thinking'. In design research the complexity in the semantic meaning of *design* can be further compounded. Love (2002, p295) reports that 'the terminology of design research has become unnecessarily and unhelpfully confused and imprecise...' and is one of his four significant criticisms of design research. One of the intended benefits of a design process ontology therefore is to support the clarification of the terminology within the domain (e.g. Galle, 2009). The design ontology can adopt well-established terms, such as *design process* or *methods*. However, in other areas, due to the 'revolution waiting to happen' (Dorst, 2008), terminology to describe certain concepts is not well established within the general design domain. For example, the concept of the 'Engine' at the centre of New Product Development - encompassing factors such as leadership and culture (Koen et al, 2001) - is re-interpreted in a subsequent paper which advocates using the term 'Heart' to describe factors including leadership, culture, emotion, motivation, risk-taking and passion. These factors are described as 'the true ingredients of innovative behaviour' (Buijs, 2003, p90). Therefore, these two views identify and corroborate the importance of 'Engine' or 'Heart' as an important element within NPD, but the general concept probably has limited recognition within design process research. In the ontology proposed, this concept is re-named again as 'Motivation'. Where concepts and terms are not well established it is recognised that this will create a barrier to ontological commitment.

Step 4: Definition of classes and class hierarchy

The overall definition of classes and hierarchy has evolved through an iterative paper-based prototyping process, drawing together the findings from the general literature review summarised earlier. The prototyping has been further informed through workshops held with MSc Integrated Product Design students. The initial design process ontology resulting from this iterative process is presented within this Chapter in two forms: firstly as a hierarchical list of classes and sub-classes with a description of how the class definition relates to the literature; and secondly, as a summary hierarchical table of classes (*Table5.2*) with properties and examples of instances.

Initial Design Process Ontology: Class and sub-class hierarchy

Super class

Design Domain: The highest level class describes the general field in which the design activity might take place. This accommodates recognition that the professional practice of design is not restricted to specific fields of professional practice (such as Product Design), nor is it intrinsically linked to specific fields of application. For example, designing clothes might characteristically be considered the preserve of fashion designers, but in reality there are many other professional design activities which might be involved within the clothing sector such as brand design, graphic design, retail design etc. Positioning Design Domain in this way facilitates the criterion of extendibility.

Classes

Input-Process-Output: This generic concept, which is used in various fields, including computing and innovation, is useful for accommodating design process within a broader context whilst keeping process as the core element. This simple classification allows accommodation of significant factors affecting impact. For example the input class can accommodate Pugh's 34 input factors (1990, p44). The output class can accommodate factors typically used to measure design and innovation such as number of patents or increases in turnover or profitability, as well as classification of designed artefacts and systems etc. This ontology development focuses on sub-classes of the *Process* class. The *Input* and *Output* classes can be extended in further work.

Sub-Classes

Motivation: Koen et al (2001) and Bujis (2003) have identified 'Engine' and 'Heart' to describe factors including leadership, culture, emotion, motivation, risk-taking and passion, terms which collectively contribute to the driving force within design process. This force could also exist within the *Input* class and could either contribute to, or be independent to, the motivation factors within the design process itself. For example one might consider a relationship between this concept of *Motivation* with the concept of *Emphasis* (Candi & Gemser, 2010)

Scale: Design research often sets scale factors aside in order to focus on exploration of the common elements of underlying process. However, in professional applications of design process, the differences between activities resulting from scale factors are significant. The *Scale* class is placed at a level with *Design process structure* in the hierarchy, on the basis that scale factors such as timescale or the complexity of the design task are often factors which determine the design process structure, rather than the other way around. The *Scale* concept can encompass a range of factors which determine the overall complexity ofa design project e.g. timescale, numbers of actors, numbers of elements etc. Ulrich and Eppinger (2004), amongst others, identify that the design process concept can be observed in the design of everything from screwdrivers (small) to aircraft (big). This affects scale factors, but note that scale factors in this context are only indirectly linked to the physical size of the designed outcome.

Path: This class addresses issues of disciplinarity, professional and personal factors which determine conscious or unconscious selection of design process structure or methodology. This is strongly illustrated by Newman's design process 'Squiggle' which literally denotes a creative designer's process *Path*. An important development within the field of design is the recognition of the importance of multi-disciplinarity and related terms. Disciplinarity typically determines design process structure, for example through a discipline's position on the creative-to-engineering spectrum. Love's taxonomy of design theory also places the classification *internal theories of designers and collaborators* above *design process structure* in his proposed hierarchy (Love, 2000, Figure 5.2). A sub-class within the *Path* class could be added to encompass the many recognised design specialisms: urban design, interior design, exhibition design etc. (von Stamm, 2003) together with emerging specialisms such as Service and UX/UI design.

Design Process Structure: Both *Path* and *Design Process Structure* could be considered as key elements of Design Activity as defined by Candi & Gemser's (2010) review. They are therefore elements to be considered as part of an exploration of design impact factors, but they are not necessarily the key factors. This class could use the alternative terminology 'design process methodology', but Figure 5.2, *Design Process Structure* has been established as an overall description to encompass the range of ways in which the design process can be structured, in terms of stages, phases and related synonyms. This class allows a significant range of design process structures, such as those described in Dubberly's (2004) compendium, to be accommodated. It is at this theoretical level, and below, where there is likely to be most ontological commitment, or recognition of the terminology, structures and interrelationships. Therefore these levels in the hierarchy can be most easily populated by instances.

Sub-classes of Design process structure

Methods: There is limited consensus on design process structures, therefore there would be limited ontological commitment to grouping methods within a sub-class of specific design process stages, although this is potentially possible. For example the visualisation of the design process ontology (*Figure 5.3*) is shown with the 5D's instance of design process structure (Dubberly, 2004, p62). Each of the 5D's could become sub-classes of Design Process Structure and design methods could be mapped to these. For example, Pugh's Product Design Specification method (Pugh, 1991) would fit within the 'Definition' stage or sub-class. However, ontological commitment would be challenged by this sub-classification.

Activity Behaviour: Recognition that design is not simply a linear process is seen as a significant milestone in the development of design process theory. For example, feedback loops are a characteristic of the third generation of NPD models as defined by Rothwell (1992). This characteristic is accommodated within the class of *Activity Behaviour*. Other significant instances of *Activity Behaviour* include divergency and convergency (e.g. Tovey, 1984; Baxter; 1995 and, Lawson, 2004). A further significant element defining *Activity Behaviour* are aspects of planning characterised by terms such as 'objectives' or 'milestones'. Specific process models such as the Stage-Gate process (Cooper, 1986) or the Water-fall process (Royce, 1970), put particular emphasis on behaviours led by attention to objectives and milestones. The visualisation of the design ontology (*Figure 5.3*) aims to communicate aspects of the inter-relationship of these key activity behaviours within design process structure and the higher level classes of *Motivation, Scale and Path*.

Table 5.2 *Interim Design Ontology - summary hierarchical table of classes*

Class/sub-class hierarchy	Properties of the class	Examples of instances
● DESIGN DOMAIN	The general field in which design practice is taking place	A web design project, design education or the NHS
1 ▶ Input	All the factors which may influence the design process within the field	Market factors for the project or stakeholder factors
2 ▼ Process	All the factors which are part of the transformative process of design	Design process structure and design methods
2.1 ▶ Motivation	All the factors which determine the level of motivation within a process	Urgency of project or culture of client company

Class/sub-class hierarchy	Properties of the class	Examples of instances
2.2 ▶ Scale	All the factors which determine the scale of the design process	Timescale or complexity of design task
2.2 ▶ Path	Factors which determine the path through a design process	Professional paradigms or personal work style
2.3 ▼ Design Process Structure	All the ways in which a design process might be structured	Creative design process or engineering design process
2.3.1 ▶Methods	All methods which are used/might be used within a design process	Product Design Specification or Ideation
2.3.2 ▶ Activity behaviour	All the characteristics of how design process methods are carried out	Convergency and Divergency or feedback and iteration
3 ▶ Output	All the factors which might describe the output of a design process	Designed artefacts or systems or Return on investment

Katifori & Halatsis et al. (2007) explore the value of - and various methods for - visualising ontologies with goals which match the design criteria of 'minimum ontological commitment' (Gruber 1995)and the final 'competency question' identified in this study. This leads to the exploration of a visualisation of the design ontology (*Figure5.3*) as a means to effectively communicate the key features amongst a range of intended audiences. Certain elements within this visualisation need further background explanation, although the intention is that the representation will have a level of recognition amongst those familiar with design process modelling.

The visualisation concentrates on the central *Process* class of the ontology. At the *Scale* sub-class level the visualisation aims to represent the possibility of a range of scales. The diamond shaped underlay relates to concepts of divergent and convergent *Activity Behaviour* (Banathy, 1996) and the double diamond design process model (Design Council, 2007a). The overall diamond is segmented into smaller diamonds. This is a representation of the possibility - dependent on the *Design Domain* and *Scale* -of a specific project being made up of varying numbers of elements, with each exhibiting characteristics of design *Behaviour*.

A central feature of the visualisation is the inclusion of a specific instance of *Design Process Structure*. Note that alternative visualisations could be developed from any other instances of *Design Process Structure* developed over the past 40 years, such as Gero & Kannengiesser's FBS structure (2004). This would allow for greater ontological commitment in any application of the ontology through selection of favoured or domain specific models of *Design Process Structure*.

The visualisation also indicates two instances of the *Path* class. These represent the characteristics of the differences between creative process and scientific or engineering design process (Howard, Culley, Dekoninck, 2008) whereby the looping path is representative of a less structured intuitive progress from start to finish (e.g. Newman, 2006) and the straight path indicates a structured series of validated steps characteristic of process models such as Stage-Gate or Waterfall. Nodes are included on these paths to indicate key milestones or decision points, which typically correspond with the divergent-convergent behaviour pattern. The *Motivation* class is represented by a graphic device based on an arrow. The visualisation indicates that instances of *Motivation* can be present both at the overall level *Path*, but also within individual instances of activity, for example with feedback and iteration.

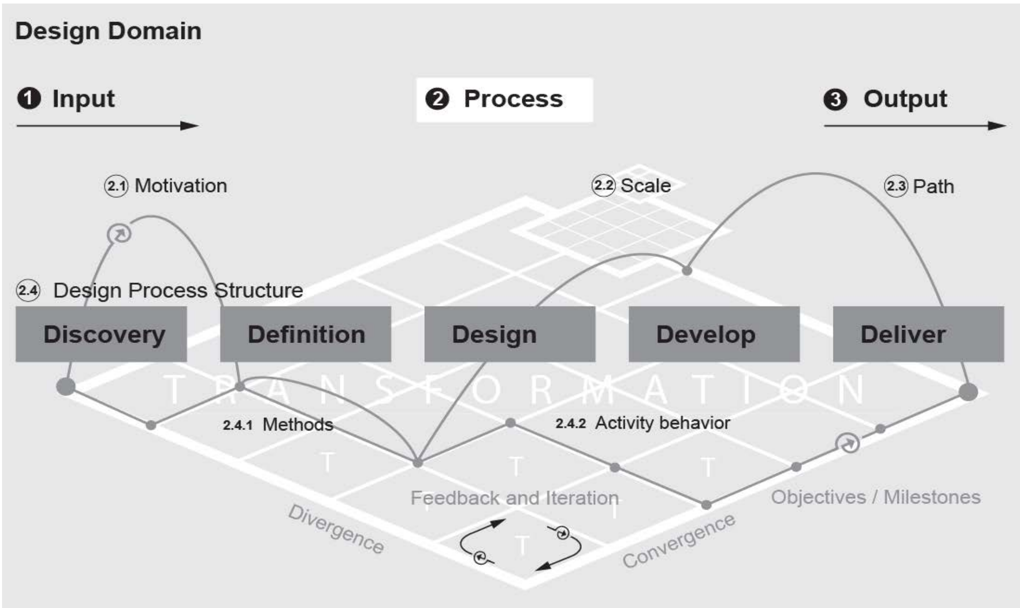

***Figure 5.3** Visualisation derived from the Interim Design Ontology*

5.2.4 Review

Three aspects of the ontology are reviewed as a basis for identifying issues for further development: 1) how well the ontology meets Gruber's (1995) criteria; 2) how well the ontology responds to the Design Ontology Competency Questions (DOCQs); and 3) a summary review of the findings mapped to the research questions.

STUDY 2.1 review: Meeting Ontology development criteria

The CLARITY and COHERENCE criteria tackle the need for objective terminology and the logic and consistency of relationships within the proposed ontology. If a rigid philosophical, logic-based approach is adopted, the work to date can be considered to be at a very early, crude stage and considerably more in-depth consideration can be given to the terms and logic in further work. Using the term Ontology, even with the *interim* prefix, may be considered too ambitious at this stage. However the literature on ontologies -especially in computing applications - is very clear that the development of ontologies is an iterative process with many possible solutions.

Acknowledging shortcomings in the precision of terms and logic is considered helpful to meeting the criteria of EXTENDIBILITY. For example, the identification of the *Motivation* class draws from literature which introduces the concepts of 'Engine' or 'Heart', which extends the ontology beyond earlier stage based studies of design process. The MINIMAL ENCODING BIAS criteria can also be considered in relation to the identification of the *Motivation* class. For example the term 'Motivation' is considered to effectively encompass the concepts embodied within 'Engine' and 'Heart', but without the connotations of mechanical or biological/emotional motive power respectively. Meeting the criteria of MINIMAL ONTOLOGICAL COMMITMENT has been initially considered through the visualisation of the ontology features (*Figure 5.3*). This is the basis of the second aspect of the review.

STUDY 2.1 review: fit to Design Ontology Competency Questions

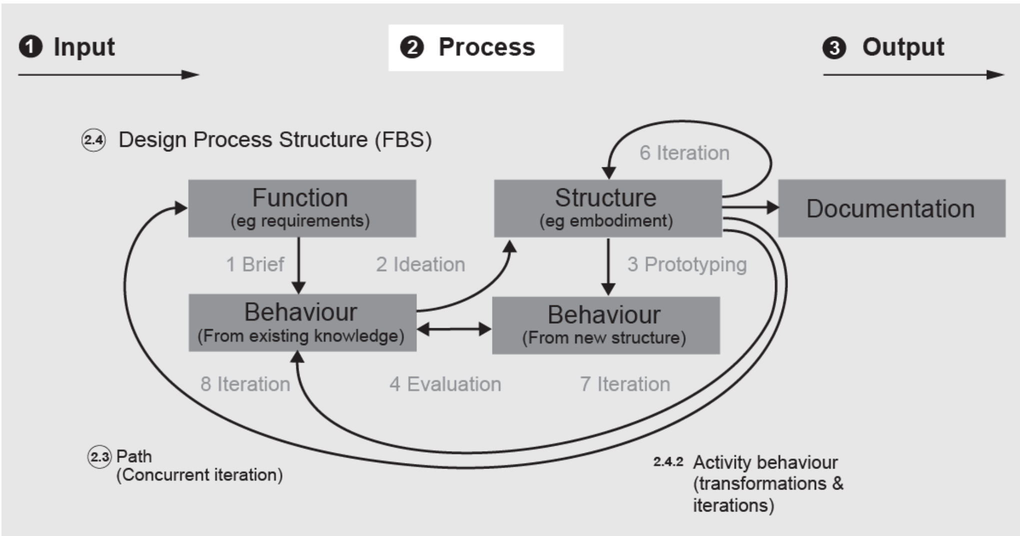

Figure 5.4 *Function, Behaviour, Structure model (Gero & Kannengiesser, 2004) visualised within the Interim Design Ontology structure*

DOCQ 1(design research based) How does any specific existing design process model or methodology fit within this ontology? The Function, Behaviour, Structure (FBS) model (Gero & Kannengiesser, 2004, ref *Figure 5.4*) is a frequently cited model for design process which purposefully eschews linear process models and puts an alternative emphasis on the transformative and iterative nature of design process. This mapping confirms the flexibility of the ontology, for example with the *Path* class highlighting concurrency and iteration and the *Activity Behaviour* class highlighting the transformative nature of design activity.

DOCQ 2(professional practice based) How does this ontology relate to either a specific design project or the general design practice of an organisation?

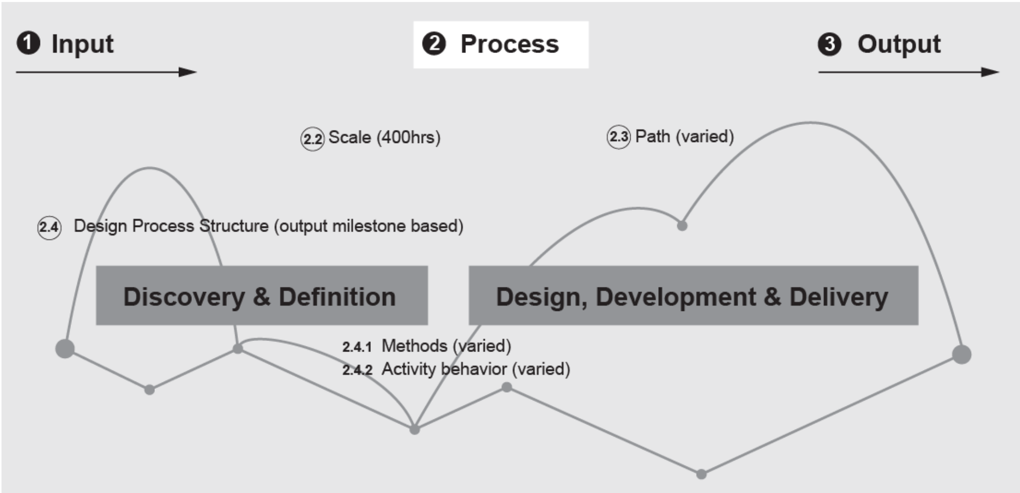

Figure 5.5 *Generic 'Major Projects' mapped to the interim design ontology structure*

The analysis of undergraduate final year design 'Major Projects' in STUDY 1.1 provides a context for considering this DOCQ. Whilst not an instance of 'professional practice', the pedagogic context does represent an 'is like' rather than a 'should be like' scenario (Eckert & Stacey, 2010). The conclusion is also that it is relatively simple to map the 'Major Project' context to the ontological structure (*Figure5.5*). Therefore the ontology provides a basis for addressing Eckert & Stacey's epistemological critique of 'should be like research' not tested in 'is like' scenarios.

DOCQ 3(usefulness to predicting design impact) Can the ontology encompass all the elements which may determine the impact of design practice? As stated earlier, it is an important principle of ontologies that they have a degree of flexibility and potential for iterative development (Noy and McGuinness, 2001). This principle is also embodied within Gruber's (1995) *Extendibility* criteria. Therefore the work todate provides a good level of confidence that the framework meets the extendibility criteria and can accommodate the elements determining design impact. But the initial design ontology has only explored the *Process* class in detail, and has not been specifically evaluated against this question at this point.

DOCQ4 (in relation to the overall study)Can the ontology be presented in a form which can be quickly and simply understood by design practitioners and design researchers alike (e.g. as a framework for UDI)? Review of the design ontology visualisation was undertaken with a group of 40 postgraduate Integrated Product Design (IPD) students. These students have a background knowledge and understanding of general design process concepts, but have not necessarily formed strong domain specific, or experience-based, paradigms in their own practice. A number of key points arising from this evaluation need to be factored into further development. Using the 5D's instance of *Design Process Structure* as a significant visual feature strongly indicates a favoured, and linear, structure. Therefore this is a potential barrier to ontological commitment. The students immediately recognise that *actual* design process does not necessarily conform to this representation of five sequential stages, confirming the views of many critics. Accordingly,there is a difficult balance to achieve between representing instances of design process structure for clarity, whilst allowing for extendibility and clear communication; issues which are core criteria for ontology design (Gruber, 1995).

The initial evaluation identified - in the opinion of the students - that a visualisation is a useful device within a pedagogic context, but the value of any application in commercial practice was far from clear. This finding echoes Galle's assertion that his ontological investigations '....are not claimed to be of immediate practical use to designers' (2009, p321). This underlines the gap between theory and practice, where initiatives such as this must effectively communicate potential for added value to the intended audience (Rhea, 2005).

STUDY 2.1 review: Mapping research questions to findings and review

*Table 5.3*maps the study research questions to the main findings of the study together with references to relevant design impact literature. .

Table 5.3 *STUDY 2.1 – Mapping research questions to findings and review*

STUDY 2.1 Research Questions	STUDY 2.1 Findings	Literature review references
RQ A2.1 To what extent do existing design process models accommodate a complete FEI to IMPACT journey?	Existing design process models are typically partial models – e.g. any single existing model is unlikely to accommodate a complete range of factors which need to be considered in relation to design impact. An *Interim Design Ontology is* developed as a potentially more robust and flexible basis for structuring a complete range of factors.	Reviews of Design process literature from a research perspective, e.g. encompassing consideration of all phases of activity: Wynn and Clarkson (2005); Howard et al.(2008); Gericke & Blessing (2011). From a practice based perspective: Design Council (2007a); Dubberly (2004).
RQ A2.2 To what extent do existing process models make explicit links to FEI or IMPACT factors?	Many existing process models include phases specifically focused on 'front end' activity, but with limited consideration of the range of Inputs. Process in most models typically ends with an output. There is very limited evidence of process models which directly consider the quality of the output or impact. However this is implicit in the aim of most models. The *Interim Design Ontology* provides a basis for exploring 'end-to-end' factors.	The strategic value of the Fuzzy Front End (FFE) and Front end of Innovation (FEI), Koen et al., 2001) concepts are well established in the field of Innovation. Rhea (2005) links these concepts to early stage design process practise. Blackwell et al (2009) identify understanding of what is meant by 'good design' (e.g. a factor creating impact) as an underexplored theme within existing research – although 'good design' is a peer reviewed metric in a number of design impact studies (e.g. Kristensen & Gabrielsen, 2010).
RQ B2 What issues and challenges do existing process models aim to address?	Very varied aims, but 'should be like' process improvement studies implicitly all have goals to enhance the quality of outputs and in turn, design impact. 'Is like' studies typically aim to identify the differentiation of design approaches and identify factors not covered by pre-existing models. There are substantial criticisms of existing design process research and design research in general. The *Interim Design Ontology* can be used as a basis to explore and evaluate both 'should be like' and 'is like' factors.	'Should be like – Is like' dichotomy and critique of design process models (Eckert & Stacey, 2010). Critics of design process models: Lawson (2004); Dorst (2008); Eckert & Stacey (2010). Critic of design research; Love (2000).
RQ C2 To what extent do existing models make links to the quality of outcomes or other benefits linked to modelling?	Explicit, rather than implicit links to quality of outcomes and/or evaluation of practice based results are rare. Whilst not focusing on output or impact at this stage, the Interim Design Ontology provides robust foundation for 'end-to-end' exploration of factors determining quality and impact.	The Design Council's (2007a) process review recommends the double diamond process as a basis for enhanced impact, but without verification. Koostra's Design Management Staircase includes process as one of 5 factors on an axis of his matrix. But process factors are not disaggregated in the results. Veryzer& Borja de Mozota's (2005) *User Orientated Design* propositions are linked to an end-to-end process but only indirectly validated.
RQ D2 How can existing design process models and theories be translated into useful and communicable information?	Based on the identified potential of Ontologies, the *Interim Design Ontology* is developed with the hypothesis that it can make a contribution to the communication of the relationship between Inputs to design process, design process, and the outputs and impact derived from design process.	The general value of Ontologies is promoted by: Gruninger& Fox, (1995); Gruber (1995), Noy and McGuinness (2001) and Bullinger (2008). The application of ontologies in the design field is explored by: Tomiyama et al. (1992), Love (2000); Galle (2009); Sim& Duffy (2003).

5.2.5 Development of the prototype framework

The initial – version 1-prototype framework is updated in *Figure 5.6* to provide a visual overview of how the hierarchy of ontology classes developed within this study can be mapped to the framework. This can be considered as a further demonstration of how the qualities of an ontological approach serve as an effective and robust foundation, with considerable flexibility to adapt and evolve.

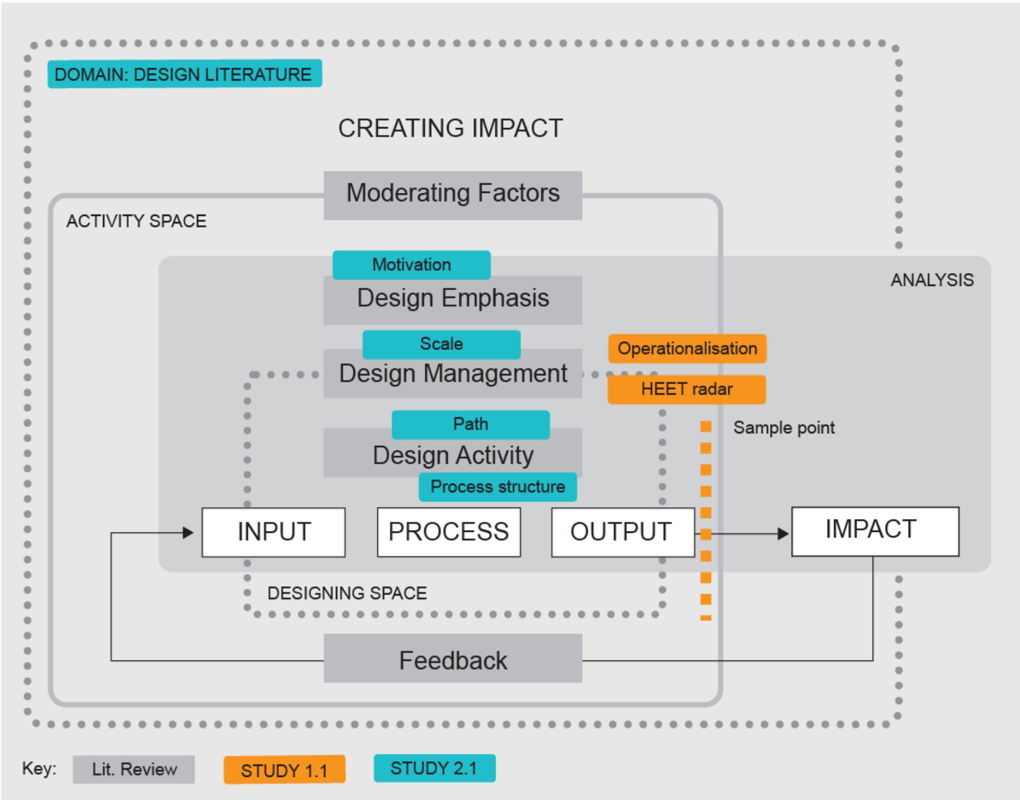

Figure 5.6 *Prototype Framework for UDI (Version 3) with outcomes from STUDY 2.1 added*

The updated framework associates the interim ontology classes with factors derived principally from Candi & Gemser's (2011) review as follows:

- Design Emphasis – *Motivation*: The relationship between these two concepts needs further exploration. But it can be seen that these two interconnected concepts are critical throughout the complete process journey.
- Design Management – *Scale:* This relationship is clearer. Particularly in the initial planning stages of design, *Scale* is a factor for managers of design to reconcile, although it is not a feature of established academic design management theory.

- Design Activity – *Path* and *Process structure*: The IPOI model combines *Who, What a*nd *How* factors associated with *Design Activity.* Candi & Gemser (2011) refer to *Capabilities*. *Path* and *Process Structure* are adopted as ontology class terms to accommodate these significant recurring themes within design literature.

5.2.6 Summary

The interim design process ontology developed within this study is an extension of the literature review work. It adopts the principles of ontologies as used in digital contexts as a means to structure and rationalise the 'constellation' of factors which need to be considered within the exploration of design impact. The work provides a robust foundation for the subsequent exploration of these factors. In doing so the ontology is also judged to have potential to address criticisms of design research in general, together with epistemological criticisms of design process studies.

5.3 Evaluation

In order to develop the ontology and prototype framework for UDI further, the next studies will generate data and findings which can be mapped onto an expanded ontology in the final prescriptive STUDY 2.2. For example, they will provide a basis for identifying significant factors within the *Input* and *Output* classes. The process for STUDY 2.2 will follow a similar literature review and paper prototyping approach to the one described above.

At this point it is not demonstrated that elements of the ontology approach have a practical application beyond informing the development of a prototype framework. It is conceivable that the contribution of the work, both within the overall UDI study and within the design research domain, remains towards the top of Love's (2000) meta-theoretical hierarchy.However this approach has subsequently been further validated by publication of a paper derived from the work (Green et al., 2014).

Finally it is worth reiterating the EXTENDABILITY criteria for ontologies – that they should allow for continuous iterative development (Gruber, 1995 & Noy & McGuinness, 2011)

Chapter Six

Reviews of Design Impact

Chapter content Page

6.1 Introduction

The first of two descriptive studies covered in this chapter (STUDY 1.2, ref *Figure 6.1*) utilises the extensive database of case study material from the UK Design Business Association Design Effectiveness Awards (DBA DEA) which have run annually since 1986. The selected data represents a proportion of the total range of types of design impact which might be considered, but is on a similar scale to a number of the frequently cited academic reviews of design impact. In contrast to the existing academic studies, this data set is entirely generated from an industry perspective. Therefore it provides a potentially contrasting (although possibly subjective) viewpoint on design impact factors.

The second study (STUDY 1.3), based on semi-structured interviews with significant figures in the design industry, provides further evidence as a basis to identify and analyse design impact factors and relationships with the earlier studies.

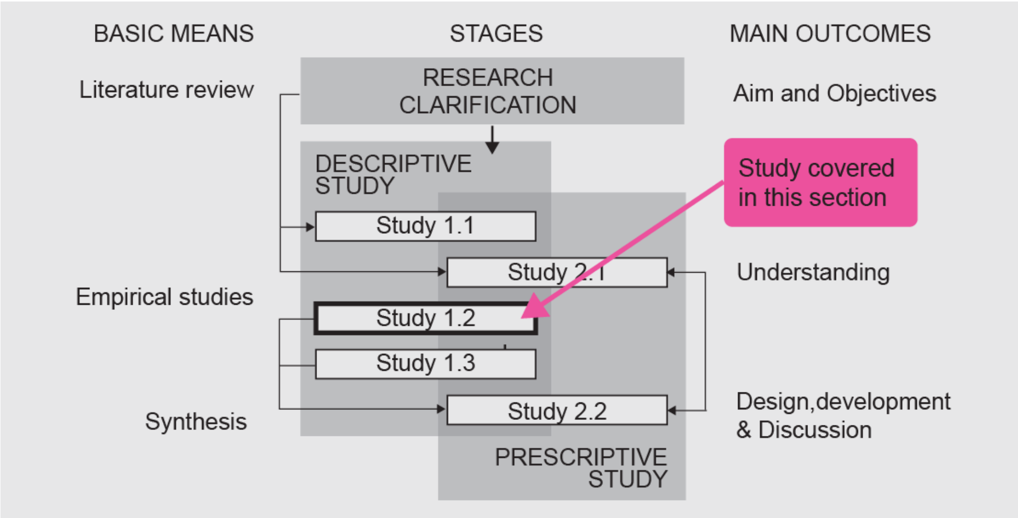

Figure 6.1 *Adopted DRM highlighting STUDY 1.2*

6.2 STUDY 1.2 - Reviews of Design Impact from Professional Practice

Since their foundation in 1986 the DBA Design Effectiveness Awards (DEAs) have played an important role in promoting the value of good design in business success. Winning entries are judged by an expert panel to provide clear evidence of this success. The DEAs are almost alone amongst design awards in evaluating success in terms of commercial or organisational benefits. Collectively and individually the entries provide rich validation and powerful communication of the variety of ways in which design can transform products, brands, services and related market performance.

Within the overall UDI study, the purpose of this review has a different overall goal. It aims to develop a detailed understanding of current best practice for describing and quantifying design impact from a professional practice perspective and for these findings to be compared to the academic literature on design impact. The overall findings of this study will then inform the development of a framework for the understanding and evaluation of design impact.

The nature of the study therefore does not necessarily directly support the goals of the DEAs (promoting design). Likewise the results of the review are not a criticism of this excellent initiative, but might nonetheless also provide useful insights to the DBA for the ongoing development of the awards and the broader challenges of the design profession of promoting the value of design.

A sample of 45 case studies was selected, covering three years of the awards scheme: 2009, 2010 and 2011.The selected cases also cover the spectrum of design disciplines covered by the awards, from brand identity to design for the environment. *Table 6.2* provides an overview of the sample selection.

The DEAs represent the activities of design consultancy or outsourced design industry. This sector is estimated to have a turnover of £7.5bn and the qualities and factors identified here can have parallels in the wider sphere of 'in-house' design activity or the professional practice of design generally within a sector with a total turnover £57.6bn (Livesey & Moultrie, 2008).

The DBA DEAs promote design through developing greater understanding of the potential for design impact in a wide range of scenarios, together with supporting the need to better communicate this potential for added value. This is widely recognised as a crucial issue for the design profession in order to consolidate and enhance the UK design profession's global standing (e.g. Tether, 2005). Therefore the case study data is judged to make an effective basis for studying design impact from a professional practice perspective.

6.2.1 Aim, Objectives and Research Questions

STUDY 1.2 Aim

To develop a detailed understanding of current best practice for describing and quantifying design impact and for the findings to contribute to the development of a framework for understanding design impact.

Table 6.1 *STUDY 1.2 Research Questions*

Overall Research Objectives	STUDY 1.2 Research Questions
Review of current situation RO A To carry out a thorough investigation of current theory and practice for understanding design impact within relevant research literature to provide a foundation of understanding for subsequent studies	RQA3.1 What impact metrics are used in design and related contexts? RQA3.2 What types of criteria are applied in the selection of impact metrics? RQ1.3.3 Are there clear relationships between impact metrics and processes at the early stages of projects?
Analysis of professional practice RO B	RQB3.1 What are the issues and challenges associated

To conduct descriptive studies of design practice to understand relationships between design practice and impact and identify gaps in current understanding	with the use of impact metrics in design practice? RQ B3.2 To what extent can impact be attributable to design?
Developing a new framework RO C To follow a process to create a framework to represent the factors which lead to design impact which, in turn, can contribute to improved understanding of design impact	RQC3 Can current professional practice for defining design impact be translated into workable elements for a new framework for UDI?
Evaluating the new framework RO D To evaluate the framework, including its potential as a basis for new working methods for understanding and communicating design impact	RQD3 Will the translation of professional practice relating to design impact into new categories and a framework be recognisable and useful (e.g. for the design profession and professional contexts for design)?

6.2.2 Content Analysis Methods

The overall research method adopted for studying the DBA DEA data set is formally described as Content Analysis (Patton, 1980). This refers to the process of identifying, coding and categorising patterns in the content as a basis for analysis.

Background to the DBA DEA Data set

Running since 1986, the DBA DEA process is based on design consultancy members working with their clients to assemble and submit case studies of design effectiveness within 19 pre-defined individual categories. These categories have remained largely unchanged since the formation of the awards and reflect the most prominent design specialisms within the design industry and DBA membership. For the purposes of reporting, the categories have been rationalised into four main categories with 14 sub-categories (ref *Table 6.2*). General entry guidelines are provided to entrants and the key point is for consultancies and their clients to assemble data relating to the 'effectiveness', or design impact, of the entry. The Awards attract around 100 entries per year, with a typical 8% increase over the previous year. The scheme is actively promoted to DBA members and is an important part of the DBA's activities.Entrants are charged a fee.

Judging is carried out by a mixed design and business based panel based on the following criteria:

– 'Cause and effect. Proof beyond reasonable doubt of a cause and effect between the design solution and the results, including evidence of the targets set in the original brief against the results achieved.'

– ‘Scale of effect. The significance of these results in the relevant commercial context or in the overall context of the business.’
– ‘Clarity of results. The judges are not looking for an in-depth analysis of why a particular design solution was chosen; they are looking for evidence of the results that have been achieved.’
– ‘Explanation and proof of effect.A project’s success must be linked to measurable fact rather than assumption. Documentation should include factual research to substantiate claims, and wherever possible should be independent of the client and the consultancy.’
– ‘Clarity of presentation. How well written, structured, and presented is the case? Clear, concise entries will deliver a stronger message.’ (Dawton, 2011)

A two stage judging process firstly identifies entrants eligible for a Gold, Silver or Bronze award. A second stage decides the level of award and an overall Grand Prix winner. The entrants have general guidelines for their case studies based on the types of data that might be used to validate design effectiveness: 1) Sales/profitability figures increased against targets in value, volume and profitability; 2) Increased distribution; 3) Market share growth against competitive products, or penetrating key consumer groups or geographical areas; 4) Consumer attitude shifts; 5) Lower manufacturing costs; and 6) Payback period for investment (DBA, 2011). Entrants are also encouraged to refer to earlier successful case studies which are all available online.

The DBA DEA case studies therefore provide a rich source of data as a basis for studying how the design industry and their clients have chosen to present design impact data in order to promote design.

Working in collaboration with the DBA, detailed data was made available for a sample of 45 case studies selected from the 265 submitted in the three years 2009-11. *Table 6.2*shows how the selected sample also represents a spectrum of 14 design disciplines.

DBA DEA case study selection

The numbers and weightings of case studies submitted to the DBA DEAs and the discipline categories reflect the membership of the DBA and well established design specialism-based classifications of design activity, for example print design, corporate/brand identity design and packaging design. To allow for the potential to observe longitudinal effects in the data, a three year period of case studies was used as a basis for the sample selection from 2009, 2010 and 2011. *Table 6.2* shows the overall numbers of entries in each category for this complete three year period. From this complete dataset a further selection was made based on achieving a relatively equal representation of all the main categories across each of the three years. A further criterion for this final selection was based on case studies containing good levels of quantitative data.

The final data set therefore represents a cross section of the main commercial activities and examples of design effectiveness from the UK design consultancy sector. Design effectiveness in this context is defined by the guidelines of the Awards and the imperatives of the consultancies and their clients.

The DBA DEA scheme also aims to promote design impacts for society as a whole with their *Design for Society* category. However, for the purposes of this specific study, these wider design impacts, for example those covered by a Triple Bottom Line approach, are not characteristic of the majority of the DBA DEA entries, and potentially introduce additional levels of complexity. Therefore only one case (6% of the total available) was selected, simply to 'flag' the inclusion in the awards and the emerging importance of this topic.

Table 6.2 *Selected DBA DEA Case Studies*

Disciplines	DBA main category	3yr total	Selected case studies				% of all*
			2009	2010	2011	Total	
2D Graphic Comms	1 Corporate/Brand Identity	60	2	3	2	7	12%
	2 Print	15	1	0	1	2	13%
	3 Interactive & digital media	7	1	1	1	3	43%
3D Packaging & Product	4 Packaging	107	4	4	3	11	10%
	5 Point of sale	5	1	1	1	3	60%
	6 Product	10	2	2	2	6	60%
Environments	7 Interiors	9		1		1	11%
	8 Temporary exhibitions& experiential environments	2			1	2	50%
	9 Museums, Galleries, Events and Visitor	8	2	1	1	4	50%

Disciplines	DBA main category	3yr total	Selected case studies 2009	2010	2011	Total	% of all*
	Attractions						
Strategy	10 Internal Communications	12	1	1	1	3	25%
	11 Communications Design	1				0	0%
	12 Design Management	7		1	1	2	29%
	13 Design for Society	16			1	1	6%
	14 Environment	6	1			1	17%
	Total entries	265	15	16	15	45	17%

*% of the total DBA DEA entries within a main category

Awards data processing

Richards (2005) rationalises data processing, or coding for qualitative research, into three sequential coding categories which are adopted here for the purposes of describing the processing of data from the 45 case studies: 1) *Descriptive coding* – the initial step of retrieving and arranging the data as a basis for study; 2) *Topic coding* – the processes of identifying the relevant parts of the data in such a way that analysis can take place; and 3) *Analytic coding* – the processes for deriving analysis from the data.

Descriptive coding stage

The entrants to the Awards have a high degree of flexibility in how they choose to present their case studies, therefore an initial step was to rework the data into a standardised template in order to make the data manageable. Refer to the *Appendix F* for completed examples of the template used for the detailed case study data. This structure was informed, to a certain extent, by the earlier literature review which identified a core Input-Process-Output framework. Therefore the populated case study template would potentially allow correlation with this emerging framework. In many cases there were minor variations in terminology used within the case studies, particularly in relation to the descriptions of metrics. Therefore another aspect of the descriptive coding stage was to unify terms wherever the meanings were identical.

Topic coding stage

Based on the results of populating the standard template for all 45 case studies, a number of categories of data or ‘topics’ emerged as strong contenders for analysis.

Table 6.3 maps these emerging topics to the analysis carried out. Summary comments on the four *Topic coding categories* are:

– *Rationalised Hard Outputs*: '*Hard Outputs'* are identified here as the range of reported impacts which are evidenced by metrics supported with statistical (or 'hard') data, such as sales growth figures or market share figures. *Rationalised Wider Impacts:* This topic area includes a wide range of reported impacts which are generally evidenced in descriptive terms rather than with statistical data. Examples here include positive customer feedback or winning an industry award. As such, they are tangible evidence of impact, but clearly fall into a 'wider' category. Operationalising or applying metrics to these factors is evident in places, but with limited sector or discipline standardisation.
– *Observations:* Whilst conducting the first phase of Descriptive coding, notes were made in response to the original content. For example, it would be noted if the definition of the case study brief appeared significant to the project impact but it was not clear who had defined the brief.
– *Discipline specific factors:* Due to the pre-existing 19 DBA DEA categories, organising the content by discipline was an obvious step. As mentioned earlier, there was a benefit at this coding stage in rationalising the original 19 categories into four main discipline categories, with nested sub-categories

Table 6.3 *DBA DEA topic coding categories and analysis applied*

Topic coding category		Analysis
1	**Rationalised hard outputs** (e.g. quantitative data and related descriptors)	a) Categorisation of hard output factors and metrics b) Instances of the use of different factors within the data-set c) Comparisons of specific output metrics such as sales growth
2	**Rationalised wider impacts** (e.g. qualitative output data and related descriptors)	a) Categorisation of wider impacts b) Instances of the use of different factors within the data-set
3	**Observations** arising from the case study outputs	a) Rationalisation of observations from output factors b) Categorisation of factors c) Review of factors identified in comparison to the literature
4	**Discipline specific factors** (e.g. within Packaging Design)	a) Comparisons between design disciplines and hard factor reporting b) Comparisons between design disciplines and wider impact reporting c) Comparisons between design disciplines and other factors

Analytic coding stage

More detailed coding of the data within the topics facilitates searching for patterns and themes and potentially for statistical analysis, for example based on frequency of a particular code or theme (Patton, 1980). Detailed coding allows complete traceability back to the original content.

Research Quality considerations

Bearing in mind that absolute validity is not achievable (Neuman, 2007), most research will be compromised to an extent by resource factors. In this case decisions were taken about the sample size owing to restrictions on available resources. Subsequently the rigour of the three stages of coding were limited by available resources. For example, the coding scheme was not tested by third party coding. There are potential threats to validity with all four of Cook & Campbell's (1979) validity criteria. However the threats to validity, such as coding bias, small sample sizes and others, is mitigated by the explorative stage of this study, e.g. the results are intended to guide the overall findings, rather than constitute the final overall findings. There is also a level of triangulation (Creswell, 2002) with the subsequent studies to enhance validity.

6.2.3 Findings

EXPLORATION AND ANALYSIS OF OUTPUT METRICS

The study categorised 157 output metrics identified within the 45 case studies into two main groups: those concerned with quantifiable data (Hard outputs), and qualitative metrics describing the 'wider 'impacts. The 71 types of hard output were further categorised into 11 subcategories. Likewise 86 types of wider impact descriptions were organised into 9 subcategories (Ref Tables 6.4 and 6.5).

Hard Outputs

The DEAs almost uniquely gather industry wide case studies containing the quantifiable data (hard outputs) which are generally considered most meaningful to the business community in terms of validating claims of design effectiveness. The most frequently occurring category of hard output metric was, as would be expected, sales performance (32% or 19 of the case studies sampled). Within sales performance metrics, sales growth percentage and sales growth amount were the most frequently used metrics (Ref *Figure 6.2*)

The average figures from case studies including these key metrics were 163% sales growth and nearly £16m increase in sales.

Table 6.4 *Hard impact categories and sub-categories*

Hard impact category	Code	Sub category (metric)
Sales performance	1a	Sales growth (Value and % increase)
	1b	Sales growth against target (% above target)
	1c	Sales growth compared to sector
	1d	Sales growth analysis (Penetration vs frequency*)
	1e	Sales growth analysis (by key customer segment, region, product)
	1f	Sales growth forecast (further value and % increases)
	1g	Sales value (from the NPD)
	1h	Sales value (in new territories)
	1i	Sales volume (% increase)
	1j	Sales volume (number and % of total market)
	1k	Sales volume (Exemplar individual item sales)
	1l	Sales volume - charity benefit
New business	2a	New business wins (contracts/trade customers/customers)
	2b	New business wins/Sales growth (future orders, % increase)
	2c	New business /sales conversion rates (different stages of New Biz process)(%)
	2d	New business/Customer contacts - enquiries (% increase)
	2e	New business/Target customers (% increase)
Market performance	3a	Market share growth (% increase by value)
	3b	Market share growth (% increase by volume)
	3c	Market growth (% share of total sector growth)
	3d	Productivity - Production (% improvement and volumes)
	3e	Productivity - Sales/New business process (per person) (value)
	3f	Sterling weighted distribution (% distribution within a retailer by total value)
	3g	Increased product/brand distribution (numbers of stores)
	3h	Market Penetration (% increase in households)
	3i	Market share - internal (within specific territory and category)
	3j	Market share ranking (change in position)
Profit / Margins	4a	Price premium / increased margin (Unit price and % increase)
	4b	Cost reductions/margin increase (% and total value)
	4c	Design costs reduced
	4d	Marketing costs (reduction amount)
	4e	Increased profitability (% reduction in discounted prices)
	4f	Profit (amount)
	4g	New business overhead/cost (% reduction)
	4h	New business productivity (per person)(% increase)
	4i	Profit Margin Growth (compared to sector) (% increase)
RoI / RoDI / NPD performance	5a	Numbers of new products introduced (number and % increase)
	5b	Time to market (%reduction and budget saving)
	5c	RoI (Return on investment)(method/basis?)

Hard impact category	Code	Sub category (metric)
	5d	RoI - Return on investment (timescale)
	5e	RoDI - Return on Design Investment
	5f	Number of Patents awarded
Brand / Campaign performance	6a	Audience database growth
	6b	Brand/Campaign impact (increased knowledge/expertise)
	6c	Brand/Campaign impact (Increase in desired behaviour)
	6d	Brand/Campaign penetration (% of target audience reached)
	6e	Brand/Campaign awareness
	6f	PR generated (estimated value)
	6g	Brand/Campaign materials (volume of orders Vs benchmark)
	6h	Brand/Campaign materials (touchpoint numbers - promotional items)
	6i	Brand/Campaign responses (Student applications, % increase and volume)
	6j	Brand/Campaign impact (numbers of petition signatures)
	6k	Brand/Campaign impact (No. national markets launching the campaign)
Online / telecoms impact	7a	Website traffic (% increase and No.)(by target segments)(% bounce rate reduction)
	7b	Online traffic click through rate - CTR (volume and/or % of target market)
	7c	Online spend (% increase and value)
	7d	App. download 'acquisition' rate (volume)
	7e	Online campaign cost effectiveness (cost per click, % cost reduction)
	7f	Telecommunications - growth in calls handled (volume and/or % increase)
	7g	Social media (connections per platform)
	7h	Social media (brand/campaign mentions)
Visitor/footfall metrics	8a	Sales events held (number and % increase)
	8b	Visitor No. / footfall (e.g. exhibition, event etc)(% increase or % above target)
	8c	Visitor spending (per person - retail, catering vs industry benchmarks)
	8d	Visitor pre-registration (% increase)
	8e	'customer occasions' (% increase and number)
Company assets	9a	Employees (% increase and numbers)
Environmental metrics	10a	Material content reduction (value, % weight saving)
	10b	Proportion of recycling from domestic waste (weight and % increase)
	10c	Trade customer benefits (cost and environmental savings)
Other impacts	11a	Corporate sponsorship (% increase and value)

*Penetration vs frequency = new customers vs customers buying more

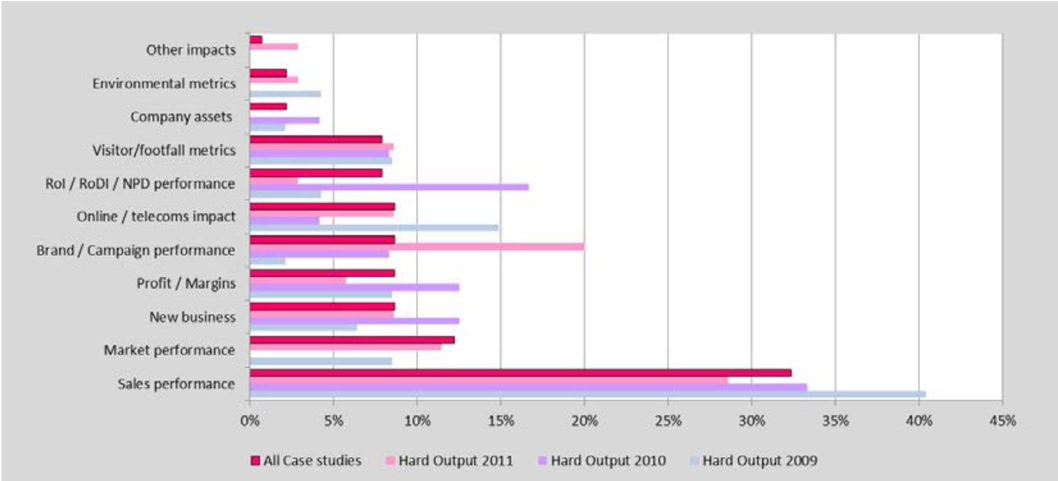

Figure 6.2 *% Frequency of hard output metrics*

Within the case studies which include sales growth and design fee data, the Design Council's measure of ratio of design cost, or fee, to sales grow this shown in *Figure 6.3*. The average from these 19 case studies is £179 for every £1 spent. This is significantly more impressive than the Design Council's figure of £20 increase in turnover for every £1 spent on design (Design Council, 2012). However, it should be noted that the DEAs are exemplars of award winning performance, and that there is limited reliability in this design investment: impact ratio methodology. Across this small data set there is no obvious correlation between the sales growth: design fee ratio and design fee, e.g. we cannot deduce that spending more on design necessarily increases sales proportionally.

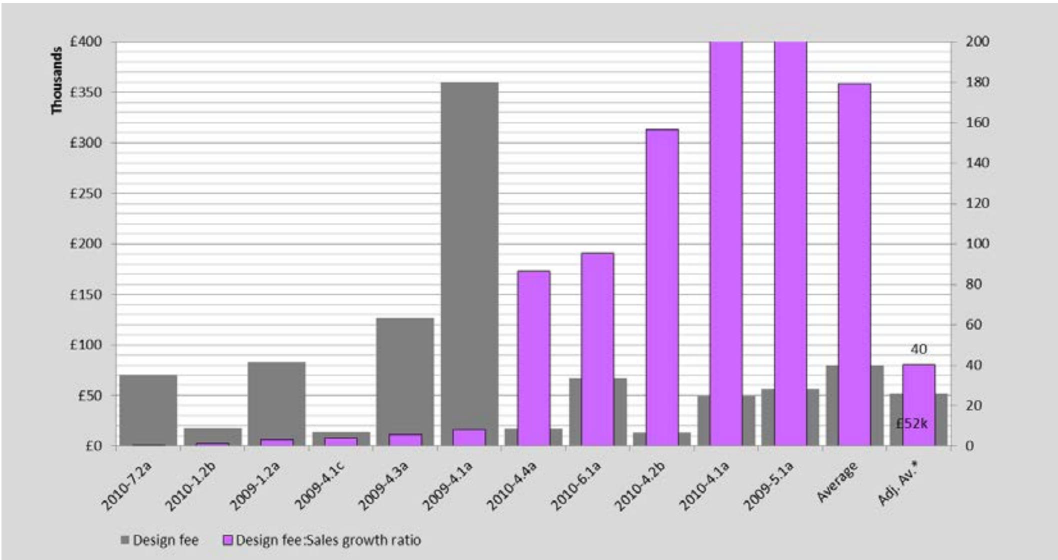

Figure 6.3 *All projects with sales growth & design fee data*

As one would expect, there is also no correlation between sales growth % and amount of sales growth (ref *Figure 6.4*). For example case studies 2009 4.1a and 4.1c both achieve sales growth of around 20%, but 4.1a achieves sales growth of £2.8m and 4.1c £56k. Or put another way, very dramatic sales growth (e.g. of 20% or above) can be achieved irrespective of the size of the market.

Other metrics aiming to illuminate the effectiveness of Design - or NPD investment - are Return on Investment (RoI) and Return on Design Investment (RoDI). These are not widely used in the design community as a whole and within the sample there were reliability and validity questions arising from the specific calculation methods used. From the full sample of 45 case studies, there were 11 instances of use of these metrics, or 8% of the sample. There was a noticeable spike in these measures in the 2010 awards (8 cases, 17% of the sample)

Showing a more consistent growth, in terms of its use as a metric, is the grouping of methods generating hard data to quantify the impact of brand or campaign activity. The full sample shows the number of instances growing from 1 in 2009 and 4 in 2010 to 7 in 2011, or 20% of the sample. However, the variety of factors being measured with these metrics means there is no significance in correlations across this sub-set.

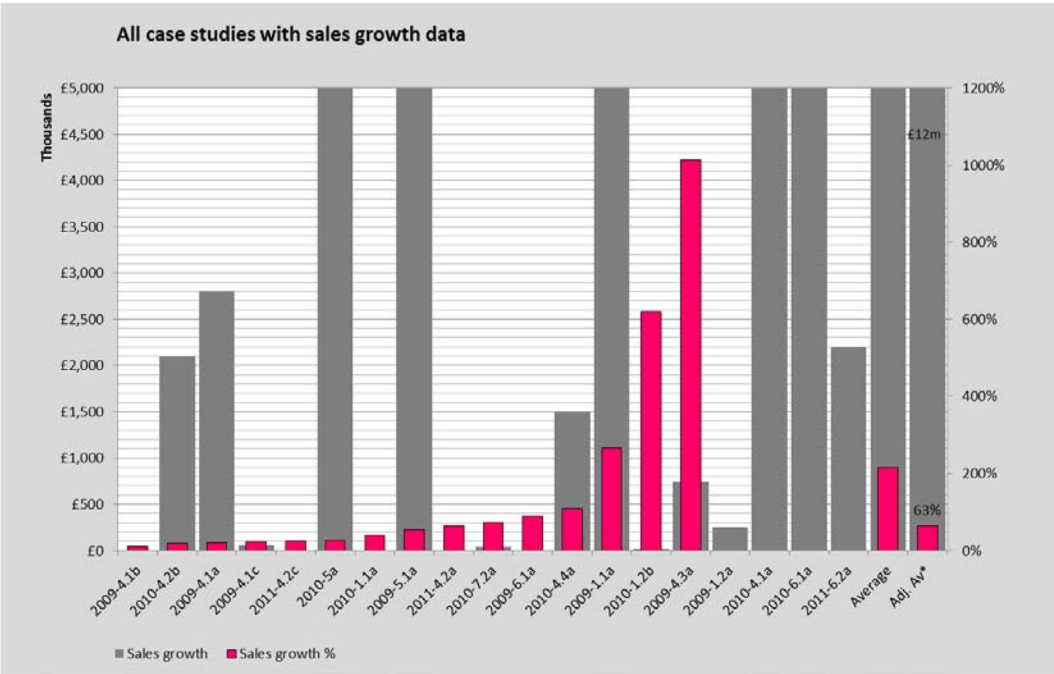

Figure 6.4 *All case studies with sales growth data*

Table 6.5 *Wider impact categories and factors*

Wider impact category	Code	Factor
Stakeholder	1a	Client's employees' moral/confidence transformed/boosted

Wider impact category	Code	Factor
feedback	1b	Client's employee feedback - positive (e.g. from client's staff questionnaire)
	1c	Client comments – positive
	1d	Customer feedback – positive
	1e	Customer survey results – positive
	1f	Customer feedback - positive (online e.g. via Twitter or website)
	1g	Online customer survey
	1h	Online ranking (tripadvisor)
	1i	key stakeholders/beneficiaries (e.g. retailers) - positive feedback
	1j	Target audience feedback - positive (client survey)
	1k	Absence of negative staff or customer feedback
	1l	Visitor satisfaction: Feefo rating
External recognition	2a	Competition wins - recognition by industry peers
	2b	High profile endorsements
	2c	Performance endorsed by professional/Government bodies
	2d	Press/media Coverage
	2e	Press/media coverage (exceeding target readership)
	2f	Press/media feedback - positive
	2g	Press/media ranking (Observer)
Brand/campaign Benefits/impacts	3a	Brand building benefits - general (e.g. from independent audience survey analysis)
	3b	Brand building benefits - awareness of brand (from independent audience survey)
	3c	Brand building benefits - increase in Word of Mouth recommendations (from independent audience survey)
	3d	Brand building benefits - consumers rate the brand values
	3e	Brand building benefits - overall perception of product (food)
	3f	Brand/campaign impact - increased awareness amongst peer companies
	3g	Brand/campaign impact - influencing Government policy
	3h	Brand/design impact - improved customer perceptions
	3i	Brand building benefits - Audience rating in relation to competition (from independent audience survey)
	3j	Customer profile improvement
	3k	Positive behaviour change in trade customers
	3l	Brand building benefits - environmental positioning
	3m	Brand building benefits - increase in brand awareness
	3n	Positive visitor behaviour
	3o	Reduction in absenteeism
	3p	'Trading up' benefits
Role of Design within client company	4a	Design as the central co-ordinating/management principle
	4b	Design spend Vs Advertising spend advantages
	4c	Development has led to improved role for design within the organisation
	4d	Effectiveness of design spend vs competitor's design spend (from independent audience survey)

Wider impact category	Code	Factor
	4e	Influencing future strategy
	4f	Longer term savings in design costs
	4g	Repeat business for agency from client
	4h	Transformed sceptical attitude to consultant input
NPD functional / operational benefits	6a	Functional benefits in relation to industry benchmarks
	6b	Functional features/benefits added/created
	6c	No production cost penalties for new design
	6d	Operational benefits
	6e	Other production efficiencies
	6f	Overhead reductions - recruitment costs
	6g	Product range rationalisation benefits
	6h	Project lead time - inception to product on shelves
	6i	Successful design roll out
Business growth potential	7a	Further business growth potential
	7b	Future business/growth potential
	7c	Future sales growth predictions
	7d	Increases in distribution
	7e	Market performance predictions
	7f	New Business - International distribution
	7g	New Business - International expansion plans
	7h	New business - International opportunities
	7i	Ongoing growth forecasts (market ranking)
	7j	Other business opportunities identified
	7k	Overseas sales growth potential
	7l	Predicted annual rise in customers
	7m	Predicted annual rise in visitors
	7n	Predicted annual sales growth for customers
	7o	Sales growth in related product range/s
Business benefits/success metrics/analysis	8a	Estimated visitor numbers
	8b	Improvement in national ranking
	8c	Market analysis statistics benchmarks (Current market share in sub-sector %) (sub-sector price point benchmarks)
	8d	National ranking against sector specific benchmarks
	8e	Patents awarded
	8f	Sales growth achieved without displacement from other lines
	8g	Sector specific sales benchmark beaten (sales value in number of weeks)
	8h	Trading space/footfall ratio
	8i	What if - potential negative impact of doing 'nothing'
Broader benefits beyond the client business	9a	Benefits to supply chain
	9b	Sales opportunities in related areas (for retailers)
	9c	Broad claims of sector-wide influence

Wider impact category	Code	Factor
	9d	Broader impact/influence on market sector
	9e	Estimated sales volume increase in target audience' spend with key stakeholders/beneficiaries (retailers)
	9f	Paradigm shifting
Other contribution to overall business success	10a	Contribution to general sales success
	10b	Design project influenced company sale
	10c	General success claims
	10d	Indirect savings in overheads

Wider impacts

33% of identified wider impact metrics utilised some form of stakeholder feedback to validate the impact of the design work (ref *Figure 6.5*). This could be from consumers, the supply chain, client company employees or management. Verbatim quotes from stakeholders are a very cost effective, simple and clear way of communicating the wider impacts of design activity.

Amongst the other categories of wider impact identified, reported instances of a positive change in the role of design within companies shows a steady rise over the 3 year sample period: 4% in 2009, 6% in 2010 to 8% of the cited wider impacts in 2011. This is potentially a very positive indicator for the design profession who have long argued for a stronger role within organisations.

Two categories, *Broader benefits beyond the client business* and *Other contribution to overall business success,* which together make up the lowest frequency(8%) of the total cited wider impact factors, demonstrate two points which are critical to an exploration of design impact. This is that there are strong incentives amongst the design community to make broad claims for the value of design impact, but this is coupled to recognised difficulties with providing objective evidence of the specific design component of successful activities.

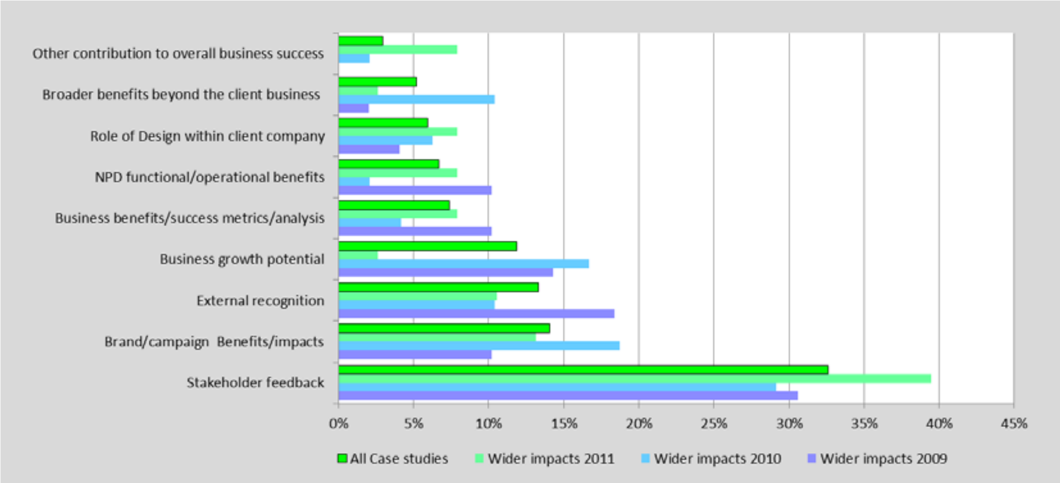

Figure 6.5 *% Frequency of wider impact metrics*

OBSERVATIONS ARISING FROM CASE STUDY OUTPUTS

In addition to the identification of the variety of ways of describing design impact, the study has also generated an analysis of a range of factors associated with understanding design impact. Using a similar coding and analysis methodology, descriptions of outputs have been reviewed and statements have been extracted from each case study. These statements have then been categorised. *Table 6.6* provides a summary of the categories used for these statements and their frequency within the 45 case studies reviewed. Summary commentaries on the factors within each category are as follows.

Design Critical Success Factors (D-CSFs)

It is widely acknowledged in the design impact literature that it is difficult to separate the specific impact that professional design activity makes within any given product, service or brand development scenario. However, what the analysis of the 45 case studies does reveal and confirm is that there are a number of core of qualities or D-CSFs which can be evidenced which are specific to what professional design activity adds to a scenario. Perhaps the most universally recognised of these factors are: 1) the ability to create transformative visual qualities. Other D-CSFs and benefits identified in the study are: 2) design as an alternative to other professional/management activities; 3) embedding design practice within an organisation; 4)the consistent application of design; 5) a focus on user/customer insights; and6)the ability to use these qualities in combination. Recognition of specific D-CSFs, individually or in combination, can provide a basis for more clearly and effectively exploring the contributions of these aspects of the 'design ingredient'.

Table 6.6 *Output comments; categories and sub categories*

Output summary category	Output summary sub category	Review frequency
Design CSFs	Benefits of design over alternative approaches - benchmarking?	10
	Innovative / transformative visual solution - CSF	5
	Close client relationship/design embedded within an organisation - CSF	4
	Consistent application of D-CSF	3
	User/customer insight focus CSF	3
	CSFs in combination (visual innovation plus new features)	1
	Category total	26
Context CSFs	Timing - opportunity and implementation factors	10
	Low baseline design standards?	8
	Category total	18
Operationalisation challenges	Disaggregation difficulty	8
	Acknowledgement of influencing factors? Design as an ingredient or silver bullet	6
	Issues with calculating ROI/RoDI or related factors	6
	Issues with fully validating claims	4
	Under reporting potential impacts	2
	Operationalisation of functional benefits	1
	Category total	27
Strategic -Tactical clarity?	Nexus of strategic approach?	9
	Origin of a key creative/strategic element?	5
	Category total	14
Opportunities/limitations (for designers)	Depth of involvement with broader investment decisions?	2
	Creating design specific terminology/added value concepts	1
	Need for effective CSF identification/communication	1
	Category total	4

Context CSFs (Critical Success Factors)

The DBA DEAs are promoting the overall success of cases where design is a key ingredient. However, from the review of the case studies, a second category of CSFs can also be identified: those instances where a significant element of the success is associated with the context of the design activity rather than, necessarily, the design activity itself. Two main subcategories are identified: firstly, the timing of the project – for example if a project coincides with a significant consumer trend; secondly, if there are low baseline design standards – for example if an existing FMCG product has particularly poorly designed packaging. In both cases there is greater potential for design to have a significant impact. The DEAs do aim to acknowledge these factors with the suggested inclusion of an 'other influencing factors' section of the case studies. Understanding or attempting to quantify the contribution of these context CSFs in detail is perhaps not significant for the DBA, but for the purposes of this study they appear critical.

Operationalisation challenges

The term *Operationalisation* is adopted throughout this study to communicate the desirability in research of translating concepts and theories into practical metrics (Crowther-Heyck, 2005). The close study of the 45 case studies has, to an extent, facilitated the disaggregation of CSFs within the projects. However a number of factors emerge which limit the reliability, granularity and operationalisation of the case study data. Six sub-categories of operationalisation challenges are defined: 1) disaggregation in complex scenarios; 2) incomplete identification of influencing factors; 3) flawed calculation of ROI or RoDI; 4) un validated claims; 5) Under-reporting of impacts; and 6) Overlooking categories of impact. Whilst not reflected in the coding of instances, a seventh operationalisation challenge - difficulties obtaining relevant data for impact analysis – can be added to this list. In the context of the DEAs there are many highly valid reasons for these unresolved challenges. For the purposes of this study, these challenges allude to many factors which require further examination. For example, there is potential value in developing and disseminating a robust methodology for calculating RoDI for adoption by industry, and supporting building a larger data set for benchmarking purposes.

Strategic – Tactical clarity?

It is clear from a number of the cases that there can be a core strategic or creative idea which is at the heart of the project success. Sometimes this core idea might fall into the D-CSF category of transformative visual quality. However, the core idea might often be associated with, what in design terms, would be described as the 'brief'. In these examples it is not always clear if the designers have defined this core strategic idea, if this has come from the client, or if it has emerged from a collaborative process. As with the other points, this doesn't necessarily negate claims of verified design success, but in terms of understanding the real nexus of added value derived from design activity, further investigation is needed. Instances of this phenomenon can be divided into those associated with the strategic underpinning (e.g. within a brief or early foundation to the work) and those associated with a 'downstream' tactical creative idea.

Opportunities/limitations (for designers)

This final category has the smallest number of instances and has been used to incorporate a number of statements which raise questions which may be worth further consideration in the context of elevating design practice. 1) There may be opportunities for designers to be involved with the strategic investment decisions associated with design and NPD. However, it is not clear to what extent designers are actively involved with these decisions with their clients, or to what extent they have in-depth sector experience in these issues. For example can retail designers contribute to the business planning of refurbishment cycles, roll-outs and budget setting of retail design schemes? 2) Corroborated by research studies there is divergent professional perspectives and terminology which can be a barrier to effective communication and collaboration between sectors and disciplines. This is highly relevant to the subject of this study, where there is value in understanding the concepts and communication which can effectively bridge between designers and the wider business and organisational context. 3) Linked to the identification of Design and Context CSFs, the review reveals that there is scope for more accurate definition and communication of the specific CSFs which underpin success.

DISCIPLINE SPECIFIC FACTORS

The combined analysis of hard output and wider impact metrics with observed factors provides a basis for discipline specific analysis. The detailed reporting is limited here to identifying overall points relating to packaging, the discipline with the highest frequency of cases, (*Figure 6.6*).The complete set of discipline specific analysis is included in Appendix G.

It can be argued that packaging projects present the most straightforward opportunity for quantifying impact. This is underlined by all 12 case studies providing sales figures (Ref *Figure 6.6* highlight A). It may simply be a feature of the 12 selected case studies, but, surprisingly, there are no instances of metrics used to demonstrate enhanced performance of the brand (highlight B). The focus is clearly on sales performance. The two instances reporting business growth potential (highlight C), both include ‘Low baseline design standards’, corroborating the potential for design impact when this CSF is present. The packaging projects have a lower overall average for D-CSFs (highlight D), which is counter- intuitive, as one might expect packaging to present the clearest evidence of D-CSFs. However, easier data acquisition in the packaging sector may have led to the entrants placing less emphasis on this element.

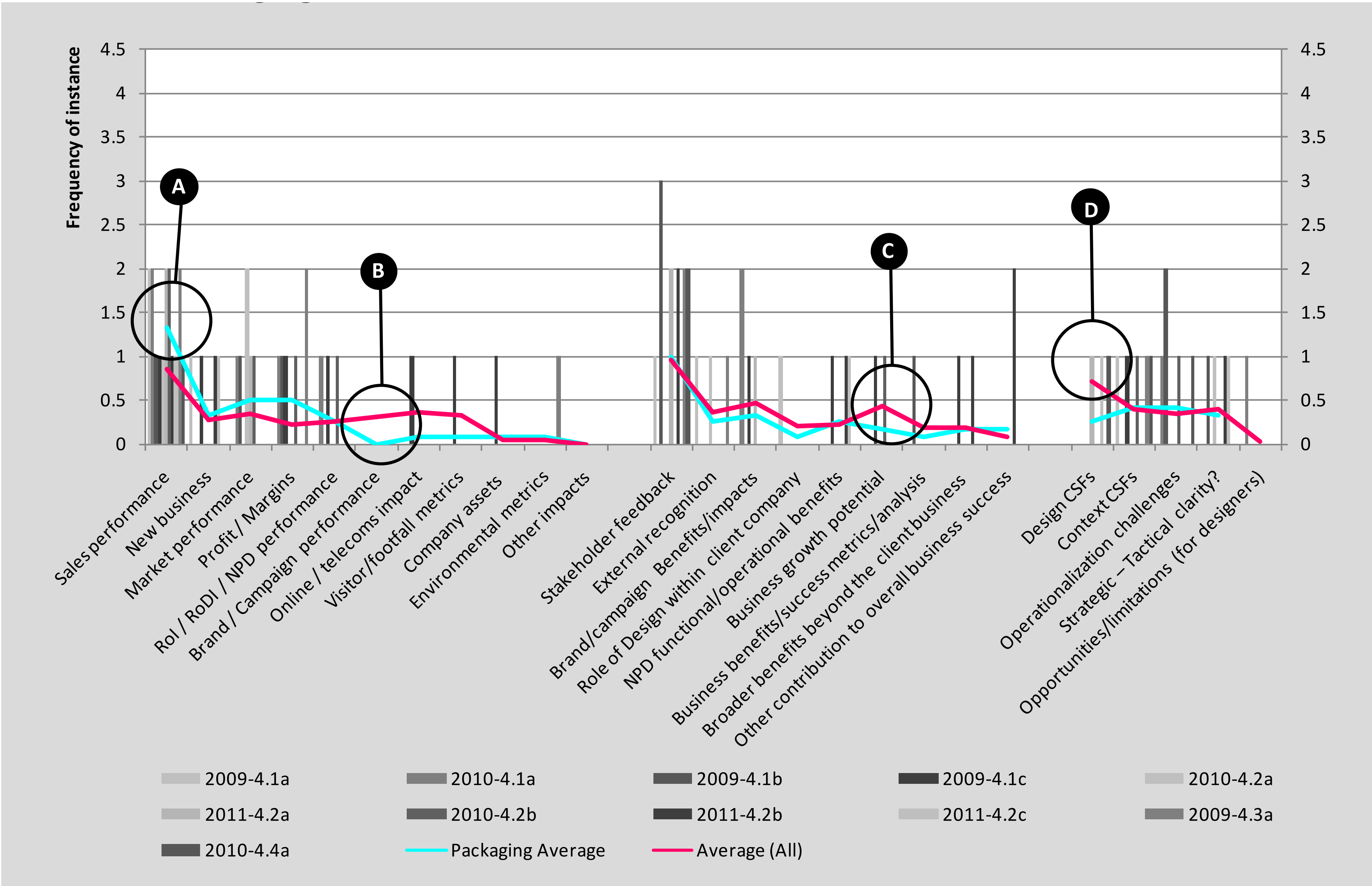

***Figure 6.6** Packaging - frequencies of instances in content analysis: highlighting significant findings*

Packaging projects were the most likely to include sales growth and design fee data (19.5% of the total sample and 75% of the packaging case studies). Therefore, in this discipline, it is also possible to review this sub-set of data. The adjusted average figures are shown in the final bars of the chart shown in Figure 6.7: £1.2m for sales growth and 39% for sales growth % compare to £12m and 63% from all case studies where this data was available. This can be accounted for by the lower unit values in FMCG markets. For example case study 2009 1.1a generated sales growth of £80m with a mid level kitchen brand and the highest achieved by a packaging project – excluding an outlier - was £2.8m for the UK re-launch of a yogurt brand. However, when considering design fees in the discipline, and design fee:sales growth ratios, packaging performs better, with adjusted average fees of £77k versus £52k and design fee:sales growth ratios of 1:52 versus 1:40 (Figure 6.7). A variety of analyses could be drawn from this. Perhaps because more statistical analysis is available for stakeholders in this sector, the value of design is more easily recognised and higher fees can accrue from these factors. Alternatively, perhaps because when considering design consultancy as a whole, there is such divergency in applications for design and types of impact, this will inevitably have a deflating effect on overall average figures.

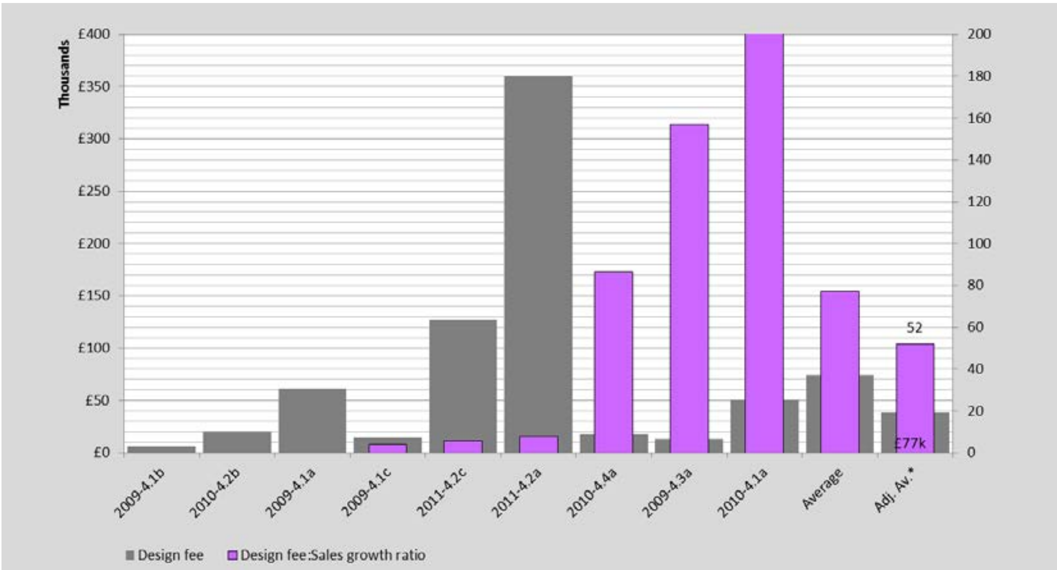

Figure 6.7 *DBA DEA Packaging case studies with Design fee data*

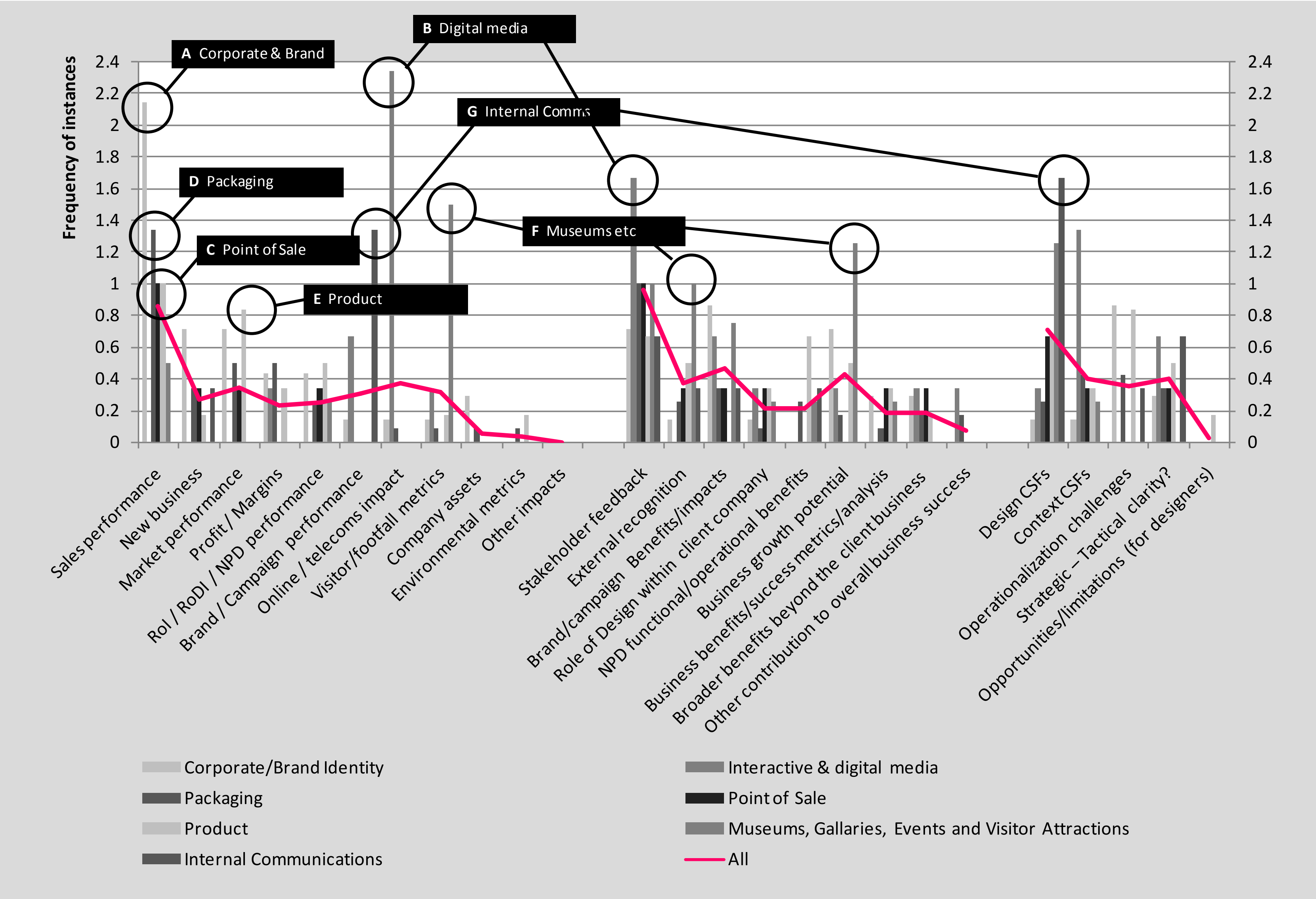

***Figure 6.8** All discipline averages*

All Disciplines

Reviewing all the discipline averages in chart form (*Figure 6.8*) highlights how each discipline demonstrates one or more distinctive applications of metrics or output factors in relation to overall averages. In summary these are:

- Corporate & Brand Identity, Packaging and Point of Sale: *Sales performance*
- Interactive & Digital Media: *Online/telecoms impact, Stakeholder feedback*
- Product: *Market Performance*
- Museums, Galleries, Events and Visitor Attractions: *Visitor/Footfall metrics, External recognition* ***and*** *Business Growth Potential*
- Internal Communications: *Brand/campaign Performance, D-CSFs*

6.2.4 Review

This section reviews the results of STUDY 1.2 in three ways: 1) in relation to the four topic coding categories defined within the study (ref *Table 6.3 & Table 6.7*); 2) review of the limitations of the study in terms of the findings and from a methodological perspective; and 3) a summary mapping of the research questions to the findings and relevant literature review points (ref *Table 6.8*)

STUDY 1.2 review: Topic coding categories

Table 6.7 provides an overview of the key findings in relation to the topic coding categories. Each category has generated useful analysis which contributes to an overall model of design input-process-output. The *Observations arising* category and five subcategories provide a new perspective on the study of design impact. In particular, the findings here reinforce the points made anecdotally and in literature about the challenges of operationalising or disaggregating design impact factors. In any study of design impact there needs to be clarity about the relative importance of disaggregating the design input. For example, it can be argued that the goal of the DBA DEAs is simply to promote design as an overall ingredient of success rather than to understand the nature of the design contribution at a more granular level.

Table 6.7 *Summary Results from DBA DEA study*

Topic coding category	Key Analysis
1 Rationalised hard outputs (e.g. quantitative data and related descriptors)	71 hard output metrics identified, organised into 11 subcategories. (Table 6.4) Sales performance is the most frequently used metric (32% of cases) Specific example: £1:179 RoDI ratio compared to DC's £1:20 Average frequency of hard output metrics = 2.9

2	Rationalised wider impacts (e.g. qualitative output data and related descriptors)	86 wider impact metrics identified, organised into 9 subcategories (Table 6.5) Stakeholder feedback is the most frequently used evidence for wider impact (33% of cases) Instances of reporting a positive change in the role of design have increased for each of the sampled years to 8% in 2011 Average frequency of wider impacts = 2.8
3	Observations arising from the case study outputs	19 factors organised into five sub categories of 'Observations': Context CSFs; Design CSFs; Operationalisation challenges; Strategic-Tactical-clarity?; and Other opportunities and challenges Difficulties associated with disaggregation of factors contributing to design impact is the overall observation. However the five sub-categories identified provide a new perspective on these challenges
4	Discipline specific factors (e.g. within Packaging Design)	Operationalising some disciplines is more challenging than others. For example packaging design impact appears to be more straightforward to isolate Metrics need to be tailored to the context Some well established sector specific metrics can be useful in this context, such as footfall in retail design or click through rates in online digital design

The categorisation of factors provides a basis for operationalisation, for example helping to disaggregate D-CSFs from Context CSFs. Design tends to be presented as a holistic panacea, yet the ways in which it can make an impact- the D-CSFs - can vary considerably in their nature, from craft skills and intuitive practical creativity, to strategic thinking. The 'Gestalt' view can be a barrier to enhanced explanation. Therefore within each sub-category there is potential for further exploration to understand the nuances within these broad categories.

The overwhelming finding from the discipline specific analysis is, not unsurprisingly, that each design discipline and the related business sector or activity lends itself to a tailored set of metrics, many of which are well established within the 'client' industry. For example, *footfall* is a metric for environmental design, and *click-through* rates are a metric for online interactive media.

Exploring the data from a design discipline specific perspective demonstrates that there are important differences between disciplines in terms of appropriate metrics and the relative operationalisation challenges. Packaging design, for instance, is relatively straightforward to operationalise and fits the DBA membership profile well. The DBA DEA data set is less effective as a basis for exploring emerging areas of design such as Experience, Service or Strategic Design. For example, design management has emerged as a discrete design specialism, but is not clearly reflected or reported within these case studies, and typically is not disaggregated within research studies: it benefits Design Management studies to conflate all design activity, likewise it benefits *tactical* support to be integrated into a broader overview of impact.

STUDY 1.2 review: Limitations of the findings and methodology

Data limitations

Inevitably the findings of this study will be limited by the nature of the data. Availability of data is a recognised limiting factor in studies of design impact. The DBA DEA data has a strong commercial, professional orientation and the quantity of data available within the selected case studies and the28 years of the awards is impressive. However, the following points can be identified as limitations created by the nature of the data and how these are mitigated within this study:

– **Underlying bias:** The original data has been generated selectively: firstly, as examples of potentially award winning design impact; secondly, with selection of metrics and statistics to put the design impact in the most favourable light; and thirdly, by limited reflection of the views of other stakeholders in the cases. Designers appear to conflate design into larger claims of impact, with somewhat limited recognition of 'other contributing factors'. This selectivity is mitigated through the limited significance attached to individual cases and statistics.

– **Incomplete sets of financial data**: For example only a proportion of the case studies included sales growth and design fee figures (13, 29%). This is partly because the DBA DEAs do not specify metrics to be used and partly because of the difficulties and sensitivities around gathering this data. Where comparative analysis from financial data is possible, this is carried out. However, statistical analysis is not the focus of the study.

– **Inconsistent definitions and use of metrics**: Whilst it can be seen that there are benefits of tailoring metrics to specific cases, the very broad range of metrics and approaches makes comparative analysis difficult. This creates coding challenges, but the resulting findings are an important outcome.

– **Design discipline category limitations**: The 'traditional' categories used reflect industry understanding and practice, but can mask the most significant design contributions (e.g. Design Management) and emerging fields (e.g. Service Design). Accommodating industry wide practice is important for the recognition of the results by third parties and any limitations are mitigated through the study being a component of more extensive, triangulated study.

- **Limited accommodation of longitudinal factors:** Due to the importance of promoting current examples by the participating consultancies, the case studies tend not to reflect any longer term impact factors which might be at least as significant as the reported results. There is also a, sometimes marked, difference between design disciplines. For example a pack design might have only a one year lifespan between refresh exercises, a store design might have a five year basic lifespan, but a brand identity or product much longer. But the Awards are not geared towards timescales longer than two, or maximum, three years. Whilst this study provides limited insight into long term impact, the results highlight the absence of consideration of these factors.

Methodology limitations

The primary methodology; content analysis and a three phase coding process have generated a significant amount of research data, of which the reported results represent a small proportion. *Appendix F* provides an indication of a completed template from the first phase of coding. Coding reliability has not been tested, for example by conducting sample double blind coding exercises. This is due to the complexity of the material and resource limitations. The potential for coding bias is recognised, however traceability of all the analysis back to the original materials is possible. Key findings from the work, particularly from the analytic coding phase, are ultimately tested through triangulation with the subsequent studies and the development of the UDI framework discussed in Chapter 7.

STUDY 1.2 review: Mapping research questions to findings and existing literature

Table 6.8 maps the study research questions to the main findings of the study together with references to relevant design impact literature. Also represented with the updated prototype UDI framework (*Figure 6.9*), this mapping demonstrates correlations between the study findings and existing literature. Neither the study nor existing literature provide detailed answers to RQ3.3.2: What evidence is there of the use of impact information in early project stages? Generally it has been found that the relatively embryonic study of design impact has not yet explored how understanding design impact factors might have a causality or feedback loop to inform the front end of design. The DBA DEA data is strongly focused on outcomes and performance and does not provide a strong basis for exploring this point.

Table 6.8 *STUDY 1.2 – Mapping research questions to findings*

STUDY 1.2 Research Questions	STUDY 1.2 Findings	Literature review references
RQ A3.1 What impact metrics are used in design and related contexts?	76 identified ‘**hard output’** metrics were categorized into 11 sub-categories 86 types of **‘wider impact’** metrics were identified and organized into 9 sub-categories Averaged across all 45 case studies nearly three ‘hard’ and three ‘wider’ impact metrics are adopted for each case study There was limited exploration of social or environmental impact metrics within the sample. Therefore potentially many more applicable metrics might be used for design impact	Design investment metrics e.g. RoDI (Design Council,2007b, Pikkänen, 2012, Eden Partners, 2012) Models for degree of design emphasis e.g. Danish Design Ladder (Danish Design Centre, 2003; Kootstra, 2009) Design Value indexes (Design Council, 2005a; Zec, 2011, Rae, 2014)
RQ A3.2 What types of criteria are applied in the selection of impact metrics?	**Promoting design**: The DBA DEA sample is primarily focused on metrics which do most to promote the impact of design for the specific discipline and sector involved. **Availability of data**: Access to, quantity of, and sensitivity of impact data are factors limiting the depth of verifiable design impact analysis **Selection bias**: the promotion purpose of the DBA DEAs means that any negative data and analysis are omitted **Triangulation**: although not scientifically applied, there is a level of triangulation reflected in the combined use of hard and wider impact metrics in the overall averages.	Policy Level promotion of design (Roy & Potter, 1993; Sentance & Clark, 1997; Danish Design Centre, 2003; Design Council 2005a, 2007b) Gaps in existing studies (Noble, 2011; Candi&Gemser, 2011; Madano Partnership, 2012) Models to operationalize design impact factors e.g. Silent Design (Gorb& Dumas 1987; Livesey& Moultrie, 2008) Methods to operationalize design impact factors (Hertenstein et al, 2001)
RQ A3.3 Are there clear relationships between impact metrics and processes at the early stages of projects?	Formulation of briefs and other strategic ‘front-end’ activities appear to be critical to the success of project. But the design input to these factors is particularly difficult to disaggregate. The case studies and metrics adopted do not demonstrate unambiguous links between ‘front end activity’ and impact. But this is not the purpose of the DBA DEAs Most of the impact analysis in the sample appears to be a retrospective activity	Impact studies focused on Design Management (Swan et al, 2005; Ravasi&Lojacono, 2005; Chiva&Alegre, 2009; Kootstra 2009; Impact studies including operational context as a variable (Swan et al, 2005; Talke et al, 2009, Tether, 2009) Process studies explicitly discussing impact (

STUDY 1.2 Research Questions	STUDY 1.2 Findings	Literature review references
RQ B3.1 What are the issues and challenges associated with the use of impact metrics in design practice?	**Opportunities/challenges (for designers):** 1) Opportunities to be involved with the strategic investment decisions associated with design and NPD; 2) Developing cross functional terminology and communication skills; 3) Distinguishing between, and more effective understanding and communication of different types of Design-CSFs, 4) Integrate data capture into design practice to improve potential for evaluation **Operationalisation challenges:** 1) Difficulties with disaggregating complex scenarios, 2) incomplete recognition and acknowledgment of all influencing factors, 3) inconsistent or faulty calculations of ROI or RoDI, 4) claims of impact which are not fully validated, 5) Under reporting of all the potential positive impacts, 6) Overlooking the potential operationalisation,7) Difficulties obtaining relevant data for impact analysis of functional benefits within certain types of project.	Existing impact studies have not directly explored the use of impact metrics in design practice as objectives. Design impact evaluation appears to be a challenge for research, but not reported as an issue at a tactical level for professional practice.
RQ B3.2 To what extent can impact be attributable to design?	Design is a significant ingredient of success in the DBA DEA case studies. The extent to which design can be disaggregated as an ingredient remains very unclear. Design can contribute to impact in a number of ways. This is also difficult to disaggregate from overall impact. It is not clear that design investment, even DBA DEA winning input, is an effective indicator of design impact	Companies investing in design perform better than those who donot (e.g. Roy & Potter, 1993; Hertenstien et al, 2001) Correlations between assessments of 'good design' and impact demonstrated (e.g. Hertenstien et al., 2005; Talke et al., 2009) Correlations between *Emphasis* and impact demonstrated (e.g. Danish Design Centre, 2003; Chiva&Alegre, 2009) Causation not reliably demonstrated
RQC3 Can current professional practice for defining design impact be translated into workable elements for a new framework for UDI (e.g. for the design profession and professional contexts for design)?	The study defines a number of categories of factors such as **D-CSF's, C-CSF's, hard impacts** and **wider impacts.** These can be mapped to the developing prototype framework and add additional detail. However the relationships between factors such as the spectrum of **strategic-tactical** approaches, D-CSFs and impacts are complex and have limited reliability (e.g. cannot easily be applied to other cases). The very diverse reporting of these factors within the original case studies suggest significant challenges for the profession and contexts for design in recognition of categories of factors.	Linking an overall process model to design impact is shown by Veryzer & Borja de Mozota, (2005) The strategic-tactical spectrum mirrors the 'Design ladder' (Danish Design Centre, 2003) concept and various scholars have posited their own categorisations of D-CSFs, but with very little consistency.
RQD3 Will the translation of professional practice relating to design impact into new categories and a framework be recognisable and useful?	At this point the framework evaluation question has not been tested in detail. However it is judged that the successful mapping of identified factors to the prototype framework demonstrates a basic level of validity.	Well established academic models with links to this work, such as the 'Design Ladder' can be considered 'should be like' models. Unlike in other impact fields there is no body of research applying and testing these models in practice.

6.2.5 Development of the prototype framework

The evolving prototype framework for UDI is updated (*6.9*) to reflect the main findings of this study. Working backwards from *impact,* metrics to analyse *hard output* and *wider impact* factors are identified (ref the 157 output metrics identified and shown in *Table 6.4* and *Table 6.5)*. Issues of operationalisation previously highlighted in STUDY 1.1 can be considered to apply throughout the model. *Design-CSFs* relate to the overarching question of, why invest in design? *Context-CSFs* is a synonym for *Moderating factors* (Candi & Gemser, 2011). The *Strategic-Tactical* factors can be considered questions for *Design Management* to address and link to concepts such as the design ladder (Danish Design Centre, 2003)

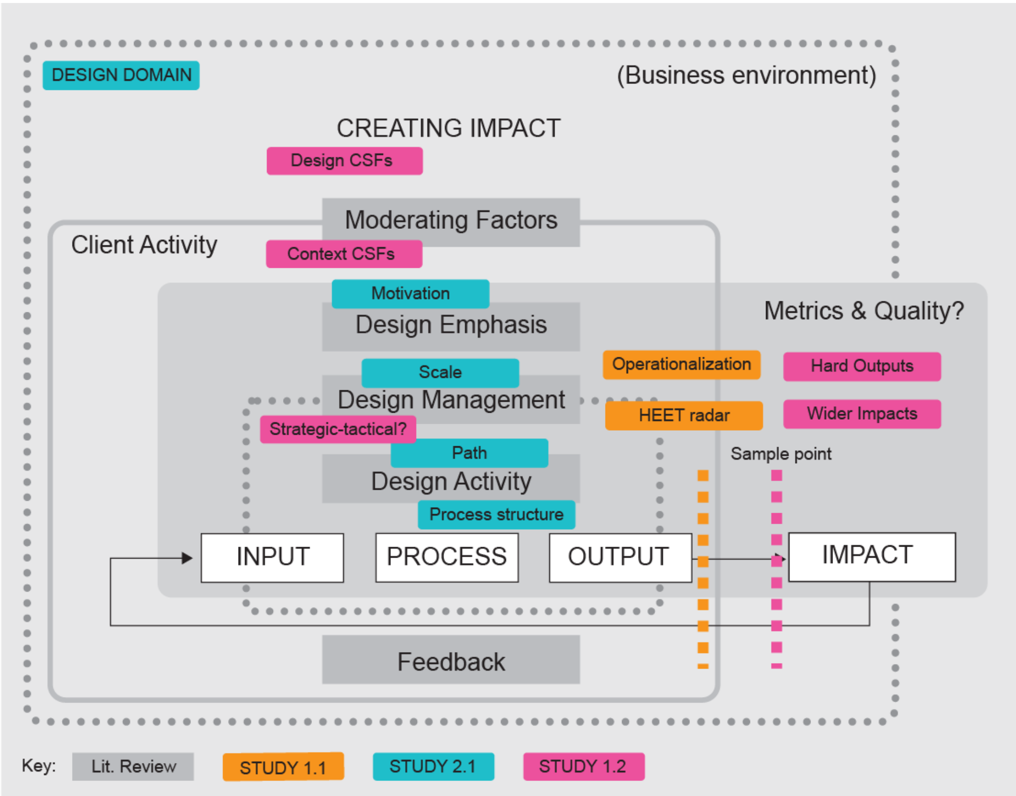

Figure 6.9 *Prototype Framework for UDI (version 4) with outcomes from STUDY 1.2 added*

6.2.6 Summary

The combination of research questions (*Table 6.1 & 6.8*) and topic coding categories (*Table 6.3*) has provided a robust framework for content analysis of the selected sample of 45 DBA DEA case studies. Key overall findings are summarised in *Table 6.8* and these findings can also be mapped to the prototype framework for understanding design impact (*Figure 6.9*). This mapping demonstrates good correlation with the existing body of design impact literature. A categorisation of 'Hard output' – 'Wider Impact' metrics is created and a distinction identified between D-CSFs and Context CSFs. The study also confirms the challenges of operationalisation within the study of design impact and the need for greater clarity in the distinction between the strategic and tactical aspects of design practice.

The nature of the underlying case study data and the purpose of the DBA DEAs are a limiting factor on the scope of the research. But as a result of using data directly derived from industry practice, the study is judged to be an accurate reflection of the outputs and impact of design practice, albeit design of the very highest standards, which intentionally precludes what might be described as 'poor design'.

Associated with the study, a report was written summarising factors of interest to the DBA. This covered the key findings of the work, but distinct from the research objectives, a number of recommendations were made for the potential development of the award data (ref *Table 6.9* and *Appendix H*). These recommendations can also be read as recommendations for better conditions and availability of data for evaluating design impact. The issue of availability of suitable data for research is clearly an issue in this field. These are factors being addressed to an extent by the European policy level work (e.g. Nomen et al., 2012). However the methods for design impact evaluation appear to be as loosely defined and lacking in coherence as the overall research into design impact. The DBA DEA data set is a valuable asset which demonstrates an important alternative perspective to academic and policy led research studies.

Resulting research agenda questions from a practice led perspective might expand to include:

– What might be effective drivers for rationalising approaches to design impact metrics in the design industry?
– What are different stakeholder perceptions of the relative values of different types of design impact metrics and communication (e.g. within hard output metrics or between hard output and wider impact metrics)?
– Can the design profession take a more active role in defining appropriate metrics?

– Can newly defined categories of design impact factors such as D-CSFs and context -CSFsbe more consistently described and understood at a profession wide level?

Table 6.9 *Summary considerations for the DEAs presented in the final report to the DBA*

Considerations for the DBA
The DBA are unique in the world in having pioneered and built up - over 27 years - an impressive library of case studies focused on communicating design effectiveness. This information is more relevant than ever as the design profession faces a number of pressures to evolve and, in the UK at least, maintain its pre-eminent global position. Therefore as a result of this review of the sample of 45 case studies, we believe the DBA is in a strong position to develop this asset and to continue to evolve the approach for the benefit of DBA members and the profession as a whole. The following are initial thoughts on actions which might result from an active approach to developing the DEA asset: - Review the briefing information/template provided to entrants to more easily facilitate deriving ongoing value from the case studies - Review the guidance given to entrants to better accommodate emerging issues and methodologies (for example specific RoDI calculation methods or rationalising metrics used) - Consider work amongst DBA members, Universities and research funding bodies to further develop relevant design effectiveness metrics - Give consideration to developing a managed open source platform for building a comprehensive library of design effectiveness case studies (e.g. providing ready access to sector, product, service or brand specific benchmarks of good practice) for the purposes of professional development within the profession and general promotion of the profession.

6.3 STUDY 1.3 - Professional perspectives on understanding and communicating design impact (UDI)

The second of two significant descriptive studies reported in this chapter uses primary data generated from a series of in-depth semi-structured interviews with design industry professionals and researchers in the field. Collectively this group of interview subjects represents a range of stakeholder perspectives on the topic of *Understanding Design Impact.*

Within the overall research study, the interviews and the findings which form the basis for STUDY 1.3 (*Figure 6.10*) are intended to capture the views and experience of design professionals and practitioners and provide a fourth viewpoint on the topic. This, in turn, will inform the further development of the overall UDI framework.

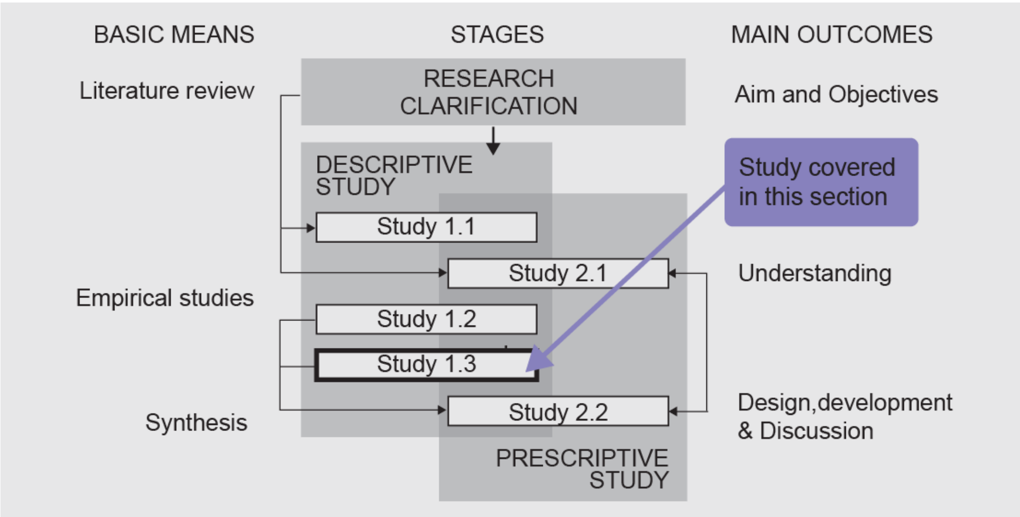

Figure 6.10 *DRM schematic highlighting STUDY 1.3*

6.3.1 Aim, Objectives and Research Questions

STUDY 1.3 Aim

To develop a detailed understanding of current practice, experience and viewpoints about the role of design and how enhanced understanding and communication of design impact may play a part in enhancing practice, outcomes and impact.

Table 6.10 *STUDY 1.3 Research Questions*

Overall Research Objectives	STUDY 1.3 Research Questions
Review of current situation RO A To carry out a thorough investigation of current theory and practice for understanding design impact within relevant research literature to provide a foundation of understanding for subsequent studies	RQ A4 What individual experiences do participants have of discussing and communicating design impact?
Analysis of professional practice RO B To conduct descriptive studies of design practice to understand relationships between design practice and impact and identify gaps in current understanding	RQ B4 What issues and challenges do the participants have with differentiating and enhancing the role of design?
Developing a new framework RO C To follow a process to create a framework to represent the factors which lead to design impact which, in turn, can contribute to improved understanding of design impact	RQ C4 Can verbatim professional experiences of design impact related factors be translated into workable elements for a new framework for UDI?
Evaluating the new framework RO D To evaluate the framework, including its potential as a basis for new working methods for understanding and communicating design impact	RQ D4 Will the translation of professional experiences relating to design impact into new categories and a framework be recognisable and useful (e.g. for the design profession, professional contexts for designing, the design research community and design pedagogy)?

6.3.2 Interview protocol and Content Analysis methods

The research within this study consisted of two main activities: firstly, the planning and conducting of semi-structured interviews following conventions of academic practice typified by the semi-structured interview methodology outlined by Robson (2002); secondly, the process of coding, categorising and analysis of the interview transcripts, referred to as 'content analysis' (Patton, 1980).

Interview protocol

Selection of Interviewees

In line with the study aim of developing a detailed overview of current practice and viewpoints about the role of design, the participants for interview were selected based on their having a current and substantial body of relevant experience and, as a group, covering a spectrum of design perspectives and specialisms. The potential for relating the findings with the DBA DEA data based study was accommodated with the inclusion of a number of professionals with experience of DBA award winning work.

The DBA DEA specialism categories provide a basis for an overview of the selected interviewee sectors and specialisms as shown in *Table 6.11.*

In total 10 interviewees were selected. This number was judged to provide an appropriate balance between coverage of the perspectives and specialisms with consideration of practical time and resource constraints. It can be seen in *Table 6.11* that a number of the participants are included in more than one perspective or specialism category, for example covering a business *and* consultancy perspective. This is due to the participant having a career which has involved working in both areas. Likewise the professional activity of designers quite often covers more than one specialism. Four of the participants can be considered to be involved with design at a strategic level. The distinction between activity which is wholly strategic and activity which is tactical is seen as an important distinction (ref STUDY 1.2). The allocation of interviewees to the categories shown in *Table 6.11* is based on the judgement that a significant proportion of their professional activity could be defined as strategic, or not directly associated with tactical work. In all cases the interviewees have considerable experience in their perspective or specialism, covering a range from 7 to 38 years, with an average of just over 24 years. Within the whole sample there is one each in research and policy, two with a business perspective and the remaining 6 from a consultancy perspective. It is argued that with substantial and successful careers in design, all the interviewees will have a broad outlook on design in business. With the exception of the research and policy perspective interviewees, all the others are directly involved with creating or influencing designed outputs.

Table 6.11 *Overview of interviewee sectors and specialisms*

Design Perspective	Design specialism	Participant code	DBA DEA winners
Design Research		RF	
Design Policy		YC, RF	
Design in business	2D Graphic Comms	BS,	
	Product	IF, BS	
	Strategy	IF, BS	
Design Consultancy	2D Graphic Comms	BM, RY	BM
	Packaging	RY	RY
	Product	GD, MT, LS	GD, LS
	Strategy	EH, BS, IF, BM, GD	

Although beyond the scope and resources of this study, further research following this general approach could explore the perspective of commissioners of design within business. However, amongst the selected interviewees are individuals who have extensive experience ‘client side’, and most, if not all, will have been involved in commissioning design, albeit from a design perspective. Non-designers from industry were considered as a potential source of an additional perspective. However, it was considered that this group would not necessarily meet the criterion of having a current and substantial body of relevant design experience. This was necessary in order to be able to provide informed answers to questions related to design practices.

All the interviewees confirmed their informed consent to participate on the basis of non disclosure of commercially sensitive information and preservation of anonymity. Therefore each interviewee is represented by a two letter code for the purposes of reporting.

Interview guide details

An interview guide and summary information document (ref *Appendix J*) were developed and piloted with the first scheduled interviewee. Each interview was planned to last for 60 minutes and would take place face to face or by telephone if necessary. Minor changes were made to the materials and further consideration given to the timings for each part of the interview guide following the pilot interview. The guide and information were created so that they could, where requested, be forwarded to the interviewees in advance, and/or referred to in the case of interviews conducted over the phone (two instances).

A series of closed questions provided initial background information on the interviewee and established their level of interest in the general topic. From this point onwards the interview became semi-structured with open questions, but followed the general guide arranged into four parts.

The second part of the interview explored issues around UDI and the interviewee’s views from a range of perspectives: their own organisation, the profession as a whole, differences between the consultancy sector, ‘in-house’ and policy levels.

Having established a relatively detailed discussion on the topic, the third part introduced a simplified diagrammatic representation of the prototype UDI framework generated in earlier studies. In the pilot interview a distinct scepticism about the relevance (to the topic and the interviewee's practice) of the *Double Diamond* model (Design Council, 2007a) was apparent and in subsequent interviews the initial version of the diagram was replaced with a one without the *Double Diamond*, although reference to this continued to be made by the interviewer where relevant.

The final section of questions explored a specific case study, either a DBA DEA winner, if the interviewee had been involved with a winning entry, or for other interviewees, a case study of their choice. This final section of questions was guided by the generic Input-Process-Output-Impact model.

The summary information guide provided some general contextualising quotes and images related to examples of existing design impact identification which could be referred to throughout the interview as needed. This was particularly relevant to discussion of broader social and environmental impacts occurring in the final section of questions.

Transcript data processing

Following Richards' (2005) three coding stages adopted in STUDY 1.2, 10 interview transcripts were produced from the recorded interviews and were processed as follows: 1) the *Descriptive coding* involved reviewing, highlighting and retrieving key text in formats suitable for the subsequent phases; 2) the *Topic coding* involved reviewing, editing and categorising key text in a number of iterative steps to facilitate a quantitative and qualitative analysis; 3) the *Analytical coding* phase involved a number of activities to facilitate identification of findings. Table 6.12 summarises how the coding phases and activities combine to create a series of reporting stages.

Table 6.12 *Interview transcript data coding and reporting stage matrix*

Reporting stage / Coding phase	A) Interviewee information	B) Primary categorisation	C) Rationalised & detailed secondary categorisation	D) Tertiary categorisation based on IPO-I model
Descriptive coding	Marking up transcripts for key data and comments and transferring data to a spreadsheet application			
Topic coding	Unifying data into consistent formats	Assigning primary codes to the interview comments	Rationalising the coded comments into a secondary detailed set of categories	

Reporting stage / Coding phase	A) Interviewee information	B) Primary categorisation	C) Rationalised & detailed secondary categorisation	D) Tertiary categorisation based on IPO-I model
Analytical coding	Identification of general findings related to interviewees	Review of comment data by ranking of frequency	Review of data by ranking of detailed categories	Analytical re-organisation into new categories linked to IPO-I model Identification of key findings from the tertiary coding
Data volume	10 one hour interview transcripts 7,009 average word length	446 comments organised into 16 categories	143 secondary categories	14 tertiary categories
Example code	**RY** (interviewee)	RF**1, B** (comment number & primary category)	RF1, B**a** (secondary categorisation)	Ba, **9** (tertiary categorisation)

Research Quality Considerations

The general research quality considerations mirror those identified in section 6.2.2. above. Note that decisions have been taken about the nature of the sample (not including non-designers from industry) and sample size (limited by resources). Both of these potential threats to validity can be either tested by the inherent triangulation of the studies or through recommendations for further research. The coding methodology was not tested by blind third party coding, but in the case of this study, the potential threat to validity through coding bias is mitigated by the relatively direct use of complete transcript comments (quoted in the reporting below where appropriate) and the references to numbers of incidences in the analysis. For example, if a category is defined by a comment which occurs in a number of interviews, it is considered to have a higher level of validity than a single comment. Finally, potential threats to validity are mitigated by the triangulation of the findings with other studies and perspectives.

6.3.3 Findings

A INTERVIEWEE INFORMATION

Table 6.13 *Summary details for STUDY interviewees*

Code	Design perspective & specialism	Job title	Design career length	Transcript word count / comments
RF	Design research	Head of Research	16	5348/35

Code	Design perspective & specialism	Job title	Design career length	Transcript word count / comments
YC	Design research / policy	Lecturer in Design	9.5	4732/32
BS	Design in Business / 2D graphic communications / Product / Strategy	Partner/Director	32	8534/52
IF	Design in Business / Product / Strategy	Independent consultant	31	7911/59
BM	Design consultancy / 2D Graphic communications / Strategy	Founder & Creative Strategy Director	24	6251/44
EH	Design consultancy / Strategy	Board Director	20	6611/46
GD	Design consultancy / Product / Strategy	Founder and Chairman	31	5325/35
LS	Design consultancy / Product	Director	38	8779/60
MT	Design consultancy / Product	Design Director	34	8042/63
RY	Design consultancy / 2D Graphic communications / Packaging	Senior Client Manager	6.5	8557/40

Following the descriptive and topic coding of the transcripts, summary interviewee details were collated as shown in *Table 6.13*. The reporting on the initial questions follows the format of the interview guide (*Appendix J*) and provides an overview of individual perspectives on UDI.

Interest in the topic

RF (2014) had worked on a number of commercial research initiatives in the public sector with direct interests in establishing robust design impact data. This interviewee's interest was at a professional level, rather than a specific interest. This professional interest was tinged with cynicism about the overall value of activity in this area, describingit as a "a lot of navel gazing" (RF, 2014). Others shared this critical view in their general interest. The expression "critically engaged" (BS, 2014) was used, while others stressed the significance of the topic: "the most important thing that the industry needs" (EH, 2014), or "hugely (important), it's something we talk about all the time" (BM, 2014). The remaining views may be considered 'interested' in a pragmatic fashion, for example commenting: "it's important and potentially as an aid to the new business process" (LS, 2014)

Explaining design value

This general question was intended to elicit an overview of how the design profession communicates design impact or value in their working scenarios. In some cases the question was not answered directly, for example: "I don't think the design profession is very good at articulating its value. End of story" (IF, 2014), but in the majority of cases the interviewees confirmed that the primary method is through case studies and the associated narrative. One interviewee stated that they aim to adopt their client's goals and metrics from the outset (BS, 2014).

Effectiveness of the design profession

All the interviewees were generally critical of the level of expertise within the design profession for understanding and articulating design value and impact. This was expressed with various levels of political sensitivity. However, on the whole, the seniority of the interviewees, and their confidence in their own professional abilities, allowed them to be broadly critical, for example stating that design has "failed" as a profession (to grasp the issue) (EH, 2014), or that the profession is "challenged" (GD, 2014). More sensitively, it was stated that the profession generally struggles, but this varies according to the specialism (BM, 2014), or the profession tends to be tactical rather than strategic (IF, 2014)

Methods and tools for UDI at the FEI

Reflecting the generally limited level of engagement with the topic by the design profession, the majority of the interviewees provided quite generic responsesto this question, such as reference to showing case studies and conducting workshops with clients (RY, 2014), or using various methods to identify and explore a wide range of factors at the front end (EH, 2014). This general approach was perhaps best expressed as "using the pragmatic end of the tool kit" and a "cut and paste" approach (for selecting methods) (MT, 2014). Others, with a possibly more strategic dimension to their own professional practice, commented on the need for a "situation analysis" (IF, 2014) or used a medical metaphor: "diagnosing" the "ailment" (LS, 2014). This question also gave the opportunity for the interviewees to promote their own best practice. In this context, what might be described as 'emerging methods' were referenced, including video ethnography (LS, 2014) and the Business Model Canvas (IF, 2014). BM (2014) noted that they aim to establish metrics at an early stage in the process. Other interviewees tended to describe methods and tools in general terms rather than highlighting those with a specific focus on the hard quantification of design impact factors.

The simplified UDI framework

Following the removal of the double diamond reference from the piloted interview information, the schematic diagram was easily understood and a provided a useful means to explore where the interviewee's particular interests and comments were situated. One further interviewee was particularly critical of the double diamond model – because in their view it does not reflect actual practice (GD, 2014). There was a general sense that putting design into a broader context was important and helpful, confirming that design should be at "the business table": "I'm fundamentally convinced of that" (RF, 2014). Within the diagram there was clear recognition of the importance of the front-end, for example as a basis for understanding needs as a basis for value creation (BS, 2014), and of the need to understand the business environment (IF, 2014). The complete framework was also useful, as a number of interviewees pointed out; for understanding and "juggling all the factors" (EH, 2014), "seeing and knowing your place in the big picture" – although it is complicated (MT, 2014) and the relationship between the front end and impact needs to be understood (LS, 2014). A slight note of caution was that whilst understanding the front end and the big picture are important, the translation of strategic thinking to creative output remains crucial (BM, 2014). One interviewee from research and policy fields used the diagram as a basis for highlighting what were described as challenges with horizontal and vertical communication, and the contention that the significant challenge is with horizontal communication (e.g. from start to finish across many discipline areas) (YC, 2014).

The nexus of (Design) success

Based on the findings from STUDY 1.2, this area of questioning might also be summarised as 'what are the *Design Critical Success Factors*?' One interviewee highlighted the difficulty of disaggregating any single CSFs, referring to the need for overall consistency in quality and implementation (GD, 2014). However, the challenge of disaggregation reported across the complete set of interview transcripts is a significant finding explored in the subsequent phases of analysis. Perhaps a surprising finding at this point, certainly in relation to the general body of research literature, was that the majority of the interviewees' responses to this area of questioning related to the socio-cultural context of design activity. For example, they referred to the importance of creating sufficient confidence for companies to invest in NPD (EH, 2014), having a consensus on goals, vocabulary and views (MT, 2014), the ‘vision’ of the CEO (BM, 2014), client relationships (RY, 2014), and design champions within the client company (LS, 2014). The interviewees clearly identify the socio-cultural working context as critical to the success of design activity, using the terminology of STUDY 1.2; a *Context – Critical Success Factor.*

Desired metrics?

Relating directly to the importance of socio-cultural factors within a working context, IF (2014) highlighted the desirability of a metric to track internal design management competency. LS (2014) suggested a metric to demonstrate how managers’ careers had been enhanced by good design management. This related to the perceived importance of design champions, but also the motivating factors for potential design champions. For example, it was thought that if managers could understand the impact of good design management on their careers, they might pay this more attention. Picking up another aspect of socio-cultural factors within a working context, BM (2014) suggested a desirable metric would be one which identified the internal culture within an organisation. This would be particularly relevant for evaluating the impact of branding programmes, where tracking the ‘before’ and ‘after’ culture would be a way to demonstrate the impact of a branding programme. Other interviewees’ comments reflected the complexity of the topic with ideas for desired metrics including the quality of decisions (BS, 2014), means to evaluate intangible ideas (EH, 2014), evaluation of the ‘wow’ factor (MT, 2014) or “desirability” (GD, 2014). And rather ambitiously, but also underlining the disaggregation difficulty, the desire was expressed for a single metric to cover all the ingredients of a complete programme of activity – strategy, creative, implementation.

Consideration of social and environmental factors

It was clear from the responses to this question that for these participants, these factors are not a significant consideration. Where they are considered it is always in the context of an economic driver. MT (2014) took the view that these factors result in a trade-off against economic factors, but that they do consider these when there is a ‘pressure’ from their clients. LS (2014) echoed the client driver scenario and commented that there is limited understanding of, but increasing consideration of, these factors.

B PRIMARY CATEGORISATION

The next phase of content analysis involved assigning each of the comments identified in the descriptive coding stage with a general category. Because of the semi-structured, open questioning nature of the interview guide, the responses to questions did not always provide a direct answer. Also, the answer to a line of questioning might fit better into another topic area. Therefore this primary categorisation allows for these mismatches between questions, responses and topic areas to be rationalised. *Table 6.14* provides an overview of this primary categorisation ranked by the frequency of comments (ref column 3, Freq (1)).

The volume of comments in the highest ranking primary category (*Issues with/challenges for the designers/the design profession*) supports the overall validity of the topic as a basis for research. The 2nd equal and 4th ranked categories, *Recommendations for tackling impact issues* and *Difficulties or challenges with the topic* would appear to further confirm the complexities and challenges associated with the topic identified in the literature.

Table 6.14 *STUDY 1.3 Primary topic coding categorisation ranked by frequency of comments*

Code	Category Description	Freq. (1)	Freq. (2)	Sub cats
E	Recommendations for tackling impact issues	46	97	19
D	Issues with/ challenges for designers/the design profession	69	77	12
B	Difficulties or challenges with the topic	43	73	12
G	Consultancy / participant approach to planning/impact evaluation	44	36	9
H	Points in relation to initial framework diagram	36	35	11
N	Recommendations for impact metrics/evaluations	26	25	10
O	Considerations in relation to social and environmental factors	23	23	15
J	Issues/points in broader business (client) fields (sectors and functions)	41	20	12
A	General interest / relevance of topic	20	20	9
I	Factors in broader fields of branding, innovation and NPD	25	16	10
L	Consultancy / Participant specific points – Case study points	46	14	8
C	Consultancy / participant’s focus	14	13	8
M	Views on nexus of success, or key CSF	12	6	4
F	What designers want	8	6	2
K	Impact factors in the wider environment/context	7	5	3
P	Policy level issues	6	0	0
16	**Totals**	**466**	**466**	**144**

C SECONDARY CATEGORISATION

In order to have a basis for more detailed analysis of the identified comments, a second phase of categorisation took place using the primary categories as a starting point. As a result of this secondary categorisation 144 detailed categories were defined and the number of primary categories reduced to 15 as a result of reassigned comments. *Table 6.14* is ordered according to the frequencies from this secondary categorisation. This confirms the earlier point about the complexity and challenge of the overall topic, with over half of the comments (247) falling within the 3 highest ranking categories (E, D and B).

For the purposes of reporting the results, commentary is provided on the secondary categories which ranked from one-to-eight for frequency of comment (ref *Table 6.15*). The two categories ranked eighth equal are each groupings of 10 original comments. This gives a rough indication that up to half of the interviewees made a comment in this category, indicating a good level of reliability in the finding. *Appendix L* shows the complete set of primary and 144 secondary categories.

Table 6.15 *STUDY 1.3 Secondary topic coding categorisation ranked by frequency of comments (Positions one-to-eight out of 144)*

Code	Secondary category title	Freq.	Posn.
Ej	Importance of deep engagement and long term relationships with client	19	1
Eq	The importance of 'Design Leadership' and internal 'Design Champions'	18	2
Bk	The disaggregation difficulty	16	3
Dj	Profession evolving, but limited professional development	15	4
Dh	Personality traits of designers/design profession can be a barrier	13	5
Ba	Antipathy to the topic (e.g. too complex, lacking objectivity, not relevant)	12	6
Bh	Important but difficult factors to evaluate within design impact	11	7=
Di	Designers as a whole not good at understanding / communicating impact	11	7=
Gg	Generic principles from models and frameworks are used - tailored	11	7=
Ef	Designers need to accurately tailor their input - a consultant approach - it might not just be a design challenge	10	8=
Gc	Communicating Design added value: Case studies - with impact metrics when available	10	8=

Importance of deep engagement and long term relationships with client (Ej)

This was ranked number one, with 19 related comments reflecting the idea that deep engagement and long term relationships with clients are crucial to the impact of design. For example, it was said that strong engagement with client companies is "absolutely essential" but "difficult" (LS20, Ej, 2014). A powerful example of the importance of the client relationship was an award winning project with a strong strategic element. In this case the strength of the relationship was founded on an earlier successful project which resulted in a £3bn business win for the client company (BM35, Ej, 2014). Good relationships are needed or "you'll always be at loggerheads" (RY1, 2014).

The importance of 'Design Leadership' and internal 'Design Champions' Eq)

The second highest ranking set of comments (18) builds on the general point about the importance of positive socio-cultural factors. For example, it is important to have an internal design champion: "Absolutely, that's essential. If you don't have one of those you might as well get up and go home because it (design) isn't going to work" (LS44, Eq, 2014). The ability to effectively communicate design value is seen as a mark of design leadership (BS11, Eq, 2014). The Design leadership could mean the "main decision maker" (BM33, Eq, 2014), or the idea of design leadership is interestingly extended to the idea of internal design champions who are not necessarily designers: "Key stakeholders (clinicians) were also part of the strong team spirit" (MT51, Eq, 2014) or "the sales team buy-in was the factor to de-risk the business model" (LS43, Eq, 2014).

The disaggregation difficulty (Bk)

16 comments expressed 'the disaggregation difficulty'. IF29, Bk (2014) sums up the general difficulty with a discussion of the design space encompassing both "magic and logic" and that "it (design) is all about everything". There is resistance to attempts to disaggregate this complexity with the suggestion that design value *could* be understood with "some sort of enormous complex calculation", but with the implication that this is not what is needed by the profession (MT10, Bk, 2014). There is also recognition that design is typically an ingredient in impact alongside other professional activities such as advertising or brand strategy, and that the word 'design' as noted by many researchers, is in itself a problem.

Profession evolving, but limited professional development (Dj)

Ranked forth for frequency of comments (16) was the recognition that although the design profession is evolving – including the challenges associated with design impact – there is limited professional development which might help to address the challenges. This was expressed in very general terms such as the notion that design is an "unfinished symphony" and that designers are "challenged" by design effectiveness issues (GD13,GD33, Dj, 2014), or that emerging factors affecting the profession, such as sensitivity to business and consumers, are not necessarily best tackled by designers (RF17, RF9, Dj, 2014)

Personality traits of designers/design profession can be a barrier (Dh)

Within the primary category of *Issues with / challenges for Designers / the design profession,* 13 comments were categorised within this secondary category. The interviewees were frank with their reflections on their professional colleagues. What links the comments is the implication that these designerly traits limit the capacity of designers and the profession to tackle design impact issues. For example, it was said that designers want their "silo" respected and that this contradicts the idea of being "collaborative" (BS9, Dh, 2014). Designers want to put themselves on a pedestal, to differentiate themselves – "get over it" (BS8, Dh, 2014). EH2, Dh (2014) reflects that designers being in love with designing products as a primary motivation is a barrier to understanding things from a commercial point of view. According to IF22, Dh (2014) most designers are "still effectively saying: 'trust me I'm a Doctor'". Only one of the 10 interviewees did not make a comment which was categorised under this heading.

Antipathy to the topic (e.g. too complex, lacking objectivity, not relevant) (Ba)

Within the total of 73 comments which covered challenges with the topic, 12 were further sub-categorised as reflecting antipathy to the topic. This did not mean amongst the interviewees, who had generally indicated strong professional interest in the overall topic, but amongst a wider stakeholder group. Therefore it was said: "there's a lot of woolly thinking out there in this space". Also there were comments about the attitude of creatives: "there's an immediate roll back from anything that's too empirical, too evidence based, too heavily analysed"(RF29, Ba, 2014). BS3, Ba (2014) doubted the efficacy of any consideration of the topic and commented that people in general do not accept any measure of design impact. MT25, Ba (2014) commented on the difficulty of establishing any link between design input and output: "there is no linearity between them".

Important but difficult factors to evaluate within design impact (Bh)

Seven of the 10 interviewees gave examples of aspects of design impact which are inherently difficult to evaluate. Interviewees drew comparisons between factors which are more straightforward to evaluate such as added value in production (straightforward) versus added value in experience (difficult) (MT8, Bh, 2014), or cost reductions by management consultants (straightforward) versus design concepts based on future scenarios (difficult) (EH38, Bh, 2014). Service and experiential factors were seen as difficult to evaluate using conventional business and scientific methodologies (YC15, Bh, 2014).

Designers as a whole not good at understanding / communicating impact (Di)

A number of the interviewees had a poor opinion of the design profession's ability to understand and communicate design impact. This can also be considered as an endorsement of the value of this research. BM (13, Bi,2014) stated that the design and brand sectors are "not great" at understanding and communicating design impact. RF (3, Di, 2014) used the expression "quite bad". EH (17, Di, 2014) felt that design has "failed as an industry" in identifying the value created by design. IF (4,5, Bi, 2014) pointed out that the UK Design Council has been trying to tackle this issue for 25-50 years, adding "'I don't think the design profession is very good at articulating its value. End of story".

Generic principles from models and frameworks are used – tailored (Gg)

Questions about case studies of design impact, processes and methods adopted by the interviewees in their own professional practice elicited a number of comments which referenced the use of models or frameworks. But there was a degree of reticence about discussing models and frameworks unless the consultancy had proudly created a bespoke tool. Overall there was a sense of not only tailoring models and methods, but also tailoring to the specific client or project scenario. For example MT (12, Gg, 2014) comments that tools can range from informal to formal and are mixed with the "actual instinctive designer thing'.

Designers need to accurately tailor their input - a consultant approach - it might not just be a design challenge (Ef)

Leading on from the earlier points about use of tools, 10 comments emphasise the need for a true consulting approach. The implication is that this can be in contrast to 'conventional' design team business models. IF (IF32, Ef, 2014) summed this up by stating that the right response may not be to spend on design: "If all you have got in your tool box is a hammer everything is going to be nail". MT (MT23, Ef, 2014) pointed out the evolving nature of design opportunities, and that there are new "hybrid guys" who can work in the spaces between marketing and manufacturing.

Communicating Design added value: Case studies - with impact metrics when available (Gc)

10 comments gathered in this category confirm that case studies are the main “ammunition” (LS5, Gc, 2014), or means design organisations use to communicate the value of their activity. These case studies are supplemented by hard data metrics wherever this information is available or it is “easy” to establish metrics (MT3, Gc, 2014). It is worth drawing attention here to the category Bd *Difficulty of getting access to impact data* with 6 collated comments, which highlights an important barrier to the stereotypical holy grail of quantitative metrics.

D TERTIARY CATEGORISATION BASED ON IPO-I MODEL

What was clear from the secondary categorisation phase was that the comments might also be grouped by alternative themes, and that these alternative groupings might provide an enhanced focus on the study objectives and key findings. For example, secondary categories Lf *Successful work leading to increased design activity (circular and referral benefits)* and Ni *Problems with, or use of existing metrics: GVA won't show repeatability* both make reference to circularity or repeatability but individually do not have a high frequency. Therefore the tertiary stage of analytical coding aims to capture these types of affinity. Figure 6.11 is an example of this manual affinity mapping exercise, showing secondary categories clustered around *Moderating Factors* (key terminology derived from Candi & Gemser, 2010).

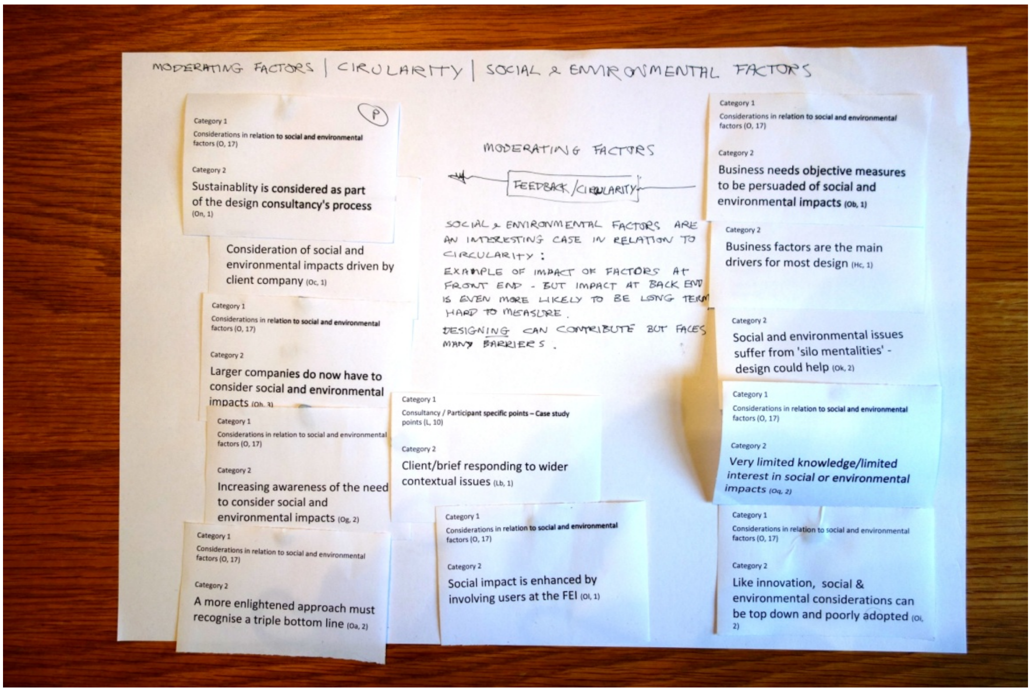

Figure 6.11 *Image from affinity mapping exercise to establish tertiary categorisation of interviewee comments*

As the affinity mapping progressed the number of clusters stabilised and descriptive titles were given to the newly established tertiary categories. *Table 6.16* is a summary of these categories and shows the total number of secondary categories and frequency of original comments encompassed within each category. For reporting purposes the tertiary categories are ordered according to the *Input-Process-Output-Impact* core of the prototype framework. A full record of the 144 secondary categories within the tertiary categories is included in *Appendix L*. Summary points arising from each tertiary category are discussed below:

Table 6.16 *Summary of STUDY 1.3 tertiary categories, ordered according to the IPO-I framework*

Ref	Tertiary category labels and titles	secondary category counts	Comment counts
1	FRAMEWORK/Process structure/Design activity/Path: Models have a value, but their purpose in specific contexts needs to be clear	9	43
2	INPUT/Moderating factors/Context CSFs/Motivation/Design emphasis: The importance of the socio-cultural drivers in a design impact context - Design authority	9	53
3	INPUT/Moderating factors: The complexity of the FEI and the difficulties of designers making an input at this stage - Design Authority	17	51
4	PROCESS/Design Management/Scale/Strategic-Tactical: The importance of design leadership/authority for determining design impact - Design Authority	11	38
5	PROCESS/Design CSFs/strategic tactical: The value of integrative approaches (e.g. branding) – Design Value	10	27
6	OUTPUT/ Moderating factors/Design CSFs/Operationalisation: The need for better recognition of quality factors within the design profession - Design value	11	45
7	IMPACT/Moderating factors/Design CSFs: Limited understanding of design impact metrics and not valued in business contexts - Design Value	10	23
8	IMPACT/Design activity/Operationalisation/wider impacts: Recognition of the value of enhanced practice, but also the difficulties – Disaggregation Challenge	13	45
9	IMPACT/Hard outputs/Wider impacts: Confirmation of complexity and antipathy – Disaggregation Challenge	12	46
10	IMPACT/Hard outputs/Wider impacts/Operationalisation: Recommendations for for impact metrics - Disaggregation Challenge	8	26
11	IMPACT/Design Domain/Moderating factors/circularity: Consideration of social and environmental factors highlights many of the overall issues for design impact – Circularity of design impact	15	22
12	IMPACT/Feedback/Circularity: Impact metrics can link impact back to input and create 'design circularity' - Circularity of design impact	8	23
13	MISCELLANEOUS/Competition reference	3	5
14	MISCELLANEOUS/Participant specific comment	7	14

Models have a value, but their purpose in specific contexts needs to be clear (1)

The interview guide for the study made reference to a schematic framework and enquired about the interviewees' own use of tools and methods. Points arising are important considerations in the development of any proposals for the UDI framework and related methods which might be adopted by designers. A high frequency of comments (Secondary category Gg) confirmed that frameworks and models are used in professional practice, but they are tailored to the specific context (category Ef). There was support for the idea that a framework which encompasses a wide range of factors will help to broaden understanding away from the 'design as a silver bullet' idea perpetuated by some designers and the media (MT35, Ha, 2014).

However a sub-group of comments highlighted that models are not necessarily a panacea. Issues highlighted and not previously reported included the idea that models can obfuscate difficult issues. They oversimplify complexity (category Hi), or when communicating design to business, models can be a distraction: clients "don't care about the process or what they put into it, or the outcome. They just want to see the result"(YC23, Hd, 2014).

The importance of the socio-cultural drivers in a design impact context (2)

Clustered at the input end of the overall framework, are a number of categories/comments which all refer to the importance of a positive socio-cultural context to creating high design impact. This includes the highest ranking category; *Importance of deep engagement and long term relationships with client* (Ej). The notion of *Design Leadership* (e.g. Koostra, 2009) may be part of the solution, but the issue is broader. The term *Design Authority* is adopted as a means to describe how conducive a socio-cultural context is to effective design impact (ref *Figure 6.12*). This would encompass the importance of horizontal integration of strategy to tactics (category Ek) and effective communications horizontally and vertically (category Eh).

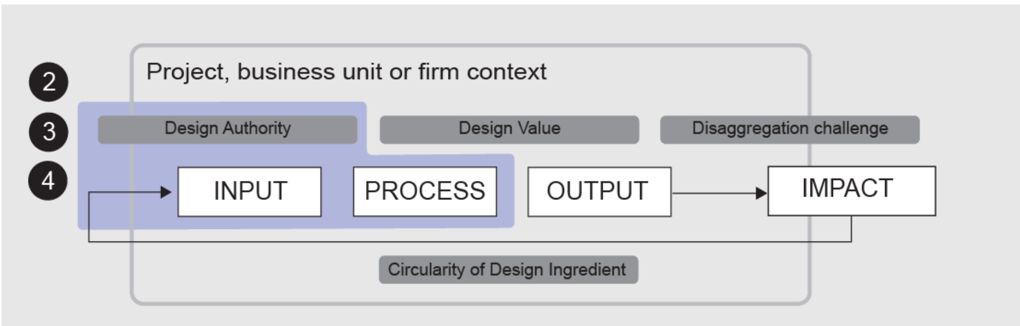

Figure 6.12 *Section of prototype framework updated to show the positioning of Design Authority and related tertiary coding categories*

The complexity of the FEI and the difficulties of designers making an input at this stage (3)

The research questions for this study put a particular emphasis on the Front (or input)end of Innovation (FEI) or design activity. This is based on literature review findings that propose that there is a correlation between the level of integration of design at early stages of NPD and the level of design impact at as a result of output (e.g. Koen et al., 2001). The findings grouped here confirm this (category Hf). But the detailed findings highlight a range of barriers to designers having this early involvement. A conducive socio-cultural context is part of this, but it is confirmed that designers as a whole are not good at understanding/communicating design impact and that this is important in order to make the case for early design intervention (category Di). This perceived poor performance possibly contributes to businesses not considering, rating or valuing the contribution of designers at the FEI (category Db). MT (MT33, Hk, 2014) remarks that the FEI is “too complex... a little bit beyond one or two people being able to nail the nub for a particular project”.

The importance of design leadership/authority for determining design impact (4)

Moving forward to the *Process* phase of design activity, this tertiary category includes the second highest ranking secondary category: *The importance of 'Design Leadership' and internal 'Design Champions'* (Eq). However, grouped here is a secondary category with 8 comments: *Designers need to demonstrate stronger interest, knowledge and empathy for business issues* (Eg). GD sums up a personal motivation for training as an engineer by stating that this was “so that the people who had to implement my designs would listen to me”. However the barriers are not all directly down to designers; companies can have fixed views on the role of design (category Ij) and this can determine if the approach is strategic (judged more impactful) or tactical (category Jk).

The prototype framework is updated to show that tertiary categories 2, 3 and 4 all provide evidence of the importance of *Design Authority* as a factor in creating design impact (ref Figure 6.12).

The value of integrative approaches (e.g. branding) (5)

Supporting the academic added value concepts, 'Design as an integrator' and the 'Design Ladder' (Borga de Mozota, 2006; Danish Design Centre, 2003), a group of comments confirm that design is most effective when integrated into organisations and NPD processes. The most significant groupings put emphasis on the FEI (category Ge) and 8 comments relate to the importance and value of a strategic 'big idea' (category Ei) resulting from FEI activities. But it is important that this added value is effectively translated or integrated into a whole range of 'downstream' activities and long term commitment (category Bl) and consistency (category Ma).

Ideally, potential added value needs to be identified, integrated and tracked throughout an NPD process and beyond, perhaps over a number of years. This overall point and the next two tertiary categories are grouped under a heading of *Design Value,* highlighting that the categories/comments explore how design activity adds value (ref figure 6.13).

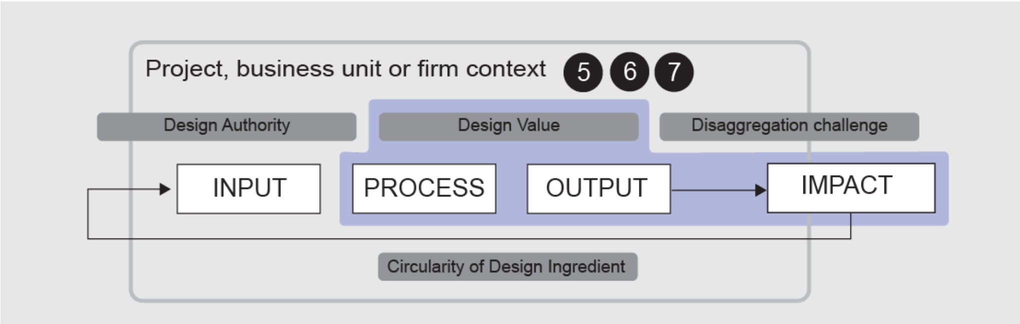

Figure 6.13 *Developing UDI framework updated to show the positioning of Design Value and related tertiary coding categories*

The need for better recognition of quality factors within the design profession (6)

This clustering of secondary categories started with consideration of the *Output* of designing and design impact. The high frequency ranking category; *Profession evolving, but limited professional development* (category Dj) was placed in this category on the basis that these are factors which are affecting the output of design activity. Likewise the category with 13 comments, *Personality traits of designers/design profession can be a barrier* (category Dh), was placed here. These comments and others explored the idea that enlightened approaches to understanding quality and design impact can have a beneficial effect on all aspects of design activity, although it was recognised that "not all design is good and not all designers are good"(RF15, Dk, 2014).Questions of what is meant by 'good design' clearly are significant to questions of *Design Value*, but there is a need to clarify the terms of reference for any exploration of quality. For example, this would distinguish between 'good' designers, 'good' designing and any designed output or impact which might be judged as 'good'.

Limited understanding of design impact metrics and not valued in business contexts (7)

In this cluster, the *Impact* part of the overall framework was the starting point for identifying affinities. RY (RY32, Bb, 2014) succinctly makes a general point that clients will analyse performance, but not necessarily consider the design ingredient. Five comments confirm that there is currently a lack of clear evidence – in business terms – of the design component of impact (category Aa). But eight comments were categorised within the heading, *Clients not interested in measuring design impact* (category Bb). From designers there is cynicism that design can be effectively disaggregated in a way which would capture the particular qualities of what they do – amongst many other reservations. For businesses, it would appear that, whilst very focused on enhancing their performance, there is simply no compelling reason for them to disaggregate the design element of their business performance. The umbrella term *Design value* may be helpful for framing this impasse. For example it can be seen that disaggregation and metrics for *design value* which have legitimacy in the opinion of designers *and* businesses would improve the current situation.

Recognition of the value of enhanced practice, but also the difficulties (8)

Clustered around *Impact,* but also building on the identification of the *operationalisation* challenges, this group of comments collates the interviewees' comments on methods for impact evaluation. The secondary category, *Important but difficult factors to evaluate within design impact* (category Bh), is clustered here with *Communicating Design added value: Case studies - with impact metrics when available* (category Gc). This confirms that it is generally accepted that where there are metrics to confirm design impact these are used and have benefits to the design companies involved. The category with the third highest frequency; *Difficulty getting access to impact data* (category Bd) is highlighted with the comment that "the main problem" is getting access to data to understand design impact, that the interviewees are "totally reliant" on clients to help put metrics in place, and that it is hard to "persuade" clients to do this as they see this as an unnecessary cost to their business. (BM16 &BM17, Bd, 2014).Client 'reticence' could only be overcome with deep client relationships (EH11, Bd, 2014).

There were five comments confirming a lack of effective tools and methods for designers (category Df). But designers would prefer to avoid 'formal' methods for impact assessment (category Ec), e.g. "I think if it gets too formal it could actually work against you" (LC10, Ec, 2014).

Confirmation of complexity and antipathy (9)

This cluster brings together the high frequency secondary categories, *Antipathy to the topic* (Ba) and *The disaggregation difficulty* (Bk). Also grouped here are three comments which indicate that there can be a distinction between the views of large corporates and small business, whereby larger businesses are increasingly recognising *design value* in a strategic sense (category Jf). The complexity of design disciplines and applications for design is seen as part of the problem (Category Dc). RF (RF6, Eb, 2014) advocates the alternative use of the word 'innovation' as a way of avoiding the barriers associated with the term 'design': "the narrow focus on this word (design), and this, rather than what it achieves, is a detriment". BS comments that "business leadership can be intellectually lazy" (BS33, Jl, 2014). This does not mean in terms of hard work, but, speaking about frameworks, it is felt that the information must be very clear, and relate to their primary interests, which of course may not be design.

Recommendations for impact metrics (10)

A total of 26 comments made reference to metrics which might be used to quantify design value and impact. Five of these comments made the point, in different ways, that it can be more straightforward to evaluate the impact of packaging design (category Dl). This is also demonstrated within Study 1.2 where there is a high frequency of packaging projects with quantitative data supporting the results. Two of the interviewees, with extensive experience of working with advertising and marketing professionals, pointed out that these industries have established methods for integrating impact evaluation into their practice. Comments tended to reinforce the challenges of operationalisation, for example three comments were made about the inherently complex notions of "desirability", "Wow" factor and making experiential concepts "real" (category Em). It is worth making the point that these comments relate to the notion of metrics to <u>predict</u> design impact, for example as part of validating ideas and reducing investment risk. With reference to process, RY (RY40, Nh, 2014) pondered that a success factor is the ability to effectively connect strategy, creativity and implementation, therefore a means to evaluate this quality might be useful. Perhaps because a number of the interviewees were also DBA DEA winners there were a number of comments endorsing the value of award schemes for highlighting design impact (category Na). Collectively the three tertiary categories 8,9 and 10 can be clustered with the term Disaggregation Challenge (ref Figure 6.14).

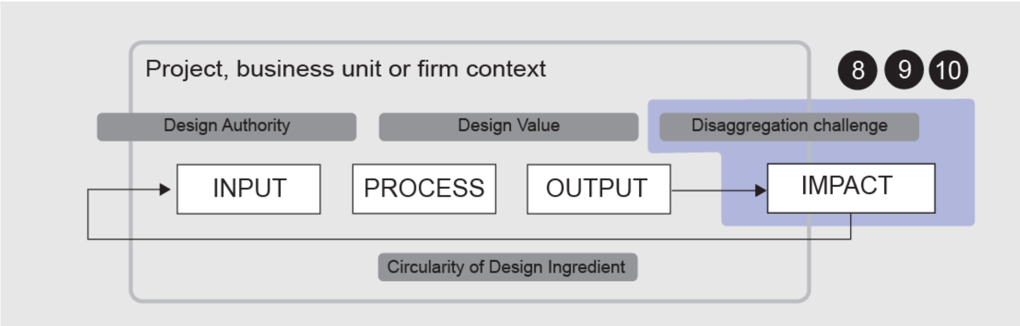

Figure 6.14 *Developing UDI framework updated to show the positioning of the Disaggregation Challenge and related tertiary coding categories*

Consideration of social and environmental factors highlights many of the overall issues for design impact (11)

This tertiary categorisation brings together relevant comments on social and environmental factors from across all the coded comments. There are no single high frequency secondary categories, but what emerges is a sense that for these factors to be effectively considered, the broader contextual view is particularly important. This breadth can simply mean the recognition of the primary drivers for most design (e.g. economic) (category Hc), therefore any consideration is dictated by the client or commissioning organisation (category Oc). A shift in attitudes often requires difficult to shift changes in company cultures (category Om), but social impact can be enhanced by greater involvement of 'end users' at the FEI (category Ol) or the design profession can help to break down 'silo mentalities' (category Ok). Overall there is a sense that the design profession as a whole is lagging or being led by the increasing awareness of the importance of these factors by larger organisations (category Oh).

Impact metrics can link *impact* back to *input* and create 'design circularity' (12)

Secondary category (Nd) *Desired metrics - various: Repeatability / sustainability* clustered a number of comments which emphasised the importance of the qualities which would lead to repeatable design impact. For example IF (IF 56, Nd, 2014) commented: "You want to look at their [a company's] ability to sustain that ability to create new products which are fantastic - Is this repeatable and sustainable?" The point was also made that successful design work will lead to repeat work and increased design activity (category Lf). Two interviewees pointed out that methodologies for demonstrating economic uplift such as GVA do not capture the quality of repeatability (category Ni); “the GVA thing is crude” (IF55, Ni, 2014). Two other interviewees made the point that designers need to be able to “relate” FEI activity to impact (category Hh). As a result of these points the term *Design Circularity* is coined to capture the idea of understanding the potential value of the repeatability or circularity of good design (Ref Figure 6.15).

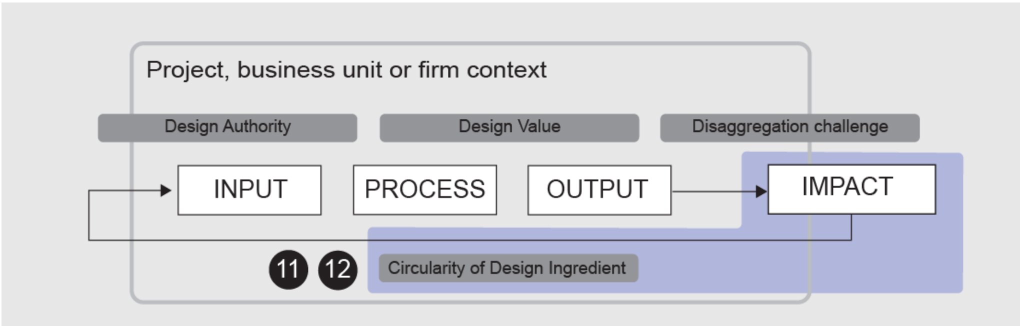

Figure 6.15 *Developing UDI framework updated to show the positioning of Design Circularity and related tertiary coding categories*

6.3.4 Review

Following the structure of reviews in earlier studies this section reviews STUDY 1.3 in three ways: 1) in relation to the coding and reporting stages (summarised in *Table 6.17*); 2) review of the limitations of the study in terms of the findings and the methodology; and 3) a summary mapping of the research questions to the results from this study and relevant literature review findings (*Table 6.18*).

STUDY 1.3 review: Coding and reporting stages

The initial analysis of the interview transcripts against the interview guide questions reveals a strong interest in the UDI topic, but scepticism about the efficacy of any study of the topic. The potential value and usefulness of a framework as a basis for exploration of end to end issues is confirmed. This would encompass a wide range of issues at the FEI, but also, importantly, allows an overview of the complete cycle of activity from FEI to impact. Differences in practice are identified between UDI for ‘could-be’ prediction and ‘as-is’ evaluation. The notion of *Design Circularity* is defined in the tertiary coding stage as a result of a further extension of integrative approaches. There is a basis for deepening the level of design activity within an organisation as a result of successful impact, in turn leading to further design work and creating a virtuous circle. It can also encompass the longer term cycles associated with social or environmental impacts.

At all stages of the coding and analysis the *Disaggregation Challenge* is highlighted. Amongst the factors explored are the inherently difficult to evaluate *Design CSFs*. For example the interviewees highlight qualities such as 'desirability', 'wow' factor or the ability to use creativity to translate a strategic 'big idea' into tangible outcomes. All of these are seen as key differentiators for design activity.

The notion of *Design Value* emerges from the work at the tertiary coding stage, and this encompasses individual *Design CSFs* and the all-encompassing 'design as integrator' design value (Borja de Mozota, 2006). However, both from a business and a design profession perspective, there appears to be limited appetite for exploring and understanding these factors. The barriers include the overheads of obtaining data for evaluation and partly because of the overhead, there is resistance to sharing data.

A prominent finding at all the stages of coding is that many of the barriers identified and potential for enhanced impact are affected by the socio-cultural context of any design activity. The term *Design Authority* is coined to encompass factors associated with a positive socio-cultural context. For example, this includes the notion of the value of design leadership and design champions. At a detail level it may mean a collaborative approach to sharing data and demonstrating design impact. The findings also show that *Design Authority* can be limited by the traits of designers and their limited experience of qualities which may positively influence *Design Authority,* such as being able to converse and see things from a business perspective.

Table 6.17 summaries the key findings emerging from each stage of the transcript coding process.

Table 6.17 *Summary Key analysis from topic coding categorisation stages of the Professional Perspectives study*

Stage	Key Analysis
A) Interviewee information	10 one hour interview transcripts A strong interest in UDI moderated with scepticism Case studies are the primary method for communicating design impact The profession has limited expertise in UDI A distinction between could-be prediction and as-is evaluation methods for UDI A framework for understanding the complete FEI to Impact context is useful A favourable socio-cultural context is a/the key *Context CSF* for enhanced impact A general desire for methods or metrics to evaluate wider impact factors especially socio-cultural factors Social and environmental factors receive limited attention unless 'client driven'
B) Primary categorisation	466 comments organised into 16 primary categories A high frequency of comments confirming difficulties or challenges with the topic and issues for the design profession to address
C) Rationalised & detailed secondary categorisation	143 secondary categories defined The overall contextual factors are identified as; an evolving profession with limited formal professional development combined with an antipathy to the topic from business and the design profession The socio-cultural context influenced positively by: strong client relationships and design champions and leaders, but negatively influenced by the traits and limited understanding by designers/design profession Tactically, disaggregation of design impact is challenging, amplified by the difficulties of operationalising key *Design CSFs*. But there is potential in using enhanced models, more use of effective metrics and tailored approaches
D) Tertiary categorisation based on IPO-I model	14 tertiary categories defined Frameworks are useful and effective if flexible *Design Authority* is defined to encompass the importance of a conducive socio-cultural project environments, design leadership and design involvement at the FEI for maximising design impact Added *Design Value* is derived from integrative approaches at the FEI and throughout the IPO cycle, how value is derived needs better understanding from designers and business, but for either party there is limited motivation to tackle the impasse The *Disaggregation Challenge* is at the heart of UDI. But there is limited appetite to tackle this from a business or design perspective. Amongst *Design CSF*s are factors such as 'desirability' which are inherently difficult to evaluate. The term *Design Circularity* is coined. This can encompass the proven value of virtuous circles of design activity. It can also be useful for exploring the longer term cycles of design impact associated with social and environmental factors

STUDY 1.3 review: Limitations of the methodology and findings

Methodology limitations

The study utilised semi-structured interviews, content analysis and affinity mapping methods.

The combined profiles of the interviewees (ref *Table 6.14*) could be judged notto provide a comprehensive set of professional perspectives, due to the lack of non-designers from industry. The findings relating to the significance of socio-cultural contexts for design do suggest that further research exploring this perspective would be relevant to further understanding of these issues. However, the high frequency of comments relating to the benefits of a conducive socio-cultural context are judged to provide a good level of reliability in these findings.

The second significant potential threat to validity identified at the study design stage was coding bias, possibly exacerbated by a lack of blind third party coding. Experience of the four coding stages did suggest that the coding methodology could have generated slightly different outcomes with third party coders, and that a number of inaccuracies can easily be introduced and, once present, are time consuming to correct. However, these concerns are mitigated by the overall transparency of the data processing and the extensive use of verbatim quotes to validate reported findings.

Similar concerns may be raised by the affinity mapping process where numerous judgements are made about the mapping of comments without input of a third party. But the tertiary coding is effectively highlighting and amplifying points which are already supported with a high frequency of aggregate comments from the primary coding.

Throughout the study, frequencies (of coded comments) are used as a general guide to significance and reliability rather than making any specific claims based on these frequencies. This mitigates any threats to validity based on doubts about quantitative analysis.

Limitations of findings

The findings could be judged to be somewhat generic in their nature, especially the aggregation of findings through the coding process. The study design was not intended to generate quantitative analysis with statistical significance. Overall the study is intended to provide an additional perspective and triangulation to complement the other studies within the overall methodology.

Any of the more specific points made by the interviewees will not provide a basis for research findings claims in isolation, but they do provide a rich database of material, which through the coding process can be used in a variety of ways to provide verbatim quotes to support specific points, to triangulate with other findings within the overall study and as a foundation for future research studies.

STUDY 1.3 review: Mapping research questions to findings and existing literature

Table 6.18 maps STUDY 1.3 research questions to the main findings together with key references from the relevant design impact related literature. Generally the findings are well matched to the research questions. RQ4.3, relating to the interviewees' suggestions for tackling design impact focusing on the FEI, did not elicit any strong consensus or specific recommendations. The findings linked to this question tended to reinforce the general findings relating to the conditions needed for enhanced exploration of design impact in professional contexts.

Table 6.18 *STUDY 1.3 – Mapping research questions to findings*

STUDY 1.3 Research Questions	STUDY 1.3 Findings	Literature review references
RQ A4 What individual experiences do participants have of discussing and communicating design impact?	Interviewees confirmed case studies are the primary method of communicating design impact within the design profession. A distinction is made between; 'could-be' prediction and 'as-is' evaluation methods for UDI Both industry and the design profession have limited appetite for exploring the evaluation of design impact in detail. This is defined as the ***Disaggregation challenge***	*Disaggregation challenges* (Gorb & Dumas 1987; Livesey & Moultrie, 2008; Nomen et al., 2012)
RQ B4 What issues and challenges do the participants have with differentiating and enhancing the role of design?	Business often commissions design based on existing practice and **preconceptions of the role of design** The design profession as a whole, as judged by the interviewees, has historically not been well prepared to articulate ***Design Value*** in terms which are effective in business contexts. This is compounded by the difficulties summed up as the ***Disaggregation challenge*** ***Design Authority*** (a favourable socio-cultural context for design) is defined as a key dimension to being able to transform the role of design into a more strategic as well as tactical activity. Establishing Design Authority can be as a result of a successful track record of design with an organisation and the term ***Design Circularity*** is coined to represent the potential **benefits of virtuous circles of design activity**. *Design Circularity* is also a way of exploring the longer term issues and potential **benefits of design in relation to social and environmental issues**	*Design value* considerations (Design Council, 2005b; Borja de Mozota, 2006; Zec, 2011) Disaggregation challenges (as above) *Design Leadership* (Koostra,2009; Topalin, 2011; Miller & Moultrie, 2013a and 2013b) Design Circularity (Candi & Gemser, 2010)
RQ C4 Can verbatim professional experiences of design impact related factors be translated into workable elements for a new framework for UDI?	The content analysis process provides a good level of validation for identifying the key factors: ***Design Value, Design Authority, Disaggregation challenge*** and ***Design circularity***. These have been mapped to the prototype framework for UDI	Ref Table 6.8 from STUDY 1.2 Linking an overall process model to design impact is shown in other forms (Veryzer & Borja de Mozota, 2005; Danish Design Centre, 2003)

STUDY 1.3 Research Questions	STUDY 1.3 Findings	Literature review references
RQ D4 Will the translation of professional experiences relating to design impact into new categories and a framework be recognisable and useful (e.g. for the design profession, professional contexts for designing, the design research community and design pedagogy)?	There is limited consistency within the design profession for articulating the key elements of ***Design Value***. Therefore improvements in the understanding of and communication, in business terms, of these qualities could be useful. **Frameworks can be useful for the design profession and in contexts for designing**, especially to put design in a broader context, to explore the interfaces with stakeholders 'horizontally and vertically' in the FEI/NPD landscape, **but these need to be flexible** At this point the prototype framework has not been evaluated in detail	Ref comments on Table 6.8 from STUDY 1.2, Veryzer & Borja de Mozota, (2005) directly link design process to design impact and the 'Design ladder' (Danish Design Centre, 2003) is a well established framework for highlighting the value of strategic design inputs. Various scholars have posited their own categorisations of D-CSFs, but with little consistency. The research community do not yet connect up all the identified elements in an overall framework. Design pedagogy tends to be a lagging indicator behind professional practice and theory, but ultimately a beneficiary of enhanced understanding.

6.3.5 Development of the prototype framework

Following the pattern of the reporting of the earlier studies, the prototype framework can be further updated to incorporate the main findings from STUDY 1.3. Therefore *Figure 6.16* shows the inclusion of *Design Authority* at the FEI - Input area, *Design Value* spanning Input, Process and Output, *Disaggregation Challenge* linked to Impact and *Design Circularity* linked to the earlier identification of the Feedback loop.

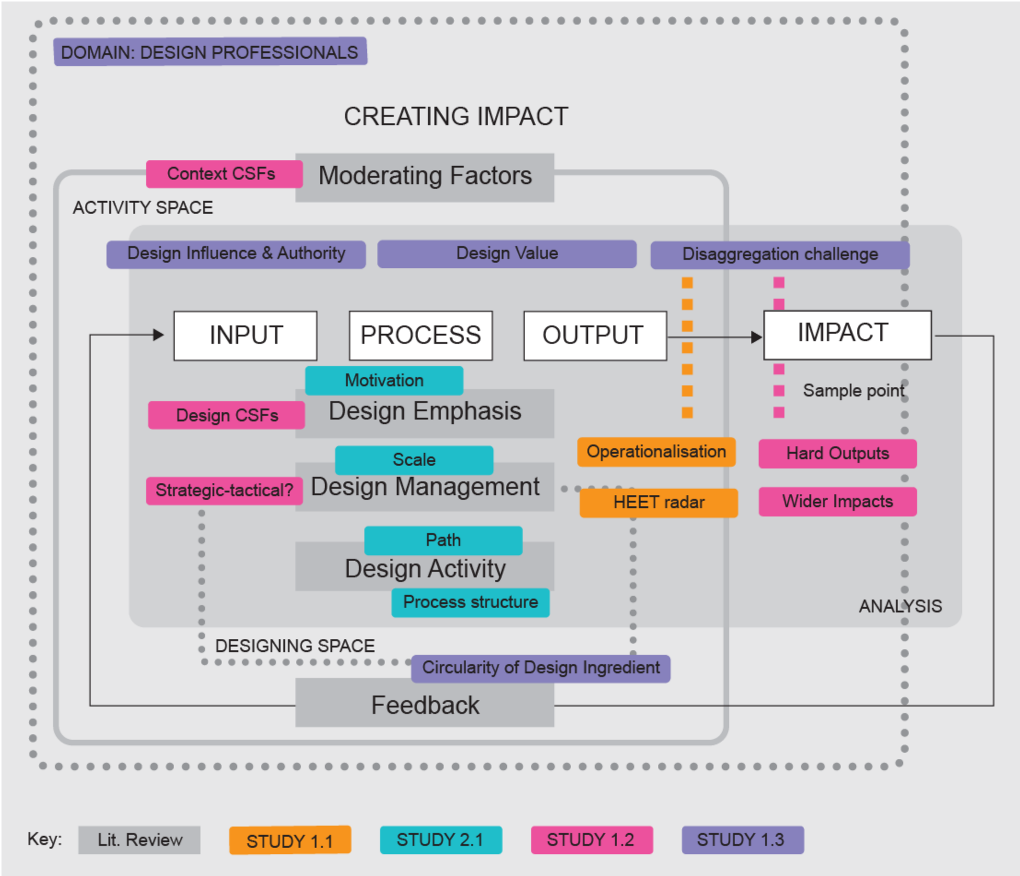

Figure 6.16 *Prototype framework for UDI (Version 4) with outcomes from STUDY 1.3 added*

6.3.6 Summary

STUDY 1.3 was designed to complement the findings of STUDY 1.2. This subsequent study used a series of 10 semi-structured interviews with design professionals from a range of specialisms (ref *Table 6.13*) to gain first hand professional perspectives on the wider range of factors relating to the conditions for successful design impact, particularly at the FEI or Input part of the design and NPD landscape.

The content analysis of the interview transcripts was conducted in 4 stages (ref *Table 6.12*). 446 coded comments were initially organised into 16 categories. A secondary coding process rationalised the comments into 143 sub-categories within the original

16 categories. A final tertiary coding stage used an affinity mapping process to rearrange and review the sub-categories into 12 main groupings which relate to the emerging UDI framework.

The 446 coded interviewee comments provide a rich data resource for understanding and triangulating findings relating to design impact. The comment or sub-category frequencies and affinity mapping process also provided a basis for identifying factors of interest and responses to the study research questions. *Table 6.1*7 provides a summary of the key findings from the four stages of content analysis and *Table 6.*18 maps the research questions to the main findings and to related literature.

Key findings and new knowledge emerging from the study relate to the definition of four groupings of more detailed factors as follows.

- *Design Authority*: Brings together a range of comments and factors which highlight the importance of a conducive socio-cultural context for both positioning the role of design for enhancing design impact, and the subsequent impact from design.
- *Design Value*: Groups comments and factors related to the extent to which business and the design profession understand and are able to leverage the ingredients of design value to enhance design impact.
- *Disaggregation challenge*: Whether emerging at the process or output part of a IPO sequence, this group of comments and factors relates to the various barriers to better granular understanding of the ingredients of design value or *Design CSFs* and how these contribute in conjunction with *Context CSFs* to overall impact. Prominent amongst these factors is the identification of scepticism about the ability to effectively understand design impact and reluctance to directly engage with the challenges, for example through professional development.
- *Design Circularity*: This group of comments and factors highlights that a more enlightened overview of design impact needs to recognise that: A) social and environmental considerations and benefits from design need to be seen across longer timescales than the relatively short term perspectives of conventional economic evaluation, and that this longer term view can inform the FEI and complete cycle of activity; and B) that crucial socio-cultural contexts (e.g. client relations) are enhanced by effective design impact – in

turn leading to further, and more integrated design in a virtuous circle of activity.

The study is not intended to provide specific recommendations for design impact analysis, either for 'could-be' prediction or 'as-is' evaluation. The work does not explore the views of non-designers in industry and there is inevitably some imprecision in the coding process. However the role of the study is judged effective as an important component of the overall study, particularly to gain first hand feedback on the professional context for design practice from experienced practitioners.

The overall key findings – expressed by the new terms - are added to the prototype framework (ref *Figure 6.16*). This overview, combined with the availability of the complete data set of 446 categorised comments, is then a basis for correlation with the detailed findings from the other studies, and informs the further development of the framework.

6.4 Evaluation

This section considers the findings of the two empirical studies exploring professional perspectives on design impact in relation to the complete UDI study.

Together, STUDY 1.2 and 1.3 provide the main empirical evidence for considering design impact factors in a professional context. Therefore the findings from these studies have particular significance in relation to the overall research objectives.

STUDY 1.2, based on 45 case studies of award winning design impact, demonstrated that there are a considerable number of metrics available for evaluating overall impact in scenarios where design has played a part. A Balanced Score Card type approach (Kaplan & Norton, 1992) could be an effective way to bring order to the wide variety of approaches adopted. However, the case studies provide limited insight into the causation between design inputs and impact. There is a strong sense that design input at the FEI is significant, but the detail of this input is poorly articulated in the case studies. In STUDY 1.2, challenges associated with evidencing design impact are summed up as *Operationalisation challenges.* In STUDY1.3 a similar, but wider, concept of *Disaggregation challenges* is defined. These findings support the approach, adopted in STUDY 2.1, of developing an ontology to provide a more robust foundation for identifying and positioning a complete range of factors which have an influence on impact.

The findings from the two studies also confirm points from the literature review, but significantly show a different emphasis or hierarchy of importance to factors explored in the literature. *Design Authority* is defined as a category of factors relating to how conducive a socio-cultural context is as a basis for achieving design impact. This was a marked finding from the STUDY 1.3 interviews. An example is where a strong client relationship or a strong advocate for design within an organisation had been key to the success of the design input. A number of academics have explored *design leadership* (e.g. Kootstra, 2009, Topalin, 2011 and Miller & Moultrie, 2013a and 2013b), but the significance of a wider definition of socio-cultural factors appears to be understated in current literature.

The concept of *Design Valu*e is emerging within impact related research, but there is inconsistency in how this is disaggregated. STUDY 1.2 defines the category Design Critical Success factors to describe the distinct 'designerly' contributors to Design Value. However, this highly significant aspect of design impact considerations emerges as an example of where there is a wide gap between theoretical ideas of design value (e.g. Borja de Mozota, 2006) and the ability of design professionals to articulate design value concepts as a basis for 'elevating' their input.

The ontological approach initiated in STUDY 2.1 has been demonstrated as an effective means to place these identified factors and issues in a complete context as a basis for ongoing exploration and enhancement of understanding.

Chapter Seven

Developing a new framework for UDI

Chapter content Page

7.1 Introduction

Within the Design Research Methodology (DRM) adopted for the overall Understanding Design Impact (UDI) study, this chapter reports on the final study of the complete sequence of studies and the second prescriptive element of the sequence. The final study focuses on the expansion of the initial design ontology developed in STUDY 2.1 (Chapter 5) and the evaluation of the linked Framework for UDI.

In their description of design research, the authors of the DRM approach (Blessing & Chakrabarti, 2009) offer an overview which suggests that design research typically has an aim of improving design (product and/or process) and that an outcome involves the development of proposals for 'support', e.g. 'the term *support* is used to cover the possible means, aids and measures that can be used to improve design' (p4). Therefore the discussion section of this chapter evaluates the outcomes from the complete set of studies and the potential for the framework to 'support' the understanding of design impact in the design profession in practice.

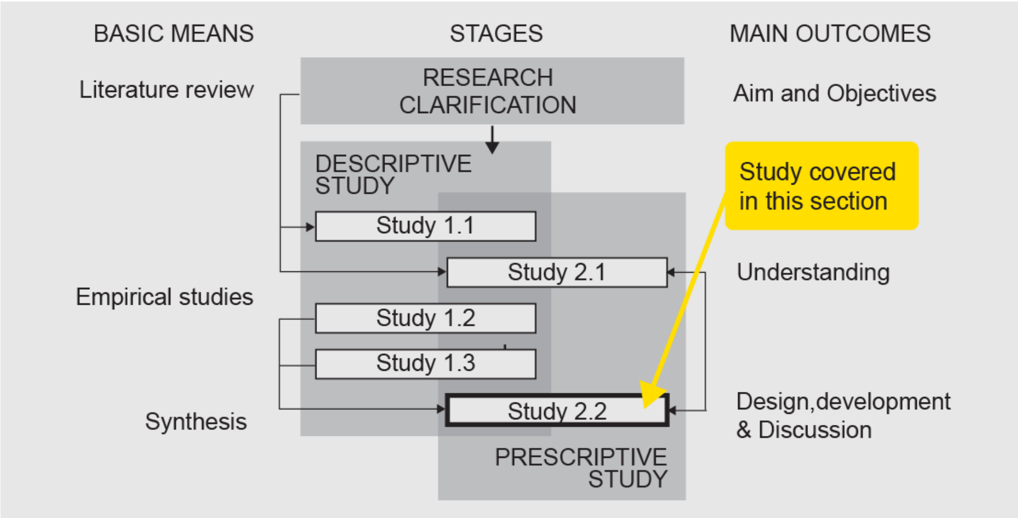

Figure 7.1 *Adopted DRM methodology highlighting STUDY 2.2*

Figure 7.1 shows an overview of the complete DRM methodology, highlighting the final Study (STUDY 2.2) of the complete sequence. The figure includes connecting lines indicating causation and reverse causation between the descriptive and prescriptive studies. Blessing & Chakrabarti point out that this representation of an iterative process reflects the reality of design research, which, similarly to design process, is unlikely to follow a strictly linear path, as controversially implied by many visual representations of design process or research.

An important point made by Blessing & Chakrabarti about Design Research, their DRM recommendations, and in terms of positioning this final stage of work, is that in any instance of design research there can be different relative levels of descriptive and prescriptive elements. In the case of the UDI work this is simplistically represented in Figure 7.1 which shows three descriptive studies in combination with two prescriptive studies. What this also means is that the main findings or research claims for the overall study are not necessarily all outcomes of the 'final' study, but emerge throughout the sequence of studies.

7.2 STUDY 2.2 - Developing a framework for UDI

The work within this study brings together the findings from the earlier studies in a second prescriptive stage of work. The ontology developed in the first prescriptive stage (STUDY 2.1) is expanded to encompass the findings of the two descriptive studies relating to professional design impact (STUDY 1.2 & 1.3). This activity extends the detail of the ontology to the *Input* and *Output* classes of the earlier initial design process ontology. The initial ontology was represented in a number of forms including a schematic visualisation (ref Figure 7.2). The prototype framework for UDI shown as versions 1 to 4 earlier should also be seen as a visualisation of the factors contained within the ontology. The extended ontology will therefore inform a final version of a 'new UDI framework'. Visualisation is an important element of communicating ontology development and exploring ontological commitment, and is a key criterion for ontologies (Gruber, 1995).

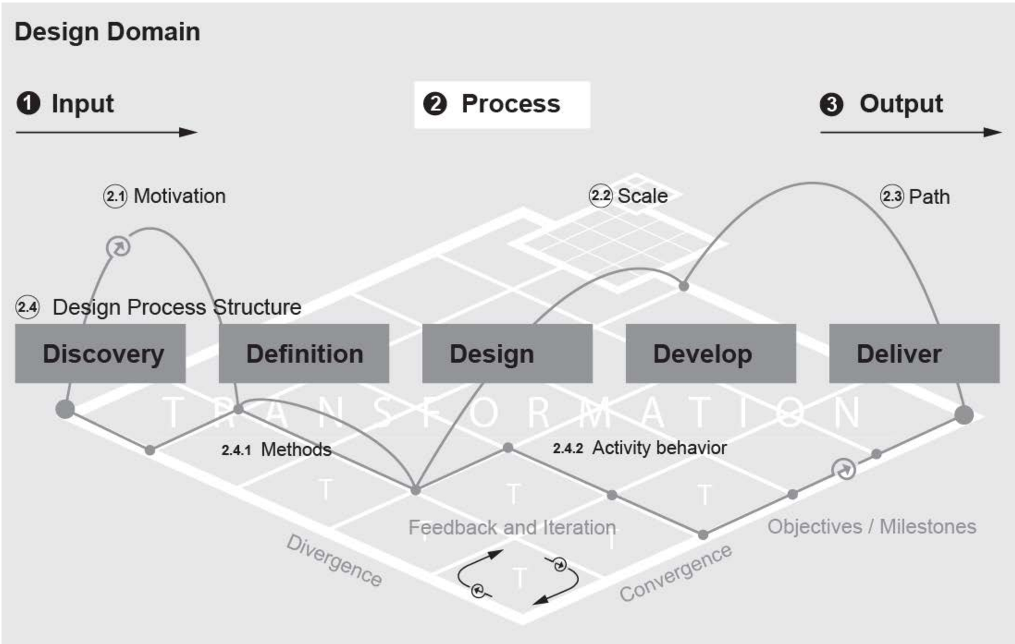

Figure 7.2 *Visualisation derived from the initial design ontology (Green et al. 2014)*

The visualisation of the 'new UDI framework' will form the basis of material for a pilot and final workshop with a spectrum of design academics and professionals which is the basis for the review and evaluation of the study.

In the discussion section the results of the workshop reviews will also provide a basis for considering the translation of the framework into methods and communication tools which may have value for enhancing professional design practice.

7.2.1 Aim, Objectives and Research Questions

STUDY 2.2Aim

To combine the findings from the earlier studies into the development of a design ontology and new UDI Framework with associated discussion of the possibilities for professional tools, applications and adoption.

Table 7.1 *STUDY 2.2 Research Questions*

Overall Research Objectives	STUDY 2.2 Research Questions
Review of current situation RO1 To carry out a thorough investigation of current theory and practice for understanding design impact within the design profession and applications for design	RQ A5 How do concepts currently used in practice compare to the ideas being developed?
Analysis of professional practice RO2 To develop an analysis of the issues and challenges for the design profession and its operating context when negotiating or assessing the potential for design impact at early project stages	RQ B5 How do the ideas being developed respond to the issues and challenges identified?
Developing a new framework RO3 To develop an improved overview of the process and factors which determine design impact which in turn can contribute to improved understanding of design impact for the design profession and related stakeholders	RQ C5 What evidence can be gathered to verify that a framework for UDI can have a positive effect on design impact (for example for the design profession, professional contexts for designing, the design research community and design pedagogy)?
Evaluating the new framework RO4 To carry out an iterative process leading to ideas for new models, methods and communication strategies to enhance understanding and communication of design impact in practice	RQ D5 What ideas for methods and communication tools emerge from the combined studies which could have potential for enhancing professional design practice?

7.2.2 Methods

The main research methods adopted within this study (STUDY 2.2) follow the ontology development principles used within STUDY 2.1. In summary this involves following the first four steps of the seven step simplified ontology development process defined by Noy and McGuinness (2001):

1) Determine the domain and the scope of the ontology (e.g. by considering competency questions and generic criteria);
2) Consider re-use of existing ontologies;

3) Identify key terminology to be used within the planned ontology;
4) Define classes and class hierarchy ('concepts' is also used as a synonym for classes. Typically 'classes' might be descriptors for collections of things or instances).

As discussed in section 4.2.2, the use of ontological principles is a robust means to combine philosophical or 'meta-theoretical' (Galle, 2009) benefits with information science benefits (Noy and McGuinness, 2001). The adoption of the ontology development process is therefore judged to respond both to the meta-theoretical critiques of design research (e.g. Love, 2000) and to provide a level of epistemological robustness and validation as required by information science applications.

The literature review and paper prototyping process reported in STUDY 2.1 are supplemented in this case with the availability of data from STUDY 1.2 – material from the 46 DBA case studies and findings, and STUDY 1.3 – material and findings from the 10 expert interviews.

In the review phase of the study, the ontology derived new UDI framework is evaluated by two focus groups of design experts. A focus group approach is selected, both for its efficiency, and to benefit from group dynamics to focus on key points (Robson, 2002). Storvang et al. (2014), reviewing the use of workshops and focus groups within the design research field, are critical of the scientific rigour of many workshops. Their three point planning process in response to these issues is adopted as a basis for planning the focus group: reflection on factors involved with 1) the roles of the researcher, facilitator and participants, 2) the 'staging' of the focus group and 3) the approach to analysing the resulting data.

RESEARCH QUALITY CONSIDERATIONS

Ontology development literature provides two mechanisms to provide review criteria: the notion of 'Competency Questions' (Gruniger & Fox, 1995) which the ontology should provide answers to; and Gruber's (1995) five generic criteria for assessing the design of ontologies, *Clarity, Coherence, Extendibility, Minimal encoding bias* and *Minimal ontological commitment*(refer to Chapter 4.2.2 for further details of these criteria). Integrating these mechanisms into the ontology development process contributes to the quality of the research. Summary consideration of Cook &Campbell's (1979) research validity criteria results in the following observations.

- *Statistical validity:* Findings from STUDY 1.2 & 1.3 highlight the paucity of, and difficulties in acquiring, data to inform objective consideration of design impact. The development of a UDI framework founded on ontology development principles is not reliant on the validity of quantitative data at this theoretical level of consideration.
- *Internal and construct validity:* Threats are mitigated by the adoption of established ontology development processes and criteria. However, the results will inevitably be compromised by the depth of work possible within resource constraints together with any possible analytical bias. These possible threats are mitigated by the overall ontological principle of *Extendibility*. For example, a robust ontology is inherently extendible to accommodate adjustments and additional content.
- *External validity:* In the same way that STUDY 2.1 specifically identifies the outcome as an *Interim* Design Process Ontology (Green et al., 2014, p517), the same statement is stressed for this development. The general principle of extendibility also mitigates against threats to external validity eg: 'An ontology is not intended to remain stable; instead its contents are subject to change' (Ahmed, Kim & Wallace, 2007, p139).

The research quality of the complete PhD study and contribution to knowledge is considered in Chapter 8 (Conclusions and Further Work).

7.2.3 Findings

Ontology Development Process

The reporting for the extension of the initial *Design Process Ontology* (STUDY 2.1 and Green et al., 2014) follows the same four steps adopted from Noy & McGuinness's (2001) ontology development process:

Step 1: Domain and Scope

The significant change to the scope of the earlier design process ontology is the extension to encompass factors within *Input* and *Output* classes. These classes were intentionally not explored in detail at the earlier stage. The concept of *Design Impact* is fundamental to the whole study, and the scope of the extended ontology is intended to help to resolve how *design impact* can be mapped onto a sequence of *Input, Process* and *Output* activities. A 'competency question' (Gruninger and Fox, 1995) can be utilised to target this overall point. Establishing these questions is important for prescribing the domain and scope for the extended ontology. The initial domain definition and competency questions established in STUDY 2.1 are reviewed and updated as needed (*Table 7.2*).

Table 7.2 *Design Ontology Competency Questions (DOCQ) updated for STUDY 2.2*

STUDY 2.1 competency questions	Updated questions for STUDY 2.2
DOCQ 1 v1 (design research based) How does any specific existing design process model or methodology fit within this ontology? E.g. can existing models such as FBS (Gero et al, 2004) be easily mapped onto the ontology?	DOCQ 1 v2 (design research based) How do existing models or methodologies for considering the value and impact of design fit within this extended ontology alongside design process models and methods?
DOCQ 2 v1 (professional practice based) How does this ontology relate to either a specific design project or the general design practice of an organisation? E.g. can projects or practice such as 'Web design' be mapped onto the ontology as instances?	DOCQ 2 v2 (professional practice based) How does this extended ontology relate to either a specific design project or the general design practice of an organisation? E.g. can projects or practice be mapped onto the ontology as instances?
DOCQ 3 v1 (usefulness to predicting design impact) Can the ontology encompass all the elements which may determine the impact of design practice? E.g. can case studies of 'good' or 'bad' design be mapped onto the ontology and does this to help clarify what constitutes the good or bad quality?	DOCQ 3 v2 v2(usefulness to adoption for design impact analysis) Can the ontology and UDI framework encompass all the elements which may determine the impact of design practice and effectively lead to methods and tools for adoption in design practice? For example what approaches may be successful and what are the barriers to adoption?

The overall domain is updated to *The <u>professional</u> practice of designing and <u>designed outcomes</u>.* The addition of *designed outcomes* reflects the extension to *Input, Output* and *Impact classes*. It is important to clearly signal the difference between the process of *designing* and *designed outcomes* (Barcelona Design Centre, 2014). For example this can help to distinguish the role of *designing* at the front end of innovation - and the added value which may accrue from this - from the possibly more straightforward identification of value within *designed outcomes.* The definition of *<u>professional</u> practice...* is important to differentiate the focus of the work from broader interpretations of design activity, for example as typified by the concept of *Hidden Design* (Gorb & Dumas, 1987).

The updated competency questions explore how the extended ontology can provide answers from the perspectives of: 1) Existing design research – e.g. factors derived from the literature review; 2) Professional practice – e.g. factors derived from the two professional practice studies (STUDY 1.2 and 1.3); and 3) Analysis relating specifically to predicting and evaluating design impact – e.g. as a result of the combination of literature review and the industry studies.

Step 2: Reuse of existing ontologies

The reporting of the potential reuse of existing ontologies in Chapter 5.2.3 provided an overview of the general landscape of ontology development. This concluded that there are very limited, or no identified, opportunities for direct re-use of existing ontology components within the initial design process ontology. However this initial review did highlight that a number of existing developments in the engineering design domain do help to establish and validate the purpose of the ontology development together with some general principles for structuring a design process ontology. Validation of an ontological approach is underlined by Atkinson (2014), who comments that the initial ontology emerging from STUDY 2.1 reported in Green et al., (2014): 'results in a remarkably clear and convincing visualisation of a 'prototype ontology' of the design process' (p486). *Table 7.3* provides an overview of selected existing ontology developments alongside the initial design process ontology.

Table 7.3 *Summary of ontology purpose and entities represented within related work*

Source	Ontology purpose	Classes
Tomiyama et al., (1992)	Systemising design knowledge as a basis for computation within 'intelligent' CAD systems	6 categories of design activity with 8 transitions
Sim & Duffy, (2003)	Identifying and classifying design activities to enable a shared understanding and consistent definitions	27 activities categorised as Definition, Evaluation, Managing activities within a *Goal: Input-Activity-Output* framework
FBS framework (Gero & Kannengiesser, 2004 and 2007)	Using the *Function-Behaviour-Structure* (FBS) conceptualisation of designing as a basis for understanding design processes	20 design activities mapped to 8 'fundamental' categories of designing
EDIT ontology (Ahmed et al, 2007)	As a knowledge structure for enhanced engineering knowledge management	4 root concepts developed with existing taxonomies and empirical research and populated with 2099 classes and sub-classes.
Design Activity Ontology (DAO), (Kumar, 2008)	Enhancement of Sim & Duffy's (2003) ontology of engineering design activities; structuring vocabulary for consistency and exchange	25 design activities and 82 interconnecting information flows
Product Design Ontology (PDO), (Catalano et al, 2009)	Enhanced information exchange in Product Data Management systems with a focus on shape data	8 core concepts including the definition of a scalable 'task' concept analogous to *activity* or *process*
Green et al., (2014)	As a basis for developing and sharing understanding of design process as a foundation to understanding design impact	6 classes or root concepts identified within the core *Process* class

Tomiyama et al.'s work (1992) is an early example of systemising design related knowledge. Their ontology distinguishes between *design process knowledge* and *design object knowledge*, commenting that design process is 'ill-defined and ill structured' (p241) and therefore, at the time, had received no attention within scientific CAD research, and that design studies are at a 'pre-scientific stage' (p244)

Sim & Duffy (2003), base their ontology on an overall *Goal: Input-Activity-Output* model which, significantly in relation to the findings in STUDY 1.3, includes a feedback loop (*Figure 7.3*). This model shares elements of the FBS model (Gero & Kannengiesser 2004). In their later 2007 paper Gero & Kannengiesser develop their FBS framework into an ontology which includes three of eight 'fundamental' categories associated with feedback activities (ref Chapter 5, *Figure 5.4*). Sim & Duffy (2003) define three overall activity categories: *Definition, Evaluation* and *Management*. Tomiyama et al. (1992) identify six categories of design knowledge.

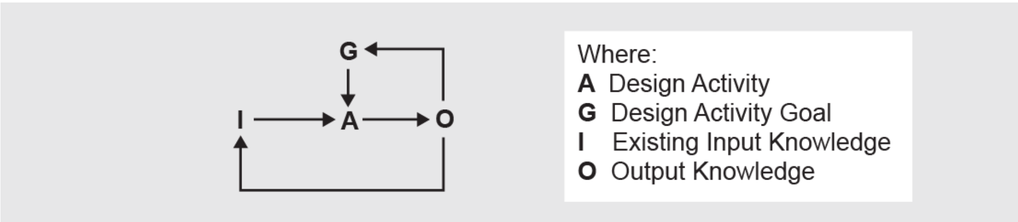

Figure 7.3 *Sim & Duffy's(2003) core activity and information flow model*

All three approaches place emphasis on the transformational nature of design activities and are subsequently able to track these transformations. For example Tomiyama et al. (1992) list eight 'transitions' between design knowledge. Kumar's work, building on the earlier work of Sim & Duffy (2003), characterises these links as 'information and knowledge flows'. Kumar emphasises the value of reducing the number of information flows in the Sim & Duffy ontology from 116 to 82.

These differences between classifications of classes and sub-classes are potential barriers to ontological commitment; but collectively confirm aspects of hierarchical structuring, categorisation and the notion of transitions/knowledge or information flows. All four ontologies are based on engineering design activity or process.

Ahmed et al.'s (2007)ontology, also in the engineering design field, has the more tactical purpose of enhancing knowledge management within engineering design organisations. It has a particular emphasis on rationalising terminology and extends to 2099 classes and sub-classes. Their ontology, named EDIT (engineering design integrated taxonomy), explicitly brings together existing taxonomies wherever they exist. In the same way, it is envisaged that ongoing development of a UDI design ontology could incorporate existing taxonomies within any of the defined classes.

Catalano et al's (2009) ontology development demonstrates the difficulty of reuse of ontology elements. Although superficially in the general domain of *design*, the ontology is concerned with a quite narrow definition of *Product design* which places a significant emphasis on *Shape* issues (for example in car styling). The core process or activity focus of the ontology (also seen in the other ontologies reviewed here) is renamed *Task*. These synonyms potentially represent a barrier to ontological commitment; this was one of Gruber's (1995) criteria for ontologies (minimal ontological commitment).

Step 3: Key terminology

As can be seen from the updated review of existing ontologies, terminology for classes can vary. Examples include the use of *Activity* (Sim & Duffy, 2003, Kumar, 2008), *Design Process*, (Ahmed et al, 2007, Green et al, 2014) and *Task*(Catalano et al, 2009). These examples are all terms to describe a general concept of *design activities*. In ontology development the consistency and clarity of the <u>concept</u> for each defined class is important. Synonyms for the concept can be acceptable (Noy& McGuinness (2001), although it can be seen that lack of agreement, or ontological commitment around concepts and terminology, is an aspect of what Love (2000) describes as: 'an unnecessary *multiplicity* of design theories and concepts'(p295). Progress in response to Love's critique is seen as an important contribution made by the work within this study. Careful selection of terminology can do this in two ways:1) by seeking to rationalise the 'multiplicity' of concepts or 'constellation of factors' (Wang and Ilhan, 2009, p20); and 2) by acknowledging that key concepts may have synonyms.

New definitions of terms to describe key concepts is considered a necessary outcome of this work, but this may create barriers to ontological commitment. For example the concepts or sub-class names, *Motivation, Scale, Path* and *Design Process Structures,* will not be immediately familiar either to academic or practitioner audiences. This terminology and ontological commitment issue is further explored through the evaluation workshop within this study.

Additional key terminology and concepts are derived from the literature review (Chapter 2) and the findings of STUDY 1.2 and 1.3.In summary, the expansion therefore builds on, incorporates and rationalises the following elements.

- **The initial design process ontology** - Key concepts include *Motivation, Scale, Path* and *Design Process Structures* as sub-classes of Process within an *Input, Process, Output* class model (ref Figure 7.2)
- **Literature review** - Key concepts include *Design value, Design impact, Design emphasis, Design impact, Design management, Design capabilities, Design Leadership, Design thinking, Silent Design*(ref Chapter 2)
- **Empirical study outcomes** - Key concepts include *Impact, Design influence and authority, Design Value, Circularity of design ingredient, Disaggregation challenges - Operationalisation, Hard outputs, Wider impacts, Strategic-tactical, Context CSFs, Design CSFs* (ref *Figure 6.16*)

Step 4: Definition of classes and class hierarchy

Potential additional classes and class hierarchy for the extension were explored through a paper prototyping exercise. All the classes from the initial ontology, together with all the potential elements summarised in Step 3, were written on 'post-its' and hierarchies and relationships were iteratively explored on a 'meta-theoretical' (Love 2000) canvas.

Through this iterative process, terms and concept relationships were updated and resolved into a relatively robust hierarchical arrangement of classes. The results of this activity are reported in three ways: 1) A description of the main classes, the rationale behind their inclusion and, where necessary, notes on changes from the initial ontology; 2) A visual summary of the expanded design ontology (*Figure 7.4)*; and 3) A summary hierarchical table of classes with descriptions of the properties of the classes (*Table 7.4*).

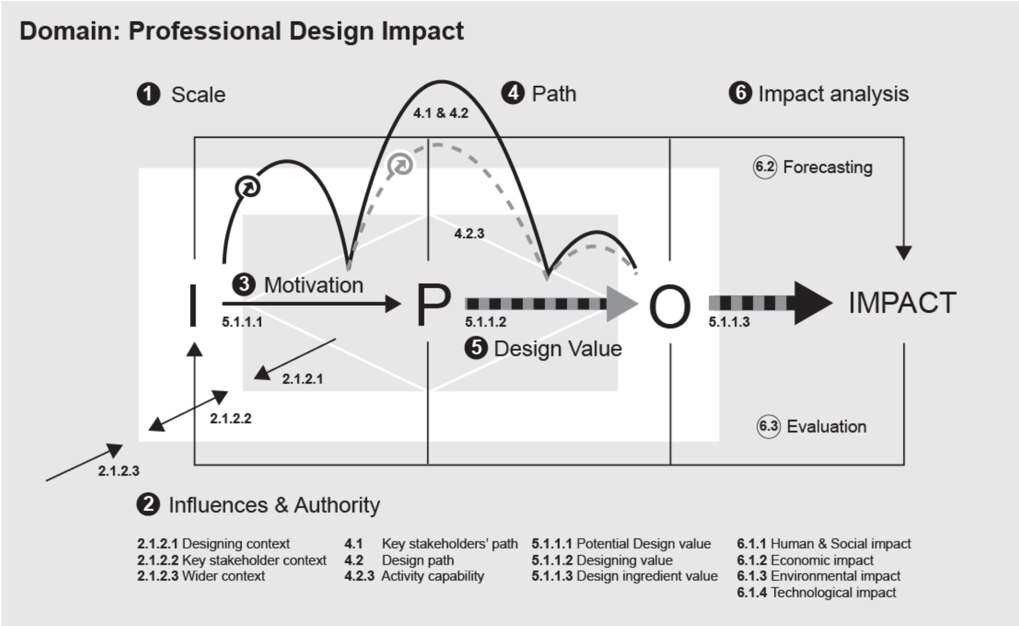

Figure 7.4 *Visual summary of the expanded design ontology*

Descriptions of the main ontology classes

Domain: Professional Design Impact

In the expanded ontology, the overall domain is updated from the more general *'Design Domain'* to *Professional Design Impact domain*. This distinction is made to separate *Professional design* from any more general scope for 'design'. This helps to delimit design (Tether, 2005) and to signal clear distinctions between professional design and other types of design as alluded to in terms such as *Silent Design* (Gorb and Dumas, 1987), *Hidden Innovation* (Miles and Green, 2008), *Technical – non technical* design (Livesey & Moultrie, 2008) or *Overt Design* (Candi, 2010). This underlines the literature review conclusion that it is helpful to clarify the distinctions between DesignERS, DesignING and the DesignED outcome. The revised domain definition is highlighting *Impact* as the primary consideration with a focus on professional designING at its heart. To further clarify: the updated domain definition delimits the scope of the ontology to focus on the impact which is accrued from designing carried out by professional designers. This positioning emphasises the central importance of *impact* considerations to all professional design activity.

Super-classes

At the conclusion of earlier ontology development, it was envisaged that the central *Process* class would be expanded to an *Input* and *Output* class. During the subsequent development and paper prototyping exercise it became clear that *Input, Process* and *Output* would be more usefully defined as <u>properties</u> of super-classes

.This is in line with Gero & Kannengiesser (2007), who state: 'The input and the output structure elements represent properties of other entities in terms of their variables and/or their values' (p380). In the expanded ontology three pairs of super-classes are defined with each pair linked to *Input, Process* or *Output* properties as follows (also ref *Figure 7.4*):

- *Scale (1), Influences & Authority(2)*– are defined as having <u>*Input*</u> properties;
- *Motivation(3), Path(4)*– are defined as having <u>*Process*</u> properties;
- *Design Value(5), Impact Analysis(6)* – are defined as having <u>*Output*</u> properties.

Scale

The *Scale* concept featured in the earlier ontology but is now defined as a super-class which has *Input* properties. Therefore the class accommodates all factors which could be considered inputs to scenarios involving professional design with *Scale* characteristics. With reference to *Table 7.4* for summary descriptions of classes and properties. The *Scale* super-class is further sub-divided into four classes: *Timescale, Size of context, Subject* and *Resources*. It is noted that scale factors do not appear to have been a significant consideration within existing studies of design impact. However based on the findings from STUDY 1.3, the diversity of hard output metric figures <u>do not</u> suggest that scale factors should be set aside in consideration of impact.

Influences & Authority

The *Influences & Authority* super-class can be explained by considering the relationship of the 'space' in which the designing is taking place to the contexts of the key stakeholders and wider audiences. In the visual representation (*Figure 7.4*) these relationships are schematically represented as three nested or overlapping spaces: a) the designing context; b) the key stakeholder context; and c) the wider context. This is based on the ontological concept that this super-class can encompass all the factors which determine the *Influences & Authority* which exist in the domain. The findings of STUDY 1.3 identified a cluster of factors grouped as 'design influences and authority' as significant to design impact. Therefore the approaches which the design profession can adopt to directly tackle these factors such as Design management (e.g. Borja de Mozota, 2003) and Design Leadership (e.g. Topalain, 2011, Miller & Moultrie, 2013a and 2013b) are classified within this super class. Candi & Gemser's 2010 work (Chapter 2, *Figure 2.3*) includes the concept of 'moderating environmental factors' to encompass other influencing factors. This is renamed within the expanded ontology as *Contextual factors*. These factors could be further classified by well established macro environmental analysis approaches such as PESTEL.

Design impact research has consistently identified that the degree of emphasis on design is a significant factor in the level of design impact achievable. The expanded ontology incorporates this concept within the *Influences & Authority* super-class, using the term *Design Emphasis* (Candi & Gemser, 2010). The four levels of the Danish Design Ladder (Danish Design Centre, 2003) concept can therefore be incorporated within the *Design Emphasis* class.

Motivation

The *Motivation* and *Path* super-classes are a basis for the important distinction between designING factors and the activities of other stakeholders. Therefore in the visual summary (*Figure 7.4*) the possibility of separate *motivations* and *paths* is indicated. For example, in the case of the *Motivation* class, this accommodates the potentially important differences between the *Motivation*, or intrinsic drivers, of a design team and the key stakeholder *Motivation*. This difference can be evidenced in the sometimes crucial difference between the 'opportunity' defined in a 'client' brief and a re-formulated brief developed by the design team.

The importance of the 'opportunity' for design impact, and capturing this aspect of *Motivation* in the form of the brief, is seen in many of the case studies explored in STUDY 1.2. The *Motivation* super-class also accommodates the aim and objectives of a scenario. The *Motivation* for a company in terms of NPD aims and objectives are often characterised in terms of desired economic uplift. The aim and objectives for designING may diverge from this, or add additional aims and objectives. Within existing ontologies the term *Goal* is used by Sim & Duffy (2003) or *Formulation* by Gero & Kannengiesser (2004).As explored in the initial ontology, *Motivation* can also encompass the ideas within Koen et al.'s (2001) 'Engine' and Bujis's (2003) 'Heart'; the 'true ingredients of innovative behaviour' (p90).

Path

The earlier ontology development referenced Newman's 'Squiggle' (2006) as a way to explain the concept of a designer's creative path. In the expanded ontology the potential divergence between the designing path and the path of key stakeholders is further emphasised with the suggestion of two sub-classes (for designing and key stakeholder paths). The *Path* concept also encompasses the idea of entities within an ontology being 'connected' by transformations (e.g. Gero & Kannengiesser, 2004 and 2007; Sim & Duffy, 2003). As previously discussed, this super-class can accommodate design specialisms. For example, a product design path or a fashion design path, a characteristically 'creative' path or an engineering design path. However, a rationalisation of the earlier ontology is to place the *Design process structure* class and sub-classes within the *Path* super class.

A significant revision and addition to the earlier conceptualisation of *Path* is to redefine *Activity Behaviour* as the broader class definition of *Capabilities.* Swan et al. (2005) refer to the concept of *Capabilities* in relation to the capabilities of firms. Kristensen and Gabrielsen (2010) use the related term 'competency' to assess 'good design' in their survey. Tether (2005) adopts the term 'design knowledge' as a factor affecting design impact. Koostra (2009) adopts 'expertise'. Participants in Study 1.3 made many references to 'experience'. Therefore we can conclude that a general concept of *Capability* can better accommodate or be a synonym for activity behaviour, design knowledge, competency, expertise and experience.

Design Value

Whilst there is a body of design research literature which explores the concept of design value (e.g. Heskett, 2008; Borja de Mozota, 2006; Nomen et al., 2012; Løvlie et al., 2010; Joziasse & Sleders, 2009; Zec, 2011; Rae, 2014;) there is less research (e.g. Joziasse & Selders, 2009) which explicitly links overarching concepts of the benefits of design value with *how* design value is created. For example, one of Borja de Mozota's (2006) 'Four Powers' of design is the generic 'Design as good business'. The other three powers, Design as differentiator, integrator and transformer, get closer to the question of *how* design adds value. The expanded ontology, based as it is with process at the core, can explicitly provide a basis to explore *how* design value is created.

Design value is created as a result of design activity. In the enlarged classification, specific instances of design value are placed in an *Added value of designing* class. Borja de Mozota's 'Four Powers' is an example of a model of design value which can be placed in a class of *Design Value Models.* An important feature of the UDI Framework is the concept of exploring design value at different points within an Input-Process-Output-Impact cycle. For example, prior to any design activity taking place we can explore *Potential design value*. During the process of designing we can explore *DesignING value*. Once there is an output with a DesignING ingredient we can explore the *Design ingredient value.* In the new UDI framework this is defined as a UDI model of Design impact*.* Signalling the design element as an *ingredient* is proposed as a vital distinction in order to contribute to the disaggregation challenge. It potentially helps to create a more robust foundation to responding to the DBA Design Effectiveness Awards question about other contributory factors (to design effectiveness).

Impact Analysis

Ultimately, this study is concerned with the impact of design. The majority of studies of design impact (e.g. the 27 studies reviewed in *Appendix B– Table B.2*) have focused on the economic impact of design. More recently the environmental and social impact of design has grown in significance. Therefore the enlarged ontology recognises a class which identifies *Type of impact (Reference Figure 7.4 and Table 7.4 point 6.1).* This concept is very clearly reflected in the Triple Bottom Line approach to impact analysis (Elkington, 1999). The Design Ontology also adds a class of *Technological Impact*, for example as basis to explore the type of significant impact enabled by technology in businesses such as AirBNB (Wall St Journal, 2014)

Furthermore, by linking the concept of impact to the Input-Process-Output associated with design activities, *Impact analysis* can be divided into two main classes, *Forecasting* and *Evaluation.* The visualisation of the ontology (*Figure 7.4*) shows *Forecasting* and *Evaluation* as parts of a virtuous circle, with evaluation feeding back into input, process and output, and with forecasting feeding into process, output and impact. This relates to the 'Circularity of the design ingredient' finding from STUDY 1.3. The participants in STUDY 1.3 collectively highlighted the paucity of actual formalised evaluation and forecasting activities in their practice.

Therefore it is considered important to draw attention to these aspects and the benefits which can accrue from forecasting and evaluation.

The *Impact analysis* super-class also provides a basis for classifying the factors associated with operationalisation. These are initially organised into Methods, Metrics and adoption classes. The *Adoption* class is considered important as a basis for exploring the types of diffusion issues highlighted by Birkhofer (2005). The 157 output metrics identified in STUDY 1.2, combined with the limited evidence of impact analysis in practice shown in STUDY 1.3, suggests that adoption issues are highly relevant to *Impact analysis*.

Table 7.4 *Expanded Design Ontology – Summary hierarchical table of classes*

Domain/class/sub-class hierarchy	Properties of the class
●PROFESSIONAL DESIGN IMPACT	The general domain in which impact resulting from professional design activity is being considered
1 ▼**Scale**	Input factors
1.1 ▶ Timescale	Time factors related to the scenario including timescales for impact
1.2▶ Size of context	Factors related to the overall scales within the nested contexts such as total audience, target audience, competition, company size
1.3▶ Subject	Factors related to the scale of the subject for design e.g. from a ball point pen to an aircraft carrier
1.4▶ Resources	Scale of the resources available within the scenario, e.g. by project, by team, by company
2 ▼Influences and Authority	Input factors
2.1 ▼ Context	All contextual input factors relating to the scenario
2.1.1▶ Contextual factors	All overall contextual factors, for example organised into sub-classes of: Human–social, Economic, Environmental, Technological
2.1.2▼ Context spaces	All factors relating to how the overall context can be classified to help understand impact
2.1.2.1▶ Designing context	Factors associated with defining the context for the core designing activity
2.1.2.2▶ Key stakeholders' context	Factors defining the boundaries of the key stakeholders within the scenario
2.1.2.3▶ Wider context	Factors defining the breadth of the complete scenario context
2.2 ▼ Design Influences & Authority	All factors relating to the, often conflicting, forces affecting design with the scenario
2.2.1 ▼ Design emphasis	All the factors which influence 'positioning' the emphasis on design
2.2.1.1▶ No Design	The factors which determine a 'no design' position
2.2.1.2▶ Design as styling	The factors which determine a 'design as styling' position
2.2.1.3▶ Design as process	The factors which determine a 'design as process' position

Domain/class/sub-class hierarchy	Properties of the class
2.2.1.4▶ Design as strategy	The factors which determine a 'design as strategy' position
2.2.2▼ Capabilities for Design I&A	All the factors which determine the capabilities within a context for affecting influence and authority
2.2.2.1▶ Design Management	Capabilities for design management within the context
2.2.2.2 ▶ Design Leadership	Capabilities for design leadership within the context
2.2.2.3▶ Design thinking	Capabilities for design thinking with the context
3 ▼Motivation	Process factors
3.1▼ Key stakeholders' motivation	All the factors which determine the key stakeholders' motivation within the scenario
3.1.1▶Opportunity	Factors relating to the stakeholders' definition of the 'opportunity' within the scenario
3.2▶ Designing motivation	All the factors which determine the motivation for desiging within the scenario
3.2.1▶ Design Opportunity	Factors relating to the professional designers' definition of the 'opportunity' within the scenario
4 ▼Path	Process factors
4.1▶Key stakeholders' path	All the factors determining the 'path' of key stakeholders, e.g. by project, product range, brand, company,
4.2▼ Design path	All the factors determining the 'path' of the design activity
4.2.1▶Design Process Structure	All the ways in which a design process might be structured
4.2.2▶Methods	All methods which are used/might be used within a design process
4.2.3 ▶Activity Capabilities	All the characteristics of how design process methods are carried out
4.2.4 ▶ Design Deliverables	All the factors which define the deliverables of designing activity
5 ▼Design Value	Output factors
5.1▼ Design value Models	All the factors which contribute to defining models of 'design value'
5.1.1 ▶ UDI IPO-I sequence model	Factors which determine 'design value' based on an IPO-impact sequence
5.1.1.1▶ Potential design value	Factors which determine 'design value' prior to design activity taking place
5.1.1.2▶ Designing value	Factors which determine 'design value' during design activity
5.1.1.3▶ Design ingredient value	Factors which determine 'design value' as an ingredient of overall added value
5.2 ▼Added value of designing	Definitions of the factors which add value as a result of professional design activity
5.2.1 ▶ Critical design value factors	Design value adding factors within the scenario
6 ▼Impact Analysis	Output factors
6.1▼ Type of impact	Classifications of different types of impact for the purposes of identification and analysis within the scenario
6.1.1 ▶ Human & social	All factors relating to identifying 'Human & Social' impacts in the scenario

Domain/class/sub-class hierarchy	Properties of the class
6.1.2▶ Economic	All factors relating to identifying 'Economic' impacts in the scenario
6.1.3▶ Environmental	All factors relating to identifying 'Environmental' impacts in the scenario
6.1.4▶ Technological	All factors relating to identifying 'Technological' impacts in the scenario
6.2▶ Forecasting	All factors relating to the activity of forecasting impact
6.3▶ Evaluation	All factors relating to the activity of evaluating impact
6.4▼ Operationalisation	All the factors relating to the process of operationalising impact analysis
6.4.1▶Methods	Classification of all methods which may be adopted for impact analysis
6.4.2▶Metrics	Classification of all metrics which may be adopted for impact analysis
6.4.3▶ Adoption	All factors determining the adoption of methods and metrics

7.2.4 Review

The enlarged ontology summarised in *Table 7.4* and *Figure 7.4* represents a major outcome from the overall study. The design impact ontology is considered a necessary foundation to establishing a robust new UDI Framework. The prototype frameworks shown earlier and the summary visualisation of the ontology are all iterative developments leading to the new UDI framework. This is the key outcome of the overall study and therefore the basis for evaluation with academic and professional experts. This expert evaluation is the first element of review.

A second element is a review of the enlarged ontology and UDI Framework in relation to Gruber's (1995) criteria for ontology development and how well the work responds to the defined Ontology Competency Questions. A third element considers the limitations of the findings and methodology and the final review element is a review of the main findings in relation to the study research questions (*Table 7.11*).

STUDY 2.2 REVIEW: EXPERT WORKSHOPS

Conducted in two stages, the expert evaluation is based on a workshop format following the planning points defined by Storvang et al., (2014). A pilot workshop allowed refinement of the 'staging' for a second and final workshop. In both cases researcher and facilitator roles are combined. Resources for the study did not allow for these roles to be separate, but the number of participants, five and six, can be practically managed. Concerns about bias and reflexivity are mitigated by the expertise of the participants and the methods for recording data.

The workshop objectives were: 1) To review the framework and related concepts; 2) To explore instances of impact applied to the framework; 3) To explore issues and challenges resulting from this mapping and; 4) To discuss the potential methods derived from the framework which might lead to benefits for the professional practice of design. These objectives translate into a series of questions and activities for the three hour duration of the workshops (*Table 7.5*). The workshop participant information pack is included for further reference in *Appendix N*.

Table 7.5 *Expert evaluation workshop questions and activities*

Workshop questions/activities	Support materials / Output
1.0 Discuss and review the clarity and understanding of the key terms in the framework.	Introductory presentation Hand out including a list of key terms with a Likert assessment scale and space for notes
2.1 What instance of impact resulting from designing do each of the participants think relevant or interesting to explore? 2.2 How would the selected instances map onto the framework?	Participants invited to consider examples in preparation for the workshop UDI Framework template and guidance notes used to allow instances to be mapped to the framework
3.1 What issues and challenges does the instance present? 3.2 Could the framework help with UDI in these instances?	Participants to identify three key challenges each from their mapping Group discussion to explore how the identified issues might be enhanced with the support of the framework (recorded on a UDI framework 'canvas' with Post-it notes)
4.0 What ideas for methods and communication might be derived from the framework, and how might they most effectively be implemented?	Discussion based on initial thoughts on tools/methods derived from the UDI framework and noted/scored on a Likert scale

Pilot workshop findings

In addition to fulfilling the workshop objectives, the pilot workshop was also an opportunity to refine the arrangements for staging the final expert workshop. The five pilot workshop participants were a graduate researcher, post-graduate and PhD students, all with a direct design research knowledge and interest in impact. All were from a design background and therefore had a good level of understanding of basic theory and practice of professional design activity.

Understanding of the framework factors (Pilot)

The initial presentation of the framework and completion of the Likert scale table to indicate levels of understanding was straightforward. Some minor refinements of the presentation and handout were made for the final workshop. It was noted that even amongst participants with a good level of design understanding, the three pairs of underlying concepts within the UDI framework are not instantly recognisable in all cases. The Likert scale table was a means to capture this spectrum of understanding (*Table 7.6*).The most frequently occurring response is shaded in darker grey on the table. Factors judged 'unclear' or 'very unclear' are shaded orange. For example factor 2, *Influences and authority – contexts* was judged to be clear by four out of five participants. The responses are given weighted scores and the average scores for each factor are shown in the final column. The initial discussion of the factors within the framework provided further insights into the scoring.

***Table 7.6** Understanding of the UDI framework factors (Pilot workshop scores)*

Factor			Very clear +2	Clear +1	Neutral 0	Unclear -1	Very unclear -2	Score Av.
1	Scale		1	3	1			1
2	Influences & Authority	Contexts	1	4				1.2
		Contextual factors		2	2	1		0.2
		Design Influence &Authority	1	3		1		0.8
3	Motivation		2	2	1			1.2
4	Path		1	2	1	1		0.6
5	Design Value	Eg Four powers model		4	1			0.8
		Eg UDI model	1	2	1		1	0.4
6	Impact Analysis	Types of impact	2	3				1.4
		Operationalisation	1	1	3			0.6
		Forecasting and Evaluation	1	3	1			1

Contextual factors scored an average of 0.2, the lowest overall score, with one participant scoring this as 'unclear'. Through discussion it was established that this was due to the participant not being familiar with the terminology. When an alternative explanation of 'PESTEL' factors was used there was not an issue, and the correlation between contextual or PESTEL factors and impact was not disputed. In the final expert workshop the HEET categorisation of contextual factors developed in STUDY 1.1 is included in brackets on an updated workshop handout.

Design Influence & Authority scored an average of 0.8 with one participant 'unclear'. This concept covers a range of factors, which individually are clear to participants, but categorising these under this heading was not familiar. No alternative terminology was suggested.

Path scored 0.6 with one participant (not the same one as before) scoring this as 'unclear'. The lack of comprehension here was to do with the distinction being made between the key stakeholder's path and the design path. To explore this point the fictional example of a ball point pen scenario was used. This demonstrated that a pen manufacturer may instigate design activity as a result of falling sales of an existing pen, therefore embarking on a *Path* prior to the involvement of professional design activity. If Philippe Starck was commissioned to redesign a pen, his role would be primarily to generate concept ideas, and his *Path* would be different to the manufacturer. The <u>differences</u> between *Path*s may be significant to the impact. In the final expert workshop, the 'Pen' example is expanded as a simple means to explain the basic concepts in the UDI framework.

*Design value - based on the UDI model*scored 0.6 with a single participant scoring this concept as 'very unclear'. The overall concept of *Design value* was clear. The individual concepts within the UDI value model of potential design value, designing value, and design ingredient value were also acknowledged as clear, but grouping these together as a design value concept which aims to recognise how design value is accrued as an ingredient within a bigger system was novel to the participants.

Mapping case studies (pilot)

The principle of using case studies and examples to explore impact factors was confirmed as extremely valuable, both with the fictional pen example and the case studies subsequently discussed with the pilot workshop participants. The breadth of the examples was useful for validating the potential universal application of the UDI Framework. The selected case studies, their breadth and relevance to design impact, are summarised as follows:

- **Swatch:** The wider context for this well known case study was the global watch market and challenges faced by Swiss watch manufacturers. The resulting impact, over 35 years since the late '70s, has resulted in sales of over 350million watches.
- **Light Touch Matters, A European consortia design research initiative:** Characterised by a complex multiple stakeholder environment and absence of direct 'conventional' economic impact imperatives
- **Repositioning Amstel beer for the Balkan regions:** On the surface a more conventional brand positioning exercise, but the successful economic

impact was identified to be due to the strategic market research ingredient, whilst the design element was at a conventional 'tactical' level.

- **Book design for a famous author campaigning for Euthanasia**: Interesting because the book was published with two different cover designs which allowed some level of comparison between the two versions, but also highlighting issues around the relative impact of the design ingredient due to the high profile topic and author.
- **Kia cars, design and brand repositioning for the whole brand**: The automotive sector has global competition and significance; this case study also included a high profile role for a famous automotive designer leading to award winning success for the brand.
- **Changing littering behaviour, Scandinavian Government commissioned design project:** Important for breadth, because this is a project clearly focused on environmental impact rather than the stereotypical economic impact interest. The enlightened approach of the key stakeholder is a further interesting contributory factor.

An overview of the mapping of these cases to the UDI framework demonstrates that this diversity of cases can be accommodated without significant omissions in terms of factors affecting impact. The mapping also demonstrates that relevant factors are spread across the whole framework, but with particular clustering at the 'front end'. Specific points were 'exposed' on the framework, demonstrating the potential value of the framework as a 'canvas' for exploring factors influencing the design ingredient of impact.

Minor refinements to the handout material and briefing as a result of the pilot workshop experience were incorporated into the final expert workshop staging.

Design professionals workshop findings

The final workshop, hosted within a leading UK product design consultancy, included six design professionals from a range of organisations: 1) Brand and Product strategist & independent consultant, 30+ years experience; 2) Associate Director and product designer at host design consultancy, 20 years experience; 3) Director and design strategist at a leading service design company, 14 years experience; 4) Associate Creative Director with a global UX design company, 12 years experience; 5)

Client Manager at a leading product and packaging design company, 5 years experience; 6) Product and service designer within a supply chain consultancy, 3 years experience. This mix of levels of experience and specialist design disciplines is intended to represent a significant spectrum of potential ‘downstream’ audiences for methods and communication tools which may be derived from the emerging UDI framework.

Figure 7.5 *Participants in the Design Professionals workshop*

Understanding of the framework factors (Professionals)

Minor refinements and adjustments were made to the workshop staging, but the underlying workshop programme remained unchanged. The participants discussed and scored the core factors on the framework as shown in *Table 7.7*. The modal response to each factor is shaded. The numbers involved with the workshop (five for the first exercise) are not statistically significant, however the results provide a level of supporting evidence to the points made during the initial discussion of the factors. *Table 7.8* provides further information based on the aggregate results and differences between the two workshops.

Table 7.7 *Understanding of the UDI framework factors (Design professionals workshop scores)*

Factor			Very clear +2	Clear +1	Neutral 0	Unclear -1	Very unclear -2	Score Av.
1	Scale			5				1
2	Influences &Authority	Contexts	2	0.5	2.5			0.9
		Contextual factors	1	2.5	1.5			0.9

Factor			Very clear +2	Clear +1	Neutral 0	Unclear -1	Very unclear -2	Score Av.
		Design Influence &Authority		4.5	0.5			0.9
3	Motivation			4	1			0.8
4	Path			1	3	1		0
5	Design Value	Eg Four powers model	1	2		1	1	0.2
		Eg UDI model		3		2		0.2
6	Impact Analysis	Types of impact	1	3	0.5	0.5		0.9
		Operationalisation		1.5	1	2.5		-0.2
		Forecasting and Evaluation		1	2.5	1.5		-0.1

In overall comparison the design professionals judged the framework factors to be slightly less clear than the pilot workshop design research participants. This could be accounted for by the more critical view of the topic often adopted by design professionals (e.g. Micheli, 2013). However, the validity of the results is best considered from a qualitative, rather than quantitative point of view. Despite minimal introduction to the factors, the overall level of understanding from both workshops is between 'neutral' and 'clear'.

Impact analysis operationalisation was 'unclear' as the modal answer from the design professionals and has the lowest overall ranking across both workshops. At this point no specific operationalisation is being presented, therefore the lack of clarity can be considered a reflection and confirmation of the widely acknowledged complexity of this aspect and lack of specific recommendations on this point.

Path had a average score of 0.6 in both workshops, reflecting that the concept of exploring the relationships between one or more paths in a scenario is new to the participants. However, when discussed in more detail, the participants could see the benefit of this disaggregation, with one participant commenting "communicating all parties'*paths* to each other is key". This highlights the participant's practical experience that paths do diverge (e.g. between consultant and client in this case) and that effective communication between parties is vital in order for the differences not to have a negative influence on impact.

Design value - based on the UDI model had two participants scoring this as 'unclear'. However the modal result was that the concept was 'clear'. As with the pilot workshop, which also flagged up a lower level of understanding of this factor, this can be explained in terms of it being a novel concept. For example there was discussion about the 'Four Powers' model (Borja de Mozota, 2006) which was familiar to some participants. The point was made that although it is 'obvious' to designers that business benefit is a 'power of design', this is not the case with many business audiences. Therefore the overall communication of the correlation between design input and positive impact is vital.

Understandably, the introduction of new concepts for expressing factors presents more challenges than the use of well established concepts. For example *Impact analysis* in terms of human and social, economic, environmental and technological impacts was judged to be 'very clear' or 'clear' and across both workshops ranked highest for understanding. Conversely, the *Scale* concept, with a number of possible dimensions, was only perceived as 'clear'. One participant noted that *Scale* is a useful way to start to understand the complexity of understanding design impact, recommending that being able to visualise complexity would be useful. This sentiment is a good endorsement of the concept for using the framework as a 'canvas' for exploring design impact factors.

Table 7.8 *Understanding of the UDI framework factors (aggregate and comparison workshop scores)*

Factor			Pilot av.	Prof. av.	Diff.	Comb. Av.	Overall rank
1	Scale		1	1	0	1.0	3=
2	Influences & Authority	Contexts	1.2	0.9	0.3	1.1	2
		Contextual factors	0.2	0.9	-0.7	0.6	6
		Design Influence & Authority	0.8	0.9	-0.1	0.9	5
3	Motivation		1.2	0.8	0.4	1.0	3=
4	Path		0.6	0	0.6	0.3	9=
5	Design Value	Eg Four powers model	0.8	0.2	0.6	0.5	7=
		Eg UDI model	0.4	0.2	0.2	0.3	9=
6	Impact Analysis	Types of impact	1.4	0.9	0.5	1.2	1
		Operationalisation	0.6	-0.2	0.8	0.2	11
		Forecasting and Evaluation	1	-0.1	1.1	0.5	7=
Averages			**0.8**	**0.5**		**0.7**	
Very clear = 2 , Clear = 1, Neutral = 0, Unclear = -1, Very unclear = -2							

Mapping case studies (professionals)

The case studies pre-selected by the participants were discussed as a group to initially highlight aspects of interest in relation to exploring design impact.

- **An online platform for sneaker aficionados for a global sport shoe brand**: Interesting global scale in terms of audience and cultural diversity. The initiative represents design input in a rapidly evolving area (UX/UI, experience and service design) and the impacts are not obviously identifiable in terms of sales uplift.
- **'Boris bikes' London cycle hire scheme:** A very high profile example of a multi channel, multi touch point public and private sector initiative. Demonstrates the high levels of complexity in public environments. It is also a project which has not had a high media profile for any design aspect. On the surface it appears to be a project where design activity has been at the lower ends of the *emphasis* hierarchy.
- **Bilbao Guggenheim museum – 'starchitect' led regeneration of the Spanish fishing port:** Another massively high profile case study (96 scholarly works devoted to the topic – Scholars on Bilbao, 2015), with many directly referencing the economic impact of the Gehry designed museum (e.g. Evans, 2005). However it is not clear that these studies, or popular understanding of the case, recognise all the relevant impact factors, or take a long term view of impact.
- **Redesign of a company's innovation process and culture:** This was relevant because it is an example of the deep *embeddedness* (Micheli, 2013) that contemporary design commentators (such as Micheli) advocate, yet an understanding of the ingredients and longitudinal impacts is probably missing.
- **Gravity Light – high profile (within the design community) social innovation initiative:** Also reflecting the emerging professional design landscape, this case study involves designers adopting a different role or *pathway* and the initial motivations involved a primary focus on social and environmental benefits.
- **Copenhagen Airport considerate smoking initiative:** Another example of emerging areas of design practice, in this case behaviour change. Impact is typically considered in socio-economic terms and is a field where

designers are only starting to have a visible role – with the resulting need to articulate the value of their ingredient.

Participants were asked to map their selected case study to the UDI framework canvas (*Appendix O*). Then, as a basis for exploring how effective the framework is for drawing out significant design impact factors, they were asked to identify a number of points for discussion. These were then discussed and mapped to a final group canvas *(Figure 7.6)*. A total of 44 points from the two workshops have then been transcribed, coded and considered further in relation to the purpose of the activity. The full record of this process is included as *Appendix P*. Summary points derived from this are reported below following the six point sequence of the framework. The analysis includes reference to the underlying comment codes (shown in brackets).

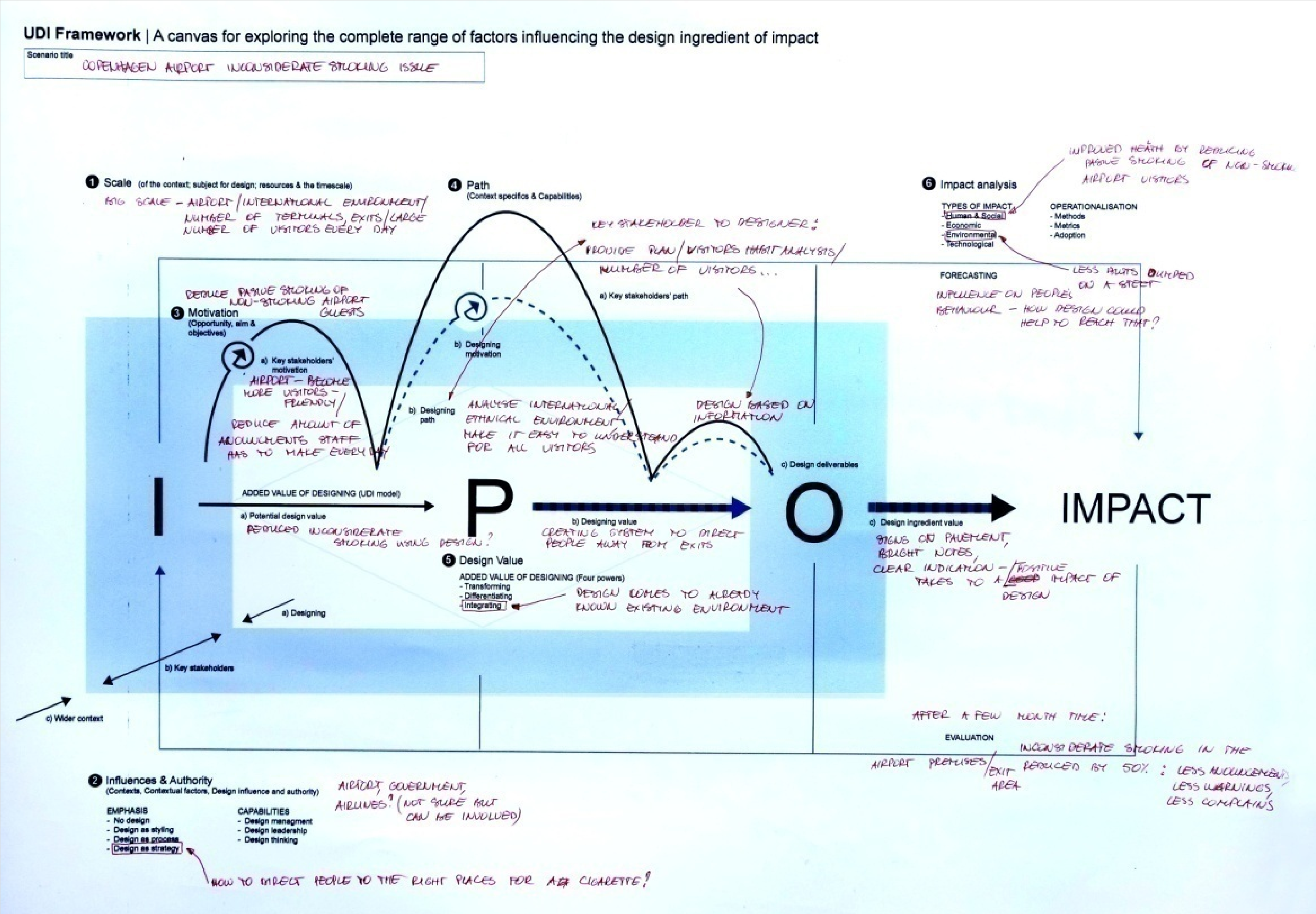

Figure 7.6 *Design professionals workshop: UDI framework canvas populated with a case study*

Effectiveness of the framework for identifying impact factors (both workshops)

- **Scale:** This dimension is effective for giving an initial overview of a scenario which includes consideration of time factors Influences and authority (W1, JB &W1, FV), and this can also support identification of opportunities (W2, AP2) especially when viewed in relation to the nested contexts of stakeholder interests (W1, IA). The overall approach links to the 'designerly' quality of being able to 'frame and reframe' the design challenge (W1, BC)
- **Influence and Authority:** It was felt in the group discussions that these factors are important in the context of the notion of 'elevating' the role of design and that the canvas approach is a basis for exploring these issues (four comments). A number of the cases explored included significant factors affecting impact within this category (four comments) and the canvas is a basis for exploring where these factors may appear (W1, ALL 1.3). It was identified that positive cycles of activity can change the dynamics of influence and authority (W2, ALL 2.1), and that the canvas can help to identify this dynamic. However the framework presented perhaps needs to clarify the differences between 'strategic capabilities' in this category (W1, JB) and 'capabilities' in the *Path* category.
- **Motivation:** High levels of motivation were seen as significant in one of the cases (W1, AC) and therefore an important factor to highlight. Exploring multiple motivations (e.g. as in stakeholder analysis) was seen as important in multi-stakeholder contexts (W2, JB2) where conflicting motivations can cancel each other out. This could be seen in relation to the concept of 'risk management' (W2, JB2). The framework could lead to exploration of ways to operationalise motivation factors (W1, AP) which may be particularly relevant in social impact contexts.
- **Path:**Based on the cases discussed, the value of exploring impact as a result of multiple or divergent paths was endorsed (W1, AC), but this also implies that there need to be effective ways of operationalising and understanding the differences (W2, YK). Working in a context with aligned paths was seen as important (W1, IA), which links back to project planning activities that might also recognise the potential of 'designerly'

paths (W1, BC). Planning links *Path* to *Design value* as does the idea that this combination can be a basis for exploring the impact of radical versus incremental innovation (W1, JB).

- **Design value:** A number of the case studies demonstrate the impact of the *integrating* quality of design activity (W1, ALL 1.4), which also endorses the 'emphasis' and 'embeddedness' findings of design impact research. However, other examples highlighted the difficulties associated with attempts to disaggregate design value from other value adding factors (W2, DN&W2, YK).
- **Impact analysis**: The virtual loop indicated on the canvas was not emphasised in the briefing but was independently recognised as significant (W1, BC). A number of the points made can be considered to relate to issues of operationalisation, as found in other parts of the overall study, including lack of data (W2, YK), cost of data acquisition/analysis (W2, DN), what any analysis should focus on (W1, AP), qualitative - 'subjective'- analysis used as a substitute (W1, ALL 1.6) and that 'good' and 'bad' judgements tend to be avoided (W1, FV). The framework was useful for identifying that impact sometimes needs to be considered longitudinally, or on longer timescales (W1, FV). The value of objective benchmarks was discussed (W1, ALL 1.7). It was recognised that, wherever impact analysis is practical, it has benefits (W1, ALL 1.5) and there was general endorsement that seeing a more complete picture of influencing factors is useful (W1, ALL 1.9)

In summary the UDI framework can be judged to be effective for exploring design impact factors. The comments generated endorse points identified in design impact literature, providing a level of triangulation of findings. Considered as a whole the comments also highlight a number of areas where the framework needs further work to clarify the distinctions between factors and the interrelationships between factors. Based on the findings, certain aspects can be further highlighted in any representation/visualisation of the framework to more effectively demonstrate a) how the framework is differentiated from other related design frameworks or models and b) factors within the framework which appear to be particularly pertinent to understanding impact.

Adoption of the UDI Framework (Professionals workshop)

The final part of the workshop discussed the question: What ideas for methods and communication might be derived from the framework, and how might they most effectively be implemented? This was done on the basis of a short briefing on three examples of methods or tools which might be derived from the framework. The participants were also invited to discuss and propose additional ideas which might be included in a Likert scale analysis of the various suggestions. Participants then scored the suggestions to reflect the outcome of the discussion (*Table 7.9*). Only the first three formally presented suggestions for methods or tools were scored by all six of the participants due to the logistics of the workshop.

Table 7.9 *Views on the effectiveness of Methods or tools derived from the UDI framework (Professionals workshop scoring)*

Methods or tools (number of responses)	Very Useful +2	Useful +1	Neutral 0	Could be useful -1	Not useful at all -2	Score Av.
1 UDI Canvas (6)		5.5	0.5			0.9
2 Design impact 'Co-efficient' (6)		3	2		1	0.2
3 Design impact mapping(6)	3	3				1.5
4 Reverse engineering'(3)	1	1	1			1
5 Macro view of design ingredient (2)		1	1			0.5
6 Customer satisfaction and or other key factor as part of dashboard (4)		2	1	1		0.25

It should be noted that the proposals for methods or tools are not to be viewed as complete or stand alone approaches. For example the DMI design value system (Westcott et al., 2013) uses a combination of three separate elements to make up the 'system'. The concepts and workshop feedback are summarised as follows:

- **UDI Canvas:** This approach is based on the principles of the Business Model Canvas (Osterwalder & Pigneur, 2010), and the simple idea that design impact factors can be explored on a canvas as a basis for impact analysis – either forecasting or evaluation. Five out of six participants saw this as useful, with the sixth participant undecided between a useful and a neutral response. This can be viewed as a reasonable endorsement of the canvas idea.

- **Design impact 'Coefficient':** The 'coefficient' idea was presented as a multiplication factor which could be used in combination with other impact related data to give an indication of the relative value of the design ingredient. This is based on the literature review finding that current studies do not show the causation between design activity and impact, only correlation. Therefore a metric to understand the value of the design ingredient would be useful. One participant scored this concept as not useful at all. This can be seen to reflect and confirm a number of factors identified elsewhere within the study: scepticism about the utility of metrics for exploring design impact and difficulties in obtaining sufficient data to enable such a metric to have authority. Three participants took the more optimistic view that such a metric would be useful, but overall this concept scored the lowest of all the approaches discussed.
- **Design impact mapping:** This concept may use elements of the UDI framework to generate visual mapping of design impact. However, the overall principle is the idea of a visual representation of design impact. This can be seen in examples such as the Design Value Index (Westcott et al., 2013), but there is potential to visualise a richer, more granular range of factors. This achieved the highest average score, with three participants scoring this as 'very useful' and the remaining three scoring the concept as 'useful'. It can be argued that the design professional participants are likely to be predisposed to favouring a visual approach. But the result can also be seen to be valid on the basis that the target audience for adoption of any resulting methods or tools will include designers, and there is considerable evidence that visual approaches to communicating complex information is effective (e.g. McCandless, 2010).
- **'Reverse Engineering':** This was proposed by a participant as a principle more than as a specific tool. The idea is that more attention should be paid to 'reverse engineering' design impact. Alternatively, examples of design impact should be deconstructed as a basis for generating benefits for the design profession such as an 'elevated' role and professional development.

- **A macro view of the design ingredient:** This proposed approach supported the idea that a method or tool should enable 'seeing' the design ingredient of impact in a wider context. This correlates with findings from other studies about the need for 'disaggregation' and aims to address the issues of 'overselling' the value of the design ingredient.
- **Customer satisfaction as part of a dashboard:** This proposal combines a number of elements and found favour with a number of the workshop participants. 'Customer satisfaction' can be considered a 'soft' or 'intangible', but significant, impact factor. It is highly relevant to many applications for design. The proposal also recognises that it is not appropriate as a single metric for identifying design impact, but that, following the principles of a Balanced Scorecard approach (Kaplan & Norton, 1992), Customer satisfaction could be an indicator on a dashboard of relevant metrics. This also confirms the importance of simple to assimilate and visual approaches to adopting impact metrics.

A second discussion point in this part of the design professionals' workshop was based around the participant's views on the most effective ways in which any methods and tools derived from the UDI framework might be adopted by the profession. *Table 7.10* shows the results of the participant scoring based on three approaches to adoption. The business model canvas (Osterwalder & Pigneur, 2010) was cited as an example of how an initial PhD research study by Osterwalder (2004) has subsequently become a widely recognised approach supported with a book, website and commercial activities. Participants generally saw this potential approach as useful, but the highest scoring approach was simply the idea of adoption at an organisational level with two participants scoring this 'very useful' and two 'useful'. This can be seen as endorsement of the potential for adoption, but also, pragmatically, that first steps to potential widespread adoption will involve the framework being taken up by single organisations. The final suggestion was that methods or tools derived from the UDI framework might be adopted as a national or international protocol. The DMI Value System (Westcott et al., 2013) shows an example of this. Alternatively, there is the potential for adoption as part of the DBA Design Effectiveness Awards protocols for documenting design effectiveness. This approach achieved the lowest of the three scores, perhaps reflecting scepticism about achieving 'buy-in' from candidate organisations.

Table 7.10 *Views on the adoption of methods and tools derived from the UDI framework (Professionals workshop scoring)*

Adoption	Very Useful +2	Useful +1	Neutral 0	Could be useful -1	Not useful at all -2	Score Av.
1 Organisation level	2	2				1.5
2 National or International protocol		2	1	1		0.5
3 Open-source or commercial initiative		3	1			0.75

STUDY 2.2 Review: Fit of the Updated Design Ontology and UDI Framework to Competency Questions

This part of the review discusses how well the updated design ontology and new UDI framework responds to the Competency Questions established at Step 1 of the ontology development process.

Updated Design Ontology Competency Questions (DOCQs)

DOCQ 1 v2 (design research based) How do existing models or methodology for considering the value and impact of design fit within this extended ontology alongside design process models and methods?

It is considered important for ontological commitment that the developed ontology can accommodate the significant design impact related concepts identified in the literature review. The overall aim is for it to be possible to map any existing theory or model on to the ontology. Key concepts directly incorporated, or related to the following super-classes include:

- ***Scale:*** No direct links to literature for this ontology super-class are identified. Ulrich &Eppinger (2004) identify that design process is evident in a wide range of scales of activity and outcomes.
- ***Influences and Authority***: *Emphasis* – and related terms (Hertenstein, 2001, Gemser & Leenders, 2001, Candi & Gemser, 2010), Design management (e.g. Borja de Mozota, 2003), *Design Leadership* (e.g. Topalain, 2011, Miller & Moultrie, 2013a and 2013b) *Moderating environmental factors* (Candi & Gemser, 2010). The high profile, but somewhat contentious concept (Woudhuysen, 2011) *Design Thinking* is also accommodated in this super class.

- ***Motivation***: *Engine* and *Heart* (Koen et al.,2001 and Bujis, 2003), *Goal* (Sim & Duffy, 2003) and *Formulation(*Gero & Kannengiesser, 2004)
- ***Path***: This super-class accommodates all models relating to what are referred to as *design process structures e.g.* as catalogued and reviewed by Dubberley (2004) or Gericke & Blessing (2011), it also accommodates concepts of Capabilities (Swan et al., 2005), competency, expertise & design knowledge (Kristensen & Gabrielsen, 2010, Koostra, 2009, Tether 2005)
- ***Design Value***: *Four Powers* (Borja de Mozota, 2006) is an example of a specific model. Rae (2014) and others create lists of design value adding qualities.
- ***Impact Analysis***: *Measuring Design Value* (Barcelona Design Centre, 2014), *Design Value System*, (Westercott et al., 2014) are recent examples of serious attempts to tackle the whole topic of design impact. Candi & Gemser (2010) is referenced in relation to the virtuous circle effect. The Triple Bottom Line (Elkington, 1999) is a reference for a widely accepted division of impacts into Social, Environmental and Economic.

DOCQ 2 v2 (professional practice based) How does this extended ontology relate to either a specific design project or the general design practice of an organisation?

The two expert workshops held with academic and design professionals spent time mapping existing case studies (12 in total) to the UDI framework derived from the expanded ontology. Once the key concepts within the framework were understood, the framework proved to be a useful basis for discussing cases. These reviews highlighted that the framework can draw out issues which may not typically be accommodated within consideration of design impact. But they also showed that terminology and classification issues and class boundaries can inhibit ontological commitment. The mapping of case studies and related discussion also suggested that certain factors are more significant to expanding the understanding of design impact than others.

DOCQ 3 v2(usefulness to adoption for design impact analysis) Can the ontology and UDI framework encompass all the elements which may determine the impact of design practice and effectively lead to methods and tools for adoption in design practice?

The framework, as presented, appears to provide a sound basis for exploring a complete range of impact factors when discussed with a well informed audience. The principles of ontologies are predicated on the ongoing evolution of the structures and content. No fundamental issues were raised during the workshops to suggest that the framework and related ontology could not accommodate further evolution. The mapping of case studies carried out in the workshops did not explore operationalisation of the framework concepts in detail. But general questions relating to adoption were explored. A number of conditions required for operationalisation of the concepts and adoption can be deduced from the findings.

Condition 1 - Availability of data: This is the fundamental prerequisite to any form of impact analysis. But, as indicated in the workshops and in earlier studies, there are a range of barriers to availability of data.

Condition 2 -Commitment to impact analysis: It is clear that in the design domain, impact analysis is not a habitual or integrated activity. Benefits which might accrue from impact analysis are not clear, and this is compounded by scepticism about the utility of impact analysis. Impact analysis is often seen as a cost rather than a value adding factor.

Condition 3 - Methods and metrics for operationalisation: Whilst there are considerable bodies of literature in broader fields of performance management and impact analysis which can supply a wide range of potential methods and metrics, there are areas where the nature of design activity is not well supported by this body of literature and practice. Issues which present particular challenges include the disaggregation of the design ingredient in any instance of design impact; divergent views on what constitutes ‘good’or ‘bad’ (design)impact, the difficulty of operationalising ‘soft’ or ‘intangible’ factors such as ‘customer satisfaction’ (identified in the second expert workshop) and the need to take a longitudinal view of impact. These challenges are further compounded by the first two conditions.

The developed design ontology and UDI framework does not directly tackle these issues. However, the findings from the expert workshops do suggest a level of usefulness. Most strongly supported the potential for adoption within individual organisations and with approaches which focus on visualisation of impact information.

STUDY 2.2 Review: Limitations of the findings and methodology

Limitations of the study are considered both for the ontology development process and for the evaluation workshops:

Ontology development process

Research quality points were explored extensively in the initial ontology development (ref STUDY 2.1) and in the quality considerations section of this study. The depth of work only incorporates the first four of seven development steps identified by Noy and McGuinness (2001) and the thoroughness of the work on the initial steps is inevitably limited by the resources available. However it is an established principle that ontologies should accommodate *Extendibility,* and it is argued here, and earlier, that this quality helps mitigate against any lack of *ontological commitment*. This was evidenced in the evaluation workshops, where participants may not have been familiar with some of the terms used – a low level ontological commitment issue. A more significant limitation would have been if participants argued that the terminology did not properly represent the related concepts, or if significant factors were missing from the ontology. This was not the case, but if it was, the ontology could accommodate this development.

Evaluation workshops

Storvang et al.’s (2014) Planning recommendations provide a simple three point basis for considering limitations to these reviews

- The roles of the researcher and participants: A possible limitation is the number and profile of the participants: A) meaning that the results may not be considered significant due to the relatively small numbers of participants (12 in total); and B) the expert nature of the participants (academically and professionally) does not reflect the complete spectrum of expertise amongst the design profession.
- The ‘staging’ of the focus group: Planning decisions were taken which determined the amount of time spent exploring each topic. There is clearly potential for each aspect to be explored in more detail. However, the agenda kept the overall focus on evaluation of the new framework.
- The approach to analysing the resulting data: The quantitative data from the Likert scale scoring is very limited and is only intended as a guide to analysis rather than the whole basis for analysis. The qualitative data from the

workshops could have been influenced by the researcher-participant dynamic, or by individual participants. The amended protocols of the second workshop were intended to overcome slight mismatches of contribution experienced in the first workshop. The analysis of findings is open to potential researcher bias, but this can be mitigated by high levels of reflexivity and triangulation approaches within the study as a whole.

STUDY 2.2 review: Mapping research questions to findings and review

*Table7.11*maps the study research questions to the main findings of the study together with references to relevant design impact literature. .

Table 7.11 *STUDY 2.2 – Mapping research questions to findings and review*

STUDY 2.2 Research Questions	STUDY 2.2 Findings	Literature review references
RQ A5 How do concepts currently used in practice compare to the ideas being developed?	Literature review identified design value indexes, models and guidelines. Some are adopted by academic and professional organisations and policy level organisations. There is **very little adoption in professional practice**. The developed ontology and UDI framework bring together and rationalise a wider range of factors affecting design impact than existing frameworks or methods. The developed ontology is structured around three pairs of factors (6 super-classes). In the UDI framework these are graphically represented to show the interrelationship of the factors in an accessible and recognisable arrangement. ***Influences & Authority, Design Value*** **and** ***Impact analysis*** are added to three super-classes identified in the initial ontology development	Indexes (e.g. Westcott et al., 2013), models (e.g. Borja de Mozota, 2006) guidelines (e.g. Barcelona Design Centre, 2014) Ref *Table 2.2*summarising research gaps in design impact literature identified by Candi & Gemser (2010); Noble (2011); Madano Partnership, (2012), Nomen et al. (2012)
RQ B5 How do the ideas being developed respond to the issues and challenges identified?	The work aims to bring coherence to the complete range of factors affecting design impact in a flexible format which can be a foundation for development of design impact analysis methods and communication approaches. **The design impact ontology and related UDI framework** is also predicated on the basis of being able to evolve to accommodate other existing and emerging concepts. *Influences & Authority* encompasses factors in the nested contexts for design activity which affect design impact and which are especially relevant at the early planning stages of NPD and innovation *Design Value* clarifies and consolidates the distinctive qualities which professional design activity contributes as a basis for understanding, disaggregating and articulating design impact *Impact Analysis* encourages a broader view of impact which recognises the longitudinal and circular aspects together with the complete HEET range of potential impacts	Ref the need for a sound theoretical basis for design impact analysis identified by Candi & Gemser (2010); Noble (2011); Madano Partnership, (2012), Nomen et al. (2012)
RQ C5 What evidence can be gathered to verify that a framework for UDI can have a positive effect on design impact (for example for the design profession, professional contexts for designing, the design research community and design pedagogy)?	In the empirical research (STUDY 1.2, 1.3 & 2.2), factors encompassed within the *Influences & Authority* and *Design Value* super-classes are consistently identified as influencing design impact. Evaluating the framework with academic and professional experts confirms that the framework can be an effective basis for exploring and highlighting these factors in a range of professional practice scenarios. Significantly, the virtuous circle of impact analysis is confirmed to be a significant factor in cases of high design impact.	The *Influences and Authority super-class has echoes in*: *Emphasis* – and related terms (Hertenstein 2001, Gemser & Leenders 2001, Candi & Gemser, 2010), Design management (e.g. Borja de Mozota, 2003), *Design Leadership* (egTopalain, 2011, Miller & Moultrie, 2013a and 2013b) *Moderating environmental factors* (Candi & Gemser 2010) andthe high profile, but somewhat contentious concept (Woudhuysen, 2011) of *Design Thinking* *And within the Design Value super-class:* Borja de Mozota, 2006) provides an example of a specific model. Rae (2014) provides a list of design value adding qualities.

STUDY 2.2 Research Questions	STUDY 2.2 Findings	Literature review references
RQ D5 What ideas for methods and communication tools emerge from the combined studies which could have potential for enhancing professional design practice?	The expert evaluation workshop discussed six possible methods, tools or approaches to adoption of the UDI framework within professional practice. Method, tools or approaches adopted at individual organisation level are seen to be most likely to be useful, and approaches which visually map design impact received the best support from design professionals. The concept of a design co-efficient, a metric to clarify the design ingredient of design impact was less well supported Additionally the review identifies **three conditions which need to be met in order for effective understanding of design impact to take place**: 1) Availability of data, 2) Commitment to impact analysis, 3) Methods and metrics for operationalisation	The Barcelona Design Centre (2014) activity is generating policy level guidelines for impact analysis. But it is not clear that this has a direct application in professional practice. The DBA and other industry based competitions and indexes recognise 'is-like' design impact. But significantly there is no evidence in literature of industry adoption of methods and communication for 'should-be-like' design impact exploration.

7.2.5 Development of the prototype framework

Figure 7.7 updates the earlier visualisation of the prototype framework for UDI to show the new elements and rationalisation resulting from the development of the ontology in STUDY 2.2. The underlying diagram has been slightly simplified and updated with the new title for the general domain: *Professional Design Impact*. The earlier 'client activity' and 'design activity' 'spaces' are represented in the same simplified manner as shown in *Figure 7.4* and as classified in the expanded ontology, e.g. as a *Key stakeholder space* encompassing the *Designing space.*

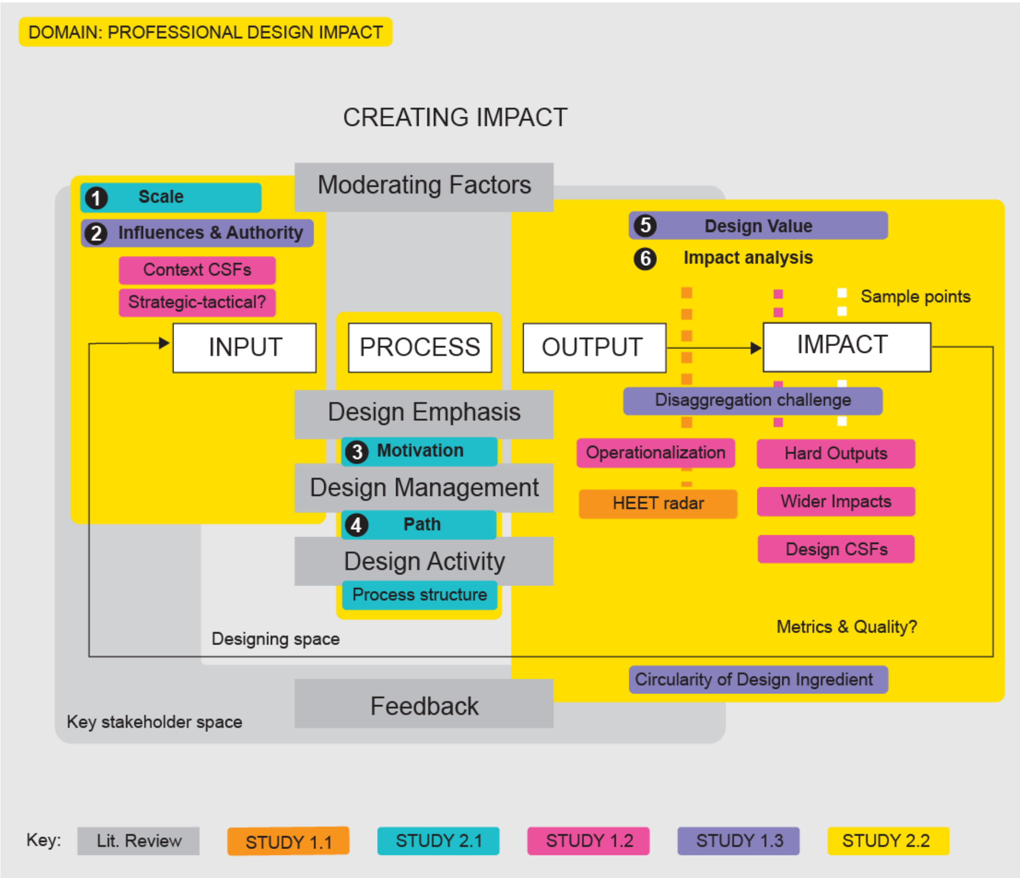

Figure 7.7 *Prototype Framework for UDI (version 5) with outcomes from STUDY 2.2 added (three pairs of factors in clusters shaded yellow)*

The rationale behind the clustering of elements (highlighted in yellow on *Figure 7.7*) is briefly explained as follows.

***Scale* and *Influences & Authority* cluster:** This incorporates the distinction between strategic and tactical approaches identified in STUDY 1.2 which is triangulated with the *Design Emphasis* (Candi & Gemser, 2010) concept from the literature review. *Context CSFs* (also from STUDY 1.2) is placed here to reflect that these are part of the *Influences* on any given scenario.

***Motivation* and *Path* cluster:** These factors are shown to span the *Key stakeholder space* and the *Designing space. Process structure*, the ontology class identified in STUDY 2.1 to include all structures for designing activity, is shown alongside *Design management* and *Design activity* from Candi & Gemser's 2010 model.

***Design value* and *Impact analysis* cluster:** This includes the most elements; the *Disaggregation challenge* identified in STUDY 1.3 links closely with the *Operationalisation* challenge from STUDY 1.2. Also from STUDY 1.2 are aspects of disaggregation, *Design CSFs, Hard outputs* and *wider impacts.* The *HEET radar* operationalisation technique adopted in STUDY 1.1 is shown in this cluster together with an indication of the sample points from this study and STUDY 1.2.

7.2.6 Definition of the new UDI framework

The new UDI framework is defined as a design process based framework of factors, derived from an ontological foundation, which is a robust basis for exploring and understanding design impact that can be used in a range of scenarios, for example as part of the professional practice of designING, within design research and design pedagogy. Methods for, and communication of, design impact analysis can be derived from this framework.

There is considerable flexibility in how the framework is visualised. *Figure 7.8* is a simplified version of the UDI framework used in the evaluation workshops.

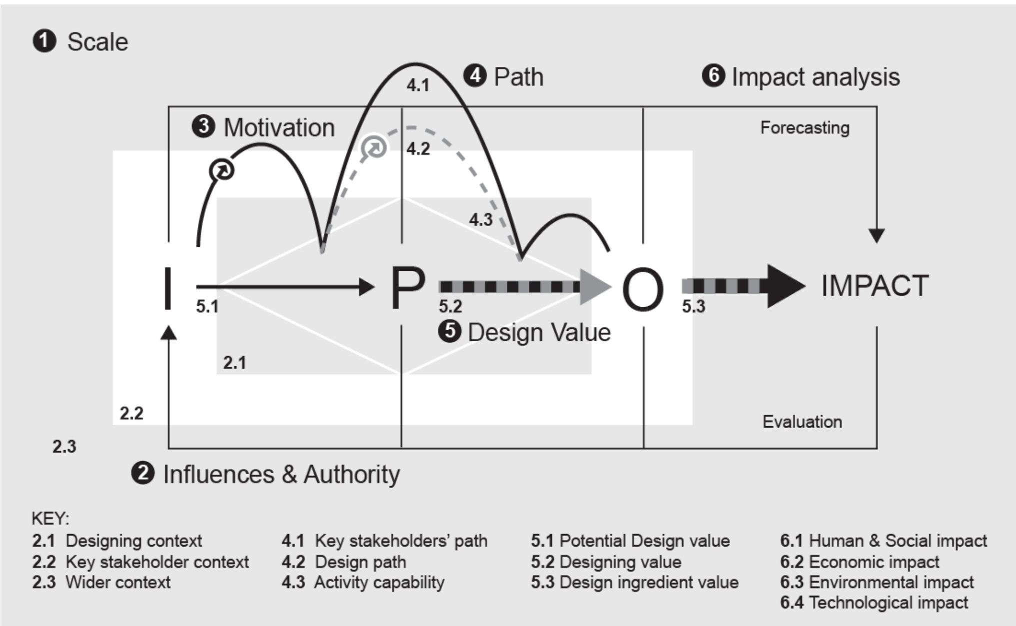

Figure 7.8 *Simplified visualisation of the new UDI framework*

7.2.7 Summary

STUDY 2.2 was a second phase of prescriptive research which built on the initial design process based ontology developed in STUDY 2.1. The study aim was *To combine the findings from the earlier studies into the development of a design ontology and new UDI Framework with an associated discussion of the possibilities for professional tools, applications and adoption*. The outcomes were evaluated with two workshops.

The expanded ontology is summarised in *Table 7.4*. This is based around six super-classes. This adds three new classes to the initial, design process focussed, ontology. The six super-classes are organised into three pairs. The visualisation *(Figure 7.4)* links the six super-classes to an Impact-Process-Output-Impact core which is overlaid onto a schematic representation of three nested contexts: the *Wider context*, the *Key stakeholder context* and the *Designing context.* The intention is that the ontology can accommodate any factor relating to design impact. The ontology expandability principle allows developments to be incorporated.

The *new UDI framework* refers to the arrangement of factors derived from the ontological foundations. This can be visualised in a number of forms according to the requirements of the context. *Figure 7.7*, version 5 of the prototype development highlights the iterative development of the framework. *Figure 7.8* shows a simplified version of the new UDI framework used in evaluation workshops. The evidence from the workshops shows that the framework is broadly clear, understood and useful.

The *Influences & Authority* and *Design Value* super-classes were identified as particularly relevant to exploration of design impact. Adoption of the framework in methods or tools would be most likely to occur at individual organisation level rather than as an industry wide initiative or as a commercial venture. The participants favoured methods which generate a visual representation of impact analysis.

Three conditions needed for impact analysis to take place were identified: Condition 1 - Availability of data; Condition 2 -Commitment to impact analysis; and Condition 3 - Methods and metrics for operationalisation. There was limited detail discussion of specific methods and tools which might be derived from the framework within the evaluation workshop, but this aspect of the overall study is explored further in the discussion section of this chapter. This includes an example of how the Gravity light case study from the Design Professionals workshop could be explored from a 'is like'

– evaluation, and a ‘should be like’ forecasting’ perspective using the new UDI framework.

7.3 Discussion

This section explores the emerging outcomes from the overall study from three perspectives: firstly, a reflection on how the complete sequence of studies has informed the development of the design impact ontology and the new UDI framework; secondly, consideration of key points arising from detailed mapping of a case study to the UDI framework; and thirdly, consideration of methods, tools and communication for design impact which might evolve from these foundations. These adoption issues were explored in summary in the review of STUDY 2.2, but are expanded on here.

7.3.1 Consideration of individual study outcomes

Rather than reporting the outcomes in the chronological sequence of the five research studies, the groupings of descriptive and prescriptive studies are considered.

Descriptive studies – Studies of design impact factors

STUDY 1.1: Modelling student design activity

This study was an early pilot to explore relationships between design practice (in a tertiary education context) with factors which might be considered significant in impact analysis with an initial, tentative, concept for operationalising the analysis.

The study utilised readily available data, which overcame the recurring issue of availability of data - Condition 1 for impact analysis. The HEET radar ‘construct’ or evaluation method was initially conceived to explore a set of factors which were not typically evaluated in the selected context. Whilst the quantitative and qualitative analysis from the HEET radar dataset are not of significance for the UDI study, the analysis of ‘contextual factors’ has been reframed in the final study as a subclass of the *Influences & Authority* super class. Therefore the HEET radar method can be considered a potential means to evaluate, or operationalise, Human & social, Economic, Environmental and Technology factors as a 360° envelope of contextual considerations. It was interesting to note that in the pilot evaluation workshop (STUDY 2.2) there was limited ontological commitment to the term ‘contextual factors’. In the final workshop this was more successfully substituted with the

‘Human & social, Economic, Environmental and Technology factors’ terminology of the HEET radar method.

STUDY 1.2: Reviews of design impact from professional practice

In this first descriptive study within professional practice, the issue of availability of data was overcome by utilising data available from the DBA Design Effectiveness Awards. Analysis of 45 case studies led to the identification of 162 rationalised impact metrics. This provides a body of data which could be classified within the metrics class of the emerging design impact ontology. The distinction between ‘Hard (quantitative) metrics’ and ‘wider qualitative) metrics’ and the observation that on average the case studies included three of each type of metric, may be a useful contribution and rationalisation of how communication of design impact could be standardised across diverse scales, specialisms or sectors, therefore potentially making a contribution to operationalisation challenges– Condition 3 for impact analysis.

The selective nature of the underlying data and case studies meant there was limited direct correlation between the reported analysis and design impact literature. For example, claims of what have been termed ‘Design CSFs’ could be considered aspects of the added value of designing, but it would appear there is limited consistency or agreement between the ways in which design researchers and design professionals articulate these qualities. In the emerging ontology these factors are grouped within the design value super-class. This super-class therefore shows considerable potential for further research.

Another limitation of the underlying data can be seen to be its focus on outcomes, with limited consideration of disaggregating design as an ‘ingredient’ of overall impact, and *how* the design ingredient has added value. Within the emerging ontology and UDI framework this can be seen to be clarified by making a much clearer distinction between DesignING and DesignED*Output.* Also the distinctions between the *Motivations* and *Paths* of DesignERS and *Key stakeholders* would be a useful basis of better understanding of the type of data available within the DBA DEAs and other professional contexts.

STUDY 1.3: Industry & Academic reviews of the design process and impact context

The in-depth perspectives from interviews with design professionals (average experience - 24 years) provided insights on design impact factors not previously explored. For example, the distinction between design impact analysis for forecasting or post outcome evaluation does not appear to have been explored within design impact literature. This distinction is added to the *Impact analysis* super-class and becomes a feature of the visualisation of the UDI framework. The recognition of the 'reverse engineering' benefits of impact analysis, accommodated by this,links to the strong validation of the circular benefits of positive impact referenced by the interview participants.

The concept of *Design Authority* was derived from the interview findings as a very significant factor influencing design impact. There are links with the exploration of Design Leadership in literature (e.g. Koostra,2009; Topalin, 2011; Miller & Moultrie, 2013a and 2013b), but the socio-cultural contexts for design activity which the term Design Authority aims to expose have received limited attention within design impact literature. Even relevant studies such as Micheli (2014) tend to generalise their findings based on the design *emphasis* hierarchy rather than exploring socio-cultural or *Design Authority* factors in more depth. In the emerging ontology and UDI framework *Design Authority* is coupled with *Influences* to encompass all these, often conflicting, forces within *Input* properties. The final study evaluation workshops tended to confirm the findings from STUDY 1.3, that *Influences and Authority* are a very significant and perhaps overlooked set of factors affecting design impact. The 'Danish Design Ladder' (Danish Design Centre, 2003) or 'Design Management Staircase' (Kootstra, 2009), can provide a partial means to operationalise these factors in impact analysis, but do not fully reflect the socio-cultural forces. Therefore the *Influences and Authority* super-class is another area requiring further research.

Prescriptive studies – Development of a design ontology and new UDI framework

STUDY 2.1: Rationalising theoretical foundations

The genesis for the initial development of a design process based ontology was derived from the literature review finding that, whilst a considerable amount of design research attention has been given to enhancing design practice through design process, there is limited connection between design process studies and design impact studies. This is then compounded by serious criticisms of the whole field of design research. Therefore the ontology development was conceived as a response to these issues and a means to provide a robust and necessary foundation for research in the design impact field.

However, process based perspectives can, understandably, oversimplify input and output factors. A criticism of process models in general is that they do not reflect reality and are of limited use to practitioners (e.g. Lawson, 2004; Birkhofer et al., 2005; Dorst, 2008; Eckert& Stacey, 2010). The initial study avoided these issues, simply by focusing on the core process aspects. The resulting ontology can also be seen as a foundation for addressing the identified issues.

By basing the ontology on a time based sequence of activity, it also provides a basis for making a clearer distinction between the impact of designING and the impact of designED output. It therefore provides a clear basis for longitudinal exploration of design impact.

The identification of *Motivation* and *Path* as distinctive ontology classes also helps to distinguish and identify the role of designERS in any given scenario.

Reviews of visualisation of the initial ontology also provided useful insights into the levels of rationalisation and simplification required in order to develop ontological commitment. The work by Birkhofer et al. (2005), and more recently Choi et al. (2014), are useful summaries of the challenges for adoption of any new knowledge in practice. The final evaluation workshop endorses a visual approach to communicating impact information, but it is also noted that in interviews with design professionals (STUDY 1.3) there were negative associations with certain aspects of visualisation (the Double Diamond design process model in this case).

STUDY 2.2: Developing and evaluating an ontology and framework for UDI

The expansion of the ontology, developed in the final study, and the related visual representation of the UDI framework, take account of the levels of simplification needed for effective communication. This approach is validated to an extent in the two evaluation workshops, although the expert profile of the participants provides an incomplete overview of levels of comprehension, or, in ontology terms, ontological commitment to the design ontology and the framework for UDI.

Building on the UDI framework and workshop findings provides a foundation for considering the further development of methods, tools and communication of design impact. Key elements to consider, in addition to the underlying ontological structure and population with instances, include: the three identified conditions for impact analysis, maintaining the flexibility to adapt any approach to the individual circumstances of adoption (adoption by individual organisations is the most likely scenario) and a preference amongst designers for a visually based approach.

7.3.2 Consideration of a case study mapped to the UDI framework

The Gravity Light case study (Figure 7.9) explored in the Professional designer's workshop is used here as a more in-depth exploration of how design impact factors might be explored using the UDI framework, from a 'should-be-like' – *Forecasting* impact – and an 'is-like' – *Evaluation* of impact - perspective.

Figure 7.9 *The Gravity Light (Therefore Design, 2015, Ben & Jerry's, 2015, Gravity Light, 2015)*

The Gravity light is a social and technical innovation concept providing low cost, zero environmental impact lighting targeted at the 20% of the World's population without access to mains electricity.

Figure 7.10 shows the basic UDI framework highlighting the two overall modes for considering the UDI factors: *Evaluation* and *Forecasting*. *Table 7.12* summarises a hypothesized *Forecasting* exploration using the UDI framework. This might be part of exploration with the 'client' about the general viability of the project and the role of the designers and design within the project context at the outset of the work. In the *Evaluating* impact summary (*Table 7.13*), the designers and the client might be using the framework to review the project to identify the most compelling evidence to support the overall impact of the light as a basis for generating further development funding.

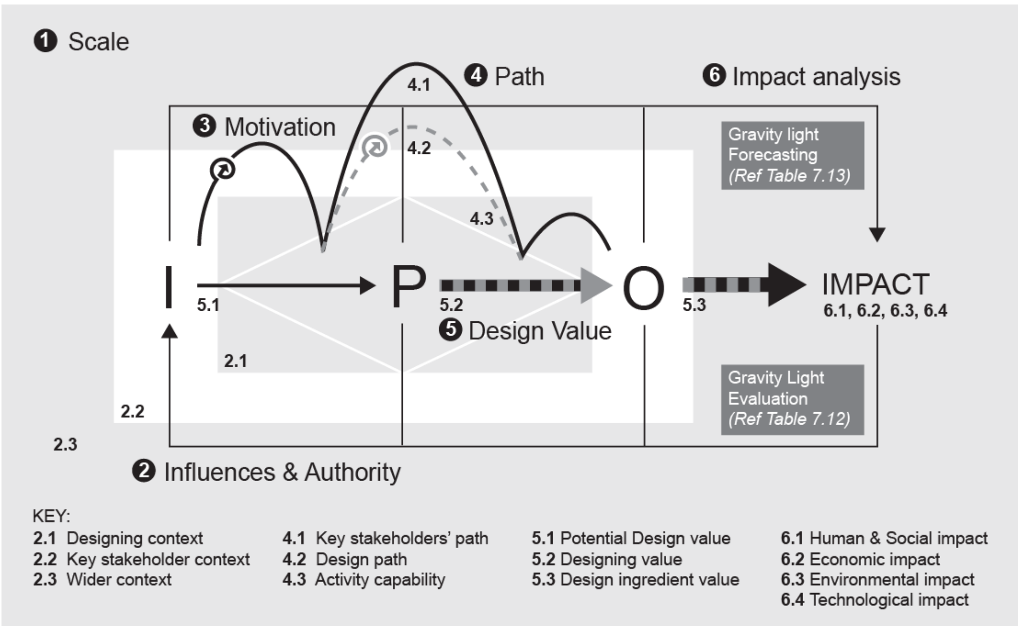

***Figure 7.10** Mapping the Gravity Light case study to the UDI framework: Evaluation and Forecasting*

Table 7.12 *Mapping the Gravity Light case study to the UDI framework for FORECASTING*

UDI Framework element	Gravity Light comments
1 **Scale**	The initial design work started in 2009 with a brief from the SolarAid charity to develop a design to eradicate kerosene lamps. At this point there was an identified need (numbers of people using Kerosene lamps in developing countries targeted by SolarAid) and a target product cost. But a potentially significant gap between the scale of the opportunity and the capability to deliver impact.
2 **Influences and Authority**	This element of the framework is a basis for understanding some of the key challenges in achieving impact within the stakeholder environment (as demonstrated by many of the earlier case studies examined).
2.1 Designing context	*Therefore* initially designed lights in response to the SolarAid challenge, based on their experience and track record of design with functional

UDI Framework element	Gravity Light comments
	innovation – this was a small step in a much larger challenge, but well focused on *Therefore's* expertise
2.2 Key stakeholder context	SolarAid were the key stakeholder – whilst they had commissioned *Therefore*, their resources for investing in product design were limited and the design brief was only a small part of their overall charitable activity
2.3 Wider context	SolarAid were able to identify the broad social and environmental context for the opportunity. However it can be seen that there are multiple challenges within the stakeholder environment for design interventions in developing countries, where neither party had strong influence or authority.
3 **Motivation**	*Therefore's* motivation was initially a combination of commercial imperatives for their business with 'designerly' motivation based on the design team's areas of expertise, plus, a general sense of the value of doing work with a potential social and environmental impact.
4 **Path**	The UDI framework encourages exploration of the differences between the paths of designers and key stakeholders. This is intended to highlight potential threats to, and opportunities for, enhancing impact
4.1 Key stakeholders' path	SolarAid's experience is based in generating charitable support for solar lighting solutions – distinct from developing product. Their approach had been based on utilising available technology – hence the involvement of Therefore to enhance their activity. Links between the two main paths were not distinct.
4.2 Design path	The early stages of the design activity were characterised by classic product design process. With a focus on enhancement to current solutions through experienced and well considered design for manufacture. The potential for design is ultimately limited by the scope of the design input.
4.3 Activity Capability	Capability can be explored for all key stakeholders. This was a new sector for *Therefore* to be working in, their capability was initially limited to the core product design activities. It could possibly be foreseen that there were gaps in the complete set of capabilities needed to deliver product solutions for developing countries at scale.
5 **Design Value**	The core design process based framework allows impact to be considered in relation to how design input can potentially aggregate impact through the chronology of NPD activity and beyond. This is distinct from most consideration of design value which tends to be based either on retrospective evaluation, or optimistic – un evidenced -aspirations.
5.1 Potential design value	Typically the *potential design value* was based on targets for cost based improvements in existing product. The potential of other forms of design innovation are very difficult to predict – designers may intuitively see potential, but it is very difficult for stakeholders to understand this in quantitative terms
5.2 Designing value	*Therefore* have an excellent track record of innovative design-led detail design for manufacture. Based on this, and the poor quality of existing product it was reasonable to predict that design could enhance existing solutions.
5.3 Design ingredient value	Based on the likely nature of design input it would have been possible to speculate about potential cost benefits – for example in a number of materials and manufacturing scenarios. In a consultancy situation, decisions need to be made about how much time to invest in *forecasting* benefits versus spending time on *designing* potential benefits.
6 **Impact Analysis**	Conventionally, professional design activity does not focus on analysis of potential impact apart from quite generalised statements about the added value of design. The UDI framework provides a simple basis for engaging with the topic.
6.1 Human & social impact	This category of impact was the primary motivation for SolarAid, who were able to substantiate the overall project context with their own data on populations affected and existing solutions
6.2 Economic impact	SolarAid were able to articulate their economic targets for the project – albeit with limited experience of NPD. *Therefore* were able to provide general validation of the potential to achieve economic benefits from good

UDI Framework element	Gravity Light comments
	design
6.3 Environmental impact	SolarAid were able to evidence the general context. But typically there would be costs associated with evidencing more detailed understanding of macro and micro environmental factors. A general consideration of these factors may have been useful for establishing a basis for future evaluation.
6.4 Technological impact	Solar power and associated LED technologies could be considered as rapidly evolving fields, for example characterised by paradigm shifts and dramatic cost fluctuations. Exploring general technology roadmaps could have provided useful background to the project, but typically acquiring forecast data was not a focus for SolarAid or *Therefore*.

***Forecasting* insights derived from the Gravity Light UDI framework mapping**

The summary mapping shows that the UDI framework can be a basis for breaking down the complex relationship between a general or intuitive sense of potential impact and known starting points. Exploring the stakeholder environment through the lens of *Influence and Authority* can help to anticipate significant factors – typically these are not analysed in professional practice. *Motivation* often needs to develop over time, one can't assume a strong mutual starting point for stakeholders. Linked to *Influence and Authority*, the *Path* concept can help to highlight factors where there is divergency between stakeholders. These factors may have a significant effect on impact.

Overall, considering *Design value* and *Potential impact* is likely to be limited by the appetite for spending time exploring this. With reference to the three conditions for impact analysis identified in Study 2.2, the UDI framework is a contribution to improving operationalisation of impact analysis, but the costs and commitment to data acquisition for *Forecasting* are likely to be a low priority. This observation tends to underline the importance of a highly flexible approach to the use of the UDI framework, such as with the Business Model Canvas (Osterwalder & Pineur, 2010).

Table 7.13 *Mapping the Gravity Light case study to the UDI framework for EVALUATION*

UDI Framework element	Gravity Light comments
1 **Scale**	Whilst the overall potential scale of the project had been identified at the outset. There was little evidence about the potential design impact for the project. More detailed understanding has inevitably evolved over the course of the project
2 **Influences and Authority**	*Evaluation* allows retrospective consideration of these significant factors to be incorporated into future development – either within the scenario or professional practice in general
2.1 Designing context	*Therefore* decided to take a stake in the project having developed their ideas tangentially to the original brief. They were able to do this based on earlier experience of risk sharing ventures. The company, in this case, was able to break-out of a straight jacket of a fees-for-hours business model

UDI Framework element	Gravity Light comments
2.2 Key stakeholder context	*Therefore's* changed role within the project fundamentally changed the key stakeholder context – whilst *Therefore* now has greater autonomy, a whole new stakeholder network needed to be established. With the crowd-funding approach adopted – the crowd funders effectively become key stakeholders.
2.3 Wider context	The general social and environmental context remained unchanged, but the emerging potential of crowd-funding became a significant influence for the project
3 **Motivation**	The design team involved with the project had significantly higher motivation in the project because it had moved beyond a conventional fees-for-hours client relationship and the team felt strongly personally invested in the work because of the social innovation subject matter (Appendix P – W1, AC). This translated into a higher commitment to achieve results.
4 **Path**	The changed relationship between *Therefore* and Solar Aid is a good example of how the divergency of paths has had an impact on the scenario. Future project impact can now be seen to be linked to how these paths have diverged
4.1 Key stakeholders' path	Solar Aid have effectively dropped out of the project – to be replaced with other key stakeholders linked to the implementation of the Gravity light concept
4.2 Design path	Because of the distinctive approach taken by the design team (taking a lead in the management of implementation etc) they have been involved with much more of the development and implementation path than would typically be the case. This is also fuelled by the high levels of motivation within the team (Appendix P – W1, AC)
4.3 Activity Capability	*Therefore's* 'Path' is entering new territory. Whilst having strong conventional product design skills, their experience in product implementation in this social innovation sector is developing.
5 **Design Value**	The project can now be *Evaluated* based on outputs and results throughout the NPD process. The design value does become more tangible, but at this stage in the development of gravity light can still not be evaluated with end-user data
5.1 Potential design value	Proxies for potential design value, such as the success of an initial crowd-funding campaign can now be captured. The nature of crowd-funding is a direct example of how evidence of impact (crowd funding success) can lead to greater success during development
5.2 Designing value	The value of the designing input in this case can be seen to be enhanced by *Therefore's* practical and emotional investment in the project (the motivation factor). This is despite *Therefore's* limited experience in implementation in this sector
5.3 Design ingredient value	The innovative Gravity Light concept has very clearly originated from *Therefore*. So this basis for design ingredient value is clear. *Therefore's* stake in the NPD also becomes a basis for tangible evidence of the value of the design ingredient
6 **Impact Analysis**	Through *Therefore's* more embedded involvement, they have a stronger interest in capturing impact data across a range of factors. They have an increased understanding of the importance of impact data to support their product development
6.1 Human & social impact	As the primary long term goal for the Gravity Light, *Therefore* have been careful to use primary research to inform the detail development of the concept. However the ultimate long term social impact is still some time off. But the ongoing research can potentially inform the team on long term impact factors.
6.2 Economic impact	The successful crowd-funding activity generates very clear evidence of impact for the NPD process – rather than longitudinal economic impact of the product itself. The success of the crowd-funding has enabled the team to develop African manufacturing rather than being reliant on Chinese manufacture. This has the potential for a longer term economic benefit to the end beneficiaries.

UDI Framework element	Gravity Light comments
6.3 Environmental impact	The Gravity Light allows a wide range of quantitative evaluations to be made. For example the amount of kerosene use replaced by each light, life cycle analysis of the Gravity Light components vs existing forms of lighting. Compared to other products or services, the product is more straightforward to analyse.
6.4 Technological impact	Technological impact can be explored from two perspectives. Firstly how the gravity powered LED combination compares to alternatives and secondly how the technology within the concept can be improved. For example over the development period there have already been significant improvements in LED performance.

Impact *Evaluation* insights derived from the Gravity Light UDI framework mapping

Using a consistent framework for Forecasting and Evaluation provides a robust basis for evaluation. Whatever level of data is available, this before and after approach will elicit greater levels of understanding. Within consideration of *Influences and Authority*, the Gravity light case study dramatically highlights how the stakeholder environment changed, and was fundamental to the future potential of the initiative. A conventional analysis would tend to focus on the outcome, not the factors which led to the outcome. As highlighted in the Study 2.2 workshop, the changed role of the designers within the project transformed the levels of motivation and this can be seen as a significant contributing factor. This impact is notwithstanding *Therefore's* limited experience or capability in implementing products in the developing country context. *Therefore's* deeper involvement makes operationalising the origin of design value more straight forward. As a stand-alone and distinctive product, the Gravity Light example also appears more straightforward to evaluate for specific triple bottom line type impacts than many other products or services. But it is also a good example of how a design can simultaneously have distinctive, social, environmental, technological and economic impacts.

As demonstrated in the Study 2.2 workshops, and with these summary explorations of *Forecasting* and *Evaluation,* the Gravity Light case study demonstrates that the UDI framework can be applied very simply to deconstruct and provide insights into design impact which are distinct from other approaches, such as business methodologies, or design based concepts such as the design ladder (Danish Design Centre, 2003).

7.3.3 Consideration of methods, tools and communication derived from the UDI framework

As noted by many researchers into design process (e.g. Lawson, 2004; Gero et al., 2004), there is often a mismatch between linear theoretical abstractions of design process and actual practice. The same comment is made about the schematic representation of DRM (Blessing & Chakrabarti, 2009). Therefore the consideration of ideas for practice based methods, tools and communication of design impact resulting from this overall study have been considered in parallel with the chronology of the main research studies. *Table 7.14* summarises the activities which have informed and contributed to the development of the three concepts presented in summary at the final evaluation workshop.

Table 7.14 *Summary activity milestones and outcomes informing ideas for methods, tools and communication*

Activity	Activity description	Outcome
Design process mapping Co-design workshops (workshops conducted as part of teaching activity)	**Participative concept design** of early 'design mapping' concepts in two workshops with design tutors and with 40 post-graduate design students	Confirms the value of visualising longitudinal or time based overviews of design activity (Ref *Figure 7.13)*
HEEG Study (linked evaluation of design projects within two leading design schools – STUDY 1.1)	Development of the **HEET radar** approach for analysis and visualisation of the design project data	The HEET radar approach has potential to be used in conjunction with design impact mapping (Ref Figure *7.12)*
SOUP workshop (a parallel research activity exploring enhancing design process to tackle dementia challenges)	**Workshop** with 6 multi-disciplinary academics) to evaluate early **prototypes** of a UDI 'canvas' concept	Visualisations of a 'canvas' adapted to the needs of the workshop (Ref *Figure 7.10)*
SVOD workshops (Parallel research activity exploring methods for identifying the Social Value of Design)	**Workshop A** (23 academic and student participants) and **Workshop B** (19 industry and academic participants) to explore the use and usefulness of 'tools' for designers	Development of principles of visualisation for the UDI framework and canvas concepts through presentation and discussion (Ref *Figure 7.9)*

In preparation for a workshop for a parallel research activity (SVOD, Choi, 2014) a rationalised meta-theoretical hierarchy and design process matrix was developed as a basis for discussing the positioning of methods, tools or communication. This matrix is updated here (*Figure 7.11*) to indicate the hypothetical positioning of the three approaches discussed in the final evaluation workshop: A) Design impact canvas; B) Design Co-efficient; and C) Design impact mapping.

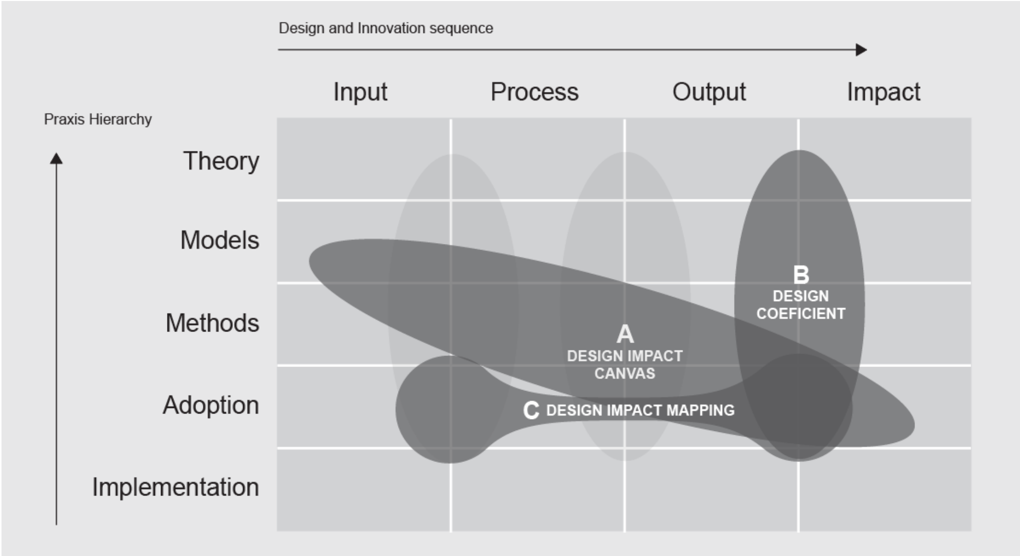

Figure 7.11 *Zones for tool development on the UDI Matrix*

Design Impact Canvas

Osterwalder and Pigneur (2010) summarise the rationale for their Business Model Canvas based on communication needs: 'We need a business model concept that everybody understands: one that facilitates description and discussion. We need to start from the same point and talk about the same thing' (p15). The combination of strategic exploration of how value is added in business with communication benefits makes the Business Model Canvas approach an ideal basis for a design impact tool. This idea is therefore based on a 'canvas' to explore instances of potential design impact. The Business Model Canvas, based on a model that 'everybody understands' has achieved excellent levels of diffusion with '5 million canvas users' (Business Model Generation, 2014).

Summary design objectives:

- Creating a tool to explore, in practice, how design adds value across the complete IPO to Impact spectrum
- Emphasis on the consideration of impact, and on how design adds value as an ingredient of this
- Simple to adopt in practice, at different levels of depth, in different working scenarios and contexts

The initial concept for a *Design Impact Canvas* used a representation of Input – Process – Output – Impact building blocks (*Figure 7.12*). This core sequence is enveloped by three nested spaces in the same way as the UDI framework. The final element of this initial concept was a combined 'lens' for considering the *value* *proposition* and the *design value proposition*. The lens idea emphasises the use of the *Design Impact Canvas* as a basis for interrogating the factors affecting design impact within and between each of the elements.

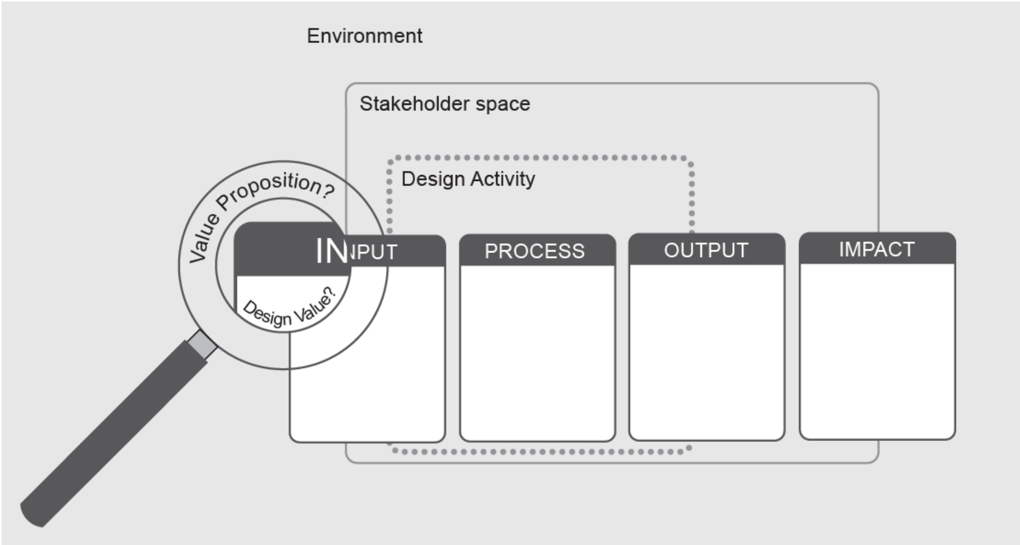

Figure 7.12 *Initial visualisation of a 'Design Impact Canvas'*

Design Impact Coefficient

The concept of a 'design impact coefficient' received the lowest of the three scores in the final evaluation workshop. The positioning aimed to contribute new concepts for a metric which could be used in the understanding and communication of actual and potential design impact. Return on Design Investment (RoDI) has been cited as a key metric for this purpose (e.g. Whicher et.al., 2011). However, others have pointed out that this measure typically does not effectively disaggregate the design contribution from overall RoI (Hertenstein et al., 2001; Visocky O'Grady & Visocky O'Grady, 2013). Understanding the nature of any design contribution to added value could be another approach, and this is explored by the €Euro Design – Measuring Design Value work (Barcelona Design Centre, 2014). However there is considerable scope for concepts which could demonstrate causality, through a metric, between ingredients of design impact and actual design impact.

Summary design objectives:

- Creating an appropriate metric for denoting the design ingredients of impact
- A metric which facilitates disaggregation and evaluation of the various design impact factors
- Meeting criteria for effective adoption in professional practice.

The naming of the concept – *Design impact Coefficient* – aims to describe the principle of a multiplication factor in an equation, for example as in the Coefficient of Drag (C_d) principle where an overall C_d figure can be used to define the drag of an entity, and is derived from a number of contributing factors such as (in drag) the effect of form and friction. Therefore, in the case of design impact, the coefficient metric is the multiplication factor to define overall design impact in a scenario, but crucially, in relation to the absence of any consistent definition of the factors contributing to the design component of impact, the idea aims to standardise the definition of these contributing factors. The idea is intended to beused for forecasting and evaluation in a wide variety of scenarios. To do this, it uses a benchmark figure from the specific context, for example an ROI figure. The overall expression for the *Design impact Coefficient* concept can be given as:

$$\textit{Design impact Coefficient} = \frac{\text{Impact metric benchmark figure } (n)}{20} \times \textbf{Design Coefficient component score (0-21)}$$

The concept aims to disaggregate the ingredients of design impact *and* for the cost of design not to be a direct factor in the calculation of the design impact coefficient. The 'Design Coefficient component score' element of the expression is derived from factors determining design impact identified within the study. *Figure 7.*13 gives an example of a three axis matrix which would generate values from 0 to 21 through a combination of Level of design, Expertise and Critical success factors.

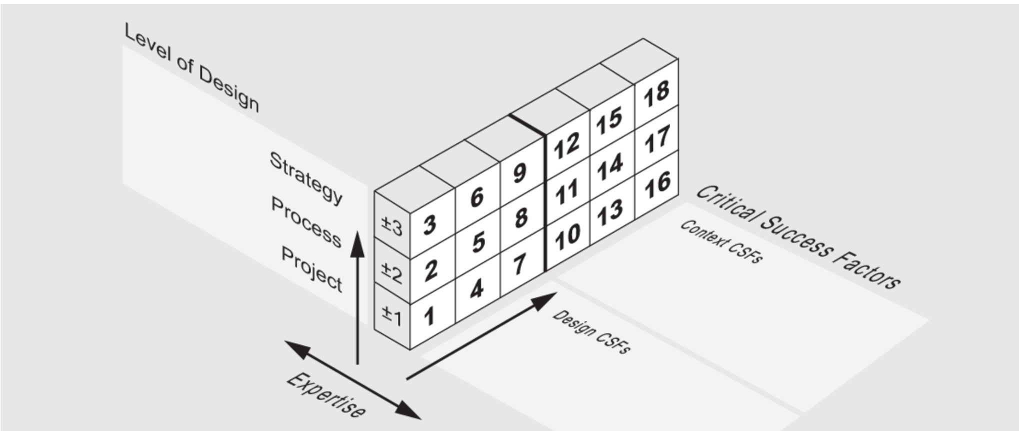

Figure 7.13 *Schematic representation of the matrix for arriving at a design coefficient component score*

DBA DEA case study data was used to test the concept. Strikingly, but perhaps unsurprisingly, the calculated results did not correlate with the actual ratios generated from the figures in the case study material! This really confirms many of the findings related to the complexity of the topic. The final evaluation workshop feedback indicated an instinctive aversion (amongst the design profession) to this kind of statistical attempt to understand design impact factors.

Design Impact Mapping

A visual approach to design impact communication was the highest rated concept discussed in the final evaluation workshop. This relates to the praxis based nature of the study and the significant emerging potential of data visualisation concepts. The positioning (*Figure 7.11)* indicates that a concept for visual mapping could be effective within design practice to communicate design impact factors at the *Input* (predictive/planning) stage, as well as the *Output* and *Impact* stage.

Summary design objectives:

– To bring together an overview of the variables explored with the *Design impact canvas* and the *Design impact Coefficient*
– Create a solution which can be used in professional practice with benefits for planning and prediction (ref Gartner Hype Cycle)
– For the approach to have the potential to highlight distinctive variances such as exemplified by the 'S' curve or 'Hype cycle'
– For the presentation approach to allow implementation in a wide variety of scenarios, e.g. from sketch planning to online systems.

Early work within STUDY 1.1 (Chapter 5) started to explore the relationships between theory and practice and the development of new design evaluation approaches in design pedagogy. An outcome from this work was a concept for how instances of design process could be mapped, either as an evaluation or prediction tool. This approach linked the idea of an envelope of contextual factors with a linear abstraction of the input-process-output model as suggested by Pugh's (1991) Total Design model. This has strong parallels with the advantages of conceptualising a 'design space' as identified by Gero & Kumar (1993) and Burgess et al. (2004). Jones & VanPatter (2009) explore methods for charting design variables within visualised design spaces as a basis for improving the performance of design and outcomes. This background led to an updated 'Total Design' model (*Figure 7.14*). Workshop exercises with academics and students using this model for evaluating design process improvement generated a series of examples of how the model might be adopted in practice (*Figure 7.15*).

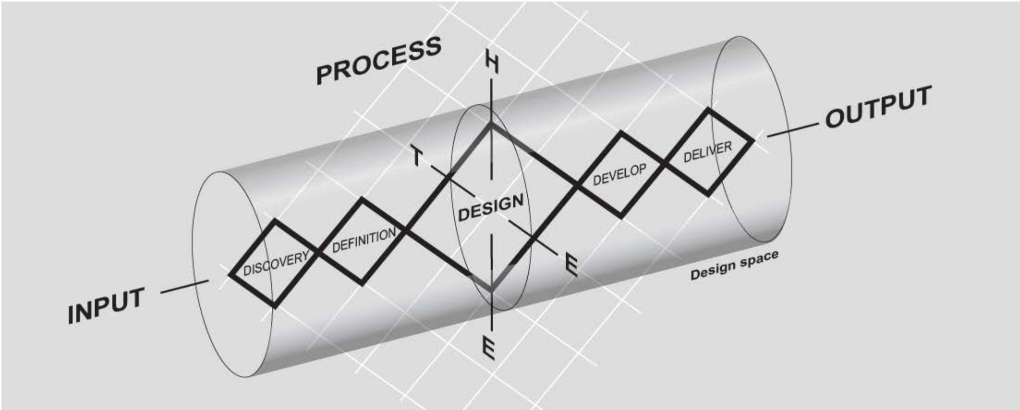

Figure 7.14 *Design space model derived from Pugh's (1991) & the Design Council double diamond process model (2007a), including a HEET radar cross section*

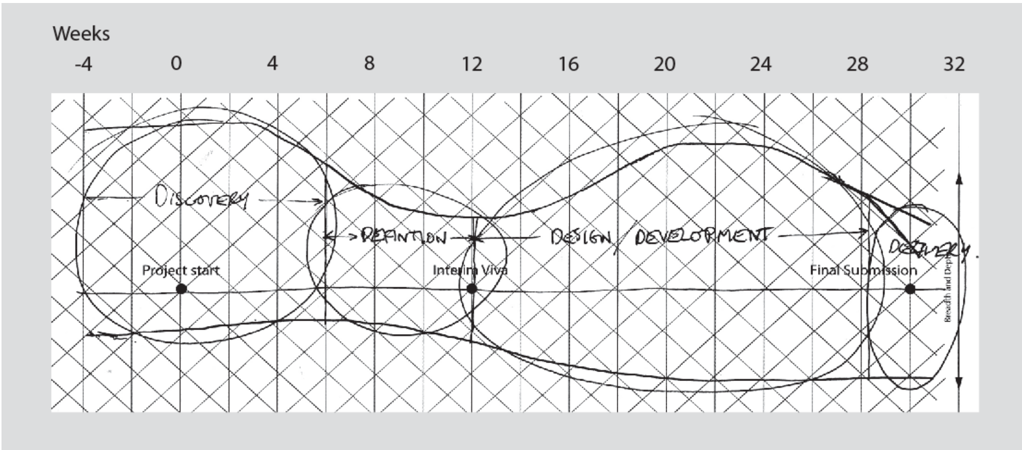

Figure 7.15 *Design Process Mapping example (Green,2012)*

As shown in STUDY 1.1, radar graphs of cross sections of the design process model could be used to evaluate the contextual orientation of projects. Combining these radar graphs with the design process mapping concept provides an overall model as a basis for evaluation for a range of factors within the project environment and design process space. Some of these principles could be adopted in a visual design impact mapping concept. A rationalised list of the factors which could be included within the concept can be derived from the emerging ontology. *Table 7.15* summarises an indicative group of factors.

Table 7.15 *Rationalised elements to be considered for inclusion in a Design Impact Mapping concept*

Element (and secondary elements)	Note
Time based factors (Input-Process-Output-Impact)	Linking impact to time based factors and the underlying process based philosophies of design is fundamental to the concept
Design Impact Components (Design CSFs, Context CSFs,	For the purposes of rationalising a wide range of influencing factors the Design Impact Coefficient concept provides the

Element (and secondary elements)	Note
Level of design expertise, Level of design intervention)	second significant dimension to the mapping concept
Benchmarks (sector, design specialism, firm level)	The Design Impact Coefficient concept and the Mapping concept require the inclusion of benchmark data in order to provide a basic level of objectivity
Predicted results (different stakeholder perspectives)	To be a useful tool in practice the mapping approach should be effective as a prediction and planning tool. Predicted results also provide a level of 'triangulation' with benchmark figures
Actual results (quality of the underlying data)	Sourcing good quality design impact data is an identified challenge. The mapping should be useable with varying quality of underlying impact data, e.g. to have value even with low quality underlying data
Visualisation (Visually highlighting significant factors)	The combination of elements should facilitate effective overviews of significant factors affecting design impact throughout the IPO-Impact sequence

7.4 Evaluation

This final evaluation section, preceding the concluding chapter, considers the outcomes of STUDY 2.2, the development of the design impact ontology, the UDI framework and associated exploration of potential tools and communication approaches, in relation to the complete sequence of studies.

The balance of emphasis between ontology, UDI framework and ideas for practice based methods for UDI has shifted over the course of the work. This has translated into a greater focus on the development of the underlying design impact ontology and UDI framework than was originally envisaged. The recognition of the need for considerable flexibility in any tools for impact analysis and communication, together with consideration of adoption and diffusion factors (Birkhofer, 2005) supports placing more emphasis on the underlying foundations.

Considered in combination with the core design impact ontology and UDI framework outcomes of this study, the subject matter of the preceding studies each provide potential for further work. For example, the tertiary design education context for STUDY 1.1 could be revisited with the benefit of the developed design impact ontology as a basis for identifying the influences of other factors on 'impact'. Likewise the developed UDI framework could be used for further longitudinal evaluation of DBA DEA case studies.

The value of the iterative 'designerly' approach embodied within the mix of descriptive and descriptive studies determined by the DRM approach is confirmed.

Chapter Eight

Conclusions

Chapter content Page

8.1 Introduction

In this final chapter of the thesis, the overall body of work is concluded from five perspectives. Firstly, overall conclusions are drawn from consideration of the sequence of study objectives and research questions. The second section covers consideration of the effectiveness of the adopted methodology. Thirdly, the adopted Design Research Methodology provides a basis for triangulating the findings through Blessing & Chakrabarti's(2009) concept of *Reference* and *Impact Model*s. The fourth section provides concluding statements about the contributions to knowledge developed over the course of the complete study. In the final section conclusions are made about the potential scope of further work which may develop as a result of the contributions made.

8.2 Consideration of the study objectives and key findings

The overall study has the aim:

> *To define a new framework as a basis to effectively explore, understand and communicate design impact.*

And the overall research question:

> *Can a new framework for understanding design impact encompass relevant factors and be a practical benefit to the design profession?*

Four objectives with linked studies and research questions are derived from the aim. This matrix of objectives, studies, research questions is included for reference in Appendix A.

Research Objective A –Review of current situation
To carry out a thorough investigation of current theory and practice for understanding design impact within relevant research literature to provide a foundation of understanding for subsequent studies.

In summary, the literature on design impact highlights that there are barriers to exploration and professional development; that there is a lack of evidence of causation between design input and impact; but there are a number of research and policy level initiatives to develop tools and frameworks for design impact analysis and research aiming to contribute to 'elevating' the role of design.

Triangulation from the descriptive studies (1.1, 1.2 and 1.3) confirm these points, suggesting that any 'elevation' of the role of design, at an industry wide level, will not easily emerge from the sceptical and complex context for impact analysis. However there is strong interest in improving the influence and authority of professional design activity.

Figure 8.1 (Section 8.3) links the following summary points to the *Reference Model*:

– Barriers to enhancement (such as scepticism and complexity)
– Causation not reliably shown (only correlation between design input and output is reliably shown)

- Policy level activity (European Design Manual)
- Potential for ‘elevating’ the role of design

Research Objective B - Analysis of professional practice

To conduct descriptive studies of design practice to identify gaps in, and relationships with, current understanding of design impact.

Barriers and challenges to understanding design impact are confirmed in the descriptive studies of design impact in practice (1.1, 1.2 and 1.3). This complexity is defined as the *disaggregation challenge*. This is compounded by significant barriers to data collection. Whilst there are many possible tools and metrics for data analysis (162 recorded within 45 case studies in STUDY 1.2), there is literally no evidence of consistently or generally adopted terminology, frameworks and methods for impact analysis. This can be described as a lack of operationalisation. Exploring how the design profession can more effectively address the potential for ‘elevating’ the role of design, the concept of *design authority*, a favourable socio-cultural context for design activity, is identified as a very significant factor.

In summary, the following key points are also linked to the *Reference Model* shown in *Figure 8.1*:

- Complexity of disaggregation (the disaggregation challenge – Design and context CSFs, strategic versus tactical factors, hard and wider impact metrics)
- Lack of data for UDI
- Lack of universally adopted terminology, frameworks and metrics to address UDI (operationalisation)
- The significance of Design authority (a favourable socio-cultural context for design as a condition for ‘elevating’ the role of design).

Research Objective C –Developing a framework

To develop an improved framework to represent the factors which lead to design impact which, in turn, can contribute to improved understanding of design impact.

In the absence of any all-encompassing framework for understanding design impact, an ontological approach and design process modelling principles provide the*input-process-output-impact*core and foundation for anew UDI framework. This helps to distinguish and disaggregatethe adding value effects and embeddedness of design at each phase of the I-P-O- Impact core. Likewise, this foundation is a basis for exploring, understanding and enhancing the effects of *design circularity.*

This can be summarised as four key points (also ref *Figure 8.1*):

- The value of an ontology as robust foundation for UDI
- Significance of design process, value, emphasis and embeddedness
- Importance of understanding the design ingredient
- Positive effects from ‘design circularity’.

Research Objective D – Evaluating the new framework
To evaluate the framework, including its potential as a basis for new working methods for understanding and communicating design impact.

The review section of the second prescriptive study (2.2) evaluates the potential for the new UDI framework, and the discussion section describes ideas for methods to be used in practice. The UDI framework is demonstrated as an effective basis for exploring instances of design impact which can draw out and highlight significant factors. Other key findings are that availability of data, commitment to impact analysis and effective methods of operationalisation are necessary preconditions for impact analysis. If these conditions are met there is a preference by designers for visual approaches to communicating design impact. Any initial diffusion of the new UDI framework or related methods is likely to be at individual organisation level.

These points are summarised as follows and also highlighted on *Figure 8.1:*

- The UDI framework is an effective basis for highlighting significant factors
- Diffusion at firm level is possible if pre-conditions are met (access to data, commitment to impact analysis and methods for operationalisation)
- Visual approaches to design impact communication are preferred (by the design community – but without clear evidence that visual approaches are more effective).

8.3 Critical reflection on the methodology and the limitations of the study

Reflection on the methodology

The Design Research Methodology (DRM) advocated by Blessing & Chakrabarti(2009) was selected as a basis for the overall study. This approach was adopted as it acknowledges the value of a distinctive designerly approach, yet addresses what Blessing & Chakrabartiand others see as weaknesses in existing design research.

A variety of descriptive and prescriptive research methods were used within the five individual studies including content analysis from datasets and case studies, ontology development, modelling, semi-structured interviews and focus groups.

In research quality terms the work can be reviewed against reliability and validity criteria. The research quality of each study has been considered and reported on in relevant sections of the chapters. Here, the complete body of research and research outcomes are considered using the same Cook and Campbell (1979) validity criteria. It is worth reiterating that absolute validity is recognised as unachievable (Neuman, 2007).

Statistical validity is not a significant concern. There has been some reporting on numbers of incidences of factors. However, this quantitative data is not the basis for the overall findings, rather, the data is used as a general guide to analysis only.

Internal validity – the plausibility of causal relationships is a significant consideration in decisions about inclusion of impact factors in the ontology and UDI Framework. It is argued that earlier research by others has tended to focus on small numbers of factors, which excludes other, perhaps significant factors. Therefore the approach taken here mitigates against this threat to validity through the expandability of the ontology. The decisions represented in the current version of the ontology and UDI framework are based on triangulation of findings in the reviewed literature and descriptive studies. However there remains scope for debate about the hierarchies of factors included.

Construct validity – The core ontological approach is well established in a number of fields. Applications for ontologies in design are more limited, but as noted in the chapters covering the ontology development, the approach is inherently resistant to threats to validity.

External validity – Potential for generalisation is the area which presents greatest threats. The peer reviewed *Towards a design process ontology* (Green et al., 2014) provides additional endorsement for the ontological approach and related research outputs. However the applicability of the UDI framework and potential for methods and tools derived from ithave only been tested with external audiences to a limited extent.

The DRM aims to balance designerly prescriptive work with more conventional descriptive research work. The method also introduces the *Reference Model* and *Impact Model* concepts as means to provide research rigour. It also recognises that the reality of research activities and knowledge development do not adhere to a rigid chronological sequence. Reflecting on the work as a whole, these distinctive elements of the DRM approach have provided a valuable structure for the work. Their moderating influence on managing the creative and divergent characteristics of a design approach have been beneficial. On reflection there was possibly scope for rebalancing the duration of the individual studies. However as highlighted in the UDI framework itself, there needs to be effective consideration of the wider context of work. And, as predicated in the UDI framework, factors in the broader context have also had a significant influence on management of the work.

Study Limitations

As noted above, the external validity of the work is restricted by the extent of the evaluation of the UDI framework and potential methods derived from this. At the outset of the research, the framing of the overall objectives envisaged a greater emphasis on development of methods, tools and communication of design impact for application in the design profession. This is reflected in the two distinct support elements shown on the *Impact Model* (*Figure 8.2*). Resource limitations restricted the outcomes in the second area.

8.4 Updated 'Reference' and 'Impact' models

Key elements of the Design Research Methodology proposed by Blessing & Chakrabarti(2007) include the scoping '*initial Reference Model*' (Chapter 2, *Figure 2.1*) which leads to an '*updated Reference Model*' (Chapter 2, *Figure 2.8*). This consolidates the literature review, which in turn enables a schematic representation of the proposed research impact in the form of an 'initial *Impact Model*' (Chapter 2, Figure 2.9). In this section of the conclusions the '*Reference Model*' is further updated with the findings of the descriptive and descriptive studies (*Figure 8.1*) and the '*initial Impact Model*' is updated with a review of how the two main 'support' elements resulting from the prescriptive studies may impact on the components of the *Reference Model*.

8.4.1 Reference Model

The combination of the literature review findings and findings from the descriptive studies (1.1, 1.2 and 1.3) provides triangulation, or robust validation, of the overall findings. These are summarised in the updated *Reference Model* (*Figure 8.1*) together with the outcomes from the prescriptive stages. These points are all linked to the overall objectives as described in Section 8.2.

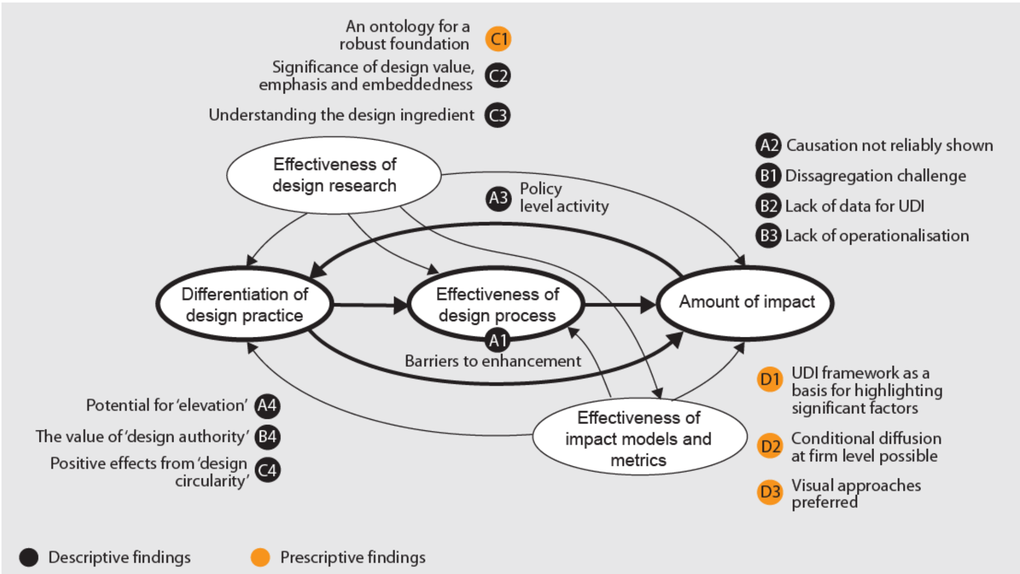

Figure 8.1 *Reference model referencing key findings related to the UDI objectives*

8.4.2 Impact Model

Blessing & Chakrabarti's (2009) review of design research includes the use of the term 'support' to refer to the outcomes of prescriptive activity. This is on the basis that design research is typically generating concepts for interventions which can 'support' the enhancement of design activities. In the updated version of the *Impact model* (*Figure 8.2*) the 'design impact ontology' is added as an additional support component and each of the links between the 'support' to the factors in the*Reference Model* are reviewed. This review considers how effectively, or otherwise, the ‘support’ might influence the negative factors identified in the earlier *Reference Model* (Chapter 2, *Figure 2.8*).

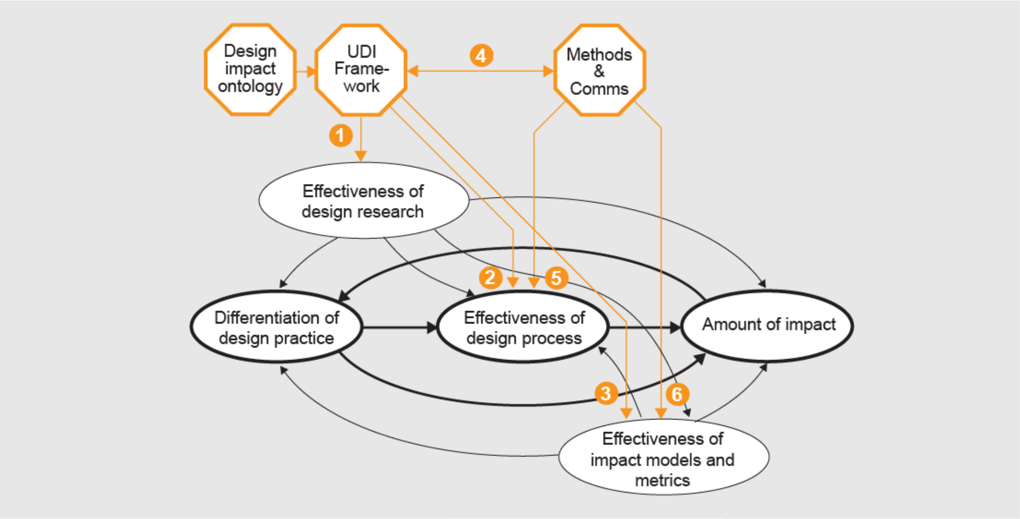

Figure 8.2 *Updated Impact model*

Each numbered link from the ‘support’ leads to positive and/or negative influences on the existing situation as summarised in *Table 8.1.*

Table 8.1 *Positive and negative influences of the ‘support’ on the reference model themes*

UDI Framework Negative (-) or positive (+) Influences		
1		**UDI framework leading to Effectiveness of Design research**
	+	The design impact ontology and related UDI framework respond to the need for a sound theoretical basis for design impact analysis
	+	The initial ontology has achieved a level of peer validation (Atkinson, 2014) and the UDI framework has been demonstrated to be an effective basis for exploring design impact in two evaluation workshops (ref Chapter 7, Section 7.2.4, STUDY 2.2. review: Expert workshops)
		The developed design impact ontology and UDI framework have not, at the time of writing, been further validated through peer reviewed publication
2		**UDI Framework leading to Effectiveness of design process**
	+	STUDY 1.1 used an early iteration of the *input-process-output* model and the HEET radar analysis to evaluate the outcomes of pedagogic design activity. This identified a longitudinal enhancement of ‘enterprise’ factors, therefore demonstrating the potential to link a review framework with targeted enhancement of design practice.
		Lack of consistent terminology and related understanding is a barrier to what is described as ontological commitment. The review of the UDI framework confirmed this, but also that the framework (and underlying ontology) was an effective basis for overcoming the terminological barriers. This also confirms the value of ontological approaches evidenced in the literature review.
3		**UDI Framework leading to Effectiveness of *Impact Model*s and metrics**
		The UDI framework is proposed as an effective model for exploring design impact and addressing the issues identified in the literature review and descriptive studies as follows:
	+	Enhancement in relation to literature review points (also ref Chapter 2, *Figure 2.8*). The UDI framework and ontology provides: a basis for interpreting results, complements existing policy level studies, aids resolving terminological confusion, places design value concepts in a broader context, a basis for exploring ‘super soft’ factors and a basis for operationalisation.
	+	The two UDI evaluation workshops demonstrate a level of effectiveness for accommodating a diverse range of case studies and identifying significant factors effecting design impact.

UDI Framework Negative (-) or positive (+) Influences	
	The quantity of testing, evaluation and development of the design impact ontology and UDI framework are limited by practical resource constraints (time, human resources and scope of current work). This point applies throughout the linkages explored here.
4	**UDI Framework and Methods and Communications linkages**
+	The success of the Business Model Canvas (Osterwalder & Pigneur, 2010) is good evidence of the potential for a similarly derived visual mapping approach to achieve good levels of adoption. The visual nature of the UDI framework is confirmed as desirable by professional design audiences (ref evaluation workshops)
+	The UDI framework is demonstrated to be a basis for deriving various visual treatments of the underlying concepts and as a basis for developing more specific design impact analysis tools (ref evaluation workshops)
Methods and communication Negative (-) or positive (+) Influences	
5	**Methods and Communications leading to Effectiveness of design process**
+	Various activities associated with enhancing design process have been conducted using methods and communications derived from the UDI Framework providing initial validation of efficacy in design education and strategic planning contexts
6	**Methods and Communications leading to Effectiveness of *Impact Model*s and metrics**
+	Because any methods and communications concepts proposed are derived from the underlying design impact ontology and UDI framework, there is inherent reliability and scope for ongoing evolution.

8.5 Contributions to knowledge

A significant criterion for the consideration of the award of a PhD is the creation of new knowledge derived from original research and advanced scholarship. New knowledge is also defined in terms of satisfying peer review. This can be demonstrated by suitability for peer reviewed publication.

One overall contribution to the body of design impact related knowledge is claimed with two supporting contributions. These are summarised as follows.

1. The creation of *a new UDI framework*: a design process based framework of factors, derived from an ontological foundation, which is a robust basis for exploring and understanding design impact that can be used in a range of scenarios. Methods for, and communication of, design impact analysis can be derived from this framework.
2. An original *Design impact ontology*: an expandable meta-theoretical hierarchy of classes and factors as a basis for re-use and shared understanding of design impact related terms and concepts.

3 Identification of the overlooked and significant *Influences and Authority* and *Motivation and Path* categories of design impact factors.

Each of these claims is briefly detailed as follows.

8.5.1 The new UDI framework

The UDI framework derived from the design impact ontology foundations provides a basis for wider dissemination of design impact understanding amongst the design profession and related stakeholders.

The originality of the ontology and class definitions underpinning the work contribute to the newness of the UDI framework. The framework has some parallels with the considerable body of design process models and these can be mapped to the framework. But vital distinguishing elements are the expansion of the scope to include the consideration of: 1) *Impact* following the traditional 'output' focus of design activity; 2) the distinction between factors associated with designERS, designING and designEDoutcomes; 3) consideration of the relationships between three nested contexts for design activity (the design space, the key stakeholder space and the wider context); and 4) the dynamics of forecasting, evaluation and circular benefits from impact analysis.

The use of framework and elements within it in associated work and evaluation with design academics and professionals validate the originality of the work and the potential for ongoing development of methods, tools and communications derived from the framework.

8.5.2 A design impact ontology

The design impact ontology summarised in Chapter 7, *Table 7.4* was developed in two stages. The initial, design process based, elements published in the paper titled 'Towards a design process ontology' (Green et al., 2014) were further validated by Atkinson (2014), commenting that the initial ontology emerging from this overall study: 'results in a remarkably clear and convincing visualisation of a 'prototype ontology' of the design process' (p486).

There are a small number of identified ontologies in the design engineering field. These make reference to the qualities of an ontological approach with goals to help create common understanding and facilitate the reuse of domain knowledge. This is considered a prerequisite of an advanced study of design impact and a means to address criticisms of design research. Creation of an ontology focused on the factors influencing design impact is an original contribution to the topic. Ontology development is also predicated on the idea of extendibility. This quality assumes that the ontology will continue to evolve. Therefore the design impact ontology is a contribution to knowledge which has a built-in ability to evolve through the activities of others.

8.5.3 *Influences and Authority* and *Motivation and Path factors*

The *Motivation* and *Path* classes of factors were identified in the first phase of development. The *Motivation* concept was derived from research in the parallel field of innovation by Koen et al., (2001) who identified the concept of ‘engine’ and Buijs (2003) who adapted this concept to the concept of ‘heart’. Buijs (2003) describes this quality as encompassingthe ‘true ingredients of innovative behaviour’ (p90). The *Motivation* concept is considered a contribution to knowledge because it consolidates and broadens the scope of the qualities encompassed within the ‘heart’ and ‘engine’ concepts. In the developed design impact ontology *Motivation* is paired with the *Path* class of factors. *Path*, also defined in the first phase, encompasses factors associated with the specific ‘path’ that designers or design teams may follow. It therefore covers variations between specialisms and can encompass emerging specialist ‘paths’. In the second phase of ontology development, an important distinction is recognised, which is the effect of interrelationships between the *Motivation and Paths* of designers and that of key stakeholders in any given scenario. Collectively these concepts have been given little consideration in existing research.

The *Influences and Authority* ontology classes were defined in the second phase of development. This paired group of factors is shown through the descriptive studies to be significant in creating design impact and in ‘elevating’ the role of design. There are some existing references to factors which could be included within these classes. For example Candi & Gemser’s (2010) literature review identifies ‘moderating factors’. The descriptive studies highlighted the significance of socio-cultural factors. These are encompassed within the *Influences* class. The *Authority* class includes factors such as the concept of ‘design leadership’. Whilst there has been some consideration of factors within these classes in design research literature, the significance of these factors has not been widely recognised.

8.6 Further work opportunities

The UK design profession appears to have reached a peak of interest in the topic of design impact with the 2012 Measuring the Impact of Design forum (Montgomery, 2012). In close parallel, Candi and Gemser's (2010) significant literature review was published, the DMI launched the Design Value System (Westcott et al., 2013) and the European Design Manual was under development (Nomen et al., 2012). The UDI study has proceeded in parallel with this activity and developed distinctive and complementary outcomes.

In keeping with the motivation for the work, and the identification by the DRM authors, there are two overall objectives for design research: the development of theory and the development of 'support' based on theory. Potential further work derived from the UDI study is therefore considered from the perspective of theory, and of support. This potential is summarised in *Table 8.2.*

8.6.1 Further development of UDI theory

The extendable nature of ontologies provides a basis for the design impact ontology to be developed and, or, integrated into other ontologies. This can take different forms. The work in this study carried out the first four of the seven steps of McGuinness's (2001) ontology development process. Therefore there is potential to continue the development through the three remaining steps. There is also the potential to carry out further work on steps 3 (key terminology) and step 4 (defining classes and class hierarchy).

Amongst the factors included in the design impact ontology, *Influences and Authority* and *Motivation and Path* are identified as significant but overlooked factors in relation to design impact. Therefore there is considerable potential for research which explores these factors in more depth, either individually or collectively, for example through case studies of professional practice.

The UDI framework is an example of praxis – a basis for theory to be applied in practice. The framework integrates a number of key ideas, each of which could be the basis of further exploration. With a praxis approach, it is logical that an action research methodology is applied to exploring the concepts, for example through exploring the forecasting of design impact with a number of real-time case studies.

8.6.2 Further development of UDI support

Within the current study the development of specific methods and communication derived from the UDI framework has received limited attention. In STUDY 2.2 and the discussion section, three ideas based on the framework were explored: a UDI canvas; a design impact co-efficient; and design impact mapping. Design impact mapping scored most favourably in reviews with professionals. Together with their stated preference for visual approaches, Design impact mapping may be the most relevant to develop. However as also shown in the evaluation workshops, there is potential for other approaches to be derived from the overall group of factors embodied within the UDI framework.

An example of further work based on Design impact mapping would be an extension of the STUDY 1.1 work. This might use further data from tertiary design education to explore aspects of the impact of student designers, their designed output, or their design process.The work in STUDY 1.2 demonstrated the potential for reviewing the methodology of the DBA Design Effectiveness Awards. A short report (Appendix H) was produced to explore the potential for developing the methodology and enhancing the benefits accruing from the DBA data set.The evaluation workshop for STUDY 2.2 identified that the most effective adoption of the UDI framework approaches would most likely be at an individual organisation level. Therefore an approach to further work would be to identify an organisation, or an aspect of an organisation's operations, which might be the basis for an action research based development.

A further practice based evolution of the ontology would be work to build a digital version. Much of the popular work on ontologies is associated with building digital knowledge management systems. This approach would have the potential benefit of reaching a large audience and inviting expansion of instances within the class hierarchy.

Table 8.2 *Summary of Further work opportunities*

Title	Description
UDI Ontology development A	Further in-depth work on steps 3 (key terminology) and step 4 (defining classes and class hierarchy).
UDI Ontology development B	Development to the proceeding 3 steps (defining class properties, defining values for the properties, populating with instances
UDI Ontology development C	Implementing the ontology within a digital environment
Influences and Authority	Further in-depth research, for example using case studies

Title	Description
Motivation and Path	Further in-depth research, for example using case studies
UDI Framework development	Further exploration, testing and evaluation of the key concepts integrated in the UDI framework: Impact as an extension of process models, differentiating designers, designing and designed impacts, effects of nested contexts and impact analysis
UDI methods and tools	Development of UDI Canvas, design impact co-efficient, design impact mapping or other UDI framework derived concepts
Applied design impact mapping	Using design impact mapping to explore factors in a specific scenario, for example a follow up to study 1.1 in tertiary design education
DBA Design Effectiveness Awards methodology	Further work with the DBA to develop data gathering for their awards and exploiting the data asset based on the findings of the UDI study
Single organisation implementation of the UDI Framework	Using a single organisation as a basis for an action research based approach to developing the UDI framework and methods and tools derived from this

8.7 Concluding remarks

In parallel with the period of study reported in this thesis, there has been considerable interest in the topic of design impact and the idea that 'better evidence of the impact of design will drive up demand' (Montgomery, 2012). This is also described as the potential to 'elevate' the role of design (Noble, 2011). The present era is also reported to be a 'golden age' of design (Maeda, 2014) as a result of the potential for design impact in business and society. However, not inconsiderable barriers to realising this potential remain.

The work presented here makes a new contribution to the topic of design impact study which is distinct to parallel work. An overall contribution to new knowledge is the creation of the new UDI framework. This is supported by the design impact ontology, and the distinctive identification of Design *Influences and Authority* and *Motivation and Path* provide fresh perspectives on factors which can have considerable influence on design impact. Each element is considered worthy of further research in their own right.

Finally, the resulting UDI framework bridges between theory and practice and is a powerful basis for placing consideration of design impact at the heart of design activity. A number of routes are identified for the further development and dissemination of the framework.

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Understanding Design Impact:

Appendices

List of Appendices

Appendix A Matrix of research studies, research questions and objectives

STUDIES / AIMS	RESEARCH OBJECTIVES (RO) and QUESTIONS (RQ)			
OVERALL STUDY To define a new framework as a basis to effectively explore, understand and communicate design impact	**Review of current situation** RO A To carry out a thorough investigation of current theory and practice for understanding design impact within relevant research literature to provide a foundation of understanding for subsequent studies.	**Analysis of professional practice** RO B To conduct descriptive studies of design practice to understand relationships between design practice and impact and identify gaps in current understanding	**Developing a new framework** ROC To follow a process to create a framework to represent the factors which lead to design impact which, in turn, can contribute to improved understanding of design impact	**Evaluating the new framework** ROD To evaluate the framework, including its potential as a basis for new working methods for understanding and communicating design impact
STUDY 1.1 (Descriptive) Modelling student design activity (304 student projects & 2 focus groups) Exploration using design process modelling concepts derived from the literature review as a basis for data collection, analysis and communication techniques (in a design education context)	RQ A1.1 What existing models and methods are there for capturing data about design activities? RQ A1.2 To what extent do existing models and methods accommodate a broader context (eg the FEI to IMPACT journey)	RQ B1 What issues and challenges are raised through process based data collection, analysis and communication?	RQ C1 How can design process based modelling and data collection concepts be used to capture attributes which lead to design impact?	RQ D1 How can the effectiveness of design process based modelling and data collection concepts for impact evaluation be judged?
STUDY 2.1 (Prescriptive) Rationalising theoretical foundations (approx 150 sources) To combine the literature review and initial study findings into a useful foundation which will serve as a robust basis for exploring impact throughout the FEI to IMPACT journey	RQ A2.1 To what extent do existing design process models accommodate a complete FEI to IMPACT journey? RQ A2.2 To what extent do existing process models make explicit links to FEI or IMPACT factors?	RQ B2 What issues and challenges do existing process models aim to address?	RQ C2 What foundations are needed as a robust basis for a framework to understand design impact?	RQ D2 What criteria do foundations for a UDI framework need to meet and can these be tested?
STUDY 1.2 (Descriptive) Reviews of design impact from professional practice (46 case studies – DBA dataset) To develop a detailed understanding of current best practice for describing and quantifying design impact and for the findings to contribute to a useful holistic model of the FEI to IMPACT journey	RQ A3.1 What impact metrics are used in design and related contexts? RQ A3.2 What types of criteria are applied in the selection of impact metrics? RQ A3.3 Are there clear relationships between impact metrics and processes at the early stages of projects?	RQB3.1 What are the issues and challenges associated with the use of impact metrics in design practice? RQ B3.2 To what extent can impact be attributable to design?	RQC3 Can current professional practice for defining design impact be translated into workable elements for a new framework for UDI?	RQD3 Will the translation of professional practice relating to design impact into new categories and a framework be recognisable and useful (eg for the design profession and professional contexts for design)?
STUDY 1.3 (Descriptive) Industry & Academic reviews of the design process and impact context (10 interviews) To develop a detailed understanding of current practice, experience and viewpoints about the role of design and how enhanced understanding and communication of design impact may play a part in enhancing practice, outcomes and impact	RQ A4 What individual experiences do participants have of discussing and communicating design impact?	RQ B4 What issues and challenges do the participants have with differentiating and enhancing the role of design?	RQ C4 Can verbatim professional experiences of design impact related factors be translated into workable elements for a new framework for UDI?	RQ D4 Will the translation of professional experiences relating to design impact into new categories and a framework be recognisable and useful (eg for the design profession, professional contexts for designing, the design research community and design pedagogy)?
STUDY 2.2 (Prescriptive) Developing and evaluating a framework for UDI (Ontology development exercise and 1 focus group) To combine the findings from the earlier studies into the development of a design ontology andnew UDI framework with associated discussion of the possibilities for professional tools, applications and adoption	RQ A5 How do methods currently used in practice compare to the ideas being developed?	RQ B5 How do the ideas being developed respond to the issues and challenges identified?	RQ C5 What evidence can be gathered to verify that a framework for UDI can have a positive effect on design impact (for example for the design profession, professional contexts for designing, the design research community and design pedagogy)?	RQ D5 What ideas for methods and communication tools emerge from the combined studies which could have potential for enhancing professional design practice??

Appendix B

Expanded literature review: Five *reference model* factors

Appendix B content Page

B.1 Introduction

This appendix is an extended version of sections of the literature review included within the main body of the *Understanding Design Impact* thesis. These sections are based on the five factors identified within the *Initial Reference Model* for the research (*Figure B.1*).

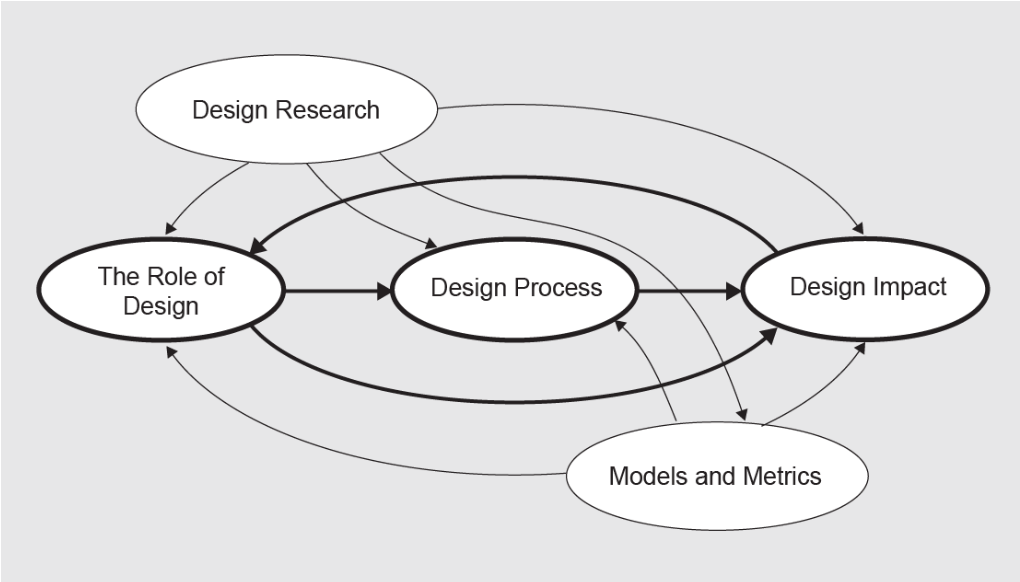


Figure B.1 *Initial reference model for Understanding Design Impact factors*

B.2 Design Impact

This section of the expanded review of literature relates to design impact and is reported according to three main themes:

- A chronological exploration of four decades of economic studies of design impact (from Moody, 1980 to Rae, 2014) summarised in Table B.6 (Section B.2.2)
- Analysis of three identified literature reviews of design impact (Candi & Gemser, 2010; Noble, 2011 and Madano Partnership (2012) and mapping the UDI research questions to the questions arising in these reviews; summarised in Table B.11 (Section 2.2.3)
- Exploration of impact studies in related areas, such as Architecture and Advertising.(Section 2.2.4)

B.2.1 Background to design impact studies

'Relatively little work appears to have been done on the economic or commercial impacts of investments in design' (Tether, 2005, p14). The limited amount of research into the impact of design within the research community and commercial organisations has been an ongoing theme from the earliest identified studies on the subject (eg Moody 1980) through to Micheli's (2013) study of companies benefiting from design input; 'No company in our sample has a robust method for assessing design's impact on performance' (p7)

At present the terms design impact, value, performance and effectiveness appear relatively interchangeable. Pre-dating much of the post Cox (2005) design research focus on these factors, the Design Business Association adopted the term *Design Effectiveness* and uses this in conjunction with the concept of *Investment in Design* (Roy & Potter, 1993; Dawton, 2011). Candi &Gemser (2010) in their review of this topic use the term *Performance*and this is generally related to commercial economic performance. The *Impact* concept can be applied more broadly than *commercial impact*, the term adopted by Roy& Potter (1993) in their early example of studies in this field. For example the concept can be expanded to encompass environmental impact, policy impact or research impact (Brewer, 2011). The more recent work in the European Commission adopts the term Design Value, evoking consideration of value concepts relevant to the macro political and economic context of the EU work (Barcelona Design Centre, 2013)

Table B.1 *Summary glossary of Impact related terms*

Key term	Note	Reference
Design Effectiveness	Adoptedby the Design Business Association for their eponymous award scheme launched in 1994	Hertenstein et al. (2005) The Impact of Industrial **Design Effectiveness** on Corporate Financial Performance
Design Performance	Adopted in Candi & Gemser's major review of design impact literature from an Industrial Design, NPD & Innovation Management perspective	Candi & Gemser (2010), An Agenda for Research on the Relationships between Industrial **Design and Performance**
Design *Value*	The EC € Design:*Measuring Design Value* initiative is focused on macro political and economic value considerations	Nomen et al. (2012), € Design: Measuring **DesignValue**, Analytical Framework Paper
Design *Impact*	Impact is a broad term used in a range of domains such as research (impact factors), eco-design (impact assessment) and policy (impact evaluation).	Roy & Potter (1993), The commercial **impacts** of investment in **design**

Early studies of the role of design in company performance emerged from Government economic policy initiatives in the UK (eg Moody, 1980, Black and Baker 1987, Roy & Potter, 1993) and Europe (Gemser & Leenders, 2001, Danish Design Centre, 2003). Nowadays the success of companies such as Apple is cited as a driving factor behind increased awareness of the potential for design impact (Micheli, 2013). The case for design having a positive impact on financial performance has now been demonstrated in a number of empirical studies dating back to 1980 (Moody) and notably in the UK by Roy and Potter (1990). Design can also have an indirect impact, for example on brand recognition, strategic thinking, morale and productivity (Micheli, 2013). Therefore design impact needs to be considered more broadly, for example as financial impact and non financial impact. The latter could include environmental impact; 'From the designer's point of view, obtaining a single indicator that evaluates the environmental behaviour of materials in such a way that it can be incorporated directly into a multi-criteria decision problem, along with the other design considerations, could be an ideal situation' (Bovea & Gallardo, 2006). However only relatively recently have direct correlations between the potential commercial and environmental impacts of design been attempted (Ellen McArthur Foundation, 2013).

Expanding the potential for design impact further within, for example a Triple Bottom Line model (Elkington, 1999, also ref Section 2.5.3), one can see, as with *Profit* and *Planet* impacts, that *People*, or social impacts from design have been given limited consideration to-date;   'Measuring the social value and impact of design is rather less straight forward, and given the wide scope of design can be applied across a huge range of areas' (Madano Partnership, 2012). Therefore difficulties and challenges with exploring design impact are a significant theme within the existing literature (e).

Whicher et al. (2011) as part of their European level work, reviewed the existing design impact literature, noting in common with many other researchers that: 'Addressing the evaluation of the return on design is more relevant than ever. Evaluation is a vital part of the evidence to support decision-making' (p46) and;'there are no studies that can ascertain indisputably the causal links between design and socio-economic development, isolating design from a wider context' (p50).Their contribution is a matrix of 'levels' of design impact study as a basis for their aim to; 'help researchers to understand these various dimensions and encourage them to conduct studies that will form a richer body of knowledge on the value of investments in design' (p45). Their model (*Figure B.2*), does provide a simple classification system for the existing studies of design impact explored in Section 2.2.1, but does not go much further in exploring the potential kaleidoscope of 'dimensions'.

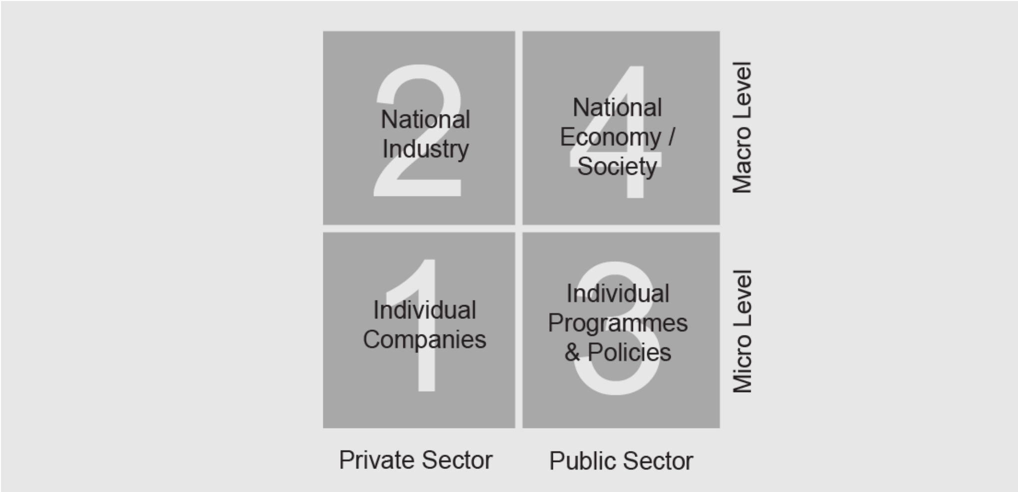


Figure B.2 *Levels of design impact evaluation (Whicher et al, 2011)*

Design Impact Cannot Be Easily Measured

In their study of Industrial design impact Hertenstein et al (2005) make the point that despite a growing recognition of the role of Industrial Designers in producing products which are successful in the marketplace, 'Design' is conflated with many other related disciplines, and therefore there is an incomplete understanding of the contribution made by design. This leads to business managers only having an intuitive sense of the value of design, based on anecdotal evidence.

'The question of what design is worth in the modern economy has been addressed in a hundred different ways and in voices ranging from the coolly measured and metaphysical to the sputteringly impassioned,'(Hertenstein et al.,2001, p. 10)

A number of challenges have been identified in relation to identifying and disaggregating design within studies of design impact including, notably, Gorb& Dumas' (1987) concept of *Silent Design,* Meaning the presence of design input which is not easily recognised. 'In a business world largely driven by the quantifiable assessments of success, the contribution of industrial design to a specific business's financial performance has stubbornly resisted measurement.' (Hertenstien, 2005, p5). This difficulty was recognised in some of the earliest research work exploring design impact. Referring to sales volume, market share, return on investment, profit, or qualitative factors such as, competitiveness, innovativeness, employment prospects, strike performance, or assessment of Critical Success Factors (Rockart,1979), Black & Baker state; 'The operationalisation of such performance concepts is problematic' (1983). They conclude their paper by stating: 'The ... problem in measuring design's contribution to success lies in the infinite definitions of success. Past researchers have attempted to measure success with a variety of quantitative and qualitative dimensions. As no single agreed definition of success exists, study comparisons are difficult' (p210)

The complexity of disaggregating design as a constituent of impact is widely recognised. For example Micheli (2013) reports the following quotation from a research participant: " I don't think you could measure the return on the money we've spent on the 'Innovation Room' and all the design; you couldn't measure that." and goes on to explain: 'Although it is important to connect investment in design to product/ service outcomes, none of the companies we looked at havedeveloped a robust way of assessing design's contribution tobusiness performance. Difficulties in estimating inputs and outputs, separating design from other interventions, and the existence oftime lags between investment and outcomes make measurementof impact difficult.'(p20) This further confirms the findings of the Design Council's (2005b) study which showed that only 3% of firms in their sample had any reliable method for evaluating design impact on overall performance.

Micheli (2013) intriguingly reports what is described as 'the paradox of quantifying benefits upfront' explaining: 'No company in our sample has a robust method for assessing design's impact on performance (especially the financial impact). Also, several interviewees identified a paradox: the greater the requirement for design to prove its contribution upfront through detailed analysis, the more conservative the approach taken – resulting in lower impact on performance. As a consequence, our interviewees – both designers and non–designers – emphasised the necessity for top management to trust, at least to some extent, the value of design and the work of designers.' (p7) Or, in other words, that attempts to quantify design impact can be counter-productive, with the implication that other tactics to increase the influence of design input might be more successful.

B.2.2 A Chronology of Design Impact studies

Putting economic studies of design impact into the broader subject context of New Product Development, the point made by a number of researchers about the lack of studies on the topic (egTether, 2005; Mondano, 2013) is emphatically demonstrated by the difference in scale between a key review of *design* impact case studies which reviewed 20 individual studies (Candi &Gemser, 2010), against 233 in Evanschitzky et al.'s (2012) review of success factors in the broader subject of NPD. This section focuses on economic studies of *design* impact, but makes reference to related fields as necessary.

It is now widely reported that there is a correlation between design input and output and economic success (eg Tether, 2005; Candi &Gemser, 2010). Studies frequently refer to the limited research into *design* impact, for example the widely referenced Danish Design Centre Study (2003) reports that their study is; 'pioneer work since no other analysis has been carried out before anywhere' (p2), although this claim is somewhat exaggerated. Therefore in reviewing the literature on the economic impact of design, it is useful to explore how the imperatives for research on the constellation of influencing factors evolves over the four decades of work in this field (ref *Table B.6* for an overview of significant economic impact studies in design).

1980s: Early years of design impact studies - design as an optional 'add-on'

A chronological landmark and the earliest reference in Candi & Gemser's (2010) literature review (ref Section B.2.3) is Moody's (1980) studyinto the role of industrial design in technological innovation. This study starts to unpack the factors identified in later studies. Moody's qualitative interviews with 9 winners of UK Design Council Design Award winners intentionally focuses on the business to business scientific equipment sector as a basis for delimiting 'the vagaries of the consumer market' (p331). Tether's (2005) later work includes a specific focus on the need to delimit factors in studies of design impact (ref *Figure B.3*).

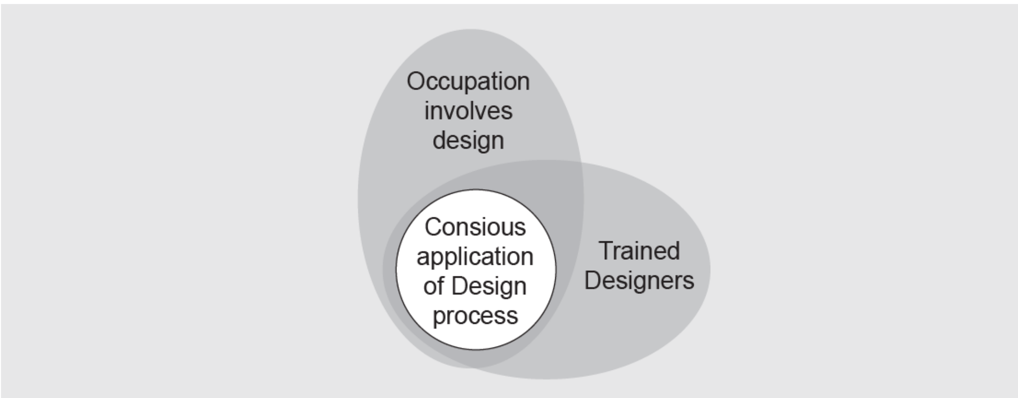


Figure B.3 *Delimiting design activity to aid impact evaluation (Tether, 2005)*

Scepticism about the value of design

Moody's study concludes that design input is a vital ingredient in successful innovation and highlights some of recurring barriers in the adoption of design in business such as; 'the management is not convinced that employing an industrial designer is advantageous to the firm. On the contrary, intelligence about its competitors which do so indicates that industrial designers can be a source of costly mistakes, eg designing stylish products which are technically unacceptable to the market. Moreover, the engineers in the firm are confident that they possess the industrial design skills to a standard ‘(Moody, 1980, p335). The study proposes 9 types of design intervention foreshadowing the later *Danish Design Ladder* concept (Danish Design Centre, 2003) and Candi &Gemser’s (2010) definition of *Emphasis*. At this point in the evolution of the design profession, the idea of ‘Design as Innovation’ as the highest step on the ladder (Danish Design Centre, 2003) has not emerged. Design is presented as input to; form, style, manufacturing and ergonomics.

Early ‘proof’ of the value of ‘design orientation’

Black & Bakers’ (1987) study of 61 Scottish companies demonstrates a direct link between economic performance data and design input factors. Their study represents an early example of linking design with commercial benefits against a background of; ‘Confusion...about what the term 'design' actually means...’ (p206). Their antidote is a five stage design process model correlating with Borja de Mozoto & Kims’ (2009) identification of a 1980-90s Design Process era in design management approaches. Black & Baker coin the term ‘design orientation’ to support their hypothesis that that economic impact is measured by ‘design participation’ in NPD. Black and Baker conclude with a critique of the lack of any agreed definition of success metrics; ‘As no single agreed definition of success exists, study comparisons are difficult’ (p210).

Design can be an ingredient of success

Walsh et al’s (1988) study concurs that different understandings of ‘design’ is a barrier to adoption, and as with Black & Baker’s (1987) study, ‘non-price’ factors are referenced and that; ‘the role of design as an essential part of the innovation process is only just gaining recognition’(p207). The returns from 100 companies on success factors over a seven year period show that 66% of the companies had a main objective of profit and sales growth, whilst only 16% focused on product excellence and good design. They report on scepticism about the financial benefits of design and perceived costs and take a pragmatic view on the specific contribution of design to success concluding; ‘Commercial success, therefore, depends on the whole chain of causation, design—quality—value for money. But the links in the chain themselves depend on other elements.’ And; ‘The answer to the frequently posed question, “does good design pay?" is thus a qualified "yes". Investment of resources in design can be a key factor in commercial success, but does not guarantee it’ (p215)

Early stage design intervention to reduce risk in NPD

Hise et al's (1989) larger sample of 189 US based new product development cases. is concerned with the costs associated with design and development in unsuccessful New Product Development (NPD), citing general failure rates of around 35% with this failure representing 46% of NPD costs. This is against a background of increasing costs associated with design and development, having risen from 28% in the 60's to 38% in the 70's citing Booz Allen & Hamilton, (1981) and Calantoneand Cooper (1981). Design and development here is a subset of a much larger, usually sequential, set of NPD activities, (eg 13 stages shown in Cooper & Kleinschmidt, 1986).The authors conclude; 'Companies should ensure that the preliminary phases of product design are not being unduly glossed over and the success levels of new offerings being jeopardized in management's haste to introduce new industrial offerings more quickly.' (p49) A more contemporary perspective would consider that design activity should be introduced even earlier in the NPD cycle and be fully integrated into company cultures (eg Michaeli, 2012 & Rae, 2014).

1990s: Towards a finer grained understanding of how design creates impact

The need to verify the value of Government investments

Contrasting with US market forces drivers (Hise et al, 1989), the UK design scene continued to be influenced by Government funding initiatives through the conduit of the Design Council and the need to demonstrate value to the tax payer.

The *'Product design and market success'* event held in January 1982, chaired by the then Prime Minister, Margaret Thatcher was linked to a five year £22.5 million programme of external design support for 5000 SME projects. Roy & Potter's (1990 and 1993) work examines the effectiveness of this support for external design input to Small and Medium Enterprises (SMEs), claiming that; 'prior to our work, there was no information available on the benefits, costs and risks of specific investments in design and product development' Roy & Potter (1993, p173)

Design continues to be described as a 'non-price' factor and; 'often misunderstood because it includes disciplines ranging from engineering, product and industrial design to fashion, textiles, graphics, interiors, exhibitions and architecture.(p171)

Roy & Potter'swork shows that on average, projects recovered investments within 15 months, but that in 25% of cases there were significant problems with managing external consultants. The authors claim that; 'it is probable that design played a major part in the outcome of most projects studied' (p182). However 40% of the projects made a loss. The commentary reports issues with access to finance, market circumstances and technical difficulties with development. This seems to suggest a lack of ability, or experience on the part of the designers as well as the companies. 'I get the designer's sketchbook out when I want a laugh' (p189) is reported as a client comment. 22% of the sample indicated dissatisfaction with the consultant's work. The paper reports these findings as signifying lack of design management capability within companies. Overall a headline figure of £500m exports from a £22.5m Government investment is extrapolated from the sampled data and the scheme judged a success.

Finer grain evaluation of factors influencing impact

Roy, with Riedel (1997); recognising the need for a finer grained understanding of the design related factors contributing to impact, and capitalising on the Roy & Potter data, developed a polar map (*FigureB.4*) as a basis for evaluating success factors in a sub-set of the data.

'Styling'and 'Range extension'were found to predominate in loss making projects, whilst 'Performance', 'Quality' and 'Features' (including ease of use) score more highly on successful projects. Successful projects also demonstrate use of a larger number of design interventions. The possibility of contextual factors influencing the results is discussed but discounted on the basis that only 12% of the sample made reference to this. The study concludes with four overall conclusions about a how design and innovation contribute to design impact;

- There were no significant differences in design roles between highly and moderately successful projects,
- There is a difference in the use of design between successful and un-successful projects with unsuccessful design interventions predominantly using styling and range extension
- Different product sectors may need different patterns of design intervention. Eg 2 or 3 dimensions (in ceramics) or multiple dimensions (consumer electronics)
- The most successful projects adopt a wide range of design dimensions

Whilst a step forward in understanding, the analysis conflates design activity with the seven generic categories of factors. There is no disaggregation of the role of design within the factors.

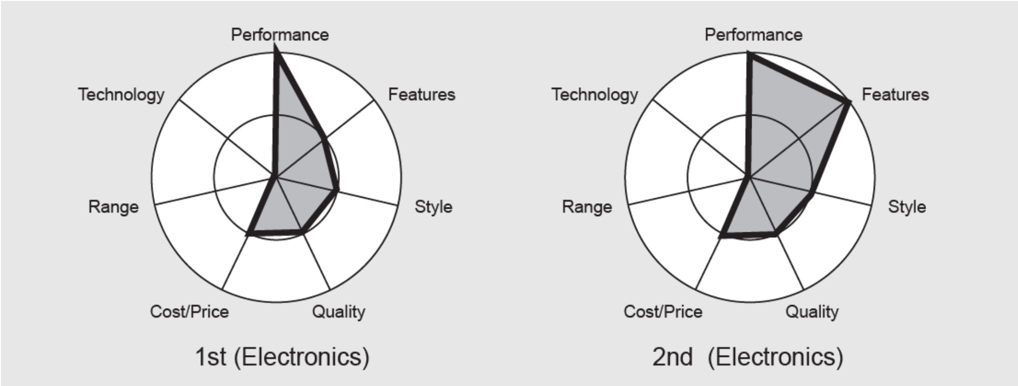


Figure B.4 *Roy & Riedel's (1997) Polar maps of success factors for the highest ranked products in their sample*

2000s The value of design as strategy is gradually emerging

Greater understanding of the influence of contextual factors

Gemser & Leenders (2001) review a growing body of research, but still note that this is; 'extremely light' (p28). Significantly at this stage in the evolution of design they move away from earlier narrow conceptions of the role of design and adopt a broader view citing Kotler & Rath (1984); arguing that the role/definition of design (still a contentious issue at the present time) relates not only to manufacture, materials, product performance, aesthetics, ergonomics, product performance (Moody, 1980), but also as a strategic tool - adopting Ulrich & Pearson's (1998) broad definition of ID. Their work tests three hypothesisesderived from their literature review, summarise here as:

- Positive links between ID intensity and corporate performance
- This positive link is moderated by the type of industry and stronger where investment in design is emerging
- ID *innovation* and company performance is also moderated and strongest where investing in ID is mature

In this study 'Professional design expertise' was defined as work carried out by someone for whom it is their main occupation (note delimiting factors explored by Tether (2005) and Silent Design (Gorb & Dumas, 1987). Secondly, 'Design innovation' was defined as the introduction of designs which were truly different from earlier designs by competitors

Their quantitative data analysis from 47 medium size companies concludes that: 1) Design has a beneficial effect on company success – especially when newly introduced to the company, 2) that there's no pattern of relative importance of design between the two industries studied, 3) Contextual factors in the respective industries are important at the strategic planning stage, and 4) *Innovative* design and design strategy is important irrespective of industries' or companies' maturity in use of design.

Ongoing research gaps, also picked up by Candi & Gemser (2010) (ref section 2.3.2) are links between design methods and performance (citing Ulrich & Pearson, 1998), effective strategies for innovation, and longitudinal studies of design investment and performance

Alternative study motivations and methodologies

Following the alternative path of US based studies (Hise et al., 1989) Hertenstein et al.'s (2001) study of 51 US firms was funded by 35 American design schools and motivated by the desire of designers and design firms to make the case for design to business. 'whether the differences we observe have enough practical significance to be valued by shareholders and the stock market' (p16). They wanted a more nuanced argument than Return on Investment; 'While there are well-understood ways to calculate a firm's return on investment (ROI), there is not yet a way to calculate a firm's return on design (ROD), or even to determine what proportion of the I is really D.' (p10); or the anecdotal and frequently cited (at the time) "Good design is good business" from Tom Watson of IBM at Harvard in 1974. They also wanted to explore successful 'poor' design and the relative success of German and Italian design.

Analysis was based on design quality data generated from a panel of 9 design experts correlated with five years of company financial data from industry databases. This included data on R&D spend. However It is noted that R&D is not an ideal representation of design spend (an issue picked up by the EU supported work ref Barcelona Design Centre, 2013).

In their conclusions Hertenstein et al. (2001) point out that, whilst the findings indicate that on average companies with good design outperform their industry and the stock market, this does not mean that every firm with good design will have superior performance or that good design cannot compensate for poor performance in other areas of firm activity. It is pointed out that the design investment decisions by 'astute' managers, might also mean astute decisions in other areas and therefore further contributing to success. Finally they point out that the results, from a relatively small sample, do not provide any insight into *how* the results are achieved.

Establishing a model for design intensity

Motivated by linking impact with the potential of design, Ulla Hovgaard Ramlau, Managing Director of the Danish Design Centre(DDC) states; '...we at the DDC have long held the view that design pays off—that it has great economic potential, and that promoting design has commercial value....' and baldly states the purpose of their survey is; 'To prove our point to industry and government' (Ramlau, 2004, p49). More specifically the work reports that decision makers have lacked information and hard facts on the economic benefit of design and that there has been no methodological platform for analysis. Boldly, and rather diminishing the arguments Ramlau states that: 'This report is pioneer work since no other analysis has been carried out before anywhere' (p2)

Table B.2 *Key findings from the Danish Design Centre impact study (Ramlau, 2004)*

Danish Design Centre design impact study based on telephone interviews and economic data from 1,476 companies. Key findings:
- The amount of total annual internal and external investments in design in Demark (the internal–external split in investment is picked up in Livesey & Moultries' (2008) work on UK 'design spend' calculations) - 22% above average growth for companies who invest in design (also ref Hertenstein's, 2001) US study) - Companies with increasing design activity achieve 40% uplifts in revenue compared to companies with static or decreasing design inputs (also ref design *Effectiveness*; Hertenstein, 2001, *Intensity*, Gemser & Leenders, 2001, *Emphasis*; Candi and Gemser, 2010, *Strength*, Zac, 2011) - External design input achieves 34% increases in export performance compared to 18% with companies adopting different design input strategies - Design active companies have higher rates of job creation - Economic performances are better the higher companies rate on the DDC's model for design intensity; the *Danish Design Ladder* (Danish Design Centre, 2005,) - 50% of companies under 10 employees rate as non-design users and only 6% have a 'solid design base'.

The findings (ref *TableB.2*) confirm positive growth for companies investing in design, but notes;'However, the analysis constitutes an insufficient basis on which to conclude the precise share of the economic growth that can be attributed to design (p2). Significantly the work defines criteria for a hierarchical 'Ladder' of intensity or effectiveness, frequently cited in related research as the 'Danish Design Ladder'.This concept shares findings from the earlier work of Hertenstein (2001) and Gemser & Leenders, (2001).

Design Council reports; 'selling' design to industry

The UK Design Council has conducted a number of annual surveys into the state of design in Britain during the 2000s (Design Council, 2002, 2003, 2005a, 2007b) and as with the Danish work (Ramlau, 2004) is broadly motivated by making the case for design to Government and industry. In the 2001 survey, design is ranked 7thcompared to financial management (1st) in the respondents' view of its importance. By the 2004 survey, design ranks 2nd against financial management at 3rd. The validity of these results may be questionable, but the direction of travel is clearly positive.

The Design Council also build on Hertenstein's (2001) work by comparing performance of selected FTSE listed design orientated companies with average FTSE 100 figures in a 'Design index' *(Figure B.5)*

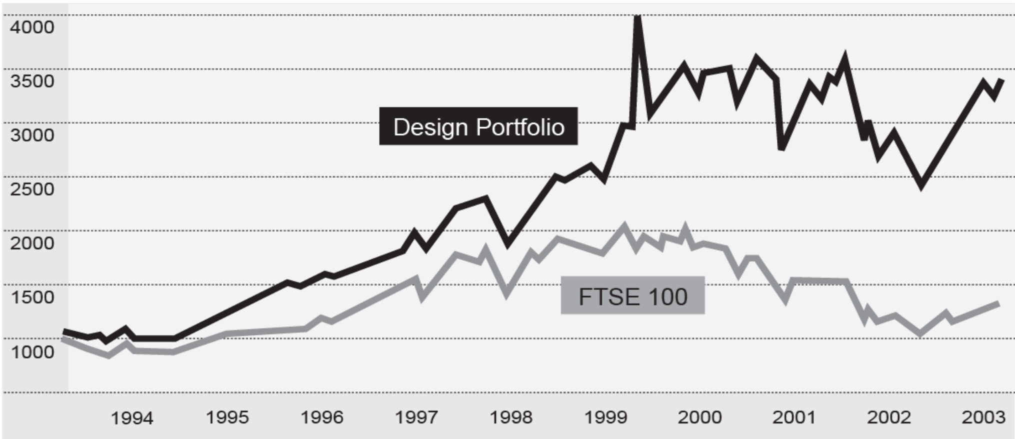


Figure B.5 *The Impact of Design on Stock Market Performance – 'Design Index' (Design Council, 2005a)*

Further work by the Design Council (2005a) to create strong arguments for the value of design uses data from the 2004 survey to identify the concept of 'Design-Alert' businesses (also ref earlier studies identifying design effectiveness or intensity (Hertenstein, 2001; Gemser & Leenders, 2001; Ramlau, 2004) and the headline extrapolated statistic; 'For every £100 a design alert business spends on design, turnover increases by £225' (Design Council, 2007b, p4). The Design Council's (2005b) categories of effectiveness and related percentages of the sample are: 'Integral or significant' (28%), 'Limited' (35%) and 'None' (37%)

Following a similar approach to Hise et al.'s (1989) study, data is also collected on the stages of NPD where designers are involved: Concept development (25%), Prototyping and detailed specification (25%), Pilot manufacturing/delivery of product or services (22%), Implementation (22%), Idea generation, research, R&D (20%) and Marketing and distribution (12%). The percentages represent the proportion of the sample citing involvement of designers in these stages of work.

Disaggregating design spend

The Design Council, (2005a) report that only 3% of companies specifically measure their design investment in a way which would allow consistent economic analysis of the added value of design. Tether (2005) in his report for the DTI picks up this issue in his work using the Design Council's 2004 data. He highlights the lack of reliable definitions of design and related availability of statistics – contrasting this to the Frascati and Oslo manual frameworks which generate detailed Europe wide data on R&D spend. Recent work supported by the EU aims to directly tackle the availability of data for analysing design impact (Nomen et al., 2012; Barcelona Design Centre, 2012) by writing in a requirement for design related data acquisition in a *'A Frascati manual for design'*.

Tether's cautious analysis of the 2004 data concludes; 'some associations between design and superior performance, but not causal relationships'(p18). Also citing his own earlier work (Tether and Massini, 1998) and in relation to the Danish study; 'One way of interpreting these results and the role of design in business performance is that investments in design increase the probability that the firm will be in the high performance sub-set of firms that create most new sales and jobs'(p19). As a result he identifies a number of questions or recommendationsfor further understanding summarised as follows:

- The need to clarify what design knowledge is (and therefore what it can contribute)? Tether (2005) offers a simple model (*Figure B.3*) for disaggregating 'conscious design'
- And how this contribution relates to innovation; 'complementary assets' as well as technical and functional (referencing examples such as the Sony Walkman, Apple iPod or mountain bikes)?
- To what extent can design play 'bridging' or 'converting' functions, for example between marketing and R&D?
- The significance of where design is located (end users or clients)?
- Are there firm size and sector barriers to the adoption of design (eg at higher levels of design intensity)?
- The need for more evidence of causation between design investment and performance?

The differences between the Design Council's (2002, 2003, 2005a, 2007b) and the more cautious Tether (2005) reports, highlight the significance of the research motivation to the outcomes. This aside, the Design Council work effectively aggregates the understanding of impact analysis to this point and Tether outlines an agenda for ever more granular understanding.

Complex multi-variate analysis of design in the NPD field

Swan et al.'s (2005) study from the NPD field explores the additional dimension of design capabilities. In this case he re-frames a general concept of firm level capabilities as 'robust capabilities' citing Rothwell, (1992); and Rothwell and Gardiner, (1989) where robust capabilities describes the ability to take a strategic approach to creating longer term value from NPD activity. As with other studies, difficulties are experienced in gaining the detailed data required for the complex multi-variate statistical tests applied to the factors shown in *TableB.3*

Table B.3 *Multiple Variables used in Swan et al.'s (2005) impact study*

FACTOR		STATISTICAL SATUS
1	Market Performance	Dependent variables
2	Speed to Market	
3	Size (Product Sales—logged)	Control variables
4	Firm Size (# of Emp.—logged)	
5	Outsourced Percentage	
6	Product-Related Resources	
7	Ownership-Related Resources	
8	Environment Uncertainty	Moderator variable
9	Robust Functionality Capabilities	Independent variables
10	Robust Aesthetics Capabilities	
11	Robust Technological Capabilities	
12	Robust Quality Capabilities	

An interesting and relevant point is made about enhancing the 'interpretability' of the results, and Swan et al.'s work uses a 'novel' plotting procedure citing Cohen & Cohen (1983) for communicating the results of the data analysis. The work aims to provide high levels of reliability and validity with the adopted methodology, but it is not clear that good levels of 'interpretability' have been achieved. Overall the results confirm that there are interrelationships between capabilities, market environment and resulting firm performance and that methodologies can be developed to provide better understanding of these interrelationships given sufficient datasets and resources.

In the conclusions Schumpeterian and resource-based (RBV) perspectives (citing Rumelt, 1984) are mentioned as approaches for optimising a firm's unique resources within changing circumstances. Swan et al. state that the results confirm that these perspectives are desirable for enhancing market performance and speed to market. Later work by Borja de Mozota (2003, 2009) also advocates 'value management' as an approach to design management for enhanced firm performance.

Recognising tactical design in an era of advocates of strategy

Citing design advocacy literature of the earlier era (eg Kotler & Rath, 1984, Lorenz, 1986, Walsh et al, 1992, Thackara, 1997). Ravasi & Lojacono's (2005) qualitative study based on analysis of 11 'design-driven' companies recognises that design creates competitive advantage when embedded within organisations. The strategic level of the Danish Design Ladder (Ramlau, 2004)

But they note that at this time; 'Design management scholars have rarely attempted to connect design activities to the process of strategy formation. Literature has generally focused on how careful management of design activities can improve product performance, quality, look and costs and therefore customer satisfaction'(p70).

Their resulting model (*Table B.4*) for strategically integrating design embraces design management concepts and extends the earlier concepts of *Intensity, Effectiveness,* together with the method of using 'design driven' company case studies as a basis for research. The model makes the, perhaps obvious point, that successful design is achieved with a combination of tactical and strategic approaches.

Table B.4 *Model for Design Driven Strategic Renewal (Ravasi & Lojacono 2005)*

Four Phases of integrated design activity	
Productdevelopmentphases	Generation ofideas
	Evaluation andselection of ideas
Organisational development phases	Revision of thedesign philosophy
	Diffusion of newideas

Developments in macro-economic analysis of design impact

Moultrie & Livesey's (2009) *Design scoreboard*initiativeacknowledges the results of earlier design impact studies, and is a logical progression of Tether's (2005) work on design spend. They note the need for a 'bounded definition of design' and an 'agreed framework' (p10) for measurements, together with more reliable data.

The authors claim that the result of their work is the first set of comparable data for UK company design spending. *Table B.5* shows how they have tackled the issue of a bounded definition of design, although this doesn't entirely disaggregate *Hidden Design* factors (Gorb & Dumas, 1984)

Table B.5 *A conceptual model of design spend (Livesey & Moultrie, 2008)*

Categories for evaluating design spend		
Design in the creation of products and services	TECHNICAL: Design relating to the technical/engineering aspects of creating products and	Technical Design Spend

Categories for evaluating design spend		
	services	
	USER: Design of the user experience in the creation of products and services	
Design in the communication, promotion and delivery of products and services or the overall business	PROMOTION DESIGN: Design as part of promotion, communication, branding, and distribution of products and services	Non - Technical Design Spend
	IDENTITY: Design as part of developing promoting and communicating the corporate identity	

The sample data was sorted into Standard Industrial Code (SIC) categories, which, based on publically available statistics, enables the survey results to be proportionally extrapolated to the whole of the UK. The resulting estimates of the total UK design spend are shown in the matrix below (*Table B.6*).

Figure B.6 *Estimates of total UK design spend by category (Livesey & Moultrie, 2008)*

At a similar time to Livesey & Moultrie's work, Tether (2009) carried out an analysis of the UK Innovation Survey results. These are the UK component of the forth Europe wide Community Innovation Survey (CIS-4). Each country has some flexibility to create their own questions. In this case '*All forms of Design'* was included as a category of expenditure and therefore in correlation with other questions allows a range of analysis to take place. Design is also a 'hidden' or 'silent' part of R&D (Gorb & Dumas, 1987) because the survey specifically requires that the R&D categories of expenditure do not include any design, when in reality they are highly likely to. Tether recommends that future surveys might replace the existing model with new categories of *Research* and *Design and Development* in order to better capture the investment in design as well as recognising what is described as *Ancillary Design* – Design activity which is not directly part of innovation. These points are now being addressed with the EU initiatives on design innovation (Barcelona Design Centre, 2012& 2014). Overall Tether's analysis shows, in 2004, a median innovation expenditure around £1,250 per employee. Of this, an average of 5% was spent on design, compared to 21% on internal and external R&D costs. His results also show that Design is not a substitute for R&D and visa versa. Tether concludes: ‘The analysis in this paper suggests that design makes a significant, yet neglected, contribution to innovation in firms’ (p26, 2009)

At a macro-economic and policy making level the incremental developments leading to the future Barcelona Manual on Design (Barcelona Design Centre, 2014) are significant developments. The work has very limited direct influence on current design practice, but the emerging recognition of design as a component of innovation is important.

Recognising design in the innovation mix

Talke et al.’s (2009) study from the field of innovation, introduces the concept of ‘Design-newness’ as an impact factor citing the Apple iMac’s transformative impact. The research aims to substantiate this phenomena in relation to ‘Technical newness’, noting that ‘this relationship has not received any research attention’ (p606). The original Dyson vacuum cleaner is cited as an example of combined technical and design newness.

Designers would be disappointed with Talke’s reduction of the design newness element to aesthetics, but it is noted that;‘This paper follows the predominant understanding of product design that is related to the exterior appearance of a product’ (p603) in this case cars. However it is a pragmatic approach to operationalisationand the need to delimit design (eg Tether, 2005) and availability of suitable data for analysis (eg Swan et al., 2005). The sales data for their sample of 157 new cars over an 8 year period is processed alongside the results of 50 evaluators grading the design-newness of the vehicles in relation to the market context of the time.

The data processing and analysis resulted in graphs showing the impact of the two newness factors over time (*Figure B.7*). Mixed technical and design ‘newness’ does not show any significant deviation from what would be expected: that combinations have a generally positive impact in comparison to products without innovation. The results also show that the positive impact of design newness persists over the lifecycle, whereas technical newness has a lagging impact and then decreases towards the end of the product life. The authors emphasise the need for NPD planning to take account of these factors across product lifecycles and to ensure a holistic view of the different potential elements of innovation.

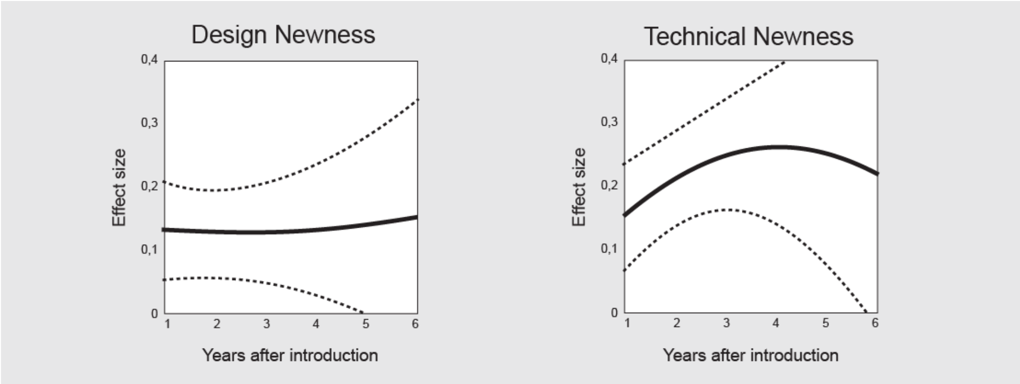


Figure B.7 *The effects of design and technical 'newness' over the product life cycle (Talke et al., 2009)*

Despite reservations about limiting design to aesthetics, Talke et al.'s work represents a detailed attempt to delimit the contribution of design to impact together with clear visualisation of longitudinal analysis and tactical management recommendations

The mediating role of design management

With interests in design management's influence on impact (citing Bruce & Bessant (2002), Chiva & Alegre (2009) recognise that earlier research has established links between design and positive performance, but that this is not unconditional. They draw a critical distinction between theoretical and empirical studies of design; 'There is plenty of theoretical research into *design management*, but empirical research is 'extremely scarce', and; 'no empirical research has linked *design management* to firm performance, and therefore there is no empirical support for the impact of *design management* on firm performance.' (p425)

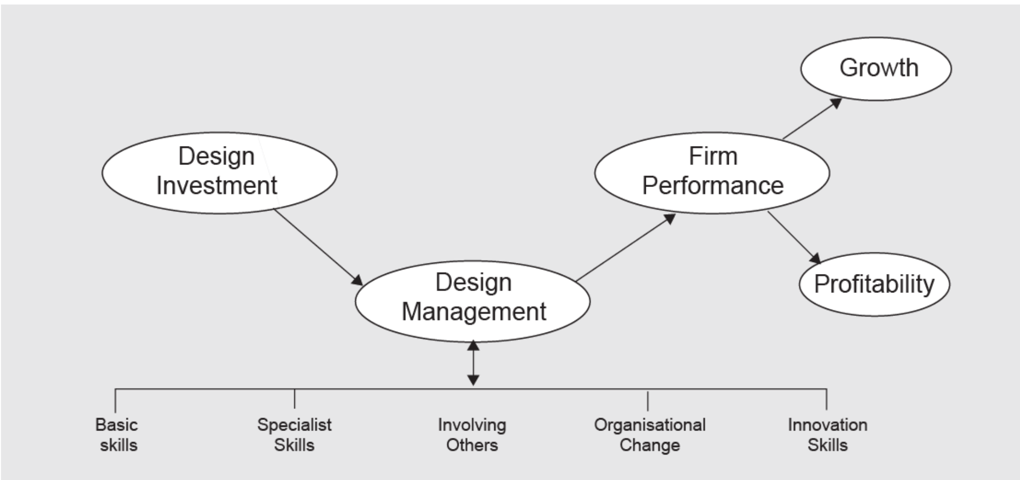


Figure B.8 *Conceptual model of design investment and design management inputs to firm performance (Chiva & Alegra, 2009)*

Similarly to other studies (eg Swan et al., 2005) the sensitivities around collecting firm performance data are noted as well as the benefits of delimiting design (eg Tether, 2005.

In this case, by focusing on the ceramic tile industry. Chiva & Alegra's (2009) findings confirm their hypotheses summarised as: 1) Design management enhances firm performance, 2) Design investment success is related to design management, 3)Design management plays a significant role in determining the effectiveness of design investment. Their conceptual model (*Figure B.8*) perhaps oversimplifies the link between design investment and performance. More interestingly their conclusionsponder the possibility of 'the existence of a virtuous cycle between design investment and design management'(p436) This is a point picked up and extended by Candi & Gemser's (2010) work which draws a causal link from design impact back to design inputs (*Figure B.10*). They also suggest using the design management model metrics as a basis for auditing companies, planning design investmentand enhancing design management skills.

2010s: Consolidating understanding of a wider range of factors

Candi and Saemundsson's (2011) study into the relationships between *aesthetic design*, contextual factors and firm performance within service design represents a useful benchmark in the chronological development of design impact studies and the evolution of the design profession as a whole. The work clearly states its contribution as extending the range of empirical studies of design impact from New Product Development (NPD) to New Service Design (NSD). The term *aesthetic design* is used as a way of delimiting the type of design applied to NSD. This does not explicitly recognise the contributions of design management or 'design thinking', but does demonstrate both the increasing sophistication of attempts to delimit design for the purposes of evaluating impact factors, and how at this time the role of design has expanded from objects to experiences (citing Norman, 2004).

Regression analysis or multivariate analysis (also ref Talke et al., 2005; Design Council, 2007b;Chiva & Alegra, 2009)is used to evaluate 101 Nordic technology companies over three years. Their data is mostly derived from participant's rating factors on a five point scale. For examplethey state that; 'it (is) challenging to create an empirical measure of *competitive advantage*' (p544)and as a result use participant ratings as a proxy. Competitive advantage, or greater economic value than a 'breakeven' competitor relates to the models developed later in the €Design: Measuring Design Value work (Barcelona Design Centre, 2012).

An important contribution of the work is, what the authors describe as the -*influence of commoditization* – or the prevailing market factors. These were assessed by a panel of experts rating; visceral, functional and experiential design dimensions on a four point scale. Whilst the overall message of the work is that aesthetic design can be a means to create competitive advantage, a key finding is reported as;

- 'The only relationship that was consistently <u>not</u> found to be significant was the direct relationship between aesthetic design and competitive advantage measured in terms of the ability to charge higher prices for services. This suggests that aesthetic design does not contribute to competitive advantage independently of the level of commoditization. The contribution is only realized under conditions when the level of commoditization is high.' (Candi and Saemundsson, 2011,p550)

Or put more simply, this means that there is no consistent demonstration of positive *aesthetic* design impact on performance independent of prevailing market factors. Candi and Saemundsson (2011) refer to Christensen's (1997) model of phases of competition as a means for managers to assess contextual, or 'commoditization' factors (Ref *Figure B.9*)

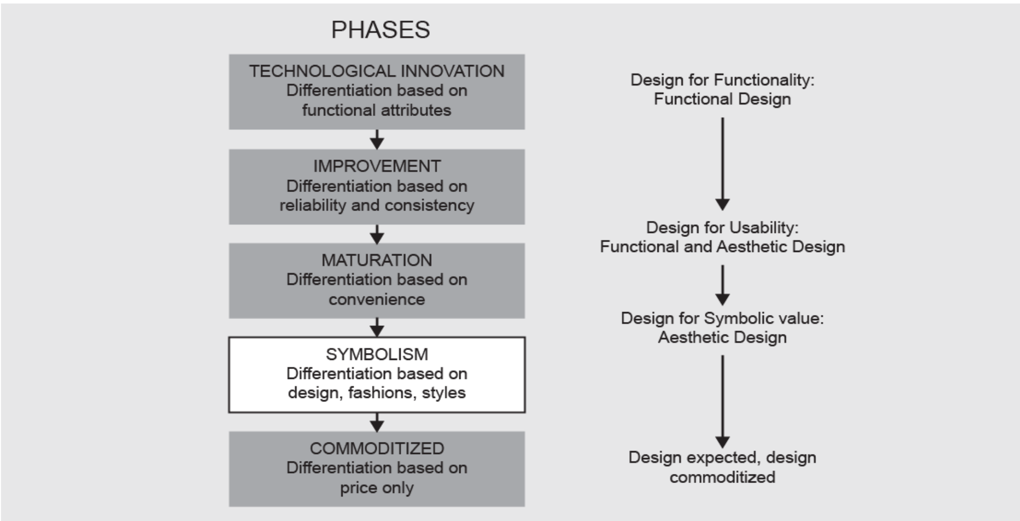


Figure B.9 *Christensen's (1997) phases of competition mapped to roles for design input (Candi and Saemundsson, 2011)*

More recent studies by Micheli (2013) in the UK and Rae (2014) in the US do not necessarily add further to the conceptual foundations for evaluating design impact, but build on the methodologies and themes explored in earlier work. In both cases their key research outcomes are definitions of the design factors which can contribute to adding value. This aspect - the role of design in creating impact is explored in Section 2.4.

Table B.6 *Chronology of Significant Economic Studies of Design Impact*

Date	Study	Sample	Notes, **key finding**, methods
1980's	Early years of design impact studies – design as an optional 'add-on'		

1980	Moody, The role of industrial design in technological innovation	9 UK firms	Concludes that Design is a vital ingredient in innovation, but no explicit link to company performance shown. Interviews
1984	Rothwell & Gardiner,Design & Competitionin Engineering	Agriculture equipment & Automotive industries	Survey of 150 farmers and UK automotive products produces evidence that design, or incremental development is integral to economic success and can be more so than technical or engineering development. Price and Non-price factors defined
1987	Black C, Baker M, Success through design	61 Scottish firms	Engineering and Textiles companies in the sample. Economic success mapped to design process and personnel. Greater design orientation correlates with enhanced performance
1988	Walsh, Roy & Bruce, Competitive By Design	100 UK firms	Survey exploring financial data in relation to assessments of design quality from design awards and citations. Correlations between 'good design' and enhanced performance demonstrated.
1989	Hise et al.The Effect of Product Design Activities on Commercial Success Levels of New Industrial Products	195 US New Products	Analysis of specific design phases and influence on success (judged by the company). Confirms correlations between using design and success vs non designapproaches, with some phases more effective than others for success.
1990s	Towards a finer grained understanding of how design creates impact		
1993	Roy & Potter, The commercial impacts of investment in design	221 UK SMEs/projects	Analysis of a Government/Design Council funded scheme showing 70% of 91 projects being profitable. Identifies direct and indirect benefits from design investment
1997	Roy & Riedel, Design and innovation in successful product competition	44 projects	Further analysis of the earlier (1993) dataset to explore the profile of design intervention in successful projects. Highly successful projects demonstrate a wider profile of different design interventions than loss making projects
1997	Sentance & Clark, The Contribution of Design to the UK Economy	800 UK Manufacturers	Cited in Livesey & Moultrie (2008); Utterback (2006) &Borja de Mozota (2003) Identified the design spend in manufacturing firms and that higher design spend levels lead to higher levels of economic impact
1998	Trueman & Jobber, Competing Through Design	108 UK companies	Confirms correlation between design input and added value. Surveyed views show an increasing importance for integrated design. Value adding factors are placed in a hierarchy
2000s	The value of design as strategy is gradually emerging		
2001	Gemser & Leenders, How integrating industrial design in the product development process impacts on company performance	43 Dutch firms	Exploration of industry context and intensity of design and innovation on company success. Design investments can be more successful if a design strategy responds appropriately to the business context– and less successful if they don't
2001	Hertenstein J, Platt M, Brown D. Valuing design: enhancing corporate performance through design effectiveness	51 US firms	Introducing the methodology of linking an expert panel's views of 'more' or 'less' effective use of design in companies with longitudinal (5yr) financial results. Correlations show between more effective use of design and economic performance, but acknowledging no indication of how this achieved

2003	Danish Design Centre, The economic effects of design	1,476Danish firms	Telephone survey linked to 5 year audited turnover figures. Results show importance of Emphasis to performance and strong correlation between design input & enhanced economic performance
2005	Design Council, Design in Britain, 2004-2005	1,500 UK firms	A cross section of company size and sector data confirms findings of earlier studies; that design effective companies have higher average economic performance than less design effective companies
2005	Swan et al.Exploring Robust Design Capabilities, Their Role in Creating Global Products, and Their Relationship to Firm Performance	84 US firms	Acknowledging that design and development are ingredients of commercial performance, the research explores how four design 'capabilities' affect impact according to variable market environment. Results support the role of design management& a RBV perspective
2005	Ravasi & Lojacono, Managing Design and Designers for Strategic Renewal	11 'Design-Driven' companies	Qualitative research linking the success of design-driven companies with a conceptual model of design and design management activities
2005	Hertenstein et al; The Impact of Industrial Design Effectiveness on Corporate Financial Performance	93 US plcs	Survey of 138 Designers leading to rankings of design quality across 93 rated public companies and 9 industry sectors which were then analysed for 7 year economic performance. Correlations shown between design quality & economic performance
2005	Tether; Think piece on The Role of Design in Business Performance	1,500 UK firms	Using the Design Council 2004 dataset to make recommendations for operationalising evaluation of design impact. But strikes a cautious note on the links between design input and company performance
2008	Livesey & Moultrie; Company spending on design: exploratory survey of UK firms	358 UK firms	Creates a model for capturing company design spend and resulting analysis from 2008 data. No direct link to impact, but part of efforts to build robust models for impact evaluation
2009	Talke et al.	157 cars, Germany	Explores the impact of technical and design innovation on performance over 8 years. Confirms the positive impact of innovation. But also that design impact endures longer than technical innovation
2009	Chiva & Alegre	182 Spanish firms	The relationship between design management, design investment and firm performance in the Ceramic tile sector. Results demonstrate that Design Management is critical to maximising the value of design investments in enhancing firm performance
2009	Kootstra, Analysis of Design Management Practices in Europe	605 Dutch companies	Focusing on Design management, correlations are found between the level of design intensity and firm performance, but the lack of evidence of causation is noted.
2009	Tether, Design in Innovation: Coming out from the Shadow of R&D,	16,446 UK companies	An Analysis of the 2005 UK Innovation Survey provides a large data set for statistical analysis. Design is shown to be a significant element of company innovation activity, but no attempt is made to link this to company performance
2010s	Consolidating understanding of a wider range of factors		

2010	Kristensen & Gabrielsen, Design Economy – Value Creation and Profitability	25 Danish Companies	Product and Logo design positively associated with financial performance, but not web design. Statistical analysis of company performance data and a panel assessment of 'good' design based on images. Research acknowledges potential for an additional 'strategic' role for design.
2010	Candi	118 Technology & internet firms	Data collected covering a 3 year period exploring impact of Silent versus Overt design. Overt design does not un-conditionally produce stronger performance
2010	Candi & Gemser	18 Design impact studies	Literature review of earlier studies identifies significant research challenges in the field and proposes a model for exploring design impact and 8 research question areas
2011	Noble	Design impact studies	Literature review focused on identifying research gaps in relation to the idea of 'elevating' the role of design. In summary; issues with how design is integrated into organisational behaviour?
2011	Candi & Saemundsson	101 Nordic tech companies	Reflecting the Expanding role of design into services this study uses regression analysis to explore a range of variables affecting design impact. Aesthetic design is confirmed as potentially contributing to economic performance, but this relationship is mediated by the prevailing business context, eg design impact is not un-conditional
2012	Eden Partners, Designing Demand National evaluation 2007-12	249 UK SMEs	Beneficiaries of the UK Design Council's Designing Demand programme, generates the headline figure of £1 design investment leads to £20 increase in turnover. Detailed methodology not published
2013	Micheli, Leading Business by Design: Why and How Business Leaders Invest in Design	48 UK companies	Qualitative analysis of Case studies. Recommendations for 3 factors for adding value through design
2014	Rae, What is the real value of Design?	14 US 'Design-Centric' Companies	Updating earlier studies demonstrating correlation between design-centricity and economic performance, and over a 10 year period with qualitative analysis of 7 value adding factors

B.2.3 Research gaps identified by literature reviews of design impact

As noted above, the notion of measuring impact is problematic (eg Hertenstein, 2001; Cooper et al., 2011). In his discussion paper on impact Brewer (2011) reflects on general research questions which need to be answered in this context: What is impact? Impact for whom? What are the domains in which it is displayed? What are its indicators? How is it measured?

As awareness of, and interest in design impacthas grown, the body of related literature has developed, to the extent that there are a number of literature reviews of the topic with objectives to identify research gaps and challenges (Candi &Gemser, 2010; Noble, 2011, Madano Partnership, 2012 and Nomen et al, 2012). The latter two come from a policy level imperative in the UK and Europe respectively, whilst the first two emerge from the field of NPD and Innovation.

Multi-dimensional relationships between Industrial Design and Performance

Candi &Gemser's (2010) work centres on Industrial Design and firm performance from an Innovation and NPD perspective and with a review of 18 significant papers. Their work results in a classification based on three categories of input to design; *ID Emphasis, ID capabilities* and *ID Management*. In their resulting model (*Figure B.10*) these are schematically shown as input into *ID Outcomes* and *Performance.* They describe their approach as an 'integrative perspective', and more 'grounded' than a completely inductive approach. As with many studies they point out that; 'A specific challenge in synthesizing research on industrial design stems from inconsistencies and unclear definitions of industrial design, if definitions are offered at all' (p67). They note that much of the work has tended to explore a single relations between factors rather than multiple relations/factors; 'Industrial design effectiveness research that empirically investigates the relationships between two or more of the manifestations of industrial design in a systematic fashion is scarce' (p69). They stress the importance of making explicit links between evaluationof *Performance*, a 'manifestation' of ID (*ID Outcomes*) and contributing factors such as *Emphasis*.

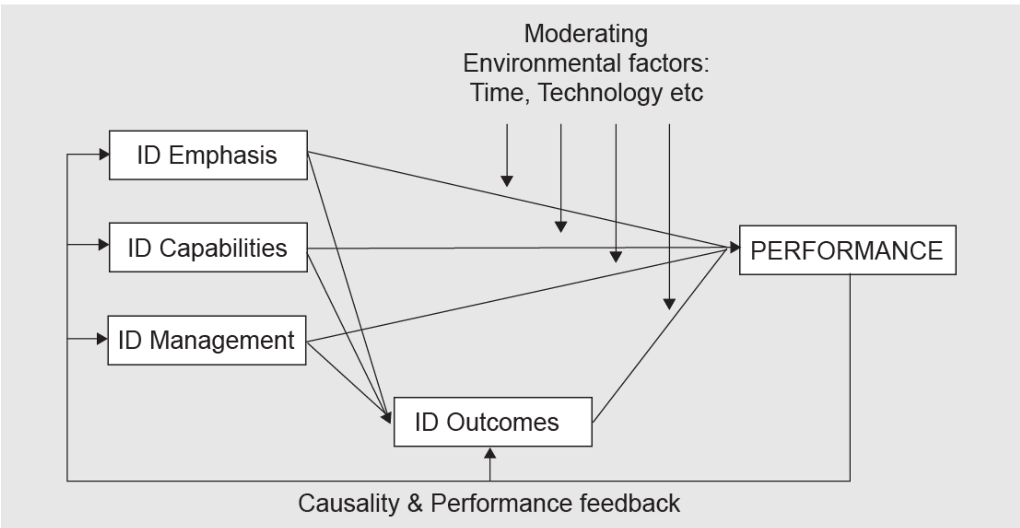


Figure B.10 *Candi & Gemser's (2010) model of relationships between Industrial Design (ID) & Performance*

Taking *ID Emphasis* as an example; this describes the level and extent of design activity with an organisation or NPD activity and correlates with studies by Candi, (2010); Candi & Saemundsson, (2011); Black & Baker (1987); Hise et al., (1989); the Danish Design Ladder

(Danish Design Centre, 2005,) and the European Design Management Staircase (Kootstra, 2009).

ID Capabilities–defines design capabilitiesin terms of nature and scale of resourceand correlates with studies by Gemser & Leenders, (2001); Swan et al., (2005); Roy & Potter, (1993). However 'expertise' (eg as explored by Cross, 2004; or Lawson, 2004) is not encompassed within this categorisation of capability or covered elsewhere within the model.

ID Outcomes– defined as measures, metrics or operationalisation of factors relating to the output of design activity cites studies by; Veryzer & Hutchinson, (1998); Veryzer, (1993); Creusen & Schoormans, (2005); Yamamoto & Lambert, (1994); Berkowitz, (1987); Hekkert, Snelders, & van Wieringen, (2003); Meyers-Levy & Tybout, (1989); Bloch, Brunel, & Arnold, (2003). Candi & Gemser also reference studies which use peer assessments of design within this category such as; Goodrich, (1994); Hertenstein et al., (2005); Platt et al., (2001); Talke et al., (2009); Walsh et al.,(1988).

ID Management - encompasses studies which make a link between the performance of a company or project and the strategic management decisions about design taken during an NPD process (Chiva & Alegre, 2009; Ravasi & Lojacono, 2005; Roy & Riedel, 1997)

The key overall point they stress is the need for analysis of these factors and the effect of their interrelationships against performance. This overall research objective is the first (Question 1) of eight research questions they identify as gaps in current research (*Table B.7*)

Table B.7 *Questions to address gaps in design impact research (Candi & Gemser, 2010)*

Relationships between Industrial Design and Performance	
1	'The relationships between industrial design emphasis, industrial design capabilities, industrial design outcomes and industrial design management should be examined to gain an improved understanding of the contribution of industrial design to performance.'
2	'Research is needed to examine the similarities and differences between the evaluation of industrial design outcomes by design experts, by peers, by customers and self-evaluations by managers.'
3	'Research is needed to examine differences in industrial design outcomes and contributions to performance depending on whether industrial design is undertaken by professional designers or as silent design.'
4	'Quantitative research is needed to compare the effectiveness of using external designers and internal designers, and also to examine whether long-term or short-term relationships with external designers are more beneficial.'
5	'Quantitative research is needed to compare the effectiveness of industrial design in the different phases of NPD processes in terms of contributing to performance as well as what degree of designer freedom is most beneficial.'

6	'Quantitative research is needed to examine the relationships between innovative industrial design and performance and how innovative industrial design should be managed to optimize the creation, commercialization, and appropriation of innovative design.'
7	'Longitudinal research is needed to examine whether industrial design leads to improved performance or whether better performing firms are more likely to exploit industrial design.'
8	'The moderating influences of environmental factors, such as technology turbulence, market turbulence, competitive intensity as well as the passage of time and product type, on the relationships between industrial design and performance should be included in research models.'

Elevating design through strategic design research

In Noble's (2011) review of design research; from an NPD and Innovation management perspective, he argues that whilst there has been consideration of design outcomes there has been limited attention to strategic factors which might 'elevate' the role of design. He introduces the topic with;'despite the growing admonitions by practitioners and management thinkers to consider design as a powerful source of competitive advantage, the academic literature on design has largely avoided a strategic focus' (p289). His objective is to define the research questions needed to improve this shortfall in existing research (*Table B.8*).

Noble isconcerned with 'strategic' factors; 'A *strategic* perspective on design suggests a change a focus on outcome measures; rather than considering consumer choice,the smooth functioning of the NPD team, or even the ''newness'' of a particular product outcome, a strategic view of design would examine variables such as firm performance, sustainable competitive advantage, corporate culture, and resource utilization.' (p391)

Citing (Chiva & Alegre, 2009 - Design management impact; Hart & Service 1988 - Senior manager attitudes to Product Design; Hertenstein, Platt & Veryzer, 2005 - Industrial Design effectiveness; Bruce, Potter & Roy, 1995 - Investment in design & firm competitiveness) Three issues are identified in relation to considering a *strategic* role for design: 1) a currently 'ambiguous' role for design in NPD, R&D, engineering and marketing, (this may be a innovation management centric view, as design management based literature will present a different perspective) 2) the difficulty of operationalising design (defining and using metrics to understand effective design) and 3) Optimising attributes into consumer benefits alone does not explain the success of brands such as Apple or B&O. (this last point suggests, but does not reference the branding domain)

Table B.8 *Research questions forelevating the role of design (Noble, 2011)*

'Elevating' the role of design

'Elevating' the role of design	
1	**'What is a design orientation?'**Eg understanding the success of deep cultural embeddedness of design within companies such as Apple?
2	**'Is design a culture, a capability, or a dynamic capability(or all of them)?'**Eg how do these qualities, individually or collectively contribute to design impact?
3	**'How is the design function best structured for innovation?'**Eg how to maximise design impact through integration into innovation processes and structures?
4	'How should the design (as a focus and as a unit) be managed in a market-oriented organization?'Eg at what point in organisational processes is design input most effective?
5	**To what extent can design be a true ''strategic asset''?**Eg if Design is something more than a service commodity, how can this strategic value be recognised, measured etc?

Macro-economic measurements of Design Value

Considerable interest in the potential of design at a macro-economic and policy level (eg as outlined by Cox, 2005) has led to recent studies in the UKand Europe.

Commissioned to explore the Design Research landscape and potential research funding agendas, the Madano Partnership's report for the AHRC and Design Council in the UK introduces the subject by stating; 'the Design Council and AHRC believe that design plays a key role in economic and social value creation. Design is key to connecting R&D efforts with innovation thereby enabling the market implementation of new knowledge that is fundamental to delivering economic growth and contributing to social renewal.' (Madano Partnership, 2012).Their overall recommendation is a focus on the emerging field of service design; 'Research work that can better understand, communicate and promote the nature of this developing sector (service design) we believe would be hugely useful and of interest to a wide range of stakeholders' (Madano Partnership, 2012). Note that the idea of 'promoting' service design is integral to the proposal. This positioning is also recommended on the basis of avoiding duplication with pan European research work funded by the EC and conducted by various consortia.

As in other studies It is noted that the design research community has mixed views about the expediency of research based around a 'measurement agenda'. They note that the strongest existing evidence base, albeit limited in relation to R&D, is in the field of innovation and NPD (note that Noble's (2011) and Candi &Gemser's (2010) reviews are in this area). They note that; 'it is very difficult to find UK studies with strong empirical bases on the value and impact of design interventions.'(p5). This leads to specific questions (ref *Table B.9*) about the contributions of design at individual business level, within the UK, and how this compares to other countries. Perhaps mindful of pan-European initiatives exploring economic value, the other research theme identified covers issues of complexity and social value; 'Measuring the social value and impact of design is rather less straight forward, and given the wide scope of design can be applied across a huge range of areas' (p6). This leads to their forth recommendation for research into design impacts on health and well-being.

Table B.9 *UK Policy level Design Impact research questions& objectives (Madano Partnership, 2012)*

AHRC/Design Council, Research Questions (author's text in brackets)	
1	'What research is needed for measuring the role and value of design?'
2	(exploration of) 'Whether and how design adds value at an individual business level, beyond that of supporting a product development role?'
3	'Research (is needed) that better understands the contribution that design makes to the UK economy, and how this compares to economies across the world?'
4	'Further academic research (needs to be) conducted to demonstrate the impact that improved environmental / urban design can have on human outcomes in health or broader well-being'

Nomen et al.'s (2012) paper is the outcome of the first work package within the EC's € Design:Measuring Design Value initiative, resulting in the definition of a series of questions and objectives to be answered by the ongoing work (*Table B.10*). Policy level Design Impact research questions& objectives (Nomen et al., 2012)

Table B.10 *European Policy level Design Impact research questions& objectives (Nomen, 2012)*

€ Design: *Measuring Design Value,* Research agenda objectives (Green's bold type)	
1	'Define the **conceptual framework** of design as an economic factor of production within user-centred innovation projects, focusing on the aspect of balance between functional, emotional, and social users needs.'
2	'Help establish **guidelines for analysing and measuring the economic impact** of design efforts and design outputs, thereby facilitating the availability of more detailed and reliable figures. The guidelines should enhance statistical analyses of design and enter the Frascati family of Manuals for R&D and Innovation.'
3	'Test early versions of the guidelines by **exploring different approaches to measuring design** and other intangible resources and capabilities.'
4	'**Improve efficiency in the dissemination of design indicators** by using available communication networks (e.g., BEDA and its Centres of Competence) and by providing a 'plug-in' or 'add-on' model to measure design inputs/impacts in innovation projects.'

Synthesis of identified design impact research agendas

Considered together, the 21 research questions posed by the four literature reviews can be synthesised to identify common themes in the gaps in design impact research. Five themes have been defined following a logical sequence from; (Theme 1), the need for a sound theoretical basis for impact analysis,through;(2) operationalisation; (3)empirical evidence; (4) dissemination, to; (5) the potential value of‘elevating’ the role of design. This synthesis of research questions to themes is represented in *Table B.11*.

1 **Need for a sound theoretical basis for design impact analysis**: All four reviews identify the need for a stronger theoretical basis. This ranges from the very broad question about what is needed to measure the role and value of design (Madano Partnership, 2012), the pragmatic need for a conceptual framework (Nomen, 2012), emphasis on the necessary multi-dimensional scope of this framework (Candi & Gemser, 2010, *Figure B.10*) and the need to understand more about ‘orientation’ or ‘emphasis’ (Noble, 2011)
2 **Need for means of operationalising design impact analysis:** Nomen et al.’s (2012) questions and work has a clear agenda, which can be traced back to Tether (2005), of producing a supplement or companion to the Frascati (OECD, 2002) and Oslo Manuals (OECD, 2005). These provide guidelines for official Europe wide data gathering on R&D and Innovation activities. Therefore incorporating design within this activity would generate significant amounts of data for analysis in various contexts. The Madano Partnership (2012) question about, ‘what is needed’, would necessarily require concepts for operationalisation.
3 **Need for Empirical evidence of design impact**: Whilst the €Design: *Measuring Design Value*work(Nomen et al., 2012) is focused on the prerequisites for gathering empirical data. Candi & Gemser’s (2010) review places particular emphasis on the need for empirical research, highlighting the need for understanding of variations of impact in; short term, long term, internal and external design investments; longitudinal study of design investment-impact circularity and the effects of contextual factors. Madano& Partnership’s (2012) recommendation for research into socio-environmental design impacts reflects broader contextual concerns and opportunities for design.
4 **Need for effective dissemination of design impact analysis**: Candi & Gemser, (2010) are interested in the ways that different stakeholders perceive design impact and how this would influence ratings of impact. This is a particularly pertinent point because it can be seen from the 30 impact studies reviewed (*Table B.6*)that the background and commissioning of the researchers strongly influences the outcomes of the research. For example making a case for government investment (Danish Design Centre, 2003), or design management (Chiva & Alegre, 2009).Gorb & Dumas’ (1987) *Silent design*concept reflects that a significant proportion of design is not recognised as design. Nomen et al,. (2012)

make the general point that research should consider how to improve the dissemination of design impact indicators.

5 **Need for building a case for integrating design in firms:** Three of the four studiespose questions which can be seen to relate directly to the idea of 'elevating' (the term used by Noble, 2011) the role of design within organisations. These can be divided into process considerations (Candi & Gemser, 2010; Noble, 2011) for example how is design integrated into innovation or NPD processes – early intervention is generally advocated (Perks, Cooper, & Jones, 2005; Ravasi & Lojacono, 2005; Veryzer & Borja de Mozota, 2005; Design Council, 2007a; Candi & Gemser, 2010). A second sub-theme is the need for better understanding of how design impact can be optimised by its *embeddedness* (Micheli, 2013; Rae, 2014)within an organisation (Candi & Gemser, 2010; Noble, 2011; Madano Partnership, 2012), a broader cultural and strategic management point. For example to overcome 'conflicts of perspective' (Candi & Gemser, 2010, p72).

Table B.11 *Synthesis of design impact research agendas from macro-economic/policy and NPD/Innovation fields*

Theme	Candi & Gemser, (2010)	Noble, (2011)	Madano Partnership, (2012)	Nomen et al. (2012)
1 Need for a sound theoretical basis for design impact analysis	Q1, Q3	Q1	Q1	Q1
2 Need for means of operationalising design impact analysis			Q1	Q2, Q3
3 Need for empirical evidence of design impact	Q4, Q7, Q8	Q2	Q3, Q4	
4 Need for effective dissemination of design impact analysis	Q2			Q4
5 Need for building a case for integrating design in firms	Q5, Q6	Q3, Q4	Q2	

B.2.4 Impact in related fields

The general scoping review of literature related to UDI identifies a number of fields or lenses through which, whilst outside the research boundaries, may provide insights into the UDI. The following fields relating to evaluating impact are significant areas of research with their own well established bodies of literature:

- Economics/econometrics – typically for considering national, international and policy level factors

- Impact assessment – usually related to social impact evaluation and policy level, or programme/project activities
- Life cycle analysis/environmental impact assessment – Increasingly adopted not only at national and policy level, but at firm and project level.
- Performance management – firm level evaluation for business functions such as sales, marketing, manufacturing, distribution etc.
- Quality Management – firm level systems for quality including evaluation of input-process-output factors. For example in a closely related field to design (human factors), Dul (2012) builds arguments for the strategic development of the human factors/ergonomics professions based on being able to more effectively articulate the added value accruing from human factors/ergonomics input. His analysis framework is relevant: a) Clarifying the benefits of human factors/ergonomics input, b) Understanding the contextual drivers, c) Understanding stakeholder categories and perspectives and d)Understanding varying views on value.

The context covered in the UK grey literature exploring design impact (ref *Table B.20*) includes recognition of the value of the creative industries to the UK economy, of which design is a part of. The DCMS report (2001) notably defines 13 sub-sectors of the creative industries. (The Work Foundation / NESTA report (2007) brings together data to substantiate the value of these sub-sectors with commentary on their potential contribution to GDP. A summary review of parallel *Understanding Impact* issues for two of the Creative Industries sub-sectors (Architecture and the built environment and Advertising services) are included here for their relevance to the design profession.

Architecture and the Built environment

MacMillan (2006) has extensively explored the context for *The Added Value of Good Design* in the built environment, identifying that the 'Pearce report' (Pearce, 2003)was the first exploration of, and call for understanding and research into, the added value of the built environment. 'in effect for the first time, a high-level, top down view of the contribution of both the construction industry and of the built environment to the national economy' (p258). However he also cites Florence Nightingale for identifying the health benefits of good lighting and ventilation in buildings. Pearce (2003) identifies four interrelated issues or areas of added value potential: 1) the flows and transactions of the industry (construction activity), 2) the building stock (the assets that comprise constructed wealth), 3) un-marketed benefits (the well-being produced by the built environment) and 4) un-marketed costs (such as pollution or the loss of aesthetic quality). MacMillan goes on to state that; 'a widely acknowledged difficulty with many of the benefits associated with good design is that they are hard to measure, or intangible' (p264) and 'Despite the body of research into the impact of good design, ...much of it was anecdotal, academic, unsorted and neither robust nor replicable. .... no common language or shared understanding, and many variables had been studied under various guises' (p265). They also noted the difficulty of measuring outcomes arising directly from design, as distinct from many other influences; '. ...at present the evidence is too diverse to provide credible value propositions or a clear foundation from which to act in a situation where investment decisions require a number of people to be persuaded.' (p265). MacMillan's work advocates a matrix approach and 'probability curve' as a way of accommodating the ranges and interrelationships of value and 'confidence levels' in available data and cites Mulgan (2005) in advocating visual value maps as a way to address these issues. Gann et al. (2003) with their work in the same sector also point out the value of visual communication citing (Tufte, 1983).

Gann et al (2003) developed the Design Quality Indicator (DQI) tool for the UK Construction Industry Council as a basis for raising quality in the sector; for example referencing the established QFD (Quality Function Deployment) method in engineering. The DQI method is intended to be used throughout the cycle of design, building and use and includes 'impact' as a dimension of the overall quality (*Figure B.11*). In their example, data is generated for the individual factors through stakeholder feedback on Likhert scales. This approach has parallels with Pugh's Total design in terms of identifying a 'resource envelope' and evaluation of a 360° set of factors, and popular radar graph presentation of Life Cycle Analysis information, eg Fussler and James (1996).

Also exploring the potential added value of design in the sector, Fuerst & McAllister, (2011) state that 'good' design *could* provide an incentive to allocate resources to design' (p167), but also ref McNeill, (2007) to report that 'the marketing weight of good design is not quantifiable' (p). In their study Fuerst & McAllister focus on the possible added value of 'signature architects' input; demonstrating through Hedonic Regression that rents might be 5-7% higher and sales 12-17% higher, but highlight a number of factors which may affect the validity of the study.

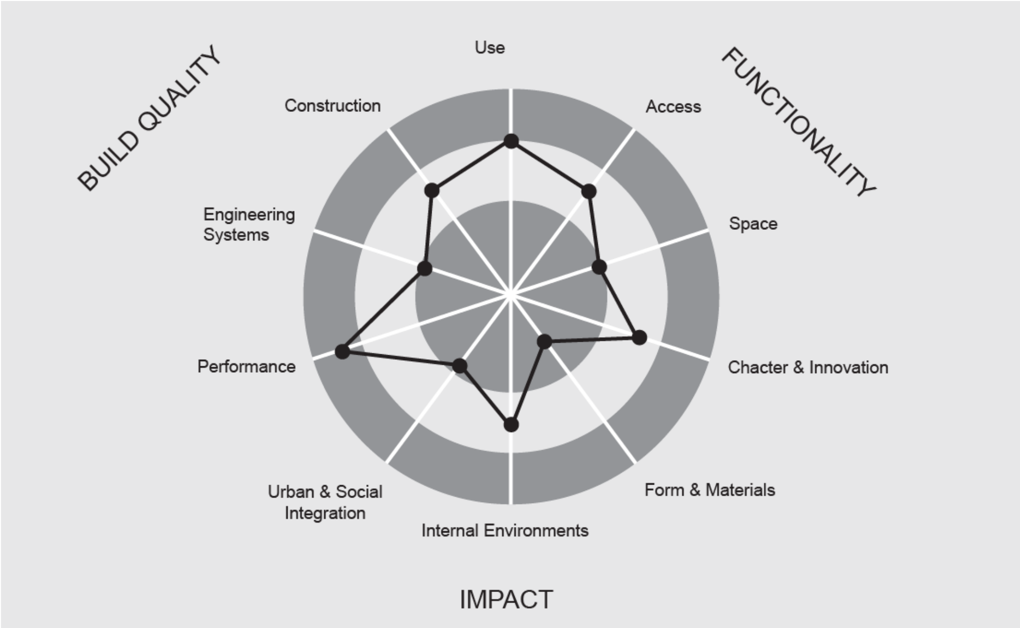


Figure B.11 *DQI for the built environment: results visualisation (Gann et al.,2003)*

Other general frameworks for evaluating impact factors in the Built environment include expressing design as a proportion of other associated costs, similar to the Design Council's RoDI ratio (ref section 2.5.4). Or BREEAM (BRE Environmental Assessment Method), claimed to be 'the leading and most widely used environmental assessment method for buildings (BRE, 2014). What all these methods aim to accommodate is the longer term impacts of design in the built environment. The longitudinal impacts are an important dimension which are perhaps overlooked in much design impact evaluation.

Advertising

The *Advertising Pays* report commissioned by the UK Advertising Association (2013)from the accountants Deloitte has the clear purpose of promoting greater investment in advertising based on providing evidence of the positive impact of advertising. As a creative industry it shares many similar issues with design, effectively summarised by the report's introduction, for example: 'Instinctively, when you work in advertising you understand its effects. Advertisers see at first-hand how it promotes competition, spurs innovation and – most importantly of all, in the current climate – connects businesses with their customers. But until now, those instincts have not been backed up with facts and consequently, I believe, advertising's potential to support growth is often overlooked' (p3). An interesting sub-text of the *Advertising Pays* report is the countering of negative stereotypes of advertising, for example that advertising unnecessarily increases consumer prices. The paper uses an econometric modeling method comparing national GDP from 17 countries over 10 years to arrive at the authors headline figures that every £1 spent on advertising leads to £6 increase in GDP. The work clearly aims to use the complexity of the economic model and the credibility of the authors (Deloitte) to provide overall authority to the claims. There is no way to assess the reliability and validity by the lay reader. However an interesting point is made about the 'virtuous circle' effects of advertising spend, (*Figure B.12*) which has similarities to Candi & Gemser's *(2010)* identification of a causality and performance feedback loop (*Figure B.10*), described in *Advertising Pays* as 'reverse causality'.

Figure B.12 *Visual communication of the 'reverse causality' of impact on GDP from advertising (Advertising Association, 2013)*

B.3 Design Process

The academic study of design process has a relatively short history (since 1962 - Bayazit, 2004). Evidenced by Dubberly's (2004) 'compendium' of 131 design process models, or Gericke & Blessing's (2011) review of 142 design process models there has been considerable ongoing activity to attempt to more accurately capture all aspects of how design activity works in reality. This research activity is not without its critics; eg Birkhofer, et al.,(2005), 'Designing is far too complex a phenomenon to be describable by a simple diagram' (Lawson, 2004 p289), 'there may never be an ideal design process' (Design Council, 2007a) and the suggestion that there is no single design process model which provides a satisfactory description of design process (Clarkson & Eckert, 2005).

Design process models are highly edited and rationalised abstractions of reality. In the context of this study it is necessary to consider whether this rationalisation overlooks factors – part of the complexity of design - which may be significant in determining design impact. For example accommodating factors within emerging design disciplines such as service design or UX/UI design, or the influence of content, actors and context (Dorst, 2008). In the broader field of Innovation, investigation into the added value of practitioners (designers) within innovation practice is relatively recent (Patterson et al, 2009). This is in contrast to popular presentation of the subject of design within the media and by designers themselves, which often puts the individual highest, or very high, in a hierarchy of factors impacting design success. Likewise, experience, which is widely recognised in many fields, receives less attention with the exception of the distinction between novices and experienced practitioners in a number of studies. NESTA (2007) also identifies the distinction between policy levelthe factors and firm level factors. Within the UK, much of the work by the national design and related bodies is concentrated on exploring the measurement and impact of design from a policy level perspective (eg Cox, 2005, Design Council, 2007b, Tether, 2009). Whereas this overall study is exploring a bottom up-approach, deconstructing the practice of design at project and process level to understand the ingredients of design impact at firm level.

B.3.1 Design Process and Design Research Co-evolution

In parallel with the broader field of NPD and innovation - with a wide range of studies exploring the relationships between *process* and success or failure, (Brown & Eisenhardt, 1995) much design process research is grounded in the exploration of deriving added economic value (Blessing & Chakrabarti, 2009, p2-4), but these design process models are in a state of flux and can be viewed as partial models. There will be factors, emerging or otherwise, which are not accommodated. Logically, only the aspects covered by these models might be enhanced as a result. The overall UDI study is concerned with exploring and understanding *all* factors which may influence design impact. Clearly each study, model or concept cited has started with a different research objective to this study. However, as a basis for identifying a comprehensive range of factors which may influence design impact the field of design process studies has been at the heart of most design research. This can be traced back to Bruce Archer's *Introduction to Design* in 1962 and the *Conference on Design Methods* in 1963 (Bayazit, 2004)

B.3.2 Reviews of Design processes and Design process literature

Rationalising 40 years of design process research and generic NPD practice with objectives of enhancing design effectiveness, the Design Council's study (2007a) recommended the four stage Double Diamond model with particular emphasis on early 'Discovery' stages, paralleling concepts of the 'Fuzzy Front End' (FFE) or the 'Front End of Innovation' (FEI), together with NDP (Koen et al, 2001)& stage-gate process (Cooper, 1988). From innovation practice Baxter (1995) defines a 'risk management funnel', also referred to as the Development Funnel (Wheelwright & Clark, 1992) demonstrating how design process models can be incorporated into broader *Input-Process-Output* models, derived from studies demonstrating the importance of market orientation and early planning (*Input*) to success factors in NPD (Baxter, 1995).

Wynn and Clarkson's (2005) review proposed a creative-to-engineering process typology (ref *Figure B.13*) highlighting that the systematic, engineering end of the spectrum - typified by the seminal work of Pahl & Beitz(1995) has greater 'suitability for process improvement'. Howard et al.'s (2008) design process literature review (*Table B.12*) also recognise this spectrum with identification of a 'routine path' and a 'creative path', but highlighting the importance of creativity to economic success (p160, also ref Cox, 2005).

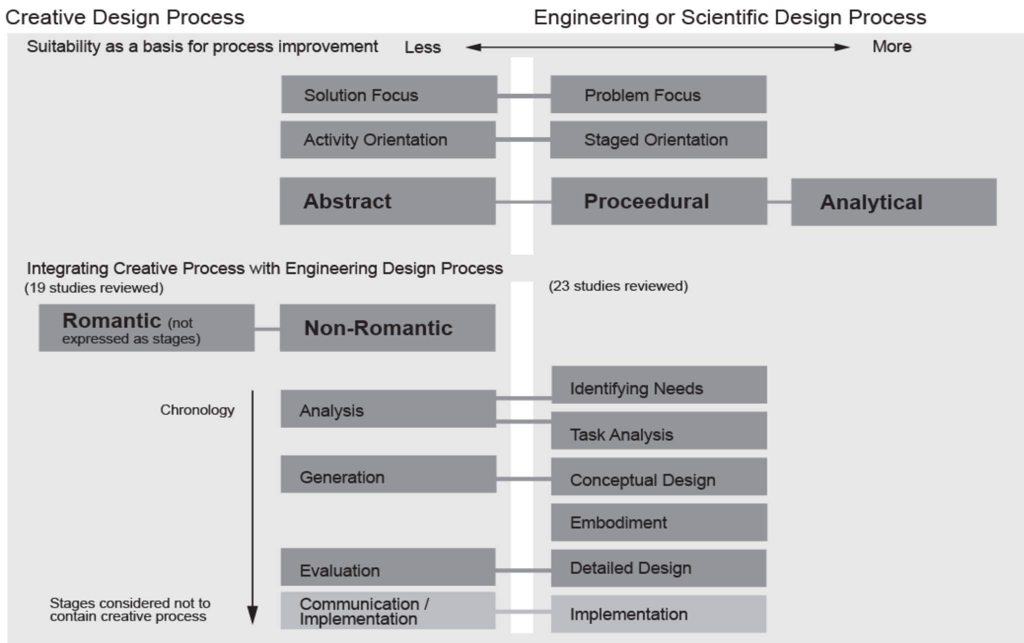


Figure B.13 *Categorisation of Design process models as a basis for process improvement derived from Wynn and Clarkson (2005) and Mapping Creative Process to Engineering Design Process derived from Howard et al.(2008)*

Table B.12 *Comparison of engineering design process models (Howard et al., 2008)*

Models	Establishing a need phase	Analysis of task phase	Conceptual design phase	Embodiment design phase	Detailed design phase	Implementation phase
Booz et al. (1967)		New Product Strategy Development	Idea generation / Screen & evaluation	Business analysis / Development	Testing	Commercialisation
Archer (1968)		Program-ming / Data collection	Analysis / Synthesis	Development	Communication	
Svensson (1974)	Need		Concepts / Verification	Decisions		Manufacture
Wilson (1980)	Societal need	Recognise & formalise / FR's & constraints	Ideate & create	Analyse and/or test	Product, prototype, process	
Urban and Hauser (1980)	Opportunity identification	Design		Testing		Introduction (launch) / Life cycle management
VDI-2222 (1982)		Planning	Conceptual design	Embodiment design	Detail design	
Hubka and Eder (1982)			Conceptual design	Lay-out design	Detail design	
Crawford (1984)		Strategic planning	Concept generation	Pre-technical evaluation	Technical development	Commercialisation
Pahl and Beitz (1984)	Task	Clarification of task	Conceptual design	Embodiment design	Detail design	
French (1985)	Need	Analysis of problem	Conceptual design	Embodiment of schemes	Detailing	
Ray (1985)	Recognise problem	Exploration of problem / Define problem	Search for alternative proposals	Predict outcome / Test for alternatives	Judge alternatives / Specify solution	Implement
Cooper (1986)	Ideation	Preliminary investigation	Detailed investigation	Development / Testing & validation		Full production & market launch
Andreasen and Hein (1987)	Recognition of need	Investigation of need	Product principle	Product design		Excecution
Pugh (1991)	Market	Specification	Concept design		Detail design	Manufacture / Sell
Hales (1993)	Idea, need, proposal, brief	Task clarification	Conceptual design	Embodiment design	Detail design	
Baxter (1995)	Assess innovation opportunity	Possible products	Possible concepts	Possible embodiments	Possible details	New Product
Ulrich and Eppinger (1995)		Strategic planning	Concept development	System-level design	Detail design	Testing & refinement / Production ramp-up
Ullman (1997)	Identify needs / Plan design process	Develop engineering solutions	Develop concept	Develop product		
BS7000 (1997)	Concept	Feasibility	Implementation (or realisation)			Termination
Black (1999)	Brief/concept	Review of 'state of the art'	Synthesis / Inspiration	Experiment-ation / Analysis/ reflection	Synthesis / Decisions - constraints	Output
Cross (2000)		Exploration	Generation	Evaluation	Communication	
Design Council (2006)	Discover	Define	Develop	Deliver		
Industrial Innovation Process 2006	Mission statement	Market research	Ideas phase	Concept phase	Feasibility phase	Pre-production

Newman's design process 'Squiggle'(2006, ref *Figure B.14*) perhaps best represents the more creative end of Wynn & Clarkson's spectrum. Pugh's *Total Design* model (1990) adds an envelope to the design process; identifying 34 categories of *input* factors. Howard et al.,(2008), state '*process* and *output* have not been linked theoretically or empirically' (p175 – authors' italics). Also responding to criticisms that exploration of design process 'maps' tend to be 'theoretical and prescriptive', 'logical and systematic', Lawson (2004) asserts - based on empirical research - that there is a disconnect between design theoreticians models and the actual practice of designers. He identifies the 'the Primary Generator', from research by Darke (1979),as a better reflection of actual practice. More recently Birkhofer et al. (2011) question the practical value of design process research; 'Industry only reluctantly adapts design methodological models and methods' (p1, citing Pahl and Beitz 1995) and 'Design methodology has achieved impressive success in research and teaching while support of it for design practice is weak and its successes there have to be judged conservatively' (p2)

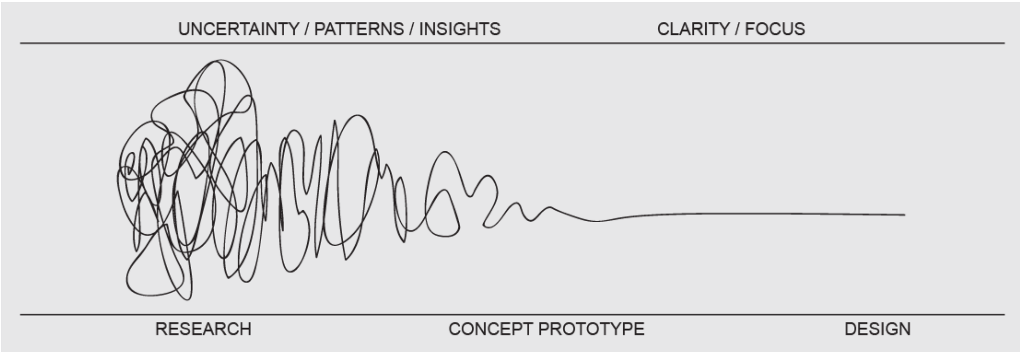


Figure B.14 *The Design Process 'Squiggle' (Newman, 2006)*

Concepts of transformation and creativity are consistent themes within the 40 years-plus of design research (Bayazit, 2004). Creative process can be described with a generally accepted three element model of: *Analysis, Generation* and *Evaluation* (Howard etal., 2008, p168). Howard et al.'s paper goes on to identify that whilst the creative process can be mapped onto a typical engineering design process (*Figure B.13*), process models do not address the *level* of creativity embodied, citing classifications such as; *Original, Adaptive, Varient* (Pahl & Beitz,1995) and their own distinction between routine paths, and creative paths.

As indicated by Gericke & Blessing's (2011) review of 142 design processes from 9 discipline areas (ref selection of 82 shown in *Table B.13*), studies of design process can predominantly be found in the Engineering Design field – the analytical end of Wynn & Clarkson's spectrum. However their study is based on the principle that as the design profession evolves to operate in many more fields, it is informative to understand the correlations between design process in varying fields. With reference to *Table B.13*, it is worth pointing out that even beyond the design engineering field, process and sequentially based models predominate.

Table B.13 *Categorisation and overview of analysed process models (Gericke & Blessing, 2011)*

Design Discipline		Type of support			Stage / Activity based				Solution / Problem orientation				Design / Project focused				Form			
	Number of analysed models	Process models	Design Methods	Management methods	Stage based	Activity based	Combined	Not clear	Solution orientated	Problem orientated	Not applicable	Not clear	Design focused	Project focused	Combined	Not clear	Sequential/waterfall	Spiral	V	Other
Mechanical Engineering	39	39	28	8	26	6	7	0	13	22	1	2	30	6	2	0	33	3	0	3
Industrial Design	1	1	1	0	1	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0

Design Discipline		Type of support			Stage / Activity based				Solution / Problem orientation				Design / Project focused				Form			
Systems Engineering	5	5	1	4	0	0	5	0	0	4	0	1	0	5	0	0	3	1	0	1
Building Design (Architecture/civil eng)	10	10	3	2	3	6	1	1	6	2	1	1	7	3	0	0	8	0	0	2
Software Design	5	5	2	1	4	0	1	0	1	4	0	0	1	2	1	0	1	1	1	1
Service Engineering	8	8	0	1	8	0	0	0	1	4	0	3	2	6	0	0	7	0	0	1
Mechatronics	6	6	0	0	3	0	3	0	2	4	0	0	3	3	0	0	2	1	2	1
Product Service Systems	5	5	1	1	5	0	0	0	0	4	1	0	0	3	0	0	4	0	1	0
Transdisciplinary Approaches	3	3	2	0	0	2	1	0	0	3	0	0	3	0	0	0	3	0	0	0
Total	82	82	38	17	50	14	18	1	23	48	3	7	47	28	3	0	62	6	4	9

B.3.3 What's missing from current Design process models?

Continuing the theme that existing models do not adequately reflect all relevant factors (eg Lawson, 2004), Blackwell et al. (2009) employed a phenomenological approach to identify three themes which are typically not encompassed within conventional design process research. Firstly, issues around defining being a 'good designer' - secondly, issues around the relationships between designers, customers and end users - and thirdly, issues around the structures and sustainability of design professions. Dykes et al (2009) propose a new framework to accommodate collaborative practice (eg as a basis to explore Blackwell et al.'s second point). Alexiou et al. (2010) approaches these types of complexity factors via the academic domain of complexity science; underlining what he describes as the 'computationally irreducible' nature of design process. Doblin's (1987) model identifies three levels of design project complexity: products, uni-systems and multi-systems in a matrix with performance design (usually functional-technical) and appearance design (where appearance is a significant element), resulting in a classification of six project types. Philips Electronics, in response to recognition of greater complexity in design (Kyffin, 2009)and the business imperative of managing innovation, have also created a matrix model. Their X axis includes the concept of three horizons of innovation derived from the Gartner hype cycle, whilst the Y axis includes three aspects of value: *communicating* value, *developing* value and *identifying* value. Each intersection on the matrix thus represents types of design activity which can be enhanced to maximise the potential for innovation. The *communicating* and *identifying* value factors also relate to Howard et al.’s(2008) identification of - but limited understanding of *-information* within various stages of the process-creativity-output matrix (p177).

Gericke & Blessing (2011) summarise that; ‘Process models are not correct representations of reality; they need interpretation' and 'A generic applicable approach does not exist - process models need (context dependent) adaptation'. They conclude their review with a summary of the gaps identified from their study (SG’s italics):

- ‘Current approaches focus on original design, despite the majority of design tasks are based on existing designs’. (*rather than adaptive or variant design-Input issue*)
- ‘Current approaches focus on development projects initiated by market pull. Technology push as an alternative impulse for product development is not appropriately considered’. (*Input issue*)
- ‘Current approaches focus usually either on design or on management. Both aspects have to be considered in order to provide an improved support. Current approaches do not explain how to perform design activities’ (*only what to do - Design Management issue*)
- ‘Current approaches do not explain the rationale of the proposed’ processes. (*Epistemological issue*)
- ‘The creative process is not sufficiently represented in current approaches’. (Process issue)
- ‘Transdisciplinary team-work is not sufficiently supported by current approaches. *(Context issue -‘*only few models show parallel activities of different stakeholders in order to highlight' (p9)
- 'That design is not executed as an isolated process'
- ‘Goal iteration is not sufficiently considered in current approaches’. *(Process Issue)*
- ‘A pattern found in different disciplines is that knowledge about problem and solution emerges together (Co-Evolution). So far this is not appropriately represented in current approaches’. *(Process Issue)*

B.4 The Role of Design

As shown in the section reviewing studies of design impact, the nature of the role of design within business highlighted in terms such as *Orientation* (Black& Baker, 1987) appears to be significant. This section explores this relationship between design activity and working context from two perspectives; firstly the overarching evolution of the professional activity of design – from craft to design thinking, and secondly through an initial ‘Six Ws’ based taxonomy.

B.4.1 From craft to design-thinking

Many design researchers have framed their studies in relation to the evolution of design in a broad sense (eg Borja de Mozota & Kim, 2009). However Tether (2005) cites lack of a clear definition of design as a major cause for under reporting the role or significance of design in creating impact. He also links this to questions of who is designing; professional designers or non designers etc together grouped under the heading of *Silent Design* (Gorb & Dumas, 1987). ‘There seems...to be considerable confusion about the role of design and designers. In part design overlaps with product development (and the development aspects of R&D), but it also overlaps with marketing, and seems to involve activities beyond R&D and marketing.’ (Tether, 2005, p20)

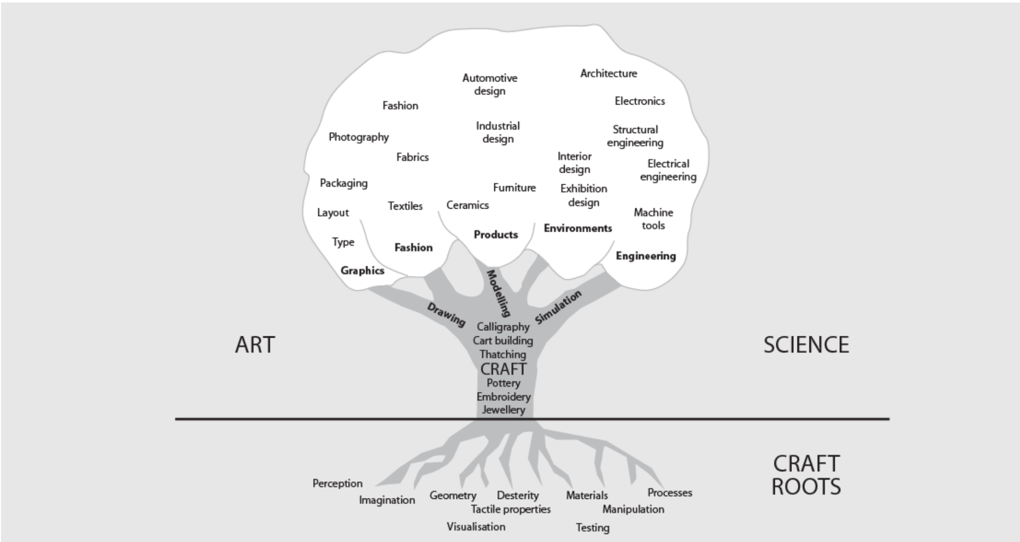


Figure B.15 *The Design Family Tree (Walker, 1989)*

Cooper et al (1995) use an illustration by Walker (*FigureB.15*) to graphically illustrate the craft roots of design growing out to specific design disciplines of graphic design, industrial design etc. Jump forward to the 20th Century and Jones and Van Patter’s (2009) four step evolution of design(*FigureB.16*) described as design 1.0, 2.0, 3.0, 4.0, emphasises an increasing ‘complexity scale’ for professional design activity. Borja de Mozota & Kim’s (2009) chronology (*Table B.14*) shows a shift from a product emphasis, through a process emphasis to a contemporary recognition of the importance of leadership and design thinking.

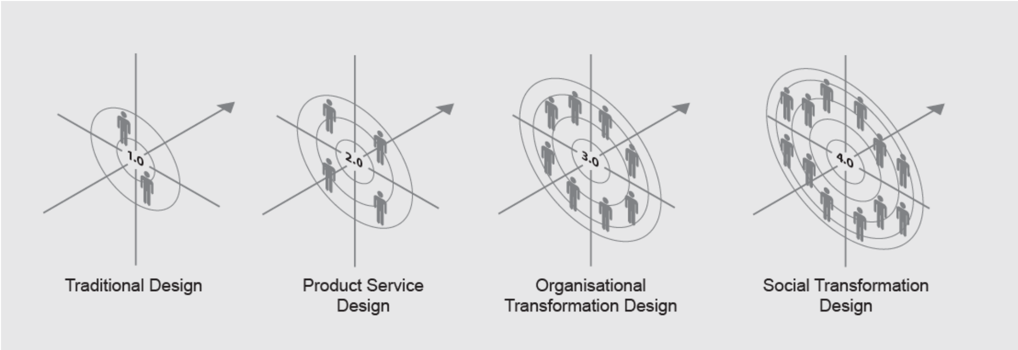


Figure B.16 *Design evolution and complexity scale derived from Jones and VanPatter, (2009)*

Therefore the manner in which design is studied and reported in design impact literature has evolved from the 'traditional' ideas of design contributing primarily to visual aesthetics, ergonomic and production efficiency concerns, (Walsh & Roy, 1985) to a broader recognition of the importance of 'customer centred' approaches (Micheli, 2013). Emphasis on Design process and management of design emerged from the 1980s onwards and this has continued to evolve to a new level of *embeddedness* (Micheli, 2013; Rae, 2014)or Integration (Borja de Mozota, 2003) combined with an expanding range of specialisms and methods to tackle these opportunities for design added value. However the design profession has not necessarily evolved in pace with the contexts they work in. For example:'Traditionally what designers lack in knowledge, they make up for in craft skills. Whether it be sketching, modelling, detailing or rendering, designers take an inordinate amount of pride in honing key techniques over many years. Unfortunately many of these very skills have limited use in the new design domains' (McCullagh, 2010) or: 'I read outrageous claims made by designers who have little understanding of the complexity of the problems they are attempting to solve or of the standards of evidence required to make claims' (Norman, 2010).

Table B.14 *Historical development of design and design management (Borja de Mozota & Kim, 2009)*

Period	Main Perspective: Design as -	Design Role	Design Management focus	Cases
1940s to 1950s	Function	Product Quality	None	AEG, Olivetti
1960s to 1970s	Style	Quality communication	Project management	Alessi, Braun
1980s to 1990s	Process	Innovation	NPD/Innovation management	Philips, Sony
1990s to 2000s	Leadership	Creativity strategy	Brand	Apple
2000 onwards	Thinking	New Business model	Creative organisation	IDEO

Borja de Mozota & Kim (2009) suggest the 'main perspective' of design evolves each decade from the 1980s -process, through 1990s -leadership to 2000s - thinking. Each decade with a corresponding design role and design management focus. This could be considered an oversimplification. For example *process* remains a fundamental component, even if it is no longer a 'mainperspective', it remains core to the emerging contemporary scene (Gerike & Blessing, 2012).

Innovation and Design

Schumpeter (1934) is universally cited as the originator of thinking on the economic importance of innovation. Tether (2005) reports that: 'the literature on innovation mainly concerns technological innovation, that is innovations which involve advancing the technical or technological frontier (of the firm, industry or country), and which therefore involve technical or technological novelty. But many if not most innovations do not involve technical novelty, and are instead based on novel designs or concepts'(p8). Tether cites examples of the mountain bike, Sony Walkman and iPod. In this vien; Multu and Er (2003); Verganti (2003) and Utterback et al,.(2006) build a case for 'design-driven innovation' (Verganti, 2003) and the idea of Design-push rather than technology-push and market-pull concepts. His model (*Figure B.17*) shows innovation can be technology led, but also led by changes in, or generation of new, 'meanings' (symbolic messages).

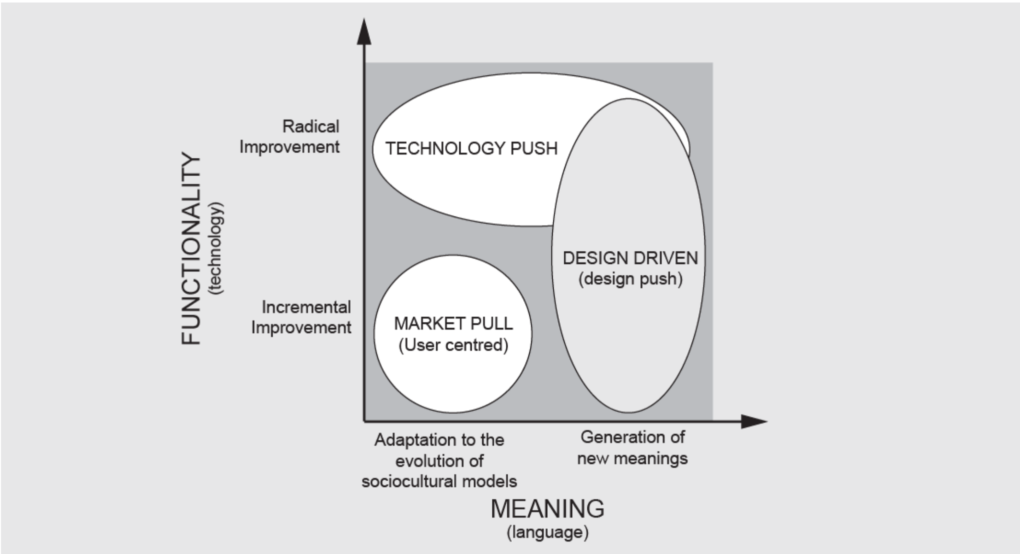


Figure B.17 *Verganti's (2003) model of design-driven innovation*

NPD and Innovation research fieldsare separate but related to design,linked by an interest in process and success factors. The 'design-driven innovation' concept has gained considerable momentum based on the increasingly recognised importance of innovation within organisations and the success of 'design-driven' innovative companies (eg as shown on the DMI Design Value Index, Westcott et al., 2013).

HoweverCandi and Gemser (2010) and Noble (2011) suggest the need for better understanding of the role of design within innovation practice and; 'relatively few studies have used large scale quantitative data to explore the impact of radical innovation on firms' performance' (Therrien et al., 2011, p655). Kootstra (2009) comments; 'How does design management impact on innovation? This last question is a pertinent one as the European policy agenda explicitly links design management to innovation management. The relationship between these two fields is, however, still a rather vague one.' (p16)

Experience design (service, system, UX/UI, participatory design)& Design thinking
The question of how emerging design disciplines (such as service design) can, or cannot, be mapped onto theoretical models is raised (eg Candi & Gemser (2010), *Figure B.10*). Kimble (2009) adds three more emerging specialisms; 'At the close of the 20th century and beginning of the 21st, the already busy category of design saw several new fields emerge, entangled in different ways with the development of new information and communications technologies (ICT) and with the changing role of design in organisational life. Interaction design, experience design, service design and transformation design, to name four' (p157).

Similarly to these four emerging specialisms, Design thinking (Buchanan, 1992), is an area of professional practice which is attracting considerable attention for its potential to create impact. However at this point, no empirical study of design impact has the explicit objective or related methodology to analyse the impact of Design thinking. A number of the eight adding value factors identified in Rae's 2014) study correlate closely with emerging specialisms within design practice (ref *Table B.15*)

B.4.2 Six W's taxonomy of factors influencing impact

Concepts of design intensity, emphasis and related terms emerge as significant to design impact from work by; Black & Baker (1987); Hise et al., (1989) Candi & Gemser (2010, Candi, (2010), Candi & Saemundsson (2011)

Micheli (2013) reports that in addition to the overall intensity or emphasis of design input in business, impact is also influenced by an equivalent 'ladder' of roles for individual designers as they gain experience and develop their careers as follows:

- Technical specialists with functional expertise
- Members of cross-functional teams – capable of using and understanding different languages and perspectives
- Influencers who champion the value of design internally and externally

- Leaders capable of articulating visions: not just products / services, but also concepts and future states.

Kotler & Rath (1984) are frequently cited for the idea that design can contribute to differentiating a company, product or service in a competitive environment and therefore create design impact. Differentiation is one example of a number of value adding factors of design identified by researchers in more recent overviews of design impact on performance (eg Rae, 2014, Micheli, 2013).

These significant design impact factors (intensity, roles, value adding qualities) can be considered responses to questions about the role of design; 1)WHY invest in, or use design? 2) HOW does design create impact? 3)WHERE and WHEN is designcarried out which adds value? 4) Related directly to the activity of design; WHO does the designing which adds value, WHAT design specialism is deployed and HOW is it carried out to add value? This taxonomy is explored and populated with existing models, theories and research , as shown in *Table B.17*.

WHY invest in design?

Dating back to 1987 (Black & Baker) correlations between design intensity or emphasis and economic successhave been demonstrated in a number of studies (ref *TableB.6*). Micheli's (2013) study builds on this and defines three general reasons WHY to invest in design; a) 'Design is customer-centred' and considers the whole system, b) 'Design is most powerful when culturally embedded' - three levels are indicated, correlating with the higher levels of the 'Danish Ladder' (the Danish Design Centre, 2003)or the'Design Management Staircase' (Kootstra, 2009);and c)'Design can add value to any organisation'. eg: 'opening up' market opportunities, differentiating products and services, strengthening brands, facilitating internal process improvements, sales growth and market share uplifts, cost reductions/efficiencies, increased customer satisfaction, greater product consistency.

Kotler & Rath (1984) and Zec, (2011) point out that design can differentiate, and influence consumer choice in markets where there is limited technological innovation.

However Micheli (2013) reports the; 'the paradox of quantifying (design) benefits upfront' and that; 'No company in our sample has a robust method for assessing design's impact on performance', and thata number of his sample emphasised the;'necessity for top management to trust, at least to some extent, the value of design and the work of designers.' (p7)

In more recent work Rae (2014) deconstructs the economic success of 14 'design-centric' companies on a 'Design Index' to define, in this case, eight 'ways design can be used as a strategic business tool to increase sales and market share, as well as build wider margins and drive customer delight.' (p37)

Rae's survey adopts the approaches used by Hertenstein (2001) and the Design Council (2005a) of comparing publicly listed 'Design centric' companies with the average performance of the market. In this case Rae's sample outperforms the average by 228% over a ten year period.

Rae comments that; 'What constitutes good design can be viewed as highly subjective' (p32). To counter this, six criteria are used as a basis for selecting the 14 companies on the index.

a) Publically traded for 10 years (eg data available and continuity (Zec, 2011) exists)
b) Design is integral (eg operating at the highest levels of intensity; Danish Design Centre, 2003; Kootstra, 2009; and capability; Swan et al, 2005; Candi & Gemser, 2010)
c) Design investment rising (eg Causality and Performance feedback, Candi & Gemser, 2010)
d) Evidence of embedded design. Eg not Silent Design (Gorb & Dumas, 1987)
e) Design Leadership is present at senior levels (Topalain, 2011; Miller & Moultrie, 2013a and 2013b)
f) There is senior level commitment to design as an innovation resource and integrative force (eg recognition by senior management of design-led innovation (von Stamm, 2011)

Rae's eight identified areas for adding design value, described as 'The Power of Design', reflect the evolution of the design profession and related emerging specialisms and methods:

1 The Wow factor (Rae's definition spans functional & aesthetic benefits and appeal over time – brand values?)
2 Brand Expression (eg design consistency over multiple touchpoints)
3 Solving unmet user needs (eg through design research rather than conventional market research)
4 Developing better customer experiences (eg experience, service or brand design principles)
5 Rethinking strategy (eg design thinking and design management approaches)

6 Hardware – Software – Service integration (eg UX/UI design)
7 Market expansion through persona development and user understanding (eg Human Centred Design methods)
8 Cost Reduction

Even more succinct than Rae's (2014) 'Power of Design' is Visocky O'Grady &Visocky O'Gradys' (2013) 'Design Currency' with a similar motivation to emphasise the potential impact of design input.

*Table B.15*Demonstrates the identification of –WHY invest in design –evolving over the period for which impact studies have been carried out. Terminology changes, but a core of three main value adding areas are clear: Cost benefits, user benefits and integration benefits

Unusually for impact studies, Trueman & Jobber (1998) place the value adding factors identified in their study into a hierarchy illustrated in the form of a four level pyramid with *Value* placed at the top, followed by *Image*, *Process* and *Production*. Part of the methodology of this relatively early study, was to ask participants to envisage their responses in the future (year 2000 and beyond). This revealed recognition of the increasing importance of design, and the resulting categorisation has some correlations with the concepts of more comprehensive embeddedness of design identified later by Borja de Mozota (2003) with the term *Integration*, and Rae (2014) with *Embeddedness*.

Table B.15 *Evolving and diverse approaches to defining HOW design adds value*

<table>
<tr><th>Walsh & Roy (1985)</th><th colspan="2">Walsh et al. (1992, p82)</th><th colspan="2">Trueman & Jobber (1998)</th><th>Micheli (2013)</th><th>Rae (2014)</th></tr>
<tr><td>Production efficiency</td><td>Price</td><td>Manufacturing & life cycle costs</td><td rowspan="8">1 Value (Quality, meeting customer expectations)</td><td>4 Production</td><td></td><td>Cost Reduction</td></tr>
<tr><td>Visual Aesthetics</td><td rowspan="4">Non-Price (product)</td><td rowspan="4">Product specification & quality (inc appearance & function)</td><td rowspan="5">2 Image (Product, branding and promotion)</td><td rowspan="6">Customer centred</td><td>Solving unmet user needs</td></tr>
<tr><td>Ergonomics</td><td>HCD approaches</td></tr>
<tr><td>Durability</td><td rowspan="2">UX/UI approaches</td></tr>
<tr><td>Safety</td></tr>
<tr><td rowspan="2">Market appeal</td><td rowspan="2">Non-Price (service)</td><td>Company image and promotion</td><td>Brand Expression</td></tr>
<tr><td>Delivery & after sales service</td><td></td><td>Customer experiences</td></tr>
<tr><td>Co-ordination</td><td colspan="2"></td><td>3 Process (integration, teamwork etc)</td><td>Culturally embedded</td><td>Design Centricity</td></tr>
</table>

				Adds value to any organisation	The Wow factor
					Rethinking strategy

How does design create impact?

Correlation between design *Emphasis* and business success was observed as early as 1983 by Roy and Walsh identifying ‘Design Conscious’ companies (Walsh et al., 1992) this quality is described as;*Orientation* (Black& Baker, 1987),*Effectiveness* in Hertenstein’s early study (2001), *Intensity* by Gemser & Leenders (2001) and *Emphasis*as a category to encompass the concept in Candi & Gemser’s literature review (2010).Taking this concept further *Integration* is used by Borja de Mozota, (2003) and *Embeddedness* by Rae, (2014).

Black & Baker (1987) hypothesised that design *Orientation* should be measured by ‘design *Participation*’. The Danish Design Centre’s (2003) study acknowledged the *Orientation – Effectiveness - Intensity* factors in earlier studies and gathered data on levels of participation based on a metaphorical ladder. The ‘Danish Design Ladder’ has subsequently become a frequently cited reference for these factors. The authors of the survey conclude; ‘All findings of the analysis indicate a very clear correlation between the employment of design and the economic success businesses achieve, which in turn benefits society as a whole. The correlation is so marked that it cannot be disregarded or questioned. The correlation is especially marked for companies that adopt a comprehensive approach to design.’ (p35). The four steps of *Intensity* on the ladder are described as follows:

- ‘Step 1:*No use of design*. In these companies, design is a hidden aspect of product development. It is generally the task of non-design disciplines to develop the functionality and aesthetics of a product.’
- ‘Step 2:*Design as styling*. Design is seen as the final styling of a product. The task may or may not be undertaken by professionaldesigners.’
- ‘Step 3:*Design as process*. Design is not an end result, but rather a work method adopted at an early stage of product development and requiring the involvement of several different disciplines, including design.’
- ‘Step 4:*Design as strategy*. Design has been adopted as a central aspect of the company’s business base, used as a means of encouraging innovation, for instance.’(Ramlau, 2004)

The Danish Design Ladder concept has subsequently been adopted by Design Management Europe as a basis for evaluating design intensity in relation to design management (Kootstra, 2009). Since the emergence of 'Design management' as a discrete area of design activity in 1964 (Cooper et al., 2011), it has shared similar issues to the wider design profession in communicating the added value of design; 'companies are not convinced of design management's ability to generate added value. Despite the fact that investing in design can indeed provide great benefit. Apart from costs, knowledge factors and cultural factors are also listed as stumbling blocks. A culture change can be brought about by convincing companies of the added value of design' (Kootstra, 2009, p54). In this context Kootstra comments on the lack of any agreed model for evaluating design management capability in companies; 'Close scrutiny of literature on the subject has confirmed that a validated model for this purpose is still lacking, albeit that there have indeed been initiatives to devise such a model (Kootstra, 2009, p12, citing Hayes, 1990; Olson et al., 2000; Borja de Mozota, 2002; Danish Design Centre, 2003; Summers, 2000;Moultrie & Frazer, 2004 as examples of work to build models). Kootstra's (2009) Design Management Staircase (*Figure B.18*) retains, but redefines the four steps of the Danish Design Ladder and adds a third dimension of five additional factors, creating a matrix for auditing and evaluation not dissimilar to the Gorb & Dumas (1987) matrices.

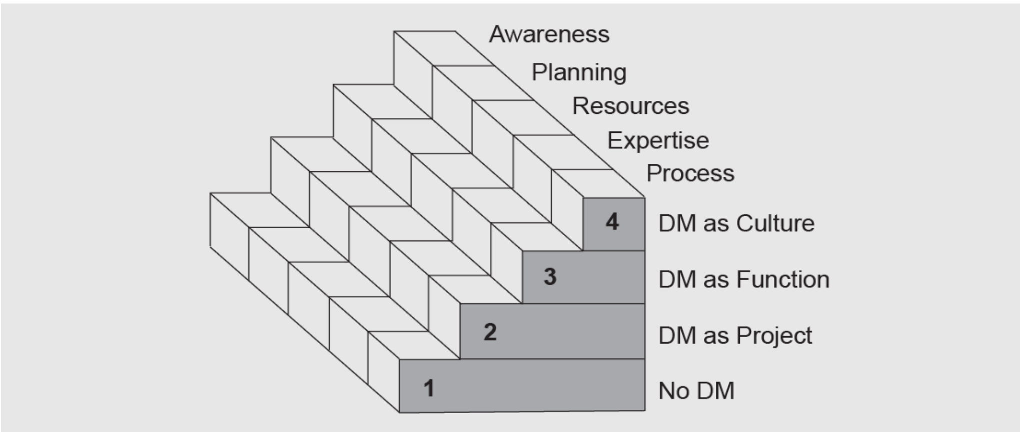


Figure B.18 *Design Management Staircase, (Kootstra, 2009)*

Concurring with earlier surveys the general results indicate stronger performance the higher the company is on the staircase, but; 'causal links have yet to be determined. While design possibly breeds success, it could also be that more successful companies tend to invest more heavily in design – and with that develop greater capability for the effective management of design.' (Kootstra, 2009, p53)

Zec (2011) identifies *Design continuity* and *Design Strength* as two qualities inherent in the success of companies such as Apple. We can consider Design *Strength* as a synonymfor *Effectiveness, Intensity* and *Emphasis.* But *Design continuity* suggests an additional time based dimension affecting impact. Zec defines *Design Value*as the intangible asset which can, using examples such as Apple and Mazda, transform the performance of companies. He suggests the elements of Design Value can be expressed as:

$$\text{Design value} = [\text{Design revenue} \times (\text{Design strength} + \text{Design continuity})] + \text{Design assets}$$

In this formula Zec suggests that *Design revenue* is based on Earnings before Interest and Tax (EBIT), eg for comparisons of performance between companies within a sector. Design Strength and Design Continuity are, in his case, evaluated based on performance in the Red Dot award scheme. He doesn't provide further detail on this, but there are parallels with the methodologies ofHertenstein (2005), Candi (2010), Kristensen & Gabrielsen (2010) and others, of using an expert panel of designers to determine values for *Design Strength* and *Design Continuity.* The Design Continuity, time based concept is important for aiming to capture the relative sustainability of design or a company's ability to benefit from design over a significant period. Zec suggests 10 years for assessing *Continuity* and 5 years for *Strength*.

Where and When does design add value?

Existing studies of design impact are typically based on firm level data and have considered how design affects performance in individual sectors, across multiple sectors and different scales of company. Refer to *Table B.6* for a complete overview of sectors and scales. Borja de Mozota (2003) provides a broader overview of perspectives for considering design impact. For example from a Government design policy level (eg Roy & Potter, 1993; Danish Design Centre, 2003; Design Council, 2005a); the Design Profession level (eg Dawton, 2011); National economies (eg Moultie, 2009) and impact on exports (eg Rothwell & Gardiner, 1984; Design Council 2012). These varying perspectives are also evident in the need to communicate design impact explored in section 2.4.3

It has been argued that studying design within a single sector benefits the issue of delimiting design, such as Chiva & Algre's (2009) study of companies in the Spanish ceramic tile industry. At the other end of the spectrum, Livesey and Moultrie (2008) have taken a relatively large sample of 358 companies and extrapolated the results using national company sector data to generate design spend figures for the whole of the UK (*Figure B.6*). Understanding how the sector or market context has affected design impact has clearly not been a significant consideration in many surveys, and the effects have been implicit rather than explicit. Swan et al. (2005) did explore *Speed to Market* as a factor together with the appropriateness of *Robust* versus *Lean* design in a market context. More recently, Talke et al. (2009) in the car industry, and Candi & Saemundsen (2011) in service design sectors have explicitly explored how design impact might vary according to where NPD fits within an industry wide - product lifecycle. Talke et al (2009) use the term *Design Newness* as a metric for this quality and further explore the relative impacts of *Design Newness* compared to *Technical Newness* and combined *Design and Technical Newness.* Candi & Saemundsen's (2011) research concludes that design impact is conditional on the level of Commoditization of the industry/product sector, and uses Christiansen's (1997) 'phases of competition' model as a basis for evaluating these factors.

These studies of contextual factors are judged to, at best, only provide a partial understanding of these influences on impact.

Design Activity: Who, What & How?

Although Candi and Gemser (2010) group a number of studies together within an ACTIVITY focused category, this is a very broad category which includes some of the most significant aspects design research of the past 40 years. For the purposes of this literature review the ACTIVITY category is further subdivided into WHO, WHAT and HOW sub-categories. HOWas an activity, is differentiated from 'HOWdoes design create impact', by its meta-philosophical hierarchical positioning (Love, 2000) (See section 2.2 for discussion of meta-philosophical hierarchies).

WHO does the designing which creates impact?

Gorb and Dumas (1987) in their highly cited research identified *Silent Design* as a phenomenon describing the considerable amounts of what can broadly be described as design activity, but which is not being recognised as design, and therefore potentially undervaluing the impact of design. Roy & Potter's 1993 research measures the amount of silent design activity in his sample (32%). Gemser and Leenders (2001) limit their results to work carried out by 'Professional Design Expertise' (which could be internal or external). Significantly, Tether (2005) explores the need to clarify the relationships between Silent Design and Professional Design expertise as a basis for delimiting design for the purposes of impact evaluation (*Figure B.3*). There is an implicit relationship between WHO designs and WHAT design specialism is being studied, and therefore complexity is created by the wide range of definitions of design specialism available. However a significant dimension which does not appear prominently in design impact studies, is the level of expertise of the design activity, although this is a significant research area in the broader field of design and innovation research. For example design leadership skills (Topalian, 2011) or novice versus expert design (Cross, 2004). Design expertise would fall within the *Capability* category of design impact study defined by Candi & Gemser, (2010). However Candi & Gemser's literature review highlights that *Capability* factors in impact studies tend to be limited to relatively easily measurable inputs, such as numbers of designers or hours engaged. Intuitively and in the popular media perception of design, individual expertise is likely to be a significant factor in design impact – think Jonathan Ives or Philippe Starke.

WHAT design specialism and HOW is it deployed to create impact?

The Black and Baker (1987) study of engineering and textile sectors differentiates between Aesthetic design (industrial & human factors) and Engineering design (technical information, functions etc). They conclude that 'aesthetic' design is a better differentiator for companies in a competitive market than engineering design. Product or Industrial design has been a focus of a significant proportion of design impact studies (eg Hise et al., 1989; Gemser & Leenders, 2001) however other studies focus on what might be considered a more specific design specialism, for example Talke et al.'s (2009) study of automotive styling and the aesthetic contribution of product design. Predating concepts of experience design, Dumas& Mintzberg (1991) highlight issues with disaggregating design between 'form' (aesthetics) and 'function' (engineering) and suggest 'fit' which also encompasses human factors.

Kristensen and Gabrielsen's (2010) survey uses the term design *Competency*, (similar to Candi & Gemser's (2010) *Capability* category to encompass a range of design activities. In their study; Product design, Logo design and Web design for 25 Danish companies are assessed by a panel of designers for 'good design'. The resulting data is compared with financial performance over 5 years. The work claims to be the first to explore different contributions of product, logo and web design to performance. In their sample, product and logo design do contribute to performance, but web design doesn't. The authors acknowledge that design might also contribute to value creation at a strategic level.

Where design management was once an integral, hidden, part of design activity, recognition of the importance of design management has led to studies of the contribution of design management to impact (eg Kootstra, 2009). However Kootstra's study tends to conflate design management with design in a more general sense, and one can see that exploring design impact by ACTIVITY causes issues around disaggregation. In this literature review we classify Design Management as a design activity.

Walker's *Design Tree* (Cooper et al.,1995, p27) is an early example of a model to communicate the range of design activities and specialisms. Tether (2005) explores this complexity (*Figure B.19*) describing the design specialisms and associated tacit knowledge as *Design Knowledge* rather than Capability or *Competency*. Tether suggests there is some value in placing individual design activities into broader categories of Expressive, Symbolic or Functional design. This correlates to an extent with Livesey and Moultrie's (2008) model of *Technical* and *Non-Technical* design investments (ref *Figure B.6*). Therefore linking Capabilities or Competencies to a financial metric rather than a 'good' design metric as in Kristensen and Gabrielsen's (2010) survey . The constantly evolving nature of design activity also causes complexity. For example *service design*, an emerging field of design activity, is somewhat confusingly defined as *Aesthetic design in* Candi & Saemundsson's (2011) study. Løvlie et al. (2010),making a claim for being 'the first Service Design consultancy in the world' (Livework, 2014), characterise the discipline as being concerned with 'experiences that reach people through many different touchpoints and that happen over time' (p174). They recognise the increasing complexity of the discipline *and* the need to understand and communicate the value of their activity. They cite GVA, Triple Bottom Line and their own 'Service Usability Index' based on scoring *proposition, experience, usability* and *accessibility* with a range of techniques.

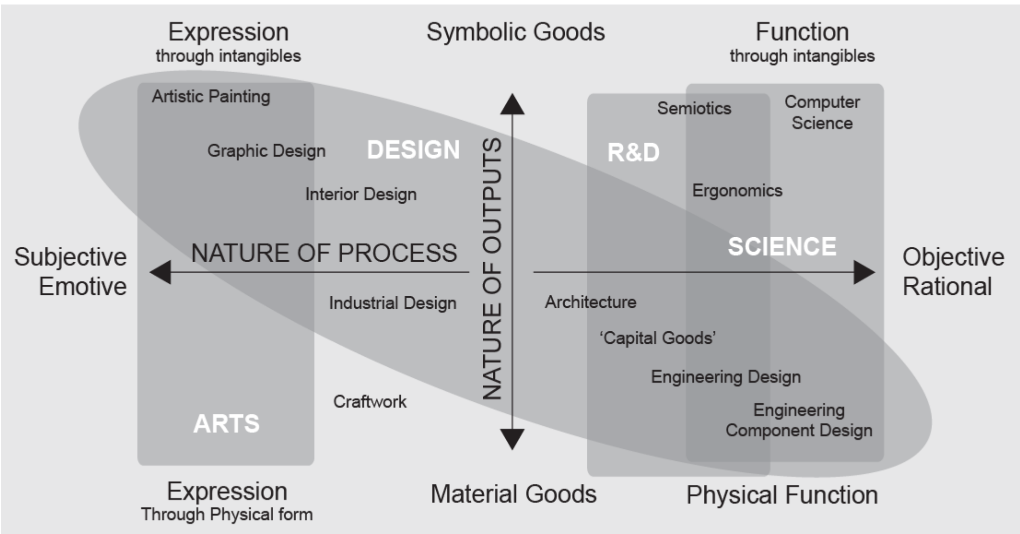


Figure B.19 *Mapping Arts, Science, Design & R&D outputs and process (Tether, 2005)*

The HOW of design activity; Design Process, is the single most dominant field within design research over the 40 plus years of design research activity (Bayazit, 2004). It has been noted that much of this activity has been focused on improving the outcomes or impact of design (Blessing & Chakrabarti, 2009, p2-4). However the relatively embryonic nature of design impact research has limited examples of exploration of HOW, aspects of design process impact on overall performance enhancement. The connections between design process improvement research and design impact tend to be implicit (Blessing & Chakrabarti, 2009). However the macro developments in the professional practice of design are evident in the chronology of design impact research (ref *Tables B.6* and *B.20*). For example Veryzer &Borja de Mozota (2005) highlight the emerging importance of User Orientated Design (UOD) in design impact (Citing Rothwell & Gardiner, 1984, Roy, 1990, Sentance and Clarke, 1997 and Walsh, 1995). Significantly they create a process based model linking UOD process to product development inclusive of market launch (ref *Figure B.20*). Their model also incorporates four 'UOD propositions'; P1) 'Greater emphasis on user-oriented design will induce a more collaborative new product development effort'. P2) 'Integration or inclusion of user-oriented design in new product development will have a positive effect on idea generation'. P3) 'Integration or inclusion of user-oriented design in the new product development process results in a superior product or service'. P4)'Inclusion of user-oriented design leads to products that are more readily adopted by users due to better product appropriateness'. These propositions potentially fit within the WHY investin design category (ref *Table B.17*). However, viewed in isolation these 'propositions' do not necessarily make a compelling argument for design impact.

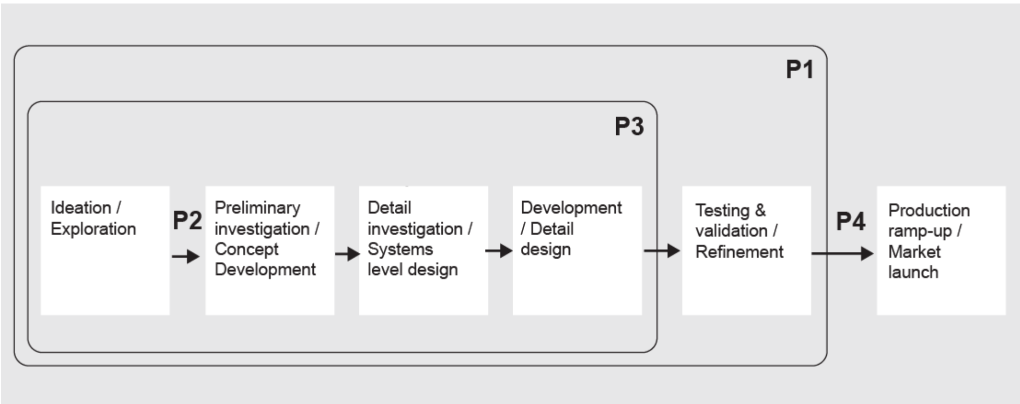


Figure B.20 *User Orientated Design Propositions (Veryzer &Borja de Mozota, 2005)*

The role of design management had been recognised since 1964 (Cooper et al., 2011), but explicit exploration of the impact of design management did not emerge until 2005 (Swan et al.,2005; Ravasi & Lojacono, 2005). Swan et al. (2005) creates four *Robust Design Capabilities*; Functional, Aesthetic, Technical and Quality based. These are considered at firm level rather than differentiating individual - internal, or out-sourced - external capabilities. The research concludes that managing these resources (design management) is a significant factor in creating impact. Ravasi & Lojacono's (2005) study emphasises the design management principle embodied in earlier work; that design should be integrated (managed) within all new product development functions within a company, and that this integration leads to greater impact.

Kootstra's (2009) work adds an extra dimension to the Danish Design Ladder (Danish Design Centre, 2003) principle (*Figure B.18*) which creates a basis for exploring design management within a company based on capabilities in; Market awareness, Planning, Resources, Expertise and Process. Chiva & Alegre (2009) take a similar approach by identifying five design capabilities which need to be managed to create impact. Their categorisation includes; Basic skills, Specialised skills, Involving others, organisational change and Innovation skills. Therefore there is a limited, but growing body of evidence to demonstrate that the management of design is a significant factor in creating design impact, however with different categorisations. As the *Silent design* concept shows, this does not necessarily mean that the design management function is explicit in any specific scenario.

Similar points can be made about the even more recent emergence of Service Design as an area of application for professional design activity. Candi & Saemundsen (2011) possibly compound the issues of delimiting design by adopting the term *Aesthetic* design to describe an independent variable in their study of New Service Design – as such there can be a miss-match between the survey respondent's understanding of the term and the particular meanings attached to it by the researchers. At the time of the literature review, no further empirical studies linking processes associated with emerging design disciplines (eg Design Thinking, UX/UI, experience design, participatory design) to impact have been identified

Table B.16 *Initial 6Ws framework of design impact research & the role of design in creating impact*

6Ws	Key References	
	Factors	Criteria/metrics
1 **WHY** invest in design?	*Price and Non price* factors (Rothwell & Gardiner, 1984),***The Power of Design***(eg 8 factors, Rae, 2014), *Design Currency* (Visocky O'Grady &Visocky O'Grady, 2013)	*Design Value Index*, six criteria for *design centric* companies (Rae, 2014)
2 **HOW** does design create impact?	Design *Conscious* (Roy & Walsh, 1983), Design *Orientation* (Black& Baker, 1987), Design *Effectiveness* (Hertenstein 2001), Design *Intensity* (Gemser & Leenders 2001), ***Emphasis***(Candi & Gemser (2010),	*Design Participation* (Black & Baker, 1987), *Danish Design Ladder* (Danish Design Centre, 2003),*Design Value* (Zec, 2011) *Design Management Staircase*, (Kootstra, 2009), *Four Powers* (Borja de Mozota, 2006)

6Ws	Key References Factors	 Criteria/metrics
	Design *Strength* &***Continuity*** (Zec, 2011), *embeddedness* (Micheli, 2013); Design centric, (Rae, 2014) ***Integration***(Borja de Mozota, 2003)	
3 **WHEN & WHERE** does design add value?	Level of *Commoditization* (Candi & Saemundsen, 2011), ***Moderating Factors*** (Candi & Gemser, 2010)	34 categories of *Resource envelope* input *(*Pugh, 1991*)* *Design Newness*(Talke et al., 2009)
4 Design activity: **WHO** is directly involved with designing which creates impact?	*Silent Design* (Gorb & Dumas, 1987), *Overt Design* (Candi, 2010), *Design Leaders* (Topalain, 2011, Miller & Moultrie, 2013a and 2013b)	Delimiting Design activity (Tether, 2005), Technical & Non-technical Design investment (Livesey & Moultrie, 2008)
WHAT design specialism and HOW is it deployed to create impact?	*The Design Tree* (Walker in Cooper et al,. 1995), Expressive – symbolic – Functional (Tether 2005), Product–Logo-Web design (Kristensen and Gabrielsen, 2010), *Design Knowledge*(Tether, 2005) *Design Management* (eg in Swan et al.,2005; Ravasi & Lojacono, 2005, Borja de Mozota, 2003), *Design Thinking*, (Brown, 2008)	*Technical – Non TechnicalDesign investments* (Moultrie &Livesey, 2008), *'Good Design'* (Kristensen and Gabrielsen, 2010), ***Capability***(Candi & Gemser, 2010),*Competency* (Kristensen and Gabrielsen, 2010); *Design capabilities* (Swan et al., 2005),

B.4.3 Communicating Design Impact

As explored in the introduction and literature review scoping sections, this UDI study focuses on the challenges and opportunities faced by the design profession in communicating design impact as highlighted by the Design Council and DBAs' (2005b) survey of the UK design industry. Their survey involving 2,433 telephone responses from the design industry to the question: 'How well does the design industry communicate the value of design?' This resulted in a figures of 88% of design consultancy businesses saying only 'quite well', through to 'not well at all'. The figure from freelance designers was even higher at 90%. Therefore the focus of the overall study is on the communication between designers and their immediate and predominant professional context.

Design Promotion and Advocacy

Communicating design impact can be considered one of the objectives of a range of International, national, public, private and professional design organisations with interests in promoting design. For organisations such as National Design bodies, such as the UK Design Council or the Barcelona Design Centre, and Professional bodies such as the UK's Design Business Association (Design Effectiveness Awards), Finish Design Business Association (Design ROI, Pikkanen, 2012) or The International Council of

Societies of Industrial Design (ICSID), this communication requirement might be a core part of their activity, for example through design awards, reports and campaigns (eg Hösselbarth, 2010). The methods and content of this activity, whilst not the focus of the UDI study, are relevant, particularly as it is in the area of design promotion, where a majority of the work to explore design impact has taken place.

Design impact in grey literature

Grey literature is defined as “that which is produced on all levels of government, academics, business and industry in print and electronic formats, but which is not controlled by commercial publishers” (The Forth International Conference on Grey Literature, cited by Cordes, 2004).Whilst much of the existing research into design impact will have communication as part of the objectives, and as noted above, communication difficulties for practicing designers are identified, no research has been found which directly addresses designers communicating design impact. The majority of existing studies are directed at policy level, macro-economic level and research community design promotion objectives. Therefore design impact is a subject evident within UK grey literature as summarised in *Table B.20* as well as in academic literature (*Table B.6*). At a policy level in Europe, there is considerable interest in design as a component of innovation (Ref Section 2.4.1) and this has led to a range of initiatives with communication of design impact embedded within them such as the European Design Innovation platform (EDIP) which has objectives to be a significant portal for the dissemination of design and innovation knowledge.

Competitions – Design Awards

Another important channel for the communication of design impact has been through Design Competitions. The DBA Design Effectiveness Awards (Dawton, 2011) has the core objective of communicating design effectiveness or design impact to a wider audience. The International Council of Societies of Industrial Design (ICSID) recently (2012) launched their global World Design Impact prize. This award focuses on societal impact, rather than the predominantly economic impact focus of the DBA awards. Other design competitions include consideration of design impact, but less directly. For example Red Dot (Zec, 2011) or the in. However it should be noted that success in design awards can in turn lead on to various forms of positive impact for the designers and the organisations they are designing for (Borja de Mozota, 2003)

Hidden Design Impact

Borrowing from the concept of *Silent Design* (Gorb and Dumas, 1987) and Hidden Innovation (Miles and Green, 2008), *Hidden Design Impact* refers here to a range of communication scenarios where design impact is an ingredient, but is not necessarily expressly identified. Various initiatives have broad objectives to promote design, however these do not necessarily make direct reference to impact, and are not typically recognised within design impact studies. For example the UK Design Council's Design Bug's Out initiative (Department of Health, 2011) has been evaluated, but this work has not been placed into any framework of impact assessment, such as Triple Bottom Line, for its social impact contribution. Likewise the work of the Ellen McArthur Foundation to promote the Circular Economy concept recognises the value of design in a broad sense, but does not specifically identify or communicate the design contribution to environmental impact (Ellen Macarthur Foundation, 2013). 'The UK Government has in recent years recognized that design can be a powerful commercial tool, that can enhance competitiveness at the firm level, and contribute to economic growth at the national level. The contribution of design to enhancing environmental sustainability is also increasingly appreciated' (Tether, 2009)

For the purposes of delimiting the scope of *Hidden Design Impact* in this section Tether's (2005) model of focusing on activities and initiatives which involve the input of professional designers with a conscious application of a design process is adopted. Therefore omitting design within Architecture (Architects) or Advertising (Creatives) for instance.

Methods for communicating Design Impact

Case studies

The predominant method for Designers and design related organisations to communicate and promote their design activity is through case studies (Freeze, 1992). Case studies in this instance don't necessarily have to conform to specific requirements, but do conform to the concept of exploring and communicating answers to *How* and *Why* questions (Yin, 2003). Hudspeth & Knirk (2008), identify three levels of case study; 'a) case problems, which are short "snapshot" depictions of a single incident; b) case studies, which include information on the background and context of a situation; and c) referenced case studies, which include citations and author insight'(p30). Typically, as in type (a), this material can be condensed to simple statements, for example Dawton, President of the Bureau of

European Design Associations says; “I have seen design that can transform transport systems so that older people can get on and off buses more easily. I’ve seen design transform the way the children can self-administer drugs in such a way that it makes them less scared and enables them to cope with the condition they’ve got. Imagine a Europe where all businesses and all public services had that level of design integrated in them” (Dawton, 2013). Type (b) case studies might be used for general design advocacy and bringing issues to life, eg advocating service design approaches with a case study of Orange the mobile network operator (Polaine et al.,2013), or advocating service design in public sector applications (Scherfig et al. 2010). In these types of example, design impact tends to be described qualitatively rather than with quantitative data. A case study research approach is also a strong feature of a number of design impact studies (eg Micheli, 2013, Ravasi & Lojacono, 2005). The DBA Design Effectiveness Awards (Dawton, 2011) and other competitions are built around case studies. The limitation of this form of communication is in the limits of generalisability. For example for generating macro economic data to inform policy, or to communicate to a sceptical Board of Directors, when a design company’s case studies aren’t a good fit with the client business.

Quantitative Survey Data

Grey literature was traditionally communicated through hard copy reports, however the internet has become the primary channel for disseminating design impact information. This leads to communications materials such as the screen shots shown in *Figure B.21* from an online animation produced by the UK Design Council utilising the headline statistics from their 2012 study.

Increasingly in the UK a range of ‘third sector’ initiatives in addition to the work of Design Council are involved with promoting design as an important element to support the growth of SME businesses (eg The Design Programme,2014; Co-innovate, 2014; Future Factory, 2014 etc). The communication channels for these initiatives have a strong emphasis on internet based information. The European Design Innovation Platform (EDIP) is a £3.2m initiative emerging from the European policy level interest in design innovation; ‘to share the power of design with European Industry’ (Design Week, 2013). All these initiatives have the need to effectively communicate design impact and a range of data visualisation and reporting techniques can be utilised for this purpose. This is perhaps particularly relevant in the design field, where there is an expectation of high quality visual communication. The various Design Council design industry and design impact surveys (Design Council, 2002, 2003 2005a, 2007b) employ a wide variety of visual treatments of conventional data visualisation methods such as graphs.

Design indexes

Within existing literature, three separate 'Design indexes' have been identified; the Design Council (2005a) comparing a 'Design Portfolio' of design effective companies to the UK FTSE100 Index of share values (*Figure B.5*); Rae (2012) and Westcott et al. (2013) adopts a very similar approach in the DMI design value index, with 'DesignCentric' companies compared to the US S&P Index and Red Dot (2014) have established their own 'Red Dot Design Index' of 'design orientated companies' who have won Red Dot awards, and have listed stocks. The performance of Red Dot's sample is compared to six leading national indexes and shows a performance over 13 years in excess of 162% higher than the weakest performing index (*Table B.18*). Whilst not directly addressing design impact, the International Design Scoreboard concept (Moultrie &Livesey, 2009) bundles data on a number of factors to create an overall index or scoreboard of 'design capabilities'. This in turn has parallels with; the Global Innovation Index (two versions; Boston Consulting Group, 2014 & Knowledge Partners, 2014); the Global Innovation Quotient (Bloomberg, 2014) and the UK's Innovation Index (NESTA, 2014). These are all interesting and relevant reference points, but in the case of the Design Indexes, it is not clear that these have long term sustainability, and the data primarily works at a general level of design promotion or advocacy of the strategic use of design, rather than providing evidence of causation at individual firm or project level.

Table B.17 *Red Dot Design Index compared to leading international Indexes (Red Dot, 2014)*

International indexes in comparison		1999 close	2009 close	10 years +/- %	2012 close	13 years+/- %
DOW JONES	USA	11,497.12	10,428.05	-9.3%	13,104.14	+14.0%
DAX 30	GER	6,958.14	5,957.53	-14.4%	7,612.39	+9.4%
NASDAQ Composite	USA	4,069.31	2,269.15	-44.2%	3,019.51	-25.8%
EURO STOXX 50	EUR	4,904.46	2,966.24	-39.5%	2,635.3	-46.3%
NIKKEI 225	JPN	18,934.34	10,546.44	-44.3%	10,395.18	-45.1%
HANG SENG	HKG	16,962.10	21,510.93	+26.8%	23,354.31	+37.7%
Red Dot Design Index		100.00	175.00	+75%	215.76	+115.8%

Table B.18 *Summary of existing formats for communicating design impact*

Format	Example / Purpose / Audience	Note
Case studies (various	Song & Chung (2010) Research to explore the role of CEOs in design management and resulting	Provides qualitative evidence of the strategic role of design

scenarios)	design impact Micheli (2013) Research to provide evidence of design impact for a wider business audience Polaine et al. (2013), Orange service design; advocacy for a service design approach to create design impact	management High profile cases verify and provide kudos for the findings Typically - whilst claiming design impact - direct and/or quantitative evaluation of design impact is rare
Competitions (Design Awards)	Red Dot Design Awards (2014) Criteria cover a wide range of ways in which design can add value. Winning entries promote these qualities through multiple channels Dawton (2011) DBA Design Effectiveness Awards provide evidence of design impact and raises the profile of the designers, the profession and validate the role of design	Design impact is not a criteria, and entries do not require data on impact Design effectiveness criteria in the DEAs are virtually unique amongst design awards
Quantitative Survey data	Design Council design industry and design impact surveys (Design Council, 2002, 2003 2005a, 2007b) use various datasets and visualisation, with a general goal of design advocacy	Validity is determined by the quality of the underlying data – and there are well reported difficulties in gathering relevant data
Indexes	Includes: The Design Council ‘Design Index’ (2005a), the ‘DMI Design Value Index’ (2014) and the Red Dot Design Index (2014) all the goal of design advocacy to ‘client’ business and the design profession	There is a level of bias in the selection of companies to include in these indexes to accentuate the design value proposition. Only correlation between design intensity and economic impact is shown
Online	A variety of ‘messaging’ approaches using online techniques are identified such as videos/animations (Design Council 2014)and downloadable tools; (DMI design value scorecard, 2014)	Online is a highly effective communications channel for reaching a large audience. Evidence of the impact of this activity is currently not clear.

Figure B.21 *The Value of Design, screen shots from animation (Design Council, 2014)*

Table B.19 *Chronology of Design Impact related reports in UK Grey literature*

Date	Report/Statistics	Note
1986	DBA Design Effectiveness Awards launched	Has run every year since. One of the first specific examples of aiming to validate the value of design in business terms
2001	DCMS, Creative Industries Mapping document	Building on the original(1998) Creative Industries Mapping document: Categorisation of 13 creative industries (one of which is Design) which combine to make a considerable contribution to the UK economy. Supported with statistics for each.
2003	Sainsbury D, Competing in the global economy: the innovation challenge, DTI	Making the case for Innovation, built on the UK's inherent strengths in creativity and inventiveness, as essential for the UK's role in the global economy
2005	DTI, Economics paper No15 – Creativity, Design and Business performance, DTI,	Underlining the (potential) role and importance of creativity and design in business performance for the UKs future economic success – in parallel with the Cox Review – for a business audience
2005	DBA & Design Council, Business of Design	Review of UK design profession activity based on 2,433 telephone interviews.

Date	Report/Statistics	Note
2005	Tether B, The role of Design in Business Performance, DTI (now BIS), HM Government	Provides a useful objective (non design centric) overview of the context, setting out key elements of an evaluation framework together with confirming (through review of existing studies) that there is a correlation between investment in design and business success, but that design cannot be isolated as the key or significant factor.
2005	Cox Review of Creativity in Business, HM Treasury	Influential, highly cited report calling for action in response to recognition of the economic importance of the creative industries. Specific recommendations for the design industry and design education
2006	Prosperity for all in the global economy – world class skills (The Leitch Review of Skills)	Reviews context and sets targets for employer skills levels: Eg 40% of working adults should have 'World Class skills' by 2020, up from 29% in 2005 – but states that skills needs are a 'moving target'
2007	The Work Foundation / NESTA, Staying ahead: the economic performance of the UK's creative industries,	An authoritative review of the value of the creative economy and challenges within each sub-sector. Data sets used within Design provide limited basis for analysis within this report
2007b	Design Council, The Value of Design Fact finder	Identification of 'design alert' businesses and the headline statistic: 'Every £100 spent on design by design alert businesses increases turnover by £225' The report strongly implies that when design is integral to business, performance exceeds non 'design alert' companies.
2008a	Design Council, Design in Britain	Summary report of the 2008 Design Council survey of how companies in the UK are using and benefiting from design. eg '80% of UK businesses believe that to some extent design will help them stay competitive in the current economic climate', but only '16% percent of UK firms believe design has been crucially important in helping to meet their biggest business challenges of the past three years'
2008	DCMS: Creative Britain: New Talents for a New Economy	Outlines a Creative Industries strategy, recognising the UK as the 'World's creative hub' and the need to invest in future generations.
2008b	Design Council , Briefing Paper No1: The impact of design on business	Short paper summarising the status of design impact understanding and identifying the need to explore the broader impact of design as a component of innovation and when used strategically
2008	Livesey & Moultrie, Company spending on design: exploratory survey of UK firms 2008, University of Cambridge/ Design Council	Reports on a survey of design spending within 358 UK companies and extrapolates the estimated value of in-house (£50.1bn) and outsourced (£7.5bn) design spend. It also creates a unique categorisation of design and spend analysis of: Technical, User, Promotional and Identity design. These align to a certain extent with design specialisms such as engineering design, product, web and corporate identity design.
2009	Design Council, Briefing Paper No 5: Measuring design	Describes the context of studies exploring design impact, establishing a need for the International Design Scoreboard. For example by stating; 'It is acknowledged that difficulties in providing consistent definitions of design make it hard to measure. ' and; 'there are currently no reliable means of comparing either the national economic or non-economic benefits of investing in design'
2009	Moultrie & Livesey, International Design Scoreboard: Initial Indicators of International Design Capability	The UK is 4th with USA Ist in this league table based on measures including numbers of design graduates, numbers of design firms, public investment in promoting design. Issues with the consistency of data across nations are identified. No direct links to impact included

Date	Report/Statistics	Note
2009	Technology Strategy Board, Creative Industries Strategy 2009-12	Useful statistical overview of how design relates to the CI sector as a whole
2010	Swan, BIS Occasional paper No.2: The economic rationale for a national design policy	The potential for a national design policy explored from three perspectives with five categories of policy initiatives. Public investment in 'designed' assets and 'design for complex systems' received the strongest support.
2010	Dyson, J, Ingenious Britain	Report for the Conservative party with general advocacy of the importance of investing in Innovation for a strong UK economy
2011a	BIS, ECONOMICS PAPER NO. 15 Innovation and ResearchStrategy for Growth	Economic data relating to Innovation and Research – forming basis for coalition government recommendations and actions in linked report
2011b	BIS, Innovation and Research Strategy for Growth	Policy document from new coalition government with specific actions for Government organisations including the Design Council
2011	Design Council, Design for Innovation	Report linked to BIS 2011 Innovation report outlining the 'Design' case and component of Government plans
2011	Dawton D, Maximising Design Effectiveness, Design Management Review	In addition to promoting the DBA Design Effectiveness Awards and the use of metrics to quantify design impact, the piece emphasises the broader impact of design - shaping company reputations, manifesting business strategy, increasing brand value and reducing development costs – using examples from the Awards
2012	The Design Commission, Restarting Britain: Design Education and Growth	Underlines 'design as a lever for growth' message and how design education is an important part of the pipeline for future growth
2012	Madano Partnership,Design Council, AHRC, research funding scoping study	Consultation and literature review with a focus on exploring the potential value of research into design impact (commercial and social). The report confirms the need for work in this area, but advocates a different focus for AHRC funding arguing that development of existing activities such as the Oslo and Frascati manuals will cover these issues
2013	NESTA, A Manifesto for the Creative Economy	Report specifically geared towards influencing UK Government policy in relation to the creative industries. Amongst 10 manifesto points it suggests a reworking of the 1998 classification of 13 sub-sectors, and also strongly encourages a better recognition and action in response to the importance of the digital realm to the creative economy (for example the importance of this was not recognised in the late 90s)
2013	Micheli, P, Leading Business by design: Warwick Business School and the Design Council	Depth interviews with 48 business users of design leading to a summary identification of three value adding factors and 8 recommendations for how business can enhance the benefit from design input. Part of the Design Council agenda of promoting the strategic use of design in business

B.5 Models and Metrics

A number of fields of impact assessment and performance management have substantially greater bodies of associated literature than *design* impact. For example Therrien et al.'s, (2011) study in the innovation field states; '(our)principal interest lies in incorporating two different dimensions of innovation intensity – market-entry and originality of the innovation – to assess the commercialization performance'(p656). Whilst needing to limit the research boundaries, there is merit in exploring relevant aspects of fields, such as innovation, with relevant links to design practice.

Within the design field a number of studies and publications include an explicit focus on models and metrics for evaluating design (eg; Borja de Mozota, 2006, Visocky O'Grady &Visocky O'Grady, 2013). The design impact studiesexplored (Section B.3.2, ref *Table B.6*)generally make *some* reference to models and metrics for impact assessment. Typically these are derived from well established business and management practice. A second cross cutting theme within impact assessment and performance management is the concept of *value*.

Therefore this section reviews value concepts and key performance management models as a basis for establishing a general framework for relationships between value and models and metrics relevant to design impact.

B.5.1 'Value' concepts

Zec (2011)writing from a practitioner perspective notes: 'So what is design value, and why is it so important? The whole purpose of quantifying design's value is to have a better financial understanding of the risks and rewards associated with it.' (p39) .Design orientated researchers have explored the idea of 'design value' within the context of economic and business theories of value (eg Heskett, 2008; Borja de Mozota, 2006, Nomen et al, 2012), others have simply adopted the idea of design value without the underpinning link to theories of value (egLøvlie et al., 2010; Joziasse & Sleders, 2009;Zec, 2011; Rae, 2014;). This work is all concerned with using value concepts as part of gaining credibility and legitimacy for the role of designamongst non-design audiences, typically focussing on how *designing* contributes to economic value. Joziasse & Selders (2009) conclude that 'the general effect of design on business is now clear enough' (p32) and compile an overview (*Table B.21*); '...to isolate 11 distinct ways in whichdesign creates wealth'(p32). Their overall point is that with the general value of design proven. The issues are now associated with *how* to maximise the value added by design in a diverse range of contexts, not simply to identify that design adds value.

Table B.20 *Joziasse & Selder's (2009) categorization of 11 types of 'value added by design'*

Different types of value added by design		
More profit	Prestige	1. More sales transactions

		2. Higher premium price
	Costs	3. Lower production costs
		4. Lower marketing costs
More Brand Equity	Awareness	5. Higher distinctiveness & user awareness
	Loyalty	6. Better reputation and user loyalty (emotional bond)
More Innovation	Time	7. Shorter time to market
	Amount	8. More opportunities and intellectual property
Faster Change	Company	9. Faster and smoother internal change
	Society	10. Lower level of environmental degradation
		11. More solutions for social issues (aging, literacy, etc.)

Herbert A Simon is acknowledged by Buchanan (2007) and others as the first economist to recognise the *value* of *designing* rathersimply considering design value as an ingredient of value in products (the results of designing). Heskett (2008) quotes Simon as follows: 'The intellectual activity that produces material artefacts is no different fundamentally from the one that prescribes remedies for a sick patient or the one that devises a new sales plan for a company or a social welfare policy for a state. Design, so construed, is the core of all professional training' (Simon, 1981,p129)

The final report of the €Euro Design – Measuring Design Value also makes the distinction between 'Design as Process' and 'Design as Outcome' (Barcelona Design Centre, 2014, p14). This is important for their proposition of design being an integrator and enhancer of 'utilities' (*Figure B.22*)

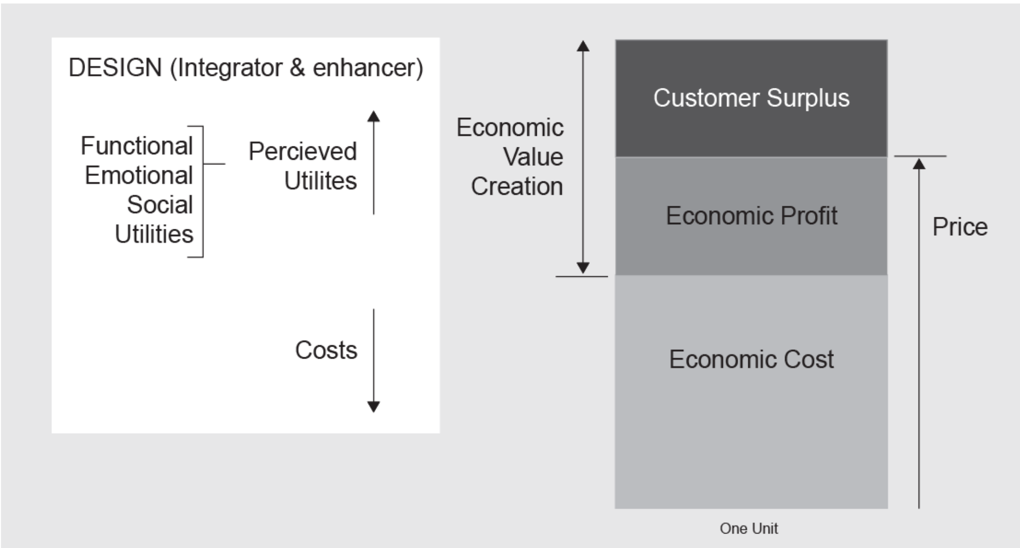


Figure B.22 *Schematic of design's potential contribution to value creation (Barcelona Design Centre, 2014)*

Heskett's, (2008) paper initiates an investigation into how design relates to economic theories of value highlighting that Neo classical economic theory inadequately allows for consideration of the added value of designing. Nomen et al, (2012) have a more specific goal of describing explicit relationships between the economic value adding attributes of designing and economic theory, pointing out that; 'There have many attempts to capture the intangible nature of design, ranging from broad and holistic definitions to highly specific. However, none of these definitions has been created explicitly to characterise design in economic terms. In general, the broader the definition, the less helpful it is in considering design as an economic factor of production' (p8). Borja de Mozota suggests that; 'business managers should know about design management's power to create value in companies, which has been proven through research and can also be demonstrated through management conceptssuch as Michael Porter's value chain' (2006, p45). Porter's seminal work on competitive forces also links to economic value: '...the five competitive forces (new entrants, substitutes, customers, suppliers, competitors) determine how the economic value created by industry is divided...' (Porter, 2008, p86).Osterwalder's (2004) focus on business model design and Value propositions references Tapscott et al. (2000) and extension of the value chain concept to *value networks*; a categorisation of different types of business webs (*Figure B.23*)

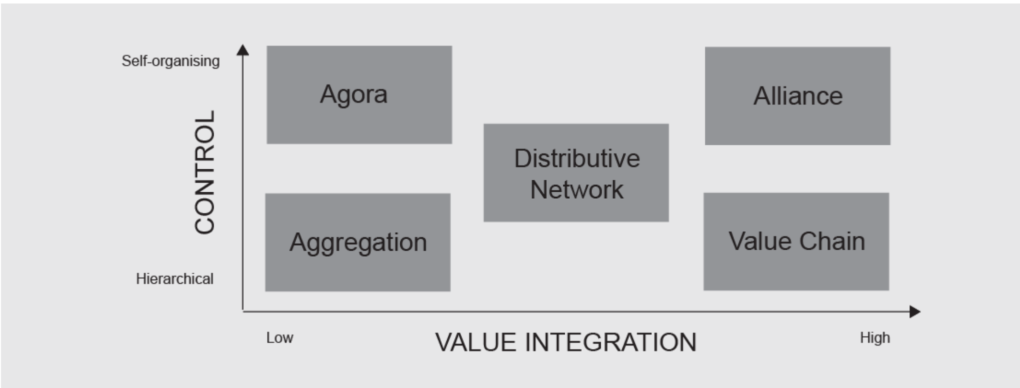


Figure B.23 *Categories of Value Integration (Tapscott et al., 2000)*

Key points from these perspectives are: that*value* is typically associated with economic value; it is important to distinguish between value created through *designing* from the value within outcomes (Heskett, 2008, Simon, 1981); but an economic view is not adequate for understanding the value adding qualities of *designing* (Heskett, 2008); it can be understood in terms of an integrator and enhancer leading to profit and 'customer surplus' (Barcelona Design Centre, 2014); the added value of *designing* can be categorised in a number of ways (eg Joziasse & Selders, 2009); that value can be considered as part of a chain (Porter, 2008) and networks (Tapscott et al., 2000) and many of these factors can be reviewed in terms of a *Value Proposition* (Osterwalder, 2004)

Table B.21 *Use of 'Value' terms in design and related literature*

Reference	Types of value discussed
Osterwalder (2004)	Defining the **Value Proposition** as a core pillar of business model design linked to analysis of how value is derived from the **Value Chain** and **Value Networks** with different categories of **Value Integration**
Borja de Mozota (2006)	Defines a **Value Model** for designreferencing Porter's **Value Chain** model
Heskett (2008)	**Economic value** based on **Use Value** and **Exchange Value** (from Neo-classical economic theory) inadequately captures the potential of design
Joziasse & Selders (2009)	'Isolation' of 11 types of **value added by design,** 9 for organisations, 2 for society
Zec (2011)	The (loosely defined) identification of '**Design Value'** as the **Added Value** derived from design input
Nomen et al (2012)	Economic Value explained as the difference between Economic Cost and Perceived Utilities, in turn comprised of Functional, Emotional and Social Utilities
Rae (2014)	Higher stock market performance through 'Design-driven Value' in 'Design-centric companies'
Barcelona Design Centre (2014)	A model for **Design Value Creation**as a basis for design impact evaluation

B.5.2 Performance management models

Balanced Scorecard (BSC) and performance dashboards

Since the late 1980s there has been business management concern for the negative effects of performance measures focused solely on financial metrics. The Balanced Scorecard (BSC) is one of a number of approaches addressing this issue (Hoque, 2014).

Kaplan & Norton presented their BSC concept in 1992 and have subsequently developed it in a number of iterative stages between 1992 and 2006. Their original introduction to the BSC uses the metaphor of an aeroplane pilot needing, not just a single metric to fly the plane, but a cockpit full of dials providing crucial information. They argue that most people would consider it a reasonable expectation for a pilot to be guided by a number of metrics. However, extending the metaphor they also point out that the approach should be likened to a flight simulator, not a dashboard. This is because a distinction of the approach is that it is conceived as a strategic, rather than a control or diagnostic tool. 'No single measure can provide a clear performance target or focus attention on the critical areas of the business. Managers want a balanced presentation of both financial and operational measures' (1992, p71)

In practice BSC requires consideration of four perspectives: Financial, Internal, Customer and Learning, and in each case defining a number of goals and related metrics. 4 to 7 measures for each perspective are suggested, totalling about 25. The point is reiterated that collectively considering the causal links between the metrics leads to a single strategic vision, rather than a confusion of 25 separate measures. BSC has achieved very good levels of diffusion as indicated by Hoque's (2014) review of 114 papers on the subject covering the 20 years since original publication. The quantitative analysis of these papers provides a clear guide to factors (% of instances) associated with models and metrics for impact evaluation:

- Uses in decision making 23.6%
- Adoption/implementation 21%
- Diffusion of the balanced scorecard 20.1%
- Balanced scorecard (general) 11.4%
- Organisational effectiveness 10.5%
- Review and critical analysis 6.1%
- Impacts on employee mental states 3.5%
- Employee incentive plans 2.6%
- Cause–effect relationships 0.8%

Applying the principles of BSC to design management Borja de Mozota adapts her (2002) 'value model' for design which identifies categories where design adds value: Design as *Differentiator, Integrator and Transformer.* With the addition of *Good for business* this maps to the four BSC perspectives and becomes the *Four Powers of Design* model. Therefore linking the differentiating aspects of design activity to creating a strategic vision, combined with a basis for establishing a tailored set of goals and related metrics (*Figure B.24*).Her work also links different management approaches to levels of design intensity (also ref Danish Design Ladder, Danish Design Centre, 2003) which also links to the distinction made by Kaplan &Norton (1996) between strategic and control approaches (*Table B.22*).

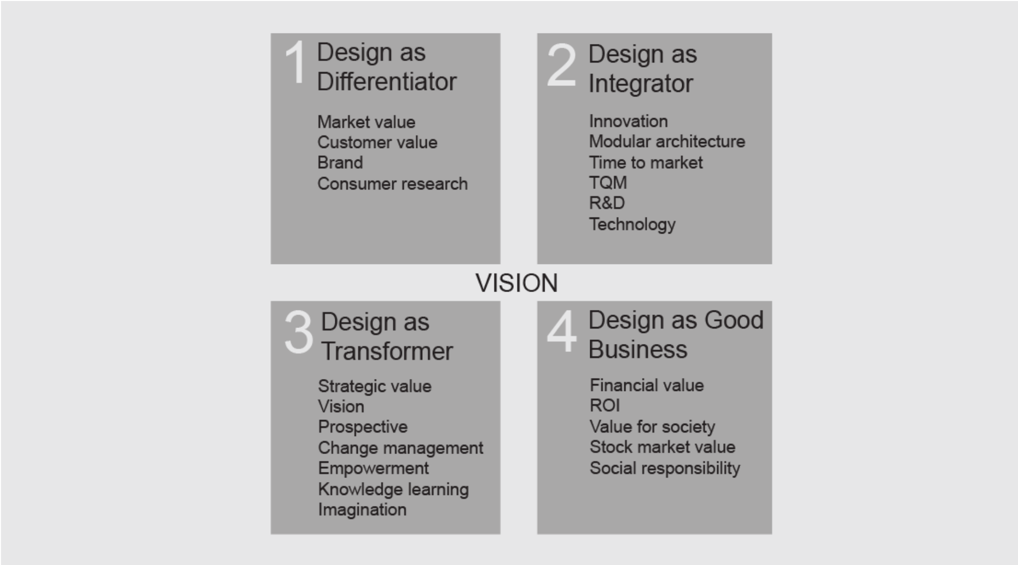


Figure B.24 *Four powers of design and indicative measurement factors management (Borja de Mozota, 2006)*

Borja de Mozota's Four Powers model is referenced by others (eg Visocky O'Grady &Visocky O'Grady), however without a substantial body of related literature exploring adoption of Borja de Mozota's model, the factors identified by Hoque's (2014) review provide a reasonable indication of categories of issues associated with the general diffusion of the tool.

Table B.22 *Matrix of perceptions of design and management (Borja de Mozota, 2006)*

	Management as command and control	Management as art of collective action	Management as managing change
Design as strategy	Controlling design ROI & business performance and brand value.	Design leadership. Coherence of the design system and driving the future "advanced design."	Design as resource for the challenges of contemporary managers—Socially responsible enterprise.
Design as process	Design research methods—ethno design, etc. DM as managing the design function.	Integrating design in other processes: brand, innovation, TQM. DM as improving the performance of processes.	Integrating design in management decision processes. DM as inventing the future and "sense building" in a changing environment. DM for the quality of staff.
Design as styling	Integrating design in marketing, R&D, Corporate communications. DM as managing a design project.		

Dashboards for presenting KPIs have developed since the evolution of computing in business and 'surging' in the late 90's linked to the popularity of the BSC approach (Kerzner, 2011). Both dashboards and scorecards aim to bring together metrics from selected KPIs. Eckerson (2006), suggests that dashboards have an operational function whilst scorecards are used strategically. This could be seen to relate to the greater complexity in setting up dashboards and the inherent idea of communicating the outputs to a wider audience.

Triple Bottom Line (TBL), Sustainability and Design

The Triple Bottom Line (TBL) accounting concept dates from the late 1990's and the publication of *Cannibals with Forks: The Triple Bottom Line of 21st Century Business*(Elkington, 1999). TBL adds two more 'bottom lines', social and environmental, to the traditional idea of a financial bottom line. TBL is a particularly high profile, well recognised term to encompass the idea of considering a wider range of factors than economic performance. However the concept has received criticism, notably by Norman and MacDonald (2004), questioning the goal of TBL: is the 'bottom line' terminology 'a mere metaphor' (p245) or is bringing accountancy paradigms to bear on social and environmental domains a practical possibility? Therefore is the concept simply about promoting the idea of more in-depth consideration of social and environmental factors, or should it be used as a specific accounting approach? Norman and MacDonald (2004) identify Five 'claims' for TBL:

- *Measurement* – considering objective measurement of social and environmental factors
- *Aggregation* – that additional measurements of social and environmental factors can be aggregated with the financial bottom line
- *Convergence* – Measuring helps draw attention to social and environmental factors which in turn improve financial performance
- *Social Obligation* – Firms have a moral obligation to improve social factors – and therefore need to demonstrate their performance
- *Transparency* – Firms have obligations to their stakeholders to demonstrate their performance in these additional areas

Their strongest criticism is against the aggregation claim, arguing that social and environmental assessments analogous to financial bottom lines are 'fundamentally… impossible' and 'inherently misleading'(p251); making the point that there are no universally agreed units of measurement or 'common currency' for social and environmental factors, and that this issue is compounded by the need, in most social and environmental assessments to consider a range of factors, all with different units of measurement. 'If there is something distinctive about the TBL approach' it is the concept of properly integrating consideration of all three sets of factors into business – citing Alexiou et al.&Alexiou et al. as a company achieving success through this approach (and pre-dating the TBL concept).

Melles et al. (2011) reporting on the evolving focus on social and environmental factors by designers -citing Papenek (1991), IDEO – design thinking (Brown, 2008) and 'Wicked problems'(Buchanan, 1992) - note the need to consider social and environmental dimensions in the early stages of design activity, but that TBL doesn't necessarily offer anything new (also a Norman and MacDonald criticism). They note that consideration of social and environmental factors (by designers) can be traced back to the Arts and Crafts movement and Bauhaus. But they also cite Whiteley's (1993) *Design for Society* and Bakshi and Fiksel (2003) in the engineering field, stating 'incorporating sustainability into engineering requires the ''boundaries''of the process to be greatly expanded – beyond the plant and even beyond the corporation' (p 1350) as examples of the need for a wider, deeper engagement with social and environmental factors; contrasting this with restricted conceptions of design focused on styling and manufacturing concerns. Ultimately their paper is arguing that the (discredited by them) TBL concept is inadequate for evaluating this emerging professional context. For example stating; 'Product designers traditionally 'own' the solution, it is 'their' product and they measure their success through a variety of mostly market-driven agendas (economic bottom line) - contrary to the co-design or participatory design process.' (p149).

However Sutcliffe et al. (2009) do use the TBL three pillar principle as a basis for their emerging framework to enhance designer's considerations of sustainability, which, importantly for this study, proposes a matrix linking product life cycle issues with the TBL pillars (*Table2.23*). These links are even more specific in the model proposed by Waage (2007, *Table 2.24*)which in turn builds on a five level decision making model developed by Robert et al. 2002, with levels as follows: 1)Defining the system, 2) Identifying outcomes and success, 3) Articulating strategies for going forward, 4) Determining actions, 5) Listing available assessment tools.

Table B.23 ***'TBL' and LCA matrix of considerations for designers (Sutcliffe et al. 2009)***

	Manufacture	Distribution	Use	Maintenance	End-of-Life
Social	Socially responsible sourcing of labour Worker safety Worker health/quality of	Patent issues Access to design Socially responsible sourcing of labour Differential	Inclusive design User safety User dependence	Ease of repair	Local impact of disposal

	Manufacture	Distribution	Use	Maintenance	End-of-Life
	life Impact of manufacture on local population	pricing			
Economic	Component choice Material choice Outsourcing choices Strategic product-service combinations	Logistics Supply chain efficiency Place of origin/outsourcin g	Reliability	Cost to repair Planned obsolescence Lifespan	Financial impact of disposal
Environ-mental	Component choice Material choice Energy Efficiency of manufacture Avoidance of contamination	Energy efficient distribution Weight considerations Transport packaging Pollution minimisation Minimum use of hazardous substances	Energy efficiency Materials consumption Avoidance of waste Pollution minimisation Minimum use of hazardous substances	Durability Ease of repair	Reuse/recovery of materials Remanufacture Recycle Disassembly Disposal (landfill or other) Avoidance of contamination

Table B.24 *Integrating sustainability process into design process (Waage, 2007)*

Design Process	Sustainability process for Designers
1 UNDERSTAND – Need or Product	A ESTABLISH SUSTAINABILITY CONTEXT – Sustainability issues in relation to client and product
2 EXPLORE -potential solutions	B DEFINE SUSTAINABILITY ISSUES - through mapping and sustainability analysis
3 DEFINE / REFINE –design options	C ASSESS - Consider potential pathways forward in relation to a vision of a sustainable solution
4 IMPLEMENT	D ACT / RECEIVE FEEDBACK - Create and roll-out sustainability-oriented product / service. Evaluate and (re)assess in terms of sustainability definition and context

Sustainability can be considered the sum of the three TBL pillars as shown in Glavic & Lukman’s (2007) model (*Figure B.25*). This model is generated as a result ofwidespread acknowledgement of an ongoing proliferation of impact assessment terms and concepts:

- ‘Terminology in the field of sustainable development becoming increasingly important’ and the need for ‘clarifying ambiguity’ (Glavic & Lukman, 2007, p1875);
- ‘The number of tools and approaches to develop sustainability is growing rapidly. Sometimes they are presented as if they are contradictory or in competition’ (Robert et al., 2002,p197);

- ‘proliferation of sustainability assessment principles, strategies, actions, and tools’ have ‘created confusion’ (Waage, 2007, p638).

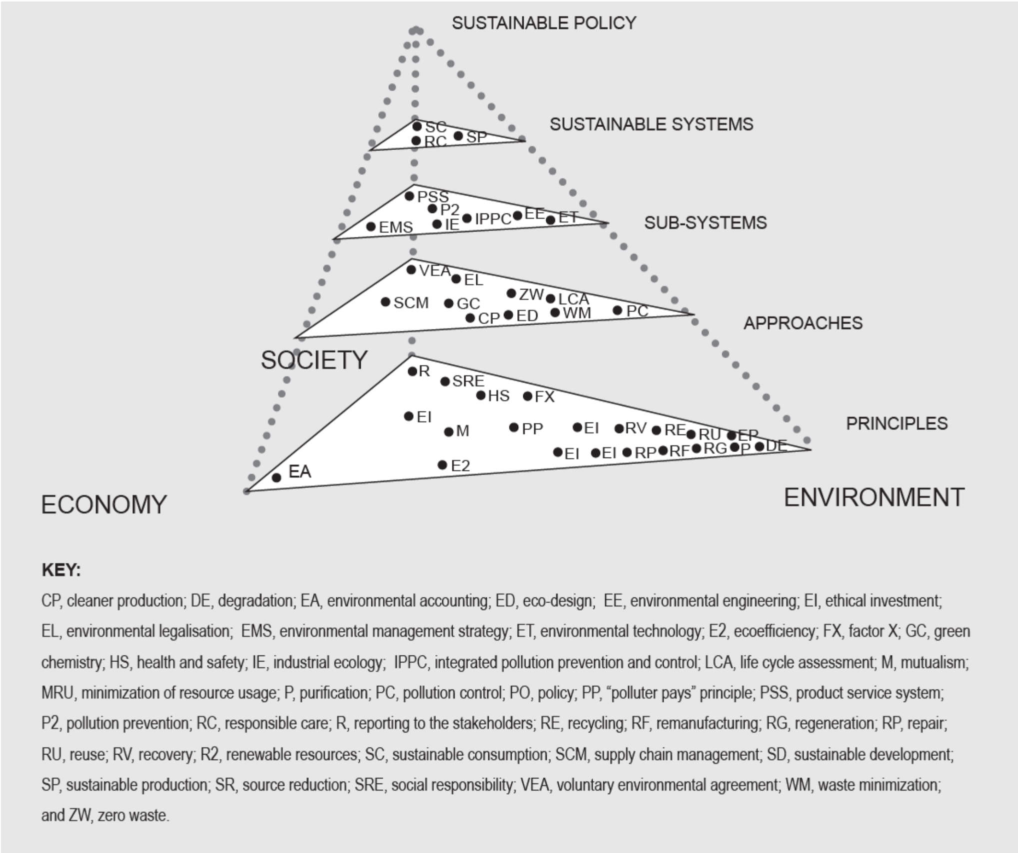


Figure B.25 *Classification of sustainability oriented terms (Glavic & Lukman, 2007)*

51 existing terms are rationalised and incorporated into Glavic & Lukman’s hierarchical model. A further ‘tools’ level is mentioned but omitted from the model. This hierarchical approach has similarities with Love’s (2000) meta theoretical model, although in this case with three dimensional triangular levels to accommodate different placement of terms according to the degree of intersection between the three pillars. Therefore this model graphically illustrates the potential ‘space’ for assessment approaches, tools etc which can provide insights and understanding of *Aggregation* (Norman & MacDonald, 2004). But notably this work is contributing a framework for rationalisation rather than recommending a specific metric for operationalising instances of the factors represented by the three pillars.

The Impact Assessment (IA) field is growing considerably, supported by at least three specialist academic journals, a quantitative network analysis literature review (Caschili et al. 2014) and leading to an ‘analytical arms race’ (Cashmore and Morgan, 2014). The Cashmore and Morgan paper makes the point that there is a ‘politics of naming’ which leads to a proliferation of concepts. They reference the World Bank’s investment in Strategic Environmental Assessment (SEA) as an example of the ‘power’ factors involved, and urging that understanding these factors is an important consideration as part of any attempt to limit, rationalise or integrate the unrestrained growth of IA concepts. Another helicopter view of the field of IA is provided by McCreless, et al., (2014) who propose an evolution of thinking about metrics (similar to Jones & VanPatter's (2009) software development metaphor) whereby Metrics 1.0 is the stage of recognition at company level of the need to identify impact; Metrics 2.0 is the stage where common sector standards become established and Metrics 3.0 (their recommendation) the stage where widespread recognition of standardised metrics leads to integration across stakeholders and a focus shifting to value enhancement rather than monitoring and auditing. The evidence from much of the design impact field is that much of the sector is not even reaching the Metrics 1.0 level.

Return on Investment (ROI) and Return on Design Investment (RODI)

Godin (2009) states that 'Return on investment is easy to measure', differentiating ROI from the greater complexity of return on *design* investments. Hertenstein et al. (2001) identified that; 'While there are well-understood ways to calculate a firm's return on investment (ROI), there is not yet a way to calculate a firm's return on design (ROD), or even to determine what proportion of the I is really D.' (p10). Whicher et.al (2011) state that ROI is 'probably the dimension that has been best explored under current practice' (p47), however they also quote the European Commission (2009); "lack of knowledge and tools to evaluate the rate of return on design investment." as a significant obstacle to the wider understanding of design. The UK's Design Council's has generated their own variation on ROI figures based on turnover rather than profit; 'For every £100 a design alert business spends on design, turnover increases by £225' (Design Council, 2007b, p4) or, based on case studies from their Designing Demand programme; 'for every £1 businesses invest in design, they can expect over £20 in increased revenues' (Design Council, 2012). Note that this ratio is not a conventional representation of ROI. The impact of design expressed as ratios also features in the review by Ive (2006) in the built environment sector where he questions the 'widely accepted' 0.1:1:5:200 ratio, where the first figure is the design cost, followed by the facilities management cost over the building life, followed by all costs of conducting business in the building. Ive highlights the inadequacies of this metric by suggesting that the actual ratios, based on a survey of London buildings are closer to 0.1:1:1.5:15. The context is the same as in other fields of design – of exploring ways to demonstrate and communicate the added value of design.

Visocky O'Grady &Visocky O'Grady (2013) give a basic formula for an ROI calculation as:

$$\frac{\text{Gain of investment} - \text{Cost of investment (gross profit)}}{\text{Cost of Investment x 100}}$$

However they also point out that this calculation doesn't disaggregate the design contribution. Therefore the calculation can be enhanced to demonstrate the *Design* ROI or RODI. However Godin (2009) cautions in his definition of 'four zones of return' (negative return, no impact, positive return, the whole thing), that most design falls into the 'no impact' category, meaning that design makes no measurable difference to revenue.Notwithstanding these challenges, the general principles of ROI has also been applied to analysis of impacts of investment on society, for example to analyse the effectiveness of public health investments (Tobacco ROI, Pokhrel, 2014) or with Social Return on Investment (SROI) (Lingane & Olsen, 2004). These metrics can be considered part of a Cost/Benefit analysis approach to considering impact, although Lingane & Olsen (2004) point out in relation to SROI that; 'cost-benefit analysis typically frames benefits and costs as trade-offs and does not facilitate planning or prioritizing that optimizes both financial and social value creation' (p117).

Key Performance Indicators (KPIs) and Critical Success Factors CSFs)

Metrics, KPIs and CSFs are very well established terms in business and more specifically, performance management fields. In simple terms metrics can be considered the measurement of a factor (eg cost, time) relevant to management. The KPI concept is concerned with selection of metrics relevant to evaluating a specific performance management situation (eg company, project or individual performance). The KPI concept emerged as a result of the increasing complexity of many business environments and management issues with using unsuitable metrics for understanding a specific situation, or the selection of metrics to specifically target enhancing performance. *Leading indicators* are KPIs which are performance indicators providing insights on future performance (Kerzner, 2011).

Related to the KPI concept, Rockart (1979) developed a method for company CEOs to monitor summary information about their companies defined as*Critical Success Factors*(CSFs). Rockart's original paper uses the example of styling in the automotive industry and NPD in the food industry as examples of sectors where metrics and data based KPIs alone might not provide a basis for strategic analysis of relevant – success-factors. Therefore it is proposed here that the concept of CSFs is relevant both to identifying CSFs within a 'client' company, and also for understanding the CSFs within design activity. Summary points from the Rockart (1979) paper are: 1) Financial data rarely captures CSFs effectively, 2) a third of the CSFs in the examples given are factors external to the company, 3) some CSFs require amalgamation of data from different sources – a role for IT, 4) about a fifth of the example CSFs rely on subjective data from within the company – initially higher, but the paper argues that work should be done to discover objective metrics – but interpreting the subjective data from the remaining 20% is part of the role of the CEO, 5) CSFs can be categorised as either 'monitoring' or 'building' eg the latter for a strategic, future planning nature. This reflects the flexible, iterative nature of the concept – CSFs will change over time.

Further relevant references to CSFs which make explicit links to performance include Belassi et al (1996) who categorise four groups of factors to be considered: 1) Project related (eg size & value), 2) Project manager and team related (eg competence and commitment), 3) Organisation related (eg senior management support) and 4) External environment related (eg client or economic context). This is deemed important in order to differentiate between CSFs which are controllable (eg by a manager) and those which are not.

In the project management field Westerveld (2002) proposes a *Project Excellence Model* claiming that the CSF concept didn't deal with 'how success is judged' (p415). This work also emphasises the different requirements of company and project level evaluation. Westerveld's literature review suggests a similar categorisation (to Belassi et al,. 1996) of factors to be considered: 1) Time, budget, quality, 2) Client satisfaction, 3) Project team satisfaction, 4) User satisfaction, 5) Supply chain satisfaction, 6) stakeholder satisfaction. The same literature review process is used to cluster CSFs into 6 groups: 1)leadership and team, 2) Policy and strategy, 3) Stakeholder Management, 4) Resources, 5) Contracting and 6) Project management.

In the architecture-engineering-construction (AEC) context, Koutsikouri et al (2008) carried out an extensive literature review of CSF studies (63 studies) concluding that it has been difficult to develop an appropriate way to measure 'success' as an holistic entity'. Their interest is in collaborative multi-disciplinary design projects and from an empirical study identify 175 CSFs, rationalised to 31 and then organised into four groups: management factors, design team factors, competencies and resources factors and project enablers. The work concludes by suggesting considering these factors in a systems model and by identifying 'super soft factors' overlooked in earlier work, such as motivations and emotions – socio-political factors – organisational catalysts.

More recently Miller and Moultrie (2013a, 2013b), not referencing Koutsikouri's work, undertake an extensive literature review and empirical study developing *A framework of design management roles in fashion retail.* This work confirms lack of earlier knowledge and understanding of the 'super soft' factors, particularly in the design field, which can be determinates of success. The focus by Miller and Moultrie on leadership correlates with design management models (eg Kootstra, 2009) which identify design leadership as a significant ingredient in impact or performance.

B.5.3 Planning Canvases

Emerging from the EC funded work exploring value creation by design (Barcelona Design Centre, 2014a), amongst other outputs, a tool kit is proposed; 'aiming to guide companies and/or organisations in their innovation processes in order for them to develop better understanding of design value and its potential' (Barcelona Design Centre, 2014b). The tool kit builds on the positioning developed within the €Design project and asks users to respond to five tasks on a 'canvas' – eg a template with five zones for recording the responses to the tasks. Whilst not referenced to the *Business Model Canvas* (Osterwalder, 2004), it can be seen that the concept derives from this and from Osterwalder's own references; the *Strategy Canvas* (Kim & Mauborgne, 2002) and the Value Map (Kambil et al., 1996).

Osterwalder's work proceeded from his PhD (2004) which looked at creating a business model ontology where 'business models help to capture, visualize, understand, communicate and share the business logic' (p20). The background work in the PhD includes results of an extensive review of existing models (*Table 2.25*), including the identification of measurement and evaluation as a significant category of factors. Osterwalder acknowledges strong influence from the Balanced Score Card (Kaplan & Norton, 1992) concept.

Table B.25 *Rationalised elements of Business models (Osterwalder, 2004)*

Pillar	Building block of Business Model	Description
Product	Value Proposition	A Value Proposition is an overall view of a company's bundle of products and services that are of value to the customer.
Customer Interface	Target Customer	The Target Customer is a segment of customers a company wants to offer value to.
	Distribution Channel	A Distribution Channel is a means of getting in touch with the customer.
	Relationship	The Relationship describes the kind of link a company establishes between itself and the customer.

Infrastructure Management	Value Configuration	The Value Configuration describes the arrangement of activities and resources that are necessary to create value for the customer.
	Capability	A capability is the ability to execute a repeatable pattern of actions that is necessary in order to create value for the customer.
	Partnership	A Partnership is a voluntarily initiated cooperative agreement between two or more companies in order to create value for the customer.
Financial Aspects	Cost Structure	The Cost Structure is the representation in money of all the means employed in the business model.
	Revenue Model	The Revenue Model describes the way a company makes money through a variety of revenue flows.

Through Osterwalder's review and the identification of the *visualisation* goal of business models, he proposes combining the strategy canvas concept (Kim and Mauborgne 2002), with the value map (Kambil, et al. 1996) together with consideration of the entire 'value life cycle' (p56). This combination results in the *Business Model Canvas* (Osterwalder & Pigneur, 2010) shown in *Figure B.26*. The application of this model involves participants making notes, diagrams and iterations on a simplified template version of the 'canvas' on the basis of 9 building blocks with *Value Proposition* at the centre of the canvas. According to the authors 'visual thinking is indispensable to working with business models' (p148) therefore the work has resonance with designers' preferred working methods. Underpinning concepts within the work also include the idea of business model *innovation*– challenging paradigms and the core *Value Proposition* 'pillar' at the centre of the canvas.

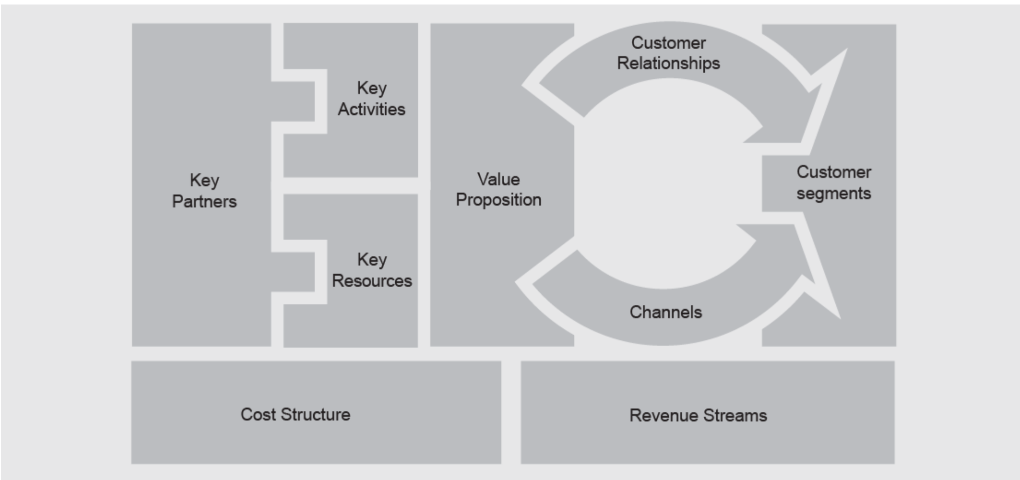


Figure B.26 *Schematic view of the Business Model Canvas (Osterwalder & Pigneur, 2010)*

Osterwalder & Pigneur also link their model with Galbraith's Star Model (Galbraith, 1973) ref *Figure B.27*. They advocate that their model fits at the middle of the star, determining strategy for all the other elements of business management. Together these models can be considered part of the fields of Business models, Enterprise architecture or Organisation design; each with considerable bodies of literature. The Business Model Canvas is of particular interest because: 1) its origins lie in a synthesis of thinking in these fields, 2) It considers ontological approaches as a means to rationalize knowledge as a basis for IT based tools, 3) In the evolution of the concept it puts emphasis on the importance of visualisation and designerly approaches, and 4) The approach is concerned with business model innovation and working across sectors and scales of operation.

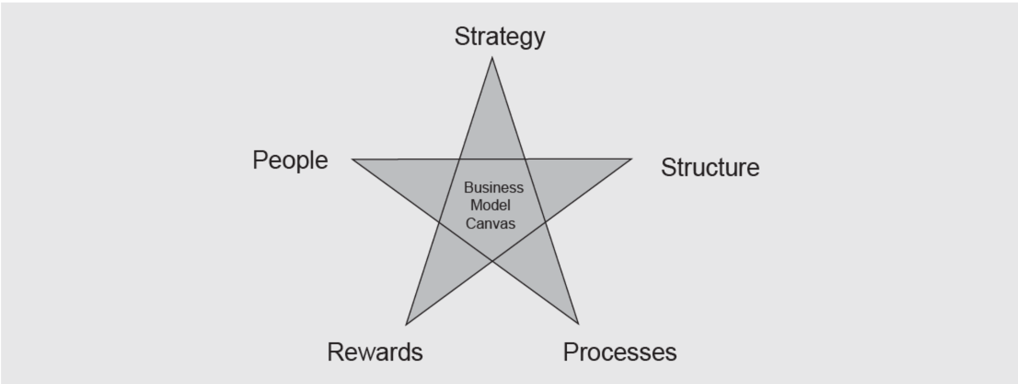


Figure B.27 *Galbraith's Star Model (1973) to guide organisation design with the Business Model Canvas (Osterwalder & Pigneur, 2010) at the core*

B.5.4 Summary framework for models and metrics

Figure B.28 provides a visual framework and summary of the review of literature related to models and metrics for understanding design impact. Key points which this framework aims to capture are summarised as follows:

a) Need for recognition of how design operates within nested contexts from the general domain to the firm, business unit or project level
b) That design is an ingredient within value propositions, value chains etc leading to impact, therefore an *ingredient* of impact
c) Design activity (the process of designing) is core to creating (design) value, and this extends beyond conventional notions of economic value
d) Many studies and approaches are focused on economic added value. But social and environmental added value factors should also be effectively integrated into a more complete understanding of design impact
e) There are a considerable number of models and metrics which can be used as a basis for operationalising studies of design impact within the framework shown.

But there is considerable scope for improvement throughout a theory to practice hierarchy

f) Relating established models and metrics for understanding design impact to a core input-process-output – impact sequence helps to distinguish the underlying design activity

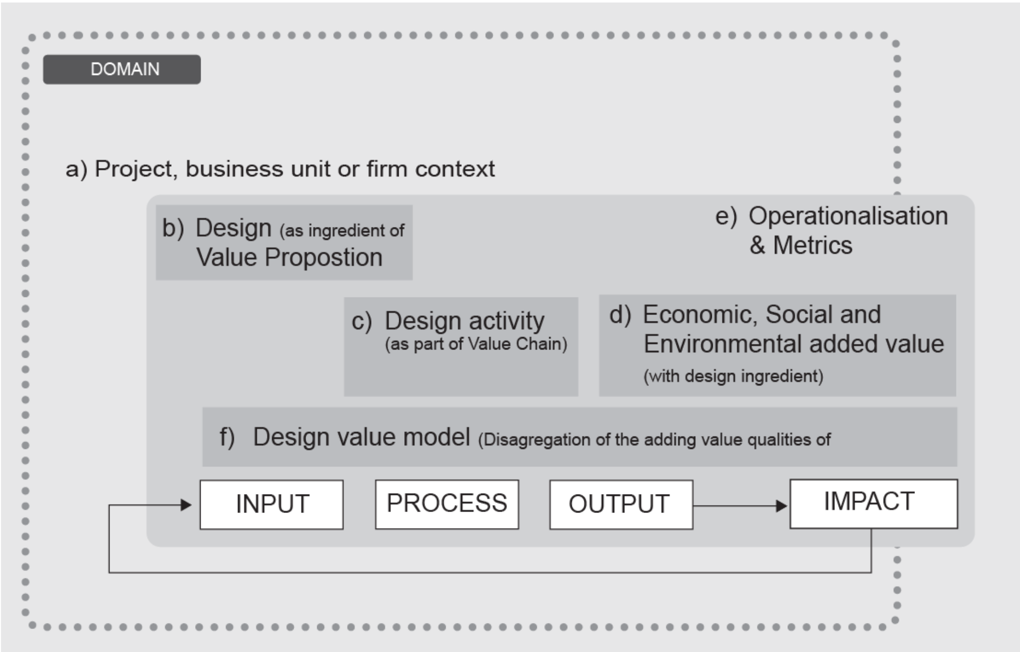


Figure B.28*Summary framework for linking value concepts*

B.6 Design Research

Many researchers exploring design theory describe the inherent complexity of design and design process and it's resistance to definition within universally agreed models. (egLawson, 2004, Clarkson &Eckert, 2005). However this complexity is acknowledged as a positive defining feature within concepts such as wicked problems (Rittel, 1967 cited by Buchanan, 1992) and design thinking (Buchanan, 1992, Brown, 2009). A further consistent theme within design and innovation process literature is the identification of, and associated problems with, the gap between academic development of conceptual models and the reality of commercial practice (eg Buijs, 2003 and Blessing & Chakrabarti, 2002). A distinction can be made between academic studies which draw directly on primary research with industry (eg Buijs, 1993) with an industry benefit aim, or primarily literature based studies which seek to rationalise and refine theoretical models (eg Love, 2000 and Lawson, 2004). Design research can also be categorised in relation to its role and value within industry. For example, the adoption by Philips design of Frayling's (1993) classification (Kyffin, 2009): Research FOR design –research in direct support of design projects, such as specific ergonomics research, Research THROUGH design – using design and it's particular creative qualities as a research method within projects and Research INTO design – which would include exploring new methodologies, for example as a result of emerging technologies or contextual issues. Cross (2001) identifies issues with the 'scientising' of design research and advocates recognition of the distinctive cross cutting theme of '*designerly ways of knowing*'.

B.6.1 Challenges for research INTO design

Emerging from the theoretical end of the spectrum of process research there are a range of issues which research INTO design is aiming to resolve. These include - at a meta theoretical level - studies aiming to rationalise a single coherent theory of design (Love, 2000 & 2002), of which design process is a key element), or to re-conceptualise the subject (Blackwell et al, 2009 and Dorst, 2008). Love's earlier literature review paper identifies four 'serious criticisms' of design research as follows:

- 'That there exists a substantial amount of *confusion* with respect to the underlying basis of many theories, concepts and methods.'
- 'That in developing and validating theoretical aspects of the study of design, many writers are unjustifiably *conflating* concepts drawn from a range of sources.'
- 'That there exists an unnecessary *multiplicity* of design theories and concepts.'
- 'That the terminology of design research has become unnecessarily and unhelpfully confused and imprecise by dint of the above points.'
- (Love, 2000, p295)

Love's later paper (2002) summarises reasons why a unified theory has not developed:Theory being tied to single domains of practice, a neglect of epistemological and ontological issues in theory-making, a lack of agreement about definitions of core concepts and terminology, in addition to poor integration of theories specific to designing and designs with theories from other bodies of knowledge. Blessing & Chakrabarti (2002) identify a three point critique of the body of design research: a lack of overview of existing research, a lack of use of results in practice, a lack of scientific rigour. Dorst (2008) identifies five criticisms of research into design: (1) an unresolved dichotomy between design process research based on reflective vs goal orientated approaches, (2) "trigger happy" research which jumps too quickly to proposals for new methods, (3) "pre-scientific" methods without rigorous evaluation, (4) no generally accepted approach to "quality" and (5) no broader view of design beyond "the design project".

- Comparing knowledge structures in design practice is explored by Wodehouse & Ion (2010) and Sim & Duffy (2003), the latter exploring the notion of an ontological approach. Wang & Ihan (2009) criticise Love's proposal of an epistemological approach reflecting the concern of many, that this does not adequately encompass the creative and social dimensions of design activity. They go on to state that "Love is just incorrect" (p15) to suggest the desirability of a single body of design knowledge. However, they do acknowledge Love's suggestion that much of the knowledge used by designers is more appropriately classified in related disciplines. Love's 2000 paper concludes by proposing a 10 point hierarchical structure for design research based on levels of theoretical abstraction. *Figure B.29* shows this placed alongside Frayling's (1993) model. The aim of this juxtaposition is as a general indicator of how design research relates to design practice. Placed together - one created to enhance the coherence of design research (Love), the other to clarify the role of design research within industry (Kyffin) - they provide a useful map; spanning *ontology of design* (Love's highest level of abstraction) through to commercially driven *research for design*.

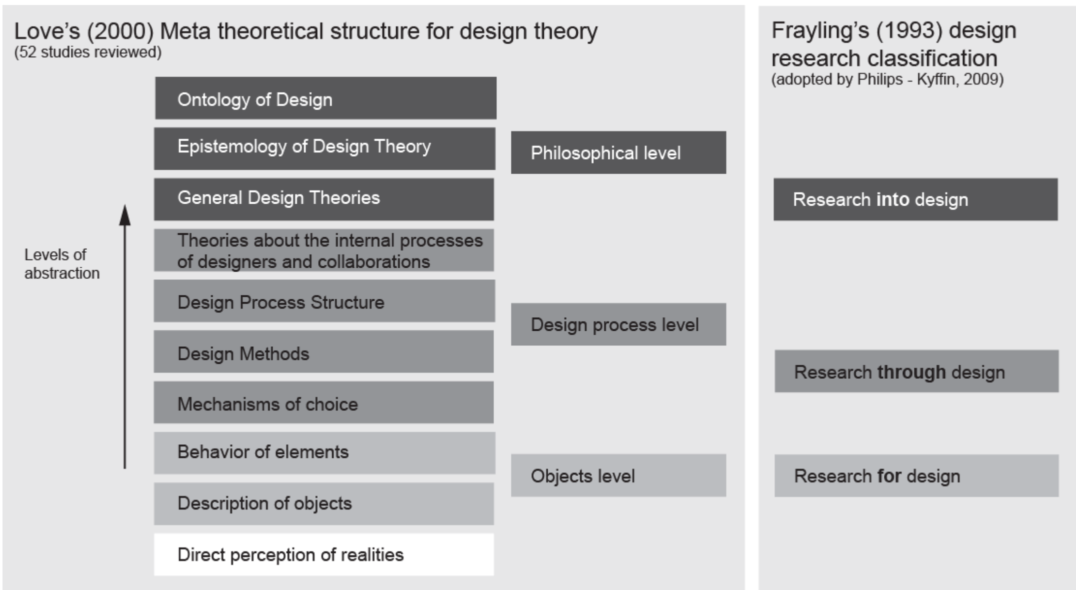


Figure B.29 *Rationalising a framework for exploring design theory and research derived fromLove (2000) and Kyffin (2009), citing Frayling(1993)*

B.6.2 Epistemological and Diffusion issues

The studies of design process by Birkhofer (2005) and Eckert& Stacey (2010) provide two further perspectives which are relevant to considering how Design research relates to the overall consideration of design impact and potential *Support* (Blessing & Chakrabarti, 2009). Adopting the term here of *Diffusion (*eg from *Diffusion of Innovations*, Rogers, 2003), it is clearly important to consider the relationships between academic studies of design, professional practice and diffusion of design research. Based on a critical view of the value of academic study of design process, Birkhofer (2005) provides a useful Venn diagram to consider these factors (*Figure B.30*) based on supply, demand and application. The optimum position, at the centre of the diagram represents examples of design methods which are universally agreed to be of benefit to design eg: requirements identification, generating variants, systematic design. Based on an industry interview study, scope for improvement is identified for the three main elements: 1) Supply - Improve utilisation of design methods & productivity factors, 2) Application- Improve efficiency of existing industry practice and 3) Demand - Improve identification of demand for new methods.

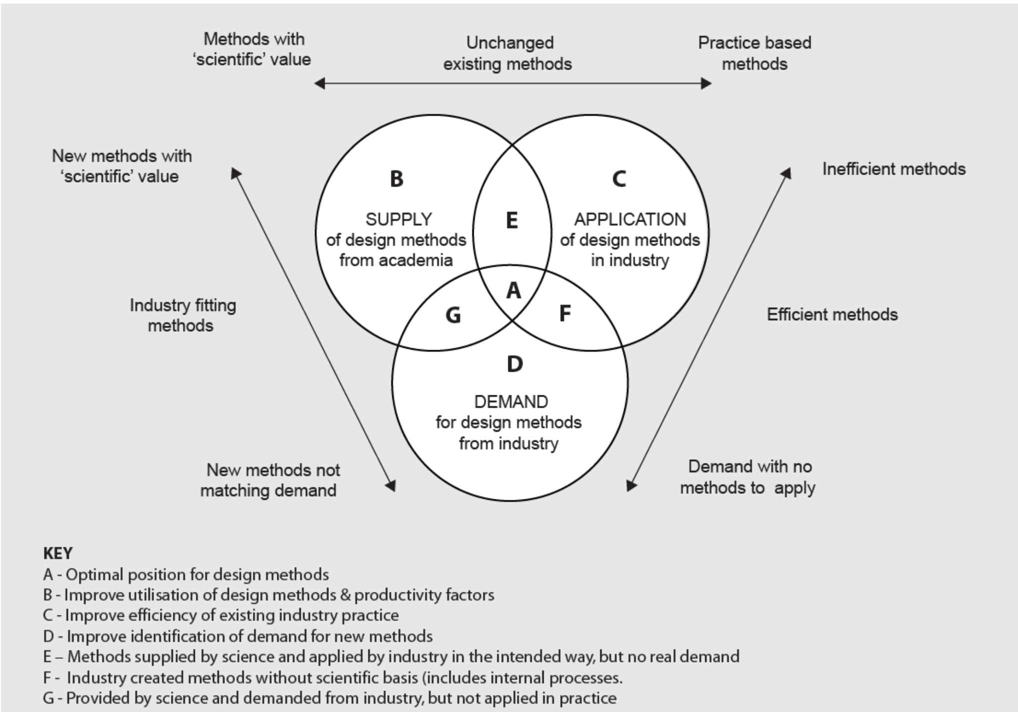


Figure B.30 *Supply, Demand and Application of Design Methods (Birkhofer, 2005)*

Related to diffusion issues Eckert& Stacey (2010) present their critique as a questioning of epistemological factors; introducing design process *models* citing Lawson (2004) '…about as much help in navigating a designer through his task as a diagram showing how to walk would be to a one year old child...Knowing that design consists of analysis, synthesis and evaluation will no more enable you to design than knowing the movements of breaststroke will prevent you from sinking in a swimming pool'. They explore 'Is like' (descriptive models), eg based on ideal case studies, versus 'should be like' (prescriptive models). They contend that the distinctions are often blurred. Highly relevant to the relationship between design process and design impact, and worth quoting in full the authors state;

- 'In the social sciences (*rather than in the natural sciences*), models are more often conscious simplifications of complex situations that are partly dependent on contingent circumstances beyond the scope of the model, so the causal factors included in the model account for part of the similarities and differences between cases. Sometimes this can be quantified statistically in terms of the proportion of the variance in the values of the dependent variables that is accounted for by the independent variables included in the model.' (Eckert& Stacey, 2010, p4)

and, referencing *Soft Systems* (Checkland, 1981)

- 'the premise that the consequence of the subjectivity of individual understanding of social processes such as designing by the people participating in them is that they have *no* objectively true structure. Instead, any account such as a design process model constitutes one subjective viewpoint that isn't necessarily more true than someone else's contradictory view; any shared understanding is both partial and the outcome of a social process of negotiation. Hence, treating a social system as though it has an objectively true or correct structure is at best a pragmatically useful compromise' (p5)

As an antidote and practical response to these complex challenges, Eckert& Stacey offer an alternative approach or criteria for considering design process models; 1) Selection (clarifying the purpose of the model), 2) Consideration of representational Bias (eg Stage Gate process emphasises decision points) and 3) Modelling choices (eg how much detail is put into mapping a situation to the model)

Appendix C Ethics checklist and participant information

Research Ethics Review Checklist

This checklist should be completed for every research project that involves human participation, the collection or study of their data, organs and/or tissue. It is used to identify whether a full application for ethics approval needs to be submitted.

Before completing this form, please refer to the University Code of Research Ethics. The principal investigator or, where the principal investigator is a student, the supervisor, is responsible for exercising appropriate professional judgement in this review.

The checklist must be completed before potential participants are approached to take part in any research.

Section I: Project details

Project title:	UNDERSTANDING DESIGN IMPACT
Proposed start date:	SEPT 2010
Proposed end date:	SEPT/OCT 2014

Section II: Applicant details

Name of researcher (applicant):	STEPHEN GREEN
Status (delete as appropriate):	~~Undergraduate student~~ BRUNEL STAFF
Brunel e-mail address:	stephen.green@brunel.ac.uk
Telephone number:	01895 232806

Section III: For students only

Module name and number or MA/MPhil course and School:	
Supervisor's or module leader's name:	
Supervisor's/module leader's Brunel e-mail address:	

Supervisor: Please tick the appropriate boxes. The study should not begin until all boxes are ticked:

☑	The student has read the University's Code of Research Ethics
☑	The topic merits further research
☑	The student has the skills to carry out the research
☑	The participant information sheet or leaflet is appropriate
☑	The procedures for recruitment and obtaining informed consent are appropriate
☑	A risk assessment has been completed.
☐	A CRB check has been obtained (where appropriate)

Comments from supervisor:

Section IV: Description of project

Please provide a short description of your project:
REF ATTACHED

Section V: Research checklist

Please answer each question by ticking the appropriate box:

	YES	NO
1. Does the project involve participants who are particularly vulnerable or unable to give informed consent (e.g., children, people with learning disabilities, your own students)?	☐	☑
2a. Will the study require the co-operation of another organisation for initial access to the groups or individuals to be recruited?	☐	☑
2b. If the answer to question 2a is **Yes**, will the research involve people who could be deemed in any way to be vulnerable by virtue of their status within particular institutional settings (e.g., students at school, members of self-help group, residents of nursing home, prison or other institution where individuals cannot come and go freely)?	☐	☐
3. Will it be necessary for participants to take part in the study without their knowledge and consent at the time (e.g., covert observation of people in non-public places)?	☐	☑
4. Will the study involve discussion of sensitive topics (e.g., sexual activity, drug use) where they have not given prior consent to such discussion?	☐	☑
5. Are drugs, placebos or other substances (e.g., food substances, vitamins) to be administered to the study participants or will the study involve invasive, intrusive or potentially harmful procedures of any kind?	☐	☑
6. Will the study involve the use of human tissue or other human biological material?	☐	☑
7. Will blood or tissue samples be obtained from participants?	☐	☑
8. Is pain or more than mild discomfort likely to result from the study?	☐	☑
9. Could the study induce psychological stress or anxiety or cause harm or negative consequences beyond the risks encountered in normal life?	☐	☑
10. Will the study involve prolonged or repetitive testing?	☐	☑
11. Will financial inducements (other than reasonable expenses and compensation for time) be offered to participants?	☐	☑
12. Will the study involve recruitment of patients or staff through the NHS?	☐	☑

If you have answered 'yes' to ***any*** of the questions in Section V, you will need to describe more fully how you plan to deal with the ethical issues raised by your research. You should use the appropriate School form or the University Application Form for Research Ethics Approval.

If you have answered 'no' to all questions, **send the completed and signed form to your School's Research Ethics Committee, for their records.**

If you answered 'yes' to ***question 12***, you will also have to submit an application to the appropriate external health authority ethics committee, **after** you have received approval from the School Research Ethics Committee.

Please note that it is your responsibility to follow the University's Code of Research Ethics and any relevant academic or professional guidelines in the conduct of your study. **This includes providing appropriate information sheets and consent forms, and ensuring confidentiality in the storage and use of data.** Any significant change in protocol over the course of the research should be notified to the School Research Ethics Officer and may require a new application for ethics approval.

Signed:	S. J. Green
Date:	27/03/14
Principal Investigator:	
Supervisor or module leader (where appropriate):	PROF. DAVID HARRISON
Signed:	
Date:	27.03.14

Table: Research methods and quality considerations within the DRM structure

Studies	Methods(Data source quantity)	Reliability & Validity considerations
RESEARCH CLARIFICATION	Literature review	
DESCRIPTIVE STUDY STUDY 1.1 Design process and impact in tertiary design education	Focus groups, pilot study of content analysis & modelling (304 student projects& 2 focus groups)	*External validity* has limited relevance for this study which is at an explorative stage. There are threats to the *Statistical validity* in the content analysis. However this is also mitigated by the preliminary nature of this study
PRESCRIPTIVE STUDY STUDY 2.1 Rationalising theoretical frameworks	Literature review& action research (ontology development process) (approx 150 sources)	*Construct validity* is key. Review and iteration of the construct through subsequent stages and triangulation will help to mitigate threats
DESCRIPTIVE STUDY STUDY 1.2 Reviews of design impact from professional practice	Content analysis /case studies (45 case studies – DBA dataset)	Good levels of *External validity* are achieved through the 'external' data source. Analysis creates potential threats to validity. This is mitigated by triangulation with the other studies
STUDY 1.3 Professional perspectives on understanding and communicating design impact (UDI)	Semi-structured interviews (10 professional and academic perspectives)	This study is crucial for triangulating with the findings from STUDY 1.1, 1.2 and 2.1 and providing good validity as a foundation to STUDY 2.2
PRESCRIPTIVE STUDY STUDY 2.1 Developing tools & case studies of application	Action research (design studies) pilot studies and focus groups (2 focus groups, 11 participants in total)	*Reliability* (repeatability & consistency) is inherent to the objectives of this study Validity is determined through the quality of the earlier studies and the range/selection of participants for pilot studies. As an interim Study (ref DRM) high levels of validity cannot be guaranteed.

Understanding Design Impact

Expert Interviews | Participant information & agreement | 07/02/14

Dear

Thank you for agreeing to be interviewed as part of my PhD study titled *Understanding Design Impact*.

Background

For this study I am interviewing around 10 design industry experts as part of an overall study exploring design impact (for example the economic benefit from a specific design project). More specifically, the idea that designers can benefit from presenting stronger arguments for the value of their design input, based on better understanding of design impact. The work has involved various studies, including an analysis of 46 case studies from the DBA Design Effectiveness Awards. This interview is formally described as a semi structured interview, meaning that we don't have to stay precisely on topic, or answer all the questions!

Stephen Green
PhD candidate and Design Programme Director, Brunel University
stephen.green@brunel.ac.uk

Data recording, storage and analysis

Unless otherwise agreed the interview will be recorded and the discussion will be transcribed as a basis for research analysis. The data will be kept securely and will only be used for the purposes of this research. It will not be shared with any third party. Extracts of conversations may be included within the final research outputs (thesis, academic papers etc). In this case all participant information will be anonymous. A summary of the research findings and access to the final thesis can be requested.

Confirmation of agreement to participate

Please sign and date below to confirm your agreement to participate and agreement to data recording, storage and analysis as described above.

Name	Signature	Date

Understanding Design Impact

Development workshop | Participant information & agreement | 15/04/12

Thank you for agreeing to take part in the development workshop as part of my PhD study titled *Understanding Design Impact*.

Stephen Green
PhD candidate and Design Programme Director, Brunel University
stephen.green@brunel.ac.uk

Data recording, storage and analysis
The workshop proceedings will be recorded and the outcomes will be transcribed as a basis for further research analysis. The data will be kept securely and will only be used for the purposes of this research. It will not be shared with any third party. Extracts of conversations may be included within the final research outputs (thesis, academic papers etc). In this case all participant information will be anonymous. A summary of the research findings and access to the final thesis can be requested.

Confirmation of agreement to participate
Please sign below to confirm your agreement to participate and agreement to data recording, storage and analysis as described above.

Name	Signature

Appendix D STUDY 1.1 Related conference paper

INTERNATIONAL CONFERENCE ON ENGINEERING AND PRODUCT DESIGN EDUCATION
6 & 7 SEPTEMBER 2012, ARTESIS UNIVERSITY COLLEGE, ANTWERP, BELGIUM

MAPPING DESIGN PROCESS AND RADAR ANALYSIS OF DESIGN ACTIVITIES

Stephen Green[1], Mark Young[2] John Boult[3]
[1,2& 3] Brunel University, UK

ABSTRACT
There is considerable interest in quantifying the impact of professional design activity: At a policy level governments and professional bodies require objective measures of value added to national economies. At firm level there are a range of benefits derived from understanding of value-added to individual businesses or product development activities. However, despite various initiatives, such as national surveys and competitions, there is limited effective communication and more detailed understanding of how design activity creates impact. Building on over 40 years of research into design process, the reported study proposes a rationalised design-space and process model for creating design process maps and radar charts as a basis for unified exploration of a range of factors which affect the outcomes, and therefore impact, of design activity. These methods: Design process maps and HEET radar charts, are applied in various longitudinal studies of design pedagogy. The results highlight differences between design theory and practice together with deficiencies in design process and project orientation within the sampled projects. The overall outcomes inform ongoing development of design evaluation techniques and the communication of design impact.

Keywords: Design process, Design space, Design impact, Design process mapping

1 INTRODUCTION

Design is widely recognised as an important component of the creative industries, innovation and New Product Development (NPD)[1][2] and together, an important driver for national economies[3]. There is considerable interest in quantifying the impact of professional design activity: At a policy level the UK Design Council identify that 80% of UK business agrees that design will help them stay competitive in the current economic climate[4]. The UK DCMS identifies that design contributes £1.6bn of the £59.1bn GVA generated by UK Creative industries[5] and various government reports highlight the potential of design and the creative industries to contribute to the future economic wellbeing of the UK, eg Cox[6], Sainsbury[7] and Dyson[8]. Although it is noted that nearly 80% of businesses surveyed stated that designers are only; '*quite good',* through to; '*not good at all',* at communicating the value of design activity[9]. At firm level the DBA's Design Effectiveness Awards or the European Design Management Award aim to highlight individual cases of the positive impact of design activity. But these initiatives do not necessarily lead to a finer grain understanding of the ingredients and recipe for design impact. Design is a component of innovation, and within this field there are numerous examples of models and methodologies with goals of identifying the constituent factors and added value of innovation[10]. However, in traditional business metrics terms the value of innovation and design have proved very resistant to quantification[11]. Within design there is more limited evidence of systematic explorations of how value is derived from design activity. Rather than simply considering outputs we can consider how outputs are derived from *inputs* and *process* in an *input-process-output* model. For example, within NESTA's work[12], input factors are identified as a basis for measurement of innovation as well as measurement of the more conventional output factors. Within the professional practice of design any instance of *input-process-output* is likely to be very complex. However, in order to develop better understanding of *potential* design impact there is a need for better understanding of the elements and inter relationships within an input-process-output model.

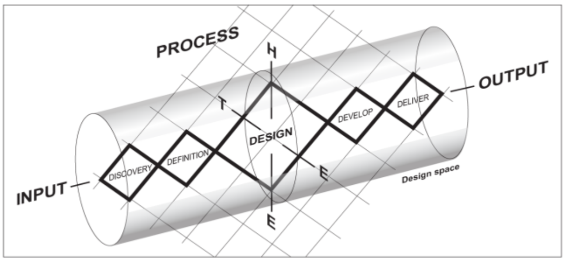
The relationships between theory and practice and the development of new design evaluation approaches can usefully be considered and developed in the context of design pedagogy with resulting benefits for design teaching as well as contributions to the overall issues of evaluating design activity.

2 MAPPING DESIGN PROCESS WITHIN THE DESIGN SPACE

Considering the design process core in an *input-process-output* model, Bruce Archer writing in Design Magazine in 1963 is credited with the first example of breaking down design process into a number of stages[13]. Subsequently, exploration of stages and sequences of design activity have been a significant focus within design research. Aims for this research are often focused on improving the performance of design outcomes. Models of design process have strong parallels with models of innovation and New Product Development (NPD) practice. For example based on NASA's work in the 1960's identifying four key sequential stages: Analysis, Definition, Design, and Operation[14].

Classifications of design process from the expanding body of literature reviews include: Rothwell's chronological categorisation of five generations of NPD models[15] and Blessing's four categories of design models (cited inWynn and Clarkson[16]). Wynn and Clarkson's own review of design process literature proposes three categories of design process models according to how relevant they are as a basis for exploring practical process improvement. The Design Council's 2007 study[13] recommended the Double Diamond model with four identified stages: Discover, Define, Develop and Deliver. The diamond shape relates to concepts of divergent and convergent *Behaviour*[17]. The Double Diamond model is reported as placing particular emphasis on the Discovery stage, with the stated benefits of maximising the impact of design interventions. The Design Council also asserts that there is a correlation between business success and presence of a formalised process for design. Four or Five 'D' design processes feature strongly in Dubberly's 'compendium' of 131 design process models[18]. Howard et al's study[19] on integrating creative process with engineering design process and output provides a more recent review of both design process and creativity literature. The core, staged, linear approach is confirmed as the dominant approach for design process models. 23 models are reviewed and rationalised within a six stage matrix. Significant points from this work include making the distinction between a 'routine path' and a 'creative path' based on the evidence from studies on innovation and the importance of creativity to economic success. They also promote the value of their work for targeting, developing and evaluating new design tools. For example, they identify the importance of, but limited understanding of *information* within various stages of the input-process/creativity-output matrix (p177).

Stuart Pugh[20]had introduced 'Total Design', a theoretical model of design process, also with a six stage linear core. A staged linear model is common to many representations of design process, however the distinction which is drawn out in his work is the importance attached to the idea of integration of a wide range of factors into an 'envelope' for the whole process. 34 categories of input factors are identified which should be considered during product engineering projects. Initial review and analysis of these factors, the first stage in the Total Design process, are defined in a Product Design Specification, which is another important element of Pugh's model (p44 op cit). The overall model also incorporates the idea of specific techniques, methods or tools which might be applied at each stage of the process (p220 op cit) The work goes on to explore how the model may also integrate with business in the form of a 'business design activity model' (p178 op cit). Pugh's envelope has strong parallels with the concept of a 'design space'. The advantages of enlarging a design space as a basis for more 'creative' design solutions is identified by Gero &Kumar[21]. Burgess et al[22] and Jones et al[23] explore methods for charting design variables within visualised design spaces as a basis for improving the performance of design and outcomes.



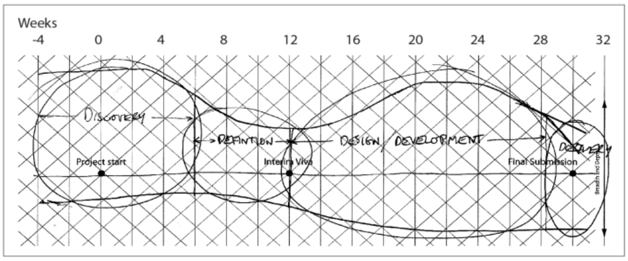


Figure 1: Design process within the design space (left), Tutor's view of 'ideal' Major Project design process (right)

An updated 'Total Design' Model (ref figure 1, left) accommodates, within an overall input-process-output model and design space, the following factors: Distinct STAGES or phases of work, DIVERGENT-CONVERGENT patterns of work and SCALEABILITY. In combination, recognition and exploration of these factors contribute to greater Knowledge and information[13][19]. Specific instances of a complete design process will also demonstrate the divergency of 'paths' adopted by different designers.

A longitudinal section of the model has been the basis for a series of exploratory exercises within the tertiary design teaching environment: Design tutors recording their reflections on actual and 'ideal' process within major projects and MSc students completing blank templates to explore their project planning and their actual design practice. The objectives for these initial applications of the mapping techniques include: refining teaching materials, highlighting issues and opportunities within the underlying design pedagogy and enhancing students' own understanding of design process as a basis for enhancing their design practice. Figure 1 (right) gives an example of a completed map template. In each exercise templates have been completed by the group taking part and results can be evaluated on the basis of these completed maps and also through discussion of points arising whilst sketching out information on the templates.

Analysis - Exploring design process principles with MSc students: Using the 5'D's model in the explanation of the map strongly indicates a favoured, and linear, structure. This can be a barrier to participants' developing a deeper appreciation of issues, with recognition that actual design practice does not necessarily conform to this representation of five sequential stages. This corresponds to the views of many critics of conventional linear design process models, eg Lawson[24]. The specific choice of terms for the stages may also be an example of criticism of inconsistent use of terminology within design methods[25]. However, in the opinion of the students, a graphic representation is a useful device within the context of design education, but the value of any application in commercial practice is untested. This underlines the gap between theory and practice, where initiatives such as this must effectively communicate potential for added value to the intended audience[26].

Analysis - MSc student maps: Reviewing 81 maps completed at various points by two separate cohorts, the distinction between theory and practice is marked. At early project stages, students understand the established principles of stage based activity and create maps which generally fit the theoretical models. However with maps reflecting actual practice; produced mid project, activities become more fluid with considerable overlaps and 'miss-matches' between designated milestones and activities. For example mapping projects which are not fully defined at a crucial deadline, but with creative work already generating ideas in response to an ill defined problem. Few participants' maps reflect *Design* activity taking place throughout a design process, and design is often 'squeezed' into short phases. Although inconclusive, this is an important finding from a pedagogical, professional and theoretical point of view. Whilst it might be argued that *Design* or creativity is a key characteristic of all design process activity and is a foundation to the Design Thinking concept, the findings from these cohorts highlight considerable potential to enhance these core attributes.

Analysis - tutor maps: The tutors' maps (completed for actual and ideal practice) strongly reinforce that students might pay more attention to *Design* or creativity throughout the design process. Figure 1 (right) shows an elegant variant of a map, where *Design* is shown as an activity enveloping all other activities. The tutors' maps also highlight their desire for students to spend more time on Development and Delivery stages. This underlines the pedagogical value of the mapping as an aid to project planning. An aspect of practice which students stereotypically struggle to manage effectively.

These longitudinal design process maps represent selective recording of the wide range of factors which ultimately determine design outcomes. However specific instances of design process can be explored in more detail using the same underlying model. This finer grain evaluation is carried through what is termed HEET radar evaluation.

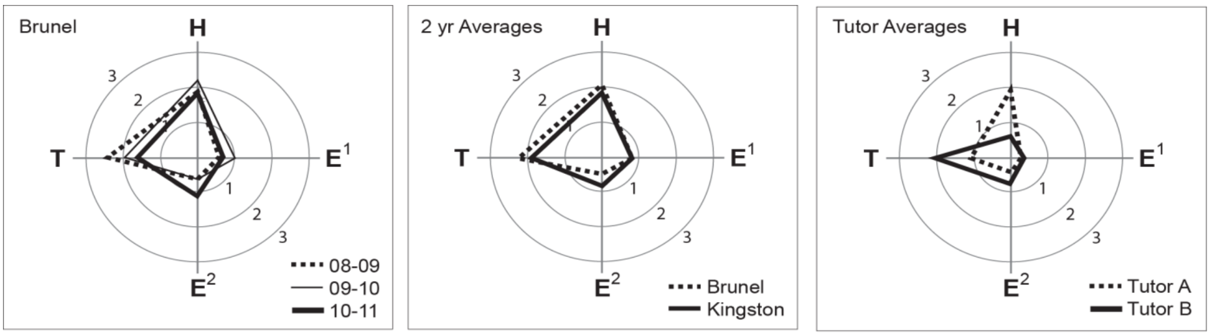
2 RADAR EVALUATION

A radar chart or spider diagram is a widely accepted tool to visually compare multiple variables. The method demonstrates benefits derived from identifying data trends, communication within teams and evaluation of alternative data sets[22]. In this study a radar chart can be used in conjunction with the design process map to evaluate the contextual orientation of specific instances of design project, and the depth and breadth of the activities. The HEET acronym is derived from the significant macro contextual factors within PESTEL type analysis, re-defined as: *Human* factors (H), *Environmental* factors (E^1), *Enterprise* factors (E^2) and *Technology* factors (T). The underlying HEET radar concept can be applied very broadly to a wide range of situations where these contextual factors need consideration. A simple diagram can be used to communicate that a typical design project will encompass a wide range of contextual factors which can be grouped under the four headings. Further, the relative weighting of these contextual factors within any given project can be plotted onto the poles of the radar chart indicating the area covered by the project. Comparative evaluation of different plots or areas can be simply visually communicated.

This 360 degree overview of all of the factors, which may impact or be relevant to a design project, links to the principle of 'major primary specification elements' – the 34 categories of factors identified by Pugh[20] and the benefits of expanding the design space envelope[21]. In parallel with Pugh's Product Design Specification, the HEET radar provides a basis to consider the weightings of contextual factors for a project as whole, and at individual points during the chronology of a design process (ref figure 1, left). The HEET Radar chart was originally conceived with the twin objectives of analysing the enterprise orientation of Design Major Projects at tertiary level together with having applications in design pedagogy as part of communicating a wider range of factors which potentially affect design outcomes.

In order to apply the HEET radar chart as an evaluative tool, meaningful values need to be attached to each pole. In the early applications for the HEET radar a simple zero to three scale with defined generic criteria has been used. The underlying concept allows for significant variation in the nature of the values applied. For example an A* to F scale familiar within educational contexts could be developed with suitable grade point descriptors. Sub-headings within each of the HEET poles (eg Pugh's 34 categories) might be identified and quantitative measurement factors applied to each sub-heading.

A longitudinal evaluation of design Major Projects at two of the UK's leading design schools (Kingston and Brunel) formed the basis of the initial application of the HEET Radar concept. The research objective of this initial exercise was to provide a benchmark of enterprise orientation within student projects and to explore variations in results between the two institutions. In a first exercise, the outcomes of all final year design major projects from each of two previous years were evaluated at both institutions. Major Projects typically represent the culmination of the whole undergraduate experience and are intended to aggregate all the earlier knowledge, skills and experience. The data gathering and evaluation of individual projects was carried out by researchers based at each institution on the basis of reviewing images and descriptions of the projects, together



with discussions with the project tutors. The researchers used a three point scale with defined criteria to grade projects against each of the HEET Radar poles.

Figure 2, HEET Radar charts for Kingston and Brunel Major Projects

A total of 55 projects at Kingston, in two years, and 249 projects at Brunel over three academic years were completed in the Product/Industrial/3D design areas. It was acknowledged that the zero to three scale combined with evaluation based largely on review of project summaries is a relatively crude evaluation. But it met the requirements of establishing a general overview of the comparative levels of consideration between different contextual factors and a comparison between practice at

Kingston and Brunel. The results are surprisingly similar between the two institutions (figure 2, middle). Average values for all the projects indicate strong focus on both *Human* (H) and *Technology* (T) factors. This is what might be expected for the professional activity of design where the historic focus, particularly in 3D design areas, ultimately leads to the production of artefacts. These artefacts typically include T in their production and/or use. They also typically aim to enhance user experience, H factors. However, as explored in the earlier sections of this paper, it is widely acknowledged within the profession that the scope of designers' activity is becoming broader and more complex[24]. The results do indicate consideration of a broader range of factors, but these other factors receive considerably less emphasis when considering the average results for the complete set of projects. The overall average for *Environment* (E^1) is 0.55, slightly lower than *Enterprise* (E^2)at 0.61. It is worth emphasising that these results are not intended to indicate a quality judgement on the work, rather to expose the comparison between the main HEET categories. The differences between E^1 values across the institutions are negligible, suggesting that neither could claim clear differentiation in these areas. H and T factors are surprisingly close. The averages for Brunel over the longer three year period do indicate a trend towards greater consideration of E^2 factors, albeit at the expense of T factors.

This initial quantitative exercise provides a simple overview as a basis for considering the relative contribution of the HEETfactors within the pedagogy of the design courses at Kingston and Brunel. In relation to the economic and academic macro context summarised in earlier sections, the results provide clear evidence of the scope for, and need for enhancement of pedagogy in the E^1 and E^2 categories. The average values indicate that whilst all students' major projects demonstrate consideration of H and T factors, individual results show that a significant number of students have zero scores for E^1 and E^2 factors. Whilst the comparative importance of each main factor might be argued and could be a point of differentiation for individual students or institutions, it is suggested that in view of the importance of the complete 360° of factors, students should be able to demonstrate at least a baseline consideration of E^1 and E^2 factors within major projects.

A second research exercise based on 108 2010/11 Major Projects introduced the HEET radar methodology to the first and second project supervisors at Brunel. Each produced values for their project supervisions. The resulting charts therefore show the distribution of projects according to the influence of the professional backgrounds of the tutors. Figure 2 (right) shows two divergent examples from amongst the 13 staff involved. The averages from a member of staff with an engineering background (Tutor A) indicate a strong orientation towards T factors. Likewise, Tutor B, with a background in inclusive design results in averages with a marked orientation towards H factors.

Consideration of E^2 factors has increased overall for final year students at Brunel between 2009/10 and 2010/11, however some projects actively demanded consideration of enterprise factors, whilst others have a clear focus on technical or human factors. More detailed analysis would require consideration of an appropriate baseline followed by evaluation at the end of the project in order to review the impact of influences, such as the tutors' input, *within* the projects.

3 DEVELOPMENT CHALLENGES FOR DESIGN PROCESS MAPPING AND HEET RADAR EVALUATIONS

Factors not included within the design process model (figure 1) include: The culture/professional medium, eg Blackwell et al.[27]& Strickfaden et al[28]), consideration of good/bad design (eg Blackwell et al[27]) & stakeholder relationships (eg Buchanan[29] &Blackwell et al[27]). Future work needs to explore how these factors might map onto the rationalised design-space design-process model in addition to any other currently omitted factors which might significantly affect design impact.

A relatively young and unstable history of design theory, combined with various critics of design process theories highlights significant credibility challenges associated with using literally any design evaluation methodology. For example entrants to the DBA design effectiveness awards adopt conventional business metrics to communicate the value of design impact yet these methods are acknowledged to be poor at capturing the essence of design or innovation[10]. Within this study the contribution of *Design* or creativity is perhaps inadequately identified.

This study also highlights another theme identified within design research; the gap between theory and practice. Most notably evidenced in before and after maps of instances of design process completed by student participants. However it is considered a strength of the model and methods explored in that they have considerable potential for simple direct visual comparisons of factors such as; the difference between instances of theory and practice, how creativity maps onto design process, the impact of different cultural and professional mediums and stakeholder relationships (input factors) and instances of good and bad design.

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Appendix E STUDY 2.1 *Towards a Design Process Ontology* – Journal paper

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Towards a design process ontology

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Abstract

In the absence of any single coherent all-encompassing theoretical model of designing, this study seeks to review and rationalise theories of design process as the foundational framework for exploring where value is added through design. This leads to an interim design process ontology, or more simply; a terminological framework whichcan accommodate the significant developments in design process modelling of the last 50 years alongside identification of other significant factors which affect design outcomes. Within the resulting ontology class hierarchy; design process is placed within the wider context of *design domain* and an *Input-Process-Output* classification. Within the *Process* class, *Motivation, Scale*, *Path and Design Process Structures* are identified as significant sub-classes. Research challenges resulting from the interim design ontology are identified.

Key words: Ontology; design process; design process models; fuzzy front end; design thinking.

Introduction

Design is widely recognised as an important component of the creative industries, innovation and New Product Development (NPD)(Jerrard, 1998, von Stamm, 2003) and together, an important driver for national economies (Trott, 1998, p5-7). However, the value of innovation in the creative industries and design in particular has proved resistant to quantification (eg Miles & Green,2008, Livesley & Moultrie, 2008, and 'metrics have generally proven elusive for design processes as a whole' Clevenger & Haymaker, 2011, p443). In this study the term *Design Impact* is used as a description of the value resulting from design *input*. Design impact can be measured, for example, by Return on Investment (ROI); increases in profitability or cost reductions. However this only crudely captures economic design impact after the event. In the macro context for design it is tacitly recognised by design professionals that design can have a wider range of impacts. For example, social or environmental design impacts. In business these might be assessed by triple bottom line methods (Elkington, 1999).

Collectively the various impacts resulting from design might be described as part of *output*. Using the established model from Information systems we can also consider how these outputs are derived from *inputs* and *process* in an *input-process-output*(IPO)model (eg Lederer & Salmola, 1996). Based on the links between these elements NESTA's work (2009), identifies *input* factors as a basis for measurement of innovation.. Within the professional practice of design any instance of IPO is likely to be very complex and adoption of this model may be confused with criticisms of linear design process models (eg Lawson, 2004). However, in order to develop better understanding of *potential design impact* there is a need for better understanding of the elements and inter relationships within instances of IPO in professional design activity. Furthermore, in order to increase the applications for design it is important, in many situations, to be able to more clearly and more accurately communicate *potential design impact.* It is noted thatin a study by the UK Design Council (2007b)nearly 80% of businesses surveyed stated that designers are only 'quite good' through to 'not good at all' at communicating the value of design activity. Typically the design profession uses case studies as a means to communicate potential design impact (Dawton,2011), but this oversimplifies the complexity of the specific instances of IPO by substitution of the nearest matches within the designer's repertoire.

This paper reports on a study which forms the initial stage of research, with the longer term goal of more effectively identifying and communicating potential design impact. This objective relates to the needs of professional design practice and the potential for widening the applications for design practice as a whole. The aim of this first stage of work can be summarised as: **To improve understanding and communication of a more comprehensive range of elements within an *input-process-output* model of design process**. The work encompasses objectives for professional practice *and* design research. For professional design practice, a contribution to foundations for improved identification and articulation of the loci of design impact within design practice. For design research, a contribution to what Dorst (2008) describes in his paper 'Design Research - a revolution waiting to happen' the need to better understand the interrelationships of a 'constellation' (Wang & Ilham, 2009, p20) of factors within design activity.

The starting point has been to deconstruct the process element of the IPO model with a review of notable design processtheory(Section 1). However it is recognised that from a business perspective, exploration of underlying, abstracted, processis typically considered less relevant than direct activity related to generating new products or services, sales and profits (Rhea, 2005). There areoften underlying disconnections between tangible design impact in business terms, praxis and much design research activity. These disconnections are perhaps at the crux of problems in regard to defining design and design impact. However -as in the broader field of NPD and innovation - with a wide range of studies exploring the relationships between process and success or failure, (Brown & Eisenhardt, 1995) much design process research is grounded in the exploration of deriving added economic value (Blessing & Chakrabarti, 2009, p2-4).

The academic study of design process has a relatively shorthistory (since 1962 - Bayazit, 2004). Evidenced by Dubberly's (2004) 'compendium' of 131 design process models there has been considerable ongoing activity to attempt to more accurately capture all aspects of how design activity works in reality. This research activity is not without its critics, however: 'Designing is far too complex a phenomenon to be describable by a simple diagram' (Lawson, 2004 p289), 'there may never be an ideal design process' (Design Council, 2007a) and that there is no single design process model which provides a satisfactory description of design process (Clarkson & Eckert, 2005). These criticisms of design research are explored and reported in Section 2.

Design process models are highly edited and rationalised abstractions of reality. In the context of this study it is necessary to consider whether this rationalisation overlooks factors – part of the complexity of design - which may be significant in determining design impact. For example accommodating factors within emerging design disciplines such as design web design or service design.Or the influence of content, actors and context (Dorst, 2008). For example in the broader field of Innovation, investigation into the added value of practitioners (actors) within innovation practice is relatively recent (Patterson et al, 2009). This is in contrast to popular presentation of the subject of design within the media and by designers themselves, which often puts the individual highest, or very high, in a hierarchy of factors impacting design success. Likewise, *experience*, which is widely recognised in many fields, receives less attention with the exception of the distinction between novices and experienced practitioners in a number of studies. NESTA (2007) also identifies the distinction between *policy level* factors and *firm level* factors. Within the UK, much of the work by the national design and related bodies is concentrated on exploring the measurement and impact of design from a policy level perspective (eg Cox, 2005, Design Council, 2007b, Tether, 2009). Whereas this study is exploring a bottom up-approach, deconstructing the practice of design to understand the raw ingredients of design impact at firm level. Therefore, Section 3 provides comment on the structuring and rationalisation the 'constellation' of factors affecting design process. This leads to the concept of creating an ontology - or terminological framework - as an organising structure to accommodate the factors explored. Section 3 goes on to describe the work to create an interim design process ontology, or more modestly; a prototype terminological framework. Section 4 concludes with a review of the issues which arise from this framework in relation to the overall study of predicting design impact.

Design process concepts and models

Much of the work on design process models has been based on enhancing the outcomes of design practice, but these models are in a state of flux and can be viewed as partial models in that there will be factors, emerging or otherwise, which are not accommodated. Logically, only the aspects covered by these models might be enhanced as a result. This study is concerned with exploring and understanding *all* factors which may influence design impact. Clearly each study, model or concept cited has started with a different research objective to this study. However, as a basis for identifying a comprehensive range of factors which may influence design impact, the following studies, key concepts and models incorporate factors which should be accommodated. This work does not represent a fully comprehensive review of design process theory, but is judged to capture sufficient key concepts to populate an initial framework.

Rationalising 40 years of design process research and generic NPD practice with objectives of enhancing design effectiveness, the Design Council's study (2007a) recommended the four stage Double Diamond model with particular emphasis on early 'Discovery' stages, paralleling concepts of the 'Fuzzy Front End' (FFE) or the 'Front End of Innovation' (FEI), together with NDP stage-gate process (Koen et al, 2001) from innovation practice. Baxter (1995) defines a 'risk management funnel' , also referred to as the Development Funnel; (Wheelwright & Clark, 1992) demonstrating how design process models can be incorporated into broader IPO models, derived from studies demonstrating the importance of market orientation and early planning (*input*) to success factors (*output*) in NPD (Baxter 1995 citing; Freeman, 1988, Booz-Allen & Hamilton Inc., & Cooper, 1993).

Wynn and Clarkson's (2005) review proposed a creative-to-engineering process typology (ref figure 1) highlighting that the systematic, engineering end of the spectrum -typified by the seminal work of Pahl & Beitz(1995) - lends itself more to improvement. Howard et al (2008) recognise this spectrum with identification of a 'routine path' and a 'creative path', but highlighting the importance of creativity to economic success (p160 inc. refs to Cox, 2005).

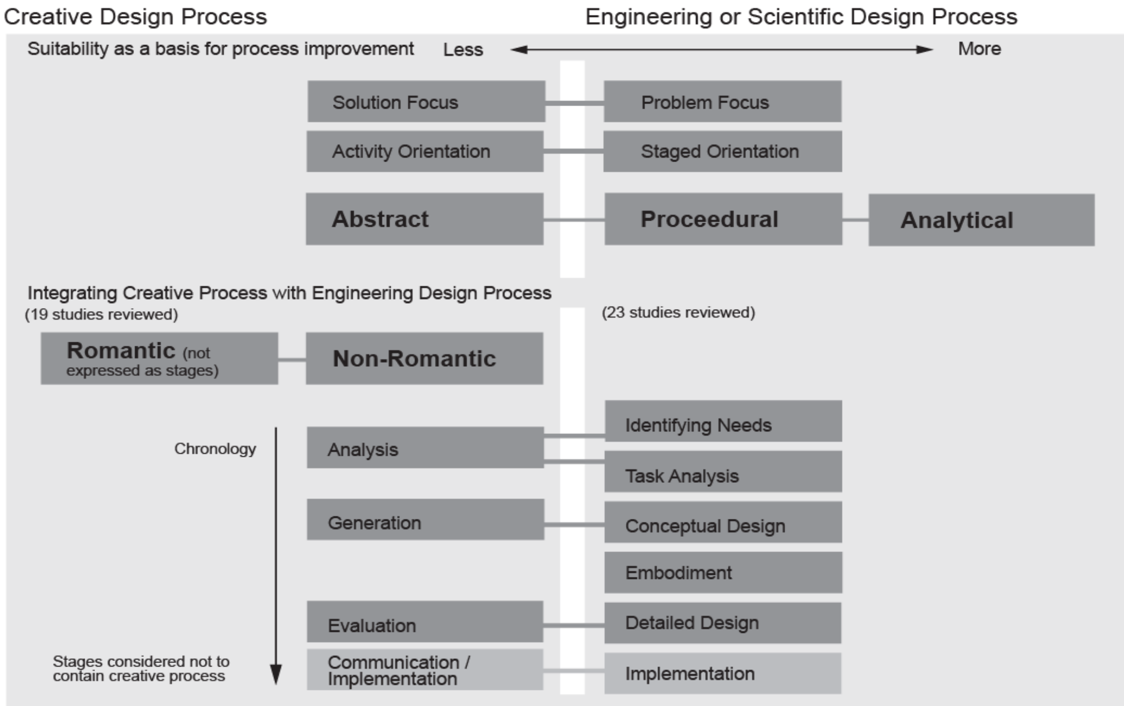

Figure1: Categorisation of Design process models as a basis for process improvement derived from Wynn and Clarkson (2005) and Mapping Creative Process to Engineering Design Process derived from Howard, Culley, Dekoninck (2008)

Pugh's *Total Design* model (1990) adds an envelope to the design process; identifying 34 categories of *input*factors. Howard et al(2008), state '*process* and *output* have not been linked theoretically or empirically' (p175 – authors' italics). Also responding to criticisms that exploration of design process 'maps' tend to be 'theoretical and prescriptive', 'logical and systematic', Lawson (2004) asserts - based on empirical research - that there is a disconnect between design theoreticians models and the actual practice of designers. He identifies the 'the Primary Generator', from research by Darke (1979),as a better reflection of actual practice. Concepts of transformation and creativity are consistent themes within the 40 years-plus of design research (Bayazit, 2004). Creative process can be described with a generally accepted three element model of: analysis, generation and evaluation (Howard etal, 2008, p168). Howard et al's paper goes on to identify that whilst the creative process can be mapped onto a typical engineering design process (figure 1), process models do not address the *level* of creativity embodied citing classifications such as; Original, Adaptive, Varient (Pahl & Beitz,1995) and their own distinction between routine paths, and creative paths.

Continuing the theme that existing models do not adequately reflect all relevant factors (eg Lawson, 2004), Blackwell et al (2009) employed a phenomenological approach to identify three themes which are typically not encompassed within conventional design process research. Firstly, issues around defining being a 'good designer' - secondly, issues around the relationships between designers, customers and end users - and thirdly, issues around the structures and sustainability of design professions. Dykes et al (2009) propose a new framework to accommodate collaborative practice (eg as a basis to explore Blackwell et al's second point). Alexiou et al. (2010) approaches these types of complexity factors via the academic domain of complexity science; underlining what he describes as the 'computationally irreducible' nature of design process. Doblin's (1987) identifies three levels of design project complexity: products, uni-systems and multi-systems in a matrix with performance design (usually functional-technical) and appearance design (where appearance is a significant element), resulting in a classification of six project types. Philips Electronics, in response to recognition of greater complexity in design (Kyffin, 2009)and the business imperative of managing innovation, have also created a matrix model. TheirX axis includes the concept of three horizons of innovation derived from the Gartner hype cycle, whilst the Y axis includes three aspects of value: *communicating* value, *developing* value and *identifying* value. Each intersection on the matrix thus represents types of design activity which can be enhanced to maximise the potential for innovation. The *communicating* and *identifying* value factors also relate toHoward et al.'s(2008) identification of - but limited understanding of - *information* within various stages of the process-creativity-output matrix (p177).

Problems with design theory and design process models

Many researchers exploring design theory describe the inherent complexity of design and design process and it's resistance to definition within universally agreed models. (egLawson, 2004, Clarkson &Eckert, 2005). However this complexity is acknowledged as a positive defining feature within concepts such as wicked problems (Rittel, 1967 cited by Buchanan, 1992) and design thinking (Buchanan, 1992). A further consistent theme within design and innovation process literature is the identification of and associated problems with the gap between academic development of conceptual models and the reality of commercial practice (eg Buijs, 2003, p81 and Blessing & Chakrabarti, 2002). A distinction can be made between academic studies which draw directly on primary research with industry (eg Buijs, 1993) with an industry benefit aim, or primarily literature based studies which seek to rationalise and refine theoretical models (eg Design Council, 2007a and Lawson, 2004) with a broader theoretical aim. Design research can also be rationalised in relation to its role and value within industry. For example, the adoption by Philips design of Frayling's (1993) classification (Kyffin, 2009): *Research for Design* –research in direct support of design projects, such as specific ergonomics research, *Research through design* – using design and it's particular creative qualities as a research method within projects and *Research into design* – which would include exploring new methodologies, for example as a result of emerging technologies or contextual issues. Cross (2001) identifies issues with the 'scientising' of design research and advocates recognition of the cross cutting theme of '*designerly ways of knowing*'.

Emerging from the theoretical end of the spectrum of process research there are a range of issues which research *into* design is aiming to resolve. These include - at a meta theoretical level - studies aiming to rationalise a single coherent theory of design (Love, 2000 & 2002), of which design process is a key element), or to re-conceptualise the subject (Blackwell et al, 2009 and Dorst, 2008). Love's earlier literature review paper identifies four 'serious criticisms' (Love, 2000, p295) of design research as follows:

' • That there exists a substantial amount of *confusion* with respect to the underlying basis of many theories, concepts and methods.

That in developing and validating theoretical aspects of the study of design, many writers are unjustifiably *conflating* concepts drawn from a range of sources.

That there exists an unnecessary *multiplicity* of design theories and concepts.

That the terminology of design research has become unnecessarily and unhelpfully confused and imprecise by dint of the above points.

Love's later paper (2002) summarises reasons why a unified theory has not developed:Theory being tied to single domains of practice, a neglect of epistemological and ontological issues in theory-making, a lack of agreement about definitions of core concepts and terminology, in addition to poor integration of theories specific to designing and designs with theories from other bodies of knowledge. Blessing & Chakrabarti (2002) identify a three point critique of the body of design research: a lack of overview of existing research, a lack of use of results in practice, a lack of scientific rigour. Dorst (2008) identifies five criticisms of research into design: (1) an unresolved dichotomy between design process research based on reflective vs goal orientated approaches, (2) "trigger happy" research which jumps too quickly to proposals for new methods, (3) "pre-scientific" methods without rigorous evaluation, (4) no generally accepted approach to "quality" and (5) no broader view of design beyond "the design project".

Comparing knowledge structures in design practice is explored by Wodehouse & Ion (2010) and Sim & Duffy (2003), the latter exploring the notion of an ontological approach. Wang & Ihan (2009) criticise Love's proposal of an epistemological approach reflecting the concern of many, that this does not adequately encompass the creative and social dimensions of design activity. They go on to state that "Love is just incorrect" (p15) to suggest the desirability of a single body of design knowledge. However, they do acknowledge Love's suggestion that much of the knowledge used by designers is more appropriately classified in related disciplines. Love's 2000 paper concludes by proposing a 10 point hierarchical structure for design research based on levels of theoretical abstraction. Figure 2 shows this placed alongside Frayling's (1993) model. The aim of this juxtaposition is as a general indicator of how design research relates to design practice. Placed together - one created to enhance the coherence of design research (Love), the other to clarify the role of design research within industry (Kyffin) - they provide a useful map; spanning *ontology of design* (Love's highest level of abstraction) through to commercially driven *research for design*.

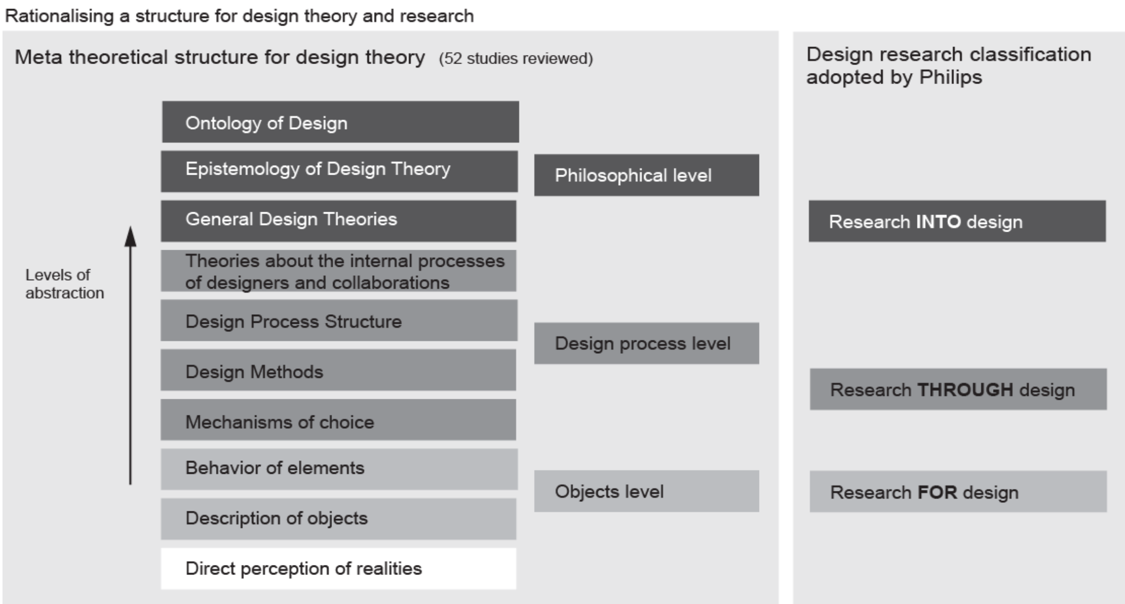

Figure B.31 *Figure2: Rationalising a framework for exploring design theory and research derived fromLove (2000) and Kyffin (2009), citing Frayling(1993)*

The potential of a Design Ontology

As identified by Love (2002), the ontology concept could represent the highest level of philosophical abstraction of design theory (ref figure 2). Love's use of the term ontology draws on themeaning of ontology from philosophy; 'a systematic account of existence' (Gruber, 1993, p1). Love uses examples to demonstrate that this level of philosophical critical analysis would be needed to answer complex questions which encompass human values and the values and assumptions of design researchers (Love, 2000, p306). Galle (2009, p324) concurs and states that 'a meta-theoretical philosophical approach to design may improve the clarity of our thinking about design and design methodology' (Galle, 2009). Sim & Duffy (2003, p200) propose an ontology of generic engineering activities to help resolve issues such as 'no shared understanding' of design process, process models 'not reflecting the reality' of design and 'no consensus and widespread application of theory in industry'.

Also widely used within the development of Artificial Intelligence, the concept of ontologies has broadened into the domain of computer and information science (Noy, and McGuinness, 2001); often with the objective of building digital knowledge management applications. The correlation betweenLove and Galles' use of ontology (philosophy) and the information science use of ontologies is the idea of creating a hierarchical framework of concepts and knowledge as a basis for sharing understanding of concepts and the relationships between them. This objective for developing ontologies can be summarised as:

'
- To share common understanding of the structure of information among people or software agents.
- To enable reuse of domain knowledge.
- To make domain assumptions explicit.
- To separate domain knowledge from the operational knowledge.
- To analyze domain knowledge'

(Noy and McGuinness, 2001, p1)

These objectives make for a strong fit with this initial study's aim. Therefore, in line with this aim, the concept of developing an interim ontology was explored. The Noy and McGuniness paper goes on to describe fundamental principles and first steps for creating ontologies. According to these principles there is no right or wrong ontology, and that ontology development is an iterative and ongoing activity. This equates to the definition of work reported as an *interim* design process ontology (subsequently referred to without the interim prefix); an early step in an iterative process. Creating an ontology requires assessment of the scope and intended application; establishing 'competency questions' (Gruninger & Fox, 1995) which the ontology should be able to provide answers to. Gruber's paper additionally recommends a set of five generic criteria for the design of ontologies. These criteria are revisited in section 4 as part of initial analysis of the resulting interim ontology:

- CLARITY: Using objective terminology which is widely understood
- COHERENCE: The relationships or inferences between elements should be logical and consistent
- EXTENDIBILITY: The ontology should allow for continuous expansion (also ref iterative nature of ontology development – Noy and Mc Guinness, 2001)
- MINIMAL ENCODING BIAS: meaning limiting the use of more abstract or restrictive concepts to aid encoding (Gruber uses the example of encoding bias such as restricting the format for expressing dates in a bibliographic ontology)
- MINIMAL ONTOLOGICAL COMMITMENT: At a basic level this means that if the ontology is too complex for the intended application it will be less likely to be adopted, therefore contrary to the aim of knowledge sharing

A summary, simplified process for creating an ontology is defined by Noy and McGuiness (2001) as:

1) Determine the domain and the scope of the ontology (eg by considering competency questions and generic criteria)
2) Consider re-use of existing ontologies
3) Identify key terminology to be used within the planned ontology
4) Define classes and class hierarchy ('concepts' is also used as a synonym for classes. Typically classes might be collections of things or instances)
5) Define the properties of the classes (also referred to as slots)

Define the permissible or allowed values for the properties (or facets. Eg the facets of the slots)

6) Populate the classes with instances

Following steps one to four of the Noy and McGuiness recommendations,adesign process ontology has been established which has the overall aim - in line with the established generic objective of ontologies within information science - of: **creating a hierarchical structure of design process concepts and knowledge as a basis for a shared understanding of significant concepts within the domain of design and design process.**

Step 1: Domain and Scope

The overall domain is defined as *the professional practice of designing*. Although this defines the overall scope it should be emphasised that ontologies are organic and should be designed to allow for ongoing development (ref Extendibility criteria). This is appropriate within the design domain as professional design is continuously evolving and often encompasses the practices and bodies of knowledge from related professions (Wang & Ilham, 2009).Competency questions - examples of questions which the ontology should be able to provide answers to - are important tests for the work. These questions are defined as:

- (design research based) How does any specific existing design process model or methodology fit within this ontology? Eg can existing models such as FBS (Gero et al, 2004) be easily mapped onto the ontology?
- (professional practice based) How does this ontology relate to either a specific design project or the general design practice of an organisation? Eg can projects or practice such as 'Web design' be mapped onto the ontology as instances?
- (usefulness to predicting design impact) Can the ontology encompass all the elements which may determine the impact of design practice? Eg can case studies of 'good' or 'bad' design be mapped onto the ontology and does this to help clarify what constitutes the good or bad quality?

In addition to these competency questions: can the ontology be presented in a form which can be quickly and simply understood by design practitioners and design researchers alike?

Step 2: Re-use of existing ontologies?

Various sources are identified in the literature for ontology libraries and fields of application: Gruber (1995) refers to ontology developments in relation to engineering models, planning, problem solving and models of expertise. Noy and McGuiness (2001) refer to ontology libraries such as the *Ontolingua Ontology Library* based at the AI lab at Stanford University or the *DAML ontology library* which - at the time of writing (2011)- includes 283 ontologies. However much of this activity is focused on AI applications and the management of knowledge bases rather than as a means to share high level concepts and knowledge. For example, the work in the engineering domain by Tomiyama et al. (1992) to develop Intelligent CAD systems. This work classifies design process within a knowledge hierarchy, but at the design process leveldoes not have the granularity which is found either within design process literature or within design practice. However, Tomiyama et al.'s work does correlate with Love's (2000) general hierarchy of abstraction (ref Fig 2) with the identification of a'*process level'*class of design knowledge distinct from '*object level'* design knowledge (Tomiyama et al., 1992, p241). Sim & Duffy's (2003) work confirms the principle of hierarchical levels combined with an input-activity-output model. This work does explicitly explore granularity, exploring 27 designing activities in detail and placing them in categories of *Definition, Evaluation* and *Management*. Therefore it is concluded that existing ontologies can help to establish and validate some general principles for a design process ontology, but there is currently limited scope for direct re-use of ontology structures and components.

Step 3: Key terminology

'The very word 'design' is the first problem we must confront...' (Lawson, 2004). 'Design' can be used as a noun, verb and adjective; the specific meaning is usually clarified to an extent by its context, prefix or suffix. For example 'product design' or 'design thinking'. In design research the complexity in the semantic meaning of *design* can be further compounded. Love (2002, p295) reports 'that the terminology of design research has become unnecessarily and unhelpfully confused and imprecise...' and is one of his four significant criticisms of design research. One of the intended benefits of a design process ontology therefore is to support the clarification of the terminology within the domain (eg Galle, 2009). For example, we can begin to clarify *design process* by deconstructing and placing key concepts in a hierarchy – Step 4 in the design of this ontology. The design ontology can adopt well established terms, such as *design process* or *methods*. However in other areas, due to the 'revolution waiting to happen' (Dorst, 2008), terminology to describe certain concepts is not well established within the general design domain. For example, the concept of the 'Engine' at the centre of New Product Development - encompassing factors such as leadership and culture (Koen et al, 2001)- is re-interpreted in a subsequent paper which advocates using the term ‘Heart’ to describe factors including leadership, culture, emotion, motivation, risk-taking and passion. These factors are described as ‘the true ingredients of innovative behaviour’ (Buijs, 2003, p90). Therefore, these two views identify and corroborate the importance of ‘Engine’ or ‘Heart’ as an important element within NPD; but the general concept probably has limited recognition within design process research. In the ontology proposed, this concept is re-named again as ‘Motivation’. Where concepts and terms are not well established it is recognised that this will create a barrier to ontological commitment.

Step 4: Definition of classes and class hierarchy

The overall definition of classes and hierarchy has evolved through an iterative paper based prototyping process drawing together the findings from a general literature review summarised earlier. The prototyping has been further informed through workshops held with MSc Integrated Product Design students. The current status of thedesign process ontology is presented within this paper in two forms: firstly a hierarchical list of classes and sub-classes with a description of how the class definition relates to the literature -and secondly, a summary hierarchical table of classes (table 1) with properties and examples of instances.

Interim Design Process Ontology: Class and sub-class hierarchy

Super class

*Design Domain:*The highest class describes the general field in which the design activity might take place. This accommodates recognition that the professional practice of design is not restricted to specific fields of professional practice - (such as Product Design) nor that it is intrinsically linked to specific fields of application. For example, designing clothes might characteristically be considered the preserve of fashion designers, but in reality there are many other professional design activities which might be involved within the clothing sector such as brand design, graphic design, retail design etc. Positioning *Design Domain* in this way facilitates the criteria of extendibility.

Classes

Input-Process-Output: This generic concept used in various fields, including computing and innovation, is useful for accommodating design process within a broader context whilst keeping process as the core element. This simple classification allows accommodation of significantfactors affecting impact. For example the input class can accommodate Pugh’s 32 *input* factors, 1990, p44). The *output* class can accommodate factors typically used to measure design and innovation such as number of patents or increases in turnover or profitability, as well as classification of designed artefacts and systems etc. As a result of the initial focus on design process summarised in section 1, theontology focuses on sub-classes of the *process* class. The *input* and *output* classes can be extended in further work.

Sub-Classes

Motivation: Koen et al (2001) and Bujis (2003) have identified 'Engine' and 'Heart' to describe factors including; leadership, culture, emotion, motivation, risk-taking and passion, terms which collectively contribute to the driving force within design process. This force could also exist within the *input* class and could either contribute to, or be independent to, the *motivation* factors within the design process itself.

Scale: Design research often sets scale factors aside in order to focus on exploration of the common elements of underlying process. However,in professional applications of design process the differences between activities resulting from scale factors are significant. The *scale* class is placed above *design process* in the hierarchy on the basis that scale factors such as timescale or the complexity of the design task are factors which determine the design process, rather than the other way around. The *scale*concept encompass a range of factors which determine the overall complexity within a design project eg; timescale, numbers of actors, numbers of elements etc. Ulrich and Eppinger (2004), amongst others, identify that the design process concept can be observed within the design of everything from screwdrivers to aircraft. This affects *scale* factors, but *scale*factors in this context are only indirectly linked to physical scale.

Path: This class addresses issues of disciplinarity, professional and personal factors which determine conscious or unconscious selection of design process structure or methodology. An important development within the field of design is the recognition of the importance of multi-disciplinarity, together with exploration of different forms of multi-disciplinarity including cross- inter- and trans-disciplinarity (Dykes, Rodgers and Smyth, 2009). Disciplinarity typically determines design process structure;for example, by a disciplines' relationship to the creative-to-engineering spectrum (figure 1). Love's taxonomy of design theory also places the classification; *internal theories of designers and collaborators*above*design process structure* in his proposed hierarchy (Love, 2003), Ref Figure 2. A sub-class within the Path class could be added to encompass the many recognised design specialisms; urban design, interior design, exhibition design etc. (von Stamm, 2003).

Design Process Structure: This class could use the alternative terminology, *design process methodology*, but - ref figure 3, *Design Process Structure* -has been established as an overall description to encompass the range of ways in which the design process can be structured in terms of stages, phases and related synonyms. Within this class the significant range of design process structures, such as Dubberly's (2004) compendium can be accommodated. It is at this theoretical level and below where there is likely to be most *ontological commitment,* or recognition of the terminology, structures and interrelationships. Therefore these levels in the hierarchy can be most easily populated by instances.

Sub-classes of Design process structure

Methods: There is limited consensus on design process structures, therefore there would be limited ontological commitment to grouping methods within a sub-class of specific design process stages, although this is potentially possible. For example the visualisation of the design process ontology (figure 3) is shown with the 5D's instance of design process structure (Dubberly, 2004, p62). Each of the 5D's could become sub-classes of Design Process Structure and design methods could be mapped to these. For example, Pugh's Product Design Specification method (Pugh, 1991) would fit within the *Definition*stage or sub-class. However ontological commitment would be difficult with this sub-classification.

Activity Behaviour: Recognition that design is not simply a linear process is seen as a significant milestone in the development of design process theory; for example, feedback loops are a characteristic of the third generation of NPD models as defined by Rothwell (1992). This characteristic is accommodated within the class of *activity behaviour*. Other significant instances of *activity behaviour* include divergency and convergency (eg Tovey, 1984, Baxter, 1995 and Lawson, 2004). A further significant element defining *activity behaviour* are aspects of planning characterised by terms such as 'objectives' or 'milestones'. Specific process models such as the Stage-Gate process (Cooper, 1986) or the Water-fall process (Royce, 1970), put particular emphasis on behaviours led by attention to objectives and milestones. The visualisation of the design ontology (Figure3) aims to communicate aspects of the inter-relationship of these key *activity behaviours* within *design process structure* and the higher level classes of *Motivation, Scale* and *Path*.

Class/sub-class hierarchy	Properties of the class	Examples of instances
●DESIGN DOMAIN	The general field in which design practice is taking place (or might take place)	A web design project, design education or the NHS
1 ▶Input	All the factors which may influence the design process within the field	Market factors for the project or stakeholder factors
2 ▼Process	All the factors which are part of the transformative process of design	Design process structure and design methods
2.1▶Motivation	All the factors which determine the level of motivation within a design process	Urgency of project or culture of client company
2.2▶Scale	All the factors which determine the scale of the design process	Timescale or complexity of design task
2.2 ▶Path	Factors which determine the path through a design process	Professional paradigms or personal work style
2.3 ▼Design Process Structure	All the ways in which a design process might be structured	Creative design process or engineering design process
2.3.1 ▶Methods	All methods which are used/might be used within a design process	Product Design Specification or Ideation
2.3.2 ▶Activity behaviour	*All the characteristics of how design process methods are carried out*	*Convergency and Divergency or feedback and iteration*
3 ▶Output	All the factors which might describe the output of a process involving design	Designed artefacts or systems or Return on investment

Table 1: Interim Design Ontology - summary hierarchical table of classes

Katifori & Halatsis et al (2007)explore the value of - and various methods for - visualising ontologies with goals which match the design criteria of 'minimum ontological commitment' (Gruber 1995)and the final 'competency question' identified in this study. This leads to the exploration of avisualisation of thedesign ontology (figure 3) as means to effectively communicate the key features amongst a range of intended audiences. Certain elements within this visualisation need further background explanation, although the intention is that the representation will have a level of recognition amongst those familiar with design process modelling.

The visualisation concentrates on the central *Process* class of the ontology. At the *Scale* sub-class level the visualisation aims to represent the possibility of a range of scales. The diamond shaped underlay relates to concepts of divergent and convergent *Behaviour* (Banathy, 1996) and the double diamond design process model (Design Council, 2007a). The overall diamond is segmented into smaller diamonds, and this is a representation of the possibility - dependant on the *Design Domain*and*Scale* -of a specific project being made up of varying numbers of elements, with each exhibiting characteristics of design *Behaviour*.

A central feature of the visualisation is the inclusion of a specific instance of *Design Process Structure*. Note that alternative visualisations could be developed from any other instances of *Design Process Structure* developed over the past 40 years, such as Gero's FBS structure (2004). This would allow for greater ontological commitment in any application of the ontology through selection of favoured or domain specific models of *Design Process Structure*. The visualisation also indicates two instances of the *Path* class. These represent the characteristics of the differences between creative process and scientific or engineering design process (Howard, Culley, Dekoninck, 2008) whereby the looping path is representative of a less structured intuitive progress from start to finish and the straight path indicates a structured series of validated steps characteristic of process models such as Stage-Gate or Waterfall. Nodes are included on these paths to indicate key milestones or decision points, which typically correspond with the divergent-convergent behaviour pattern. The *Motivation* class is represented by a graphic device based on an arrow. The visualisation indicates that instances of *Motivation* can be present both at the overall level of the *Path* class, but also within individual instances of activity, for example with feedback and iteration.

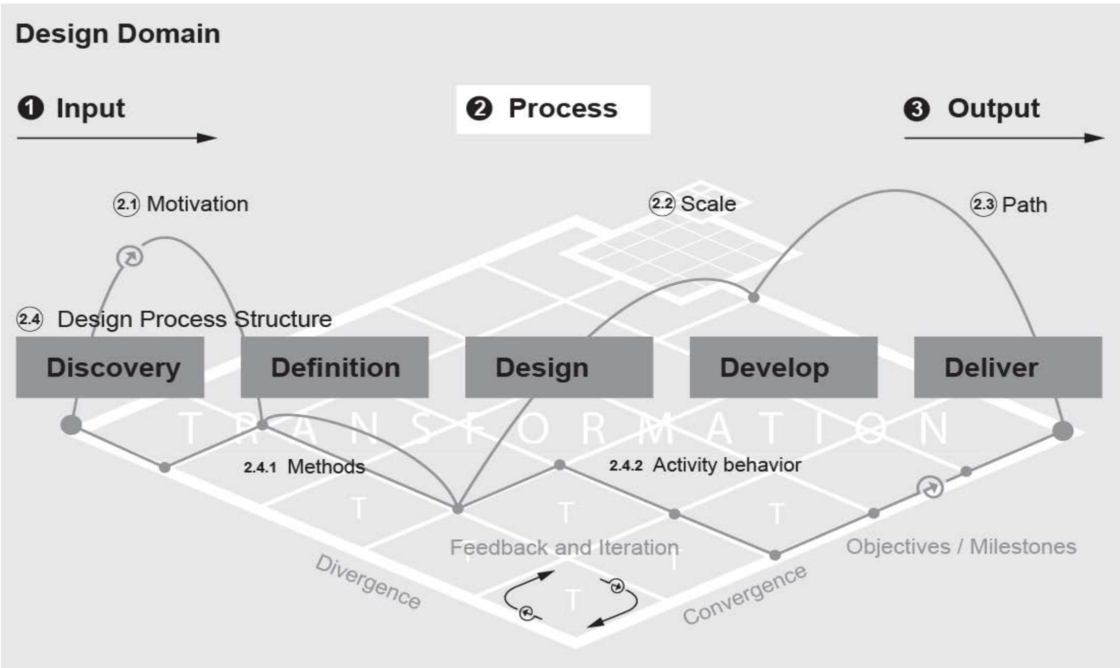

Figure3: Visualisation derived from the Interim Design Ontology

Further development issues

Two aspects of the ontology are reviewed as a basis for identifying further research challenges. Firstly, how well the ontology meets Gruber's (1995) criteria. Secondly, in relation to the aim of improving understanding and communication of a more comprehensive range of factors within an IPO model.

The CLARITY and COHERENCE criteria tackle the need for objective terminology and the logic and consistency of relationships within the proposed ontology. If a rigid philosophical, logic-based approach is adopted the work to date can be considered to be at a very early, crude stage and considerably more in-depth consideration can be given to the terms and logic in further work. Using the term Ontology, even with the *interim* prefix may be considered too ambitious at this stage. However the literature on ontologies -especially in computing applications - is very clear that the development of ontologies is an iterative process with many possible solutions. Acknowledging shortcomings in the precision of terms and logic is considered helpful to meeting the criteria of EXTENDIBILITY. For example the identification of the *Motivation* class draws from literature which introduces the concepts of; 'Engine' or 'Heart', which extends the ontology beyond earlier stage based studies of design process. The MINIMAL ENCODING BIAS criteria can also be considered in relation to the identification of the *Motivation* class. For example the term 'Motivation' is considered to effectively encompass the concepts embodied within 'Engine' and 'Heart', but without the connotations of mechanical or biological motive power respectively. Meeting the criteria of MINIMAL ONTOLOGICAL COMMITMENT has been initially considered through the visualisation of the ontology features (figure 3). This is the basis of the second aspect of the review

Review of the design ontology visualisation was undertaken with a group of 40 postgraduate Integrated Product Design (IPD) students. These students have a background knowledge and understanding of general design process concepts, but have not necessarily formed strong domain specific, or experience-based paradigms in their own practice. A number of key points arising from this evaluation need to be factored into further development. Using the 5D's instance of *Design Process Structure* as a significant visual feature strongly indicates a favoured, and linear, structure. This can be seen as a barrier to ontological commitment (the adoption of the concepts and interrelationships represented). The students immediately recognise that actual design process does not necessarily conform to this representation of five sequential stages. This corresponds to the views of many critics of conventional linear design process models (eg Lawson, 2004).

The specific choice of terms for the stages may also be an example of Love's criticism of the miss-use of terminology (Love, 2000, p295). However exploration of the phenomenon of phases or stages within design process structure has been one of the predominant features of much of the research in this field. Therefore there is seen to be a difficult balance to achieve between representing instances of design process structure for clarity whilst allowing for extendibility and clear communication; issues which are core criteria for ontology design (Gruber, 1995).

The development challenge is to explore this conflict through investigation of applications for a design ontology. The initial evaluation identified - in the opinion of the IPD students - that a visualisation is a useful device within a pedagogic context, but the value of any application in commercial practice was far from clear. This finding echoes Galle's assertion that his ontological investigations '....are not claimed to be of immediate practical use to designers' (2009, p321). This underlines the gap between theory and practice, where initiatives such as this must effectively communicate potential for added value to the intended audience (Rhea, 2005). At an interim stage, this issue is not of primary importance, but it is significant as it relates back to the broader purpose of the research as a component of exploring and communicating potential for added value through design practice.

In order to develop the ontology further, with a focus on understanding added value through design practice, the next phase of research will map case studies from the Design Business Association (DBA) (a leading UK professional organisation) Design Effectiveness Awards submissions onto the design ontology and to explore the outcomes with expert panels consisting of both design practitioners and design researchers. The DBA data is already documented to highlight the added value of design. It is acknowledged that whilst not representing the broadest scope of possible design domains the Awards scheme does draw entries from graphics, brand, strategy, products, digital & interactive media and interiors.

This work will also contribute data as a basis for mapping out significant factors within the *Input* and *Output* classes following a similar literature review and paper prototyping approach to the one described above for developing the core *Process* class. Combined with the feedback from the expert panels this will lead to the development of a more comprehensive design ontology. Finally it is worth reiterating the EXTENDABILITY criteria for ontologies – that they should allow for continuous iterative development (Gruber, 1995 & Noy & McGuiness, 2011). This paper describes an initial design process ontology as a basis for this iterative development by the authors and others.

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Appendix F STUDY 1.2 Sample merged case study data from descriptive coding stage of content analysis

CASE STUDY DETAILS

Year/ref	Category	Award
2009	4.1Packaging |Branded Food and Drink	Bronze

Client company	Size (if available)	Consultancy	Size (if available)
Lactalis Nestlé Chilled Diary		**Coley Porter Bell**	£4.162m / 38*

Project title& summary brief

Lactalis Nestle Chilled Dairy

Ski Yogurt - UK relaunch design

Objectives & design challenge

The target market is 'working mums' 35-44 who have grown up with the brand, but don't want to pay for organic brands. Positioning solution and creative brief: 'naturally delicious yogurt' 'as nature intended it'

Objectives:

1. Conveying that Ski is now made from all natural ingredients and real fruit for real yogurt taste.

2. Build sales and penetration quickly to avoid being de-listed.

3. Return to positive growth on an annual basis

Challenge:

In the previous 5 years the brand had lost 'half its value' (what measure?) and was underthreat of 'delisting' (retails no longer stocking the brand). There had been an earlier unsuccessful relaunch based on adding an active ingrediant (in response to competitors)

Design Process

Input

Process

Focusing 'ruthlessly' on the the heritage and core of the brand: it's 'fruit heritage'. 'Bringing other elements into play would be a distraction'

Output (deliverables)

Design solution applied to pack design followed by print advertising

Hard outputs (quantitative data)

Sales growth (% increase and sales value): £2.8m sales value or 20% increase after 32 weeks from relaunch. £16.8M sales Vs £14M total sales in 32 weeks prior to launch. 40% reported for annual increase Analysis of sales growth (Penetration-new customers vs frequency - customers buying more): Ref above sales figures (numbers are not explained fully) New business wins (contracts/trade customers): New retailers (Asda) were added

Sales growth %	Sales growth amount
20%	2800000

Wider impacts – (qualitative data)

Customer feedback - positive: Qualitative research findings: 'lovely big fresh lumps of fruit in a creamy yogurt', 'you taste the fruit, not just the yogurt', 'not yet picked, still on the leaves', 'looks natural', 'They were left behind, so they needed to do this', 'It's a brand we've always known' What if - the negagative impact: If the project didn't happen and the product was delisted the total UK sales could have been lost. Design as the central co-ordinating/management principle: 'A holistic approach with linked pack and print advertising design, design was at the heart of the success' Competition wins - recognition by industry peers: Product won 'dairy product of the year' 2008

Other influencing factors

No television advertising - only print ads and pack re-design Activa launched Intensly Creamy and Shape in same period

Questions& Commentary

What would sales have looked like if compared to long term trends for the brand and the sector? Eg how much of the success down to a sales dip as a result of the earlier 'un-successful' repositioning? 1. Sales growth figures are for 32 weeks

Consolidated output analysis

4 Low baseline design standards? - Success could have been partly due to particularly poor earlier brand positioning/packaging: eg what would the success look like in relation to the longer term market statistics for the sector.

Appendix G STUDY 1.2 Discipline Specific Factors (complete report)

This appendix provides comprehensive reporting on the analysis of all the specific disciplines within study sample. By combining the analysis of hard output metrics, wider impact metrics and the review of CSFs and other factors, it is also possible to provide an analytical commentary on the results in relation to the categories of design disciplines used within the DBA DEA. This analysis is further supported by reviewing bar charts for the case studies within seven of the disciplines. This subset is selected on the basis of disciplines where there are three or more case studies to review (ref *Table 6.7*). A commentary on the remaining seven disciplines is provided in relation to the results from the disciplines featured in individual bar charts.

Table B.26 *DBA DEA Summary discipline categories& sample sizes*

Discipline	DBA main category	All2009-11	Selectedcases	% of total
2D Graphic Comms	Corporate/Brand Identity	60	7	12%
	Print	15	2	13%
	Interactive & digital media	7	3	43%
3D Packaging &Product	Packaging	107	11	10%
	Point of Sale	5	3	60%
	Product	10	6	60%
Environments	Interiors	9	1	11%
	Temporary exhibitors &experiential environments	2	2	100%
	Museums, Galleries, Events and Visitor Attractions	8	4	50%
Strategy	Internal Communications	12	3	25%
	Communications Design	0	0	0%
	Design Management	7	2	29%
	Design for Society	16	1	6%
	Environment	6	1	17%
	Total entries	265	45	17%

Key	12	Discipline category with 3 or more case studies

Corporate/Brand Identity(7 case studies)

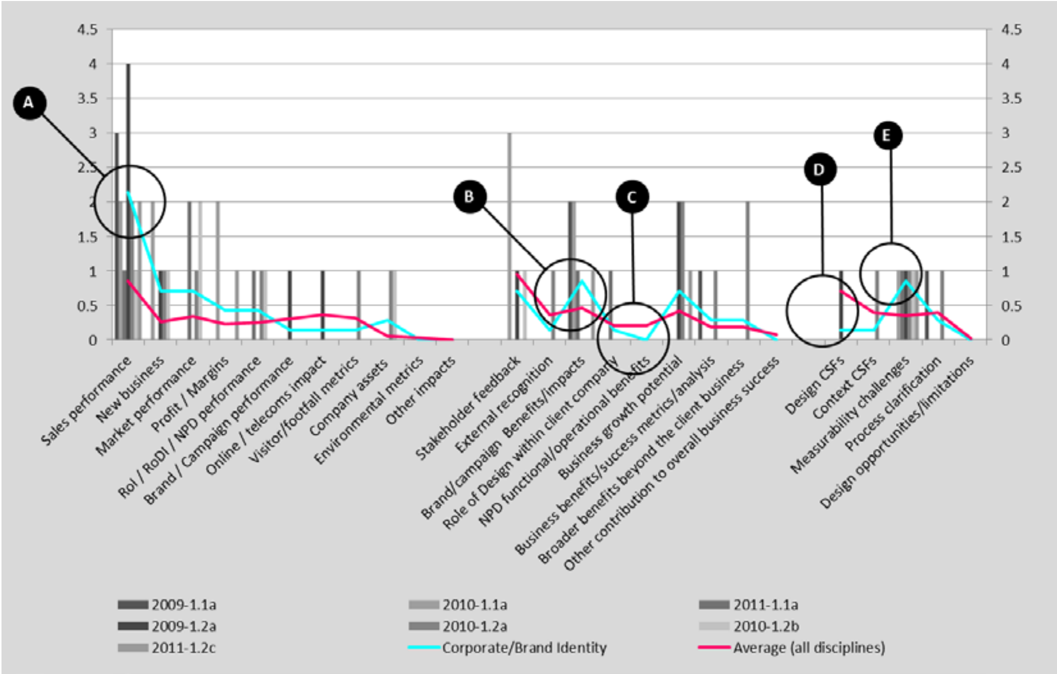

Figure B.32 *Corporate/Brand identity frequencies*

This set of seven case studies demonstrates the highest level average frequency of the use of sales performance metrics (2.1) compared to the average 1.0) (ref *Figure 6.6 highlight A*). Likewise, the instances of brand/campaign impacts are higher than any of the other disciplines (highlight B). A general pattern of certain groups of metrics or factors being predominant in one discipline is clearly observed across the whole data set. For example these case studies of corporate and brand identity show no instances of NPD functional/operational benefits as the projects have had no direct focus on these factors (highlight C). This is perhaps to be expected in this discipline category, and also the format of the competition which encourages an emphasis on stand-out statistics. More subtly it is interesting to note that instances of *D-CSFs* are below the average and *operationalisation challenges* are above the average.

Print (2 case studies)

The nature of these two case studies was that conventional economic performance was only an indirect impact. Therefore metrics associated with economic performance were not used. This would not necessarily be typical of work in this discipline area. The definition of the discipline is perhaps more to do with 'conventional' design discipline taxonomies than a category which is useful for identifying distinctive aspects of design impact. However by the omission of economic data, the point is clearly made, that there are cases where direct economic metrics are not an appropriate method for understanding design impact.

Interactive & digital media instances (3 case studies)

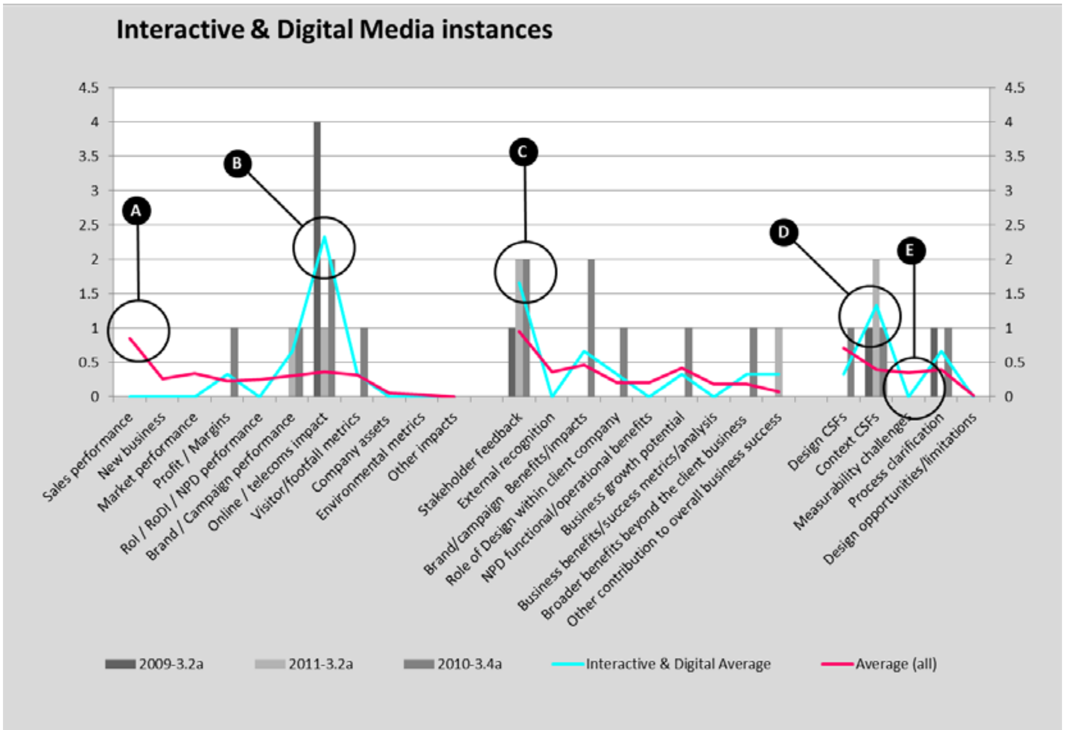

Figure B.33 *Interactive & Digital Media Instances*

This group of three case studies is notable because they do not include any sales or market performance metrics such as increases in sales volumes (Ref *Figure 6.6* highlight A). This would be an indirect measure in relation to the project deliverables. Therefore to compensate for this, there is a whole class of metrics (highlight B) which can be used to quantify the direct performance of online campaigns such as Click Through Rates (CTR) (ref *Table 6.4*). Unsurprisingly this group of case studies has higher incidences of using these metrics than any other discipline. Stakeholder feedback is also higher than average (highlight C), which may also be a result of compensating for lack of direct business performance metrics. Context CSFs are also higher than in any other discipline (highlight D). When looked at in detail, it can be seen that at the time of the projects, there were significant opportunities arising from the rapid growth of online activity and how design has been able to exploit these opportunities. Finally there are no *operationalisationchallenges* noted, this is linked to the use of metrics for online outputs, which can generate data with a minimal acquisition cost.

Packaging instances (12 case studies)

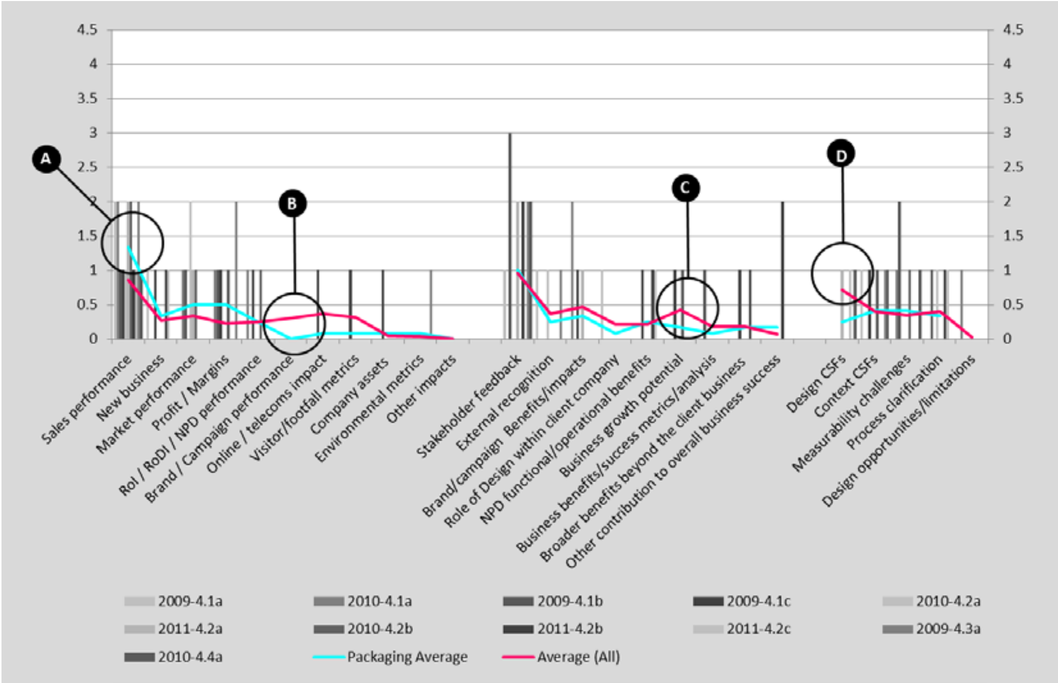

Figure B.34 *Packaging frequencies*

The 12 selected packaging case studies drawn from 107 case studies submitted to the DBA DEAs over the three years make up the largest single discipline area within the awards and this sample. It can be argued that packaging projects present the most straightforward opportunities for quantifying impact. This is underlined by all 12 case studies providing sales figures (Ref *Figure 6.8* highlight A). It may simply be a feature of the 12 selected case studies, but, surprisingly there are no instances of metrics used to demonstrate enhanced performance of the brand (highlight B). The focus remains clearly on sales performance. The two instances reporting business growth potential (highlight C), both also record an entry for the Context CSF category of 'Low baseline design standards', providing specific corroboration of the potential design impact when this CSF is present. The packaging projects have a lower overall average for D-CSFs, which is counter intuitive, as one might expect packaging to present the clearest evidence of D-CSFs. However easier acquisition of data in the packaging sector may have led to the entrants placing less emphasis on this element. Overall, and partly due to the large sample size, these packaging projects conform quite closely to the average results.

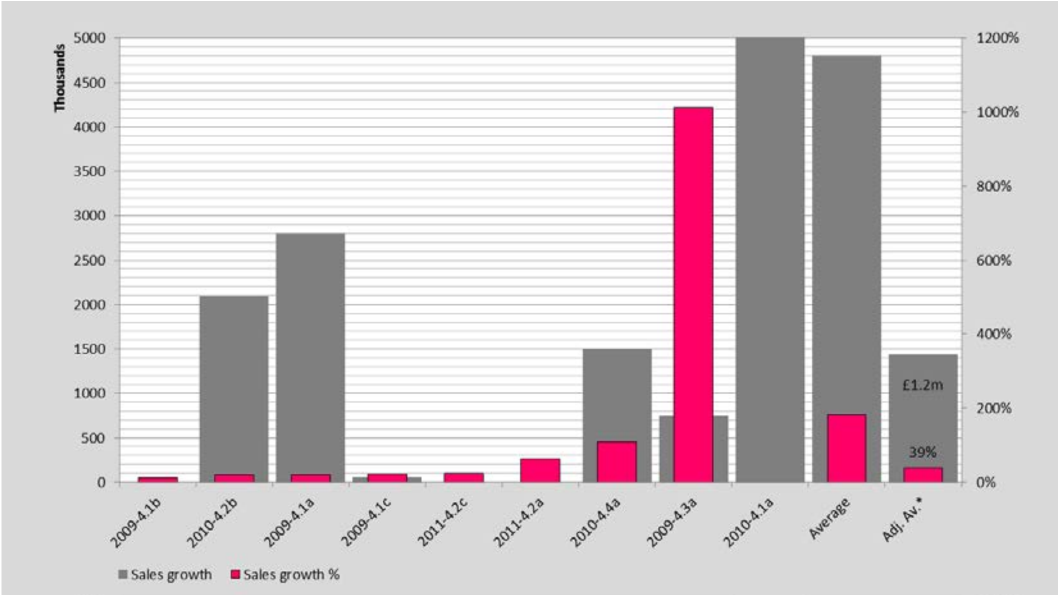

Figure B.35 *DBA DEA Packaging case studies with sales growth data*

Packaging projects were the most likely to include sales growth and design fee data (19.5% of the total sample and 75% of the packaging case studies). Therefore in this discipline, it is also possible to review this sub-set of data. The adjusted average figures are shown in the final bars of the chart shown in *Figure 6.9*; £1.2m for sales growth and 39% for sales growth %, compare to £12m and 63% from all case studies where this data was available (ref *Figure 6.3*). This can be accounted for by the different potential to generate sales growth dependant on the subject for design. For example case study 2009 1.1a generated sales growth of £80m with a mid level kitchen brand and the highest achieved by a packaging project – excluding an outlier - was £2.8m for the UK relaunch of, a yogurt brand – a low item cost item. However when considering design fees and design fee:Sales growth ratios, the packaging discipline performs better with adjusted average fees of £77k versus £52k and design fee:Sales growth ratios of 1:52 versus 1:40 (*Figure 6.9*). A variety of analyses could be drawn from this. For example; perhaps because more statistical analysis is available for stakeholders in this sector; the value of design is more easily recognised; and higher fees can accrue from these factors. Alternatively, perhaps because when considering design consultancy as a whole, there is such divergency in applications for design and types of impact, this will inevitably have a deflating effect on overall average figures.

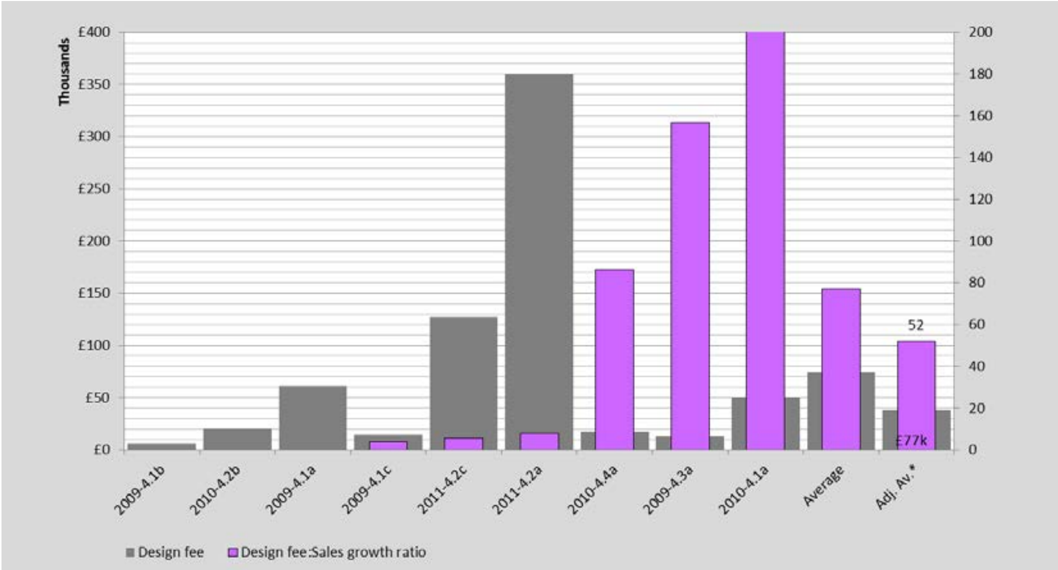

Figure B.36 *DBA DEA Packaging case studies with Design fee data*

Point of Sale (3 case studies)

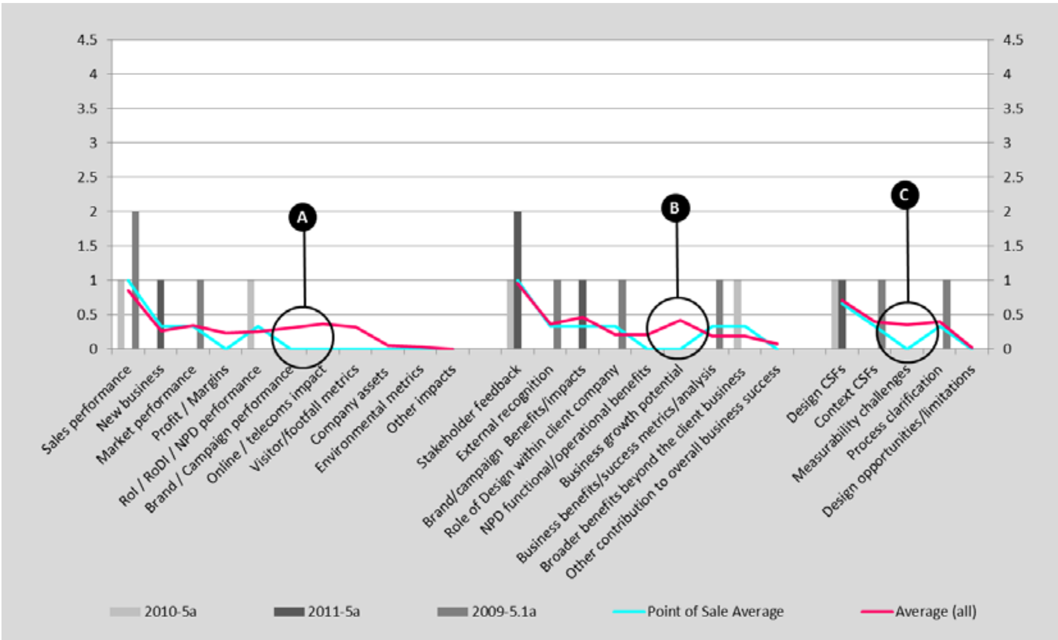

Figure B.37 *Point of Sale frequency*

The pattern of instances recorded for Point of Sale (PoS) generally closely follows the averages for the whole data set. PoS work is often linked to specific campaigns, but the three case studies selected do not include metrics related to this impact (ref *Figure 6.11* highlight A). This is because of the lack of availability of sales and market performance metrics. Eg when sales and market performance metrics are available, they will tend to have greater weight for demonstrating design impact than other *hard output*metrics. PoS projects will tend to have a shorter lifespan than other forms of design intervention, therefore in the wider impact category there are no instances of *business growth* *potential* factors, eg evidence of the potential longer term business impacts of PoS projects (highlight B). In the overall impact analysis section, the frequencies, although only from three case studies, almost precisely matches the averages for the whole data set from 45 case studies. However in this case there are no instances of *operationalisation challenges* compared to the average of 0.75. This perhaps indicates that PoS projects are amongst the more straight forward to quantify in terms of impacts.

Product (6 case studies)

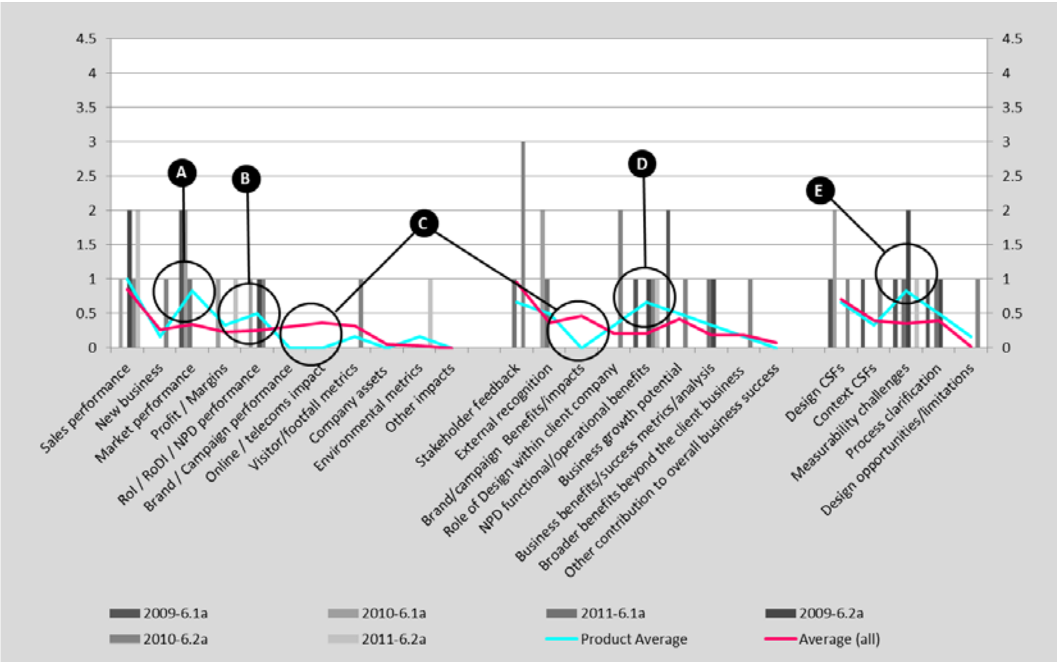

Figure B.38 *Product Frequencies*

The six product design case studies are equally split between consumer and B2B markets. The average frequency of market performance metrics are higher than any other discipline (Ref *Figure 6.12* highlight A) and this perhaps demonstrates that product design often has to consider longer product cycles than other design disciplines, therefore the market impact metric is alluding to a broader potential impact. Product designers and their clients are probably more familiar with Return on Investment factors (highlight B); for example investment in new plant and product tooling associated with NPD, is often amortised over a period of years rather than months. Product design also stands out for focusing on functional and operational benefits amongst selected impact factors (highlight C). Categories of impact metric, such as online, or brand/campaign impacts are not a feature of the selected product design case studies (highlight D). Although being the discipline with the highest frequency of RoI/RoDI/NPD performance measures also flags up that rigorous ‘industry-standard’ methods for analysing and presenting this data are not strongly established (highlight E). It should be noted that an unreported set of factors are those associated with the costs and challenges of gathering high quality impact data.

Interiors (1 case study)

Although only one case study was selected from this discipline area, it can be seen that the design impact factors and metrics are distinctive. Although grouped with discipline area 8: Temporary exhibitions &Experiential environments and 9: Museums, galleries, events and visitor attractions, the interiors categoryencompasses ‘retail design’ and is generally more directly linked to an economic performance imperative. The ratio of design spend to total investment can be quite high; for example theinvestment for a nationwide fit out for a new retail design, could be significantly higher than changing the graphic design of a piece of packaging. Likewise the returns on the investment are likely to be measured in years rather than months. The selected case study was interesting because the entry aimed to make the connection between the impact of the design exercise and the total value of the business in an acquisition scenario – a broader economic impact factor rather than an annual sales increase. At a detail level, impact data was provided for a single store, when the actual impact was potentially derived from the roll-out across a national chain. This also highlights operationalisation challenges where a full picture would require considerable amounts of data collected over an extended period.

Temporary Exhibitors & Experiential Environments(1 case study)

This single case study (for a branded exhibition stand at a major electronics show) did not use any economic performance metrics. Neither did it use footfall as a metric (this couldn’t be separated from the overall exhibition footfall or easily compared to a benchmark. The main results reinforce the points about the difficulty of disaggregating the design contribution from the overall impact of the exhibition stand, which was for one of the World’s largest electronics brands launching a paradigm shifting product at one of the World’s formost electronics exhibitions. As previously mentioned, this does not negate the DBA DEA purpose of recognising design impact and promoting design.

Museums, Galleries, Events and Visitor Attractions (4 case studies)

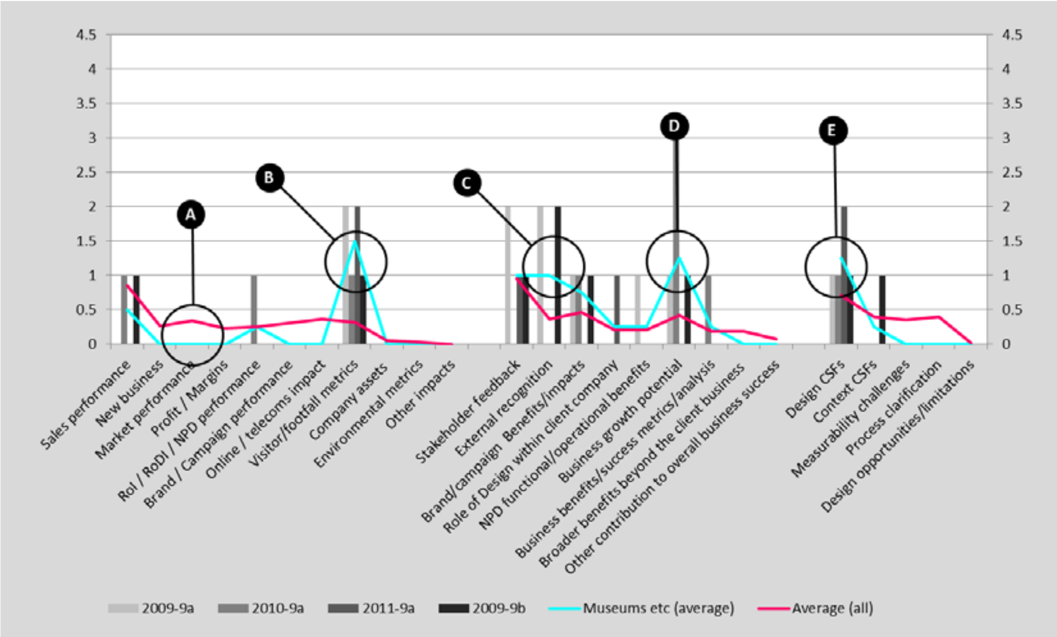

Figure B.39 *Museum, Galleries, Event & Visitor Attraction frequencies*

This category of design discipline clearly demonstrates the divergent approaches across different design disciplines for demonstrating impact. The four case studies have low levels of instances of hard output metrics (Ref *Figure 6.13* highlight A). However the *visitor numbers/footfall* category of metric is widely adopted in this sector as a substitute for other economic metrics (highlight B). It is noted that different disciplines adopt various approaches to provide a balanced set of positive output evidence. In this case other forms of external recognition, such as competition, feature more highly than other disciplines in the sample (highlight C). The high business growth potential frequency is largely due to a single case study using a range of metrics relating to potential visitor growth. This highlights both the use of discipline specific metrics and difficulties in any generalisabilty of the results. (highlight D). Finally the high instances of D-CSFs in this category is noted (highlight E), but no obvious basis for this beyond the obvious point that all these DBA DEA case studies will demonstrate elements of excellent (award winning) D-CSFs

Internal communications (3 case studies)

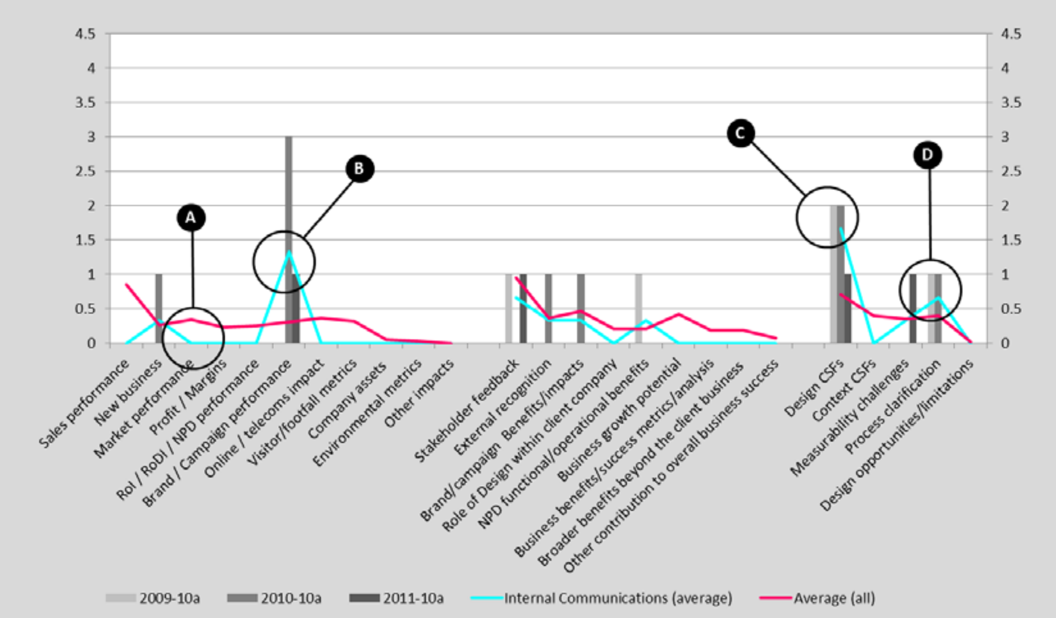

Figure B.40 *Internal Communications frequencies*

In this category the link between design activity and sales performance is indirect, therefore it is not surprising that the three selected case studies have a very low use of these metrics (Ref Figure 6.14, highlight A). As noted above, a shortfall in one aspect of metrics is typically compensated for in another area of hard metrics. In this case *Brand / campaign performance* metrics (highlight B), where specific measures are employed to quantify the specific success of the project in question. Instances of wider impact factors broadly follow the average. Within the output analysis factors, *D-CSFs* stand out with highest average number of instances of the whole data set (highlight C). This is, in large part, due to the claims that a design approach is providing advantages over other professional disciplines' approaches to the same project context. For example that a *designed* internal communications campaign is distinct, and more effective than a campaign by HR professionals. However, directly linked to this point, this category has the shared highest average of instances of the *Strategic - Tactical clarity?*output analysis point (highlight D). This is typically as a result of the lack of clarity about the nexus of the idea to use a design approach rather than other tactical approaches.

Design Management (2 case studies)

The striking outcome of the analysis of the two design management case studies is the increased difficulty of disaggregating design impact in design management scenarios. Partly because the nature of design management means that in order to be effective it has to be integrated into an organisation, which in turn makes it difficult to be clear about the design contribution. For example, with both case studies the formulation of the brief was clearly a critical factor, and most likely the final brief was a result of collaborative work. Therefore what is the design contribution in that scenario? Also, with design management, the key input, such as input to the strategic brief, is not only focused around 'designed' output, such as with packaging design for instance.

Design for Society (1 case study)

Whilst important for highlighting the contribution design can make to society, this case study reflects the predominant capabilities of the DBA membership in brand and packaging sectors. The main factors and metrics highlighted in the case study are associated with creating a strong campaign through the transformative effect of excellent visual design. The significant direct impact in the case study is raising awareness and funds for a charitable cause. No attempt is made to explore the indirect impacts, which ultimately are the overall objective of the charity and the campaign. In this case tackling sex trafficking in young women and children

Environment (1 case study)

The two key factors emerged from this single case study: firstly, the potential for design to make an impact in areas not traditionally associated with design input; in this case a design-led, rather than a marketing-led approach to promoting recycling; secondly, issues around the lack of clarity in articulating the contribution of design, rather than other factors. As with the Design for Society case study, the work reflects the capabilities of the DBA membership , and as a single case study cannot reflect the significantly broader field of 'environmental' or 'eco' design

All Disciplines

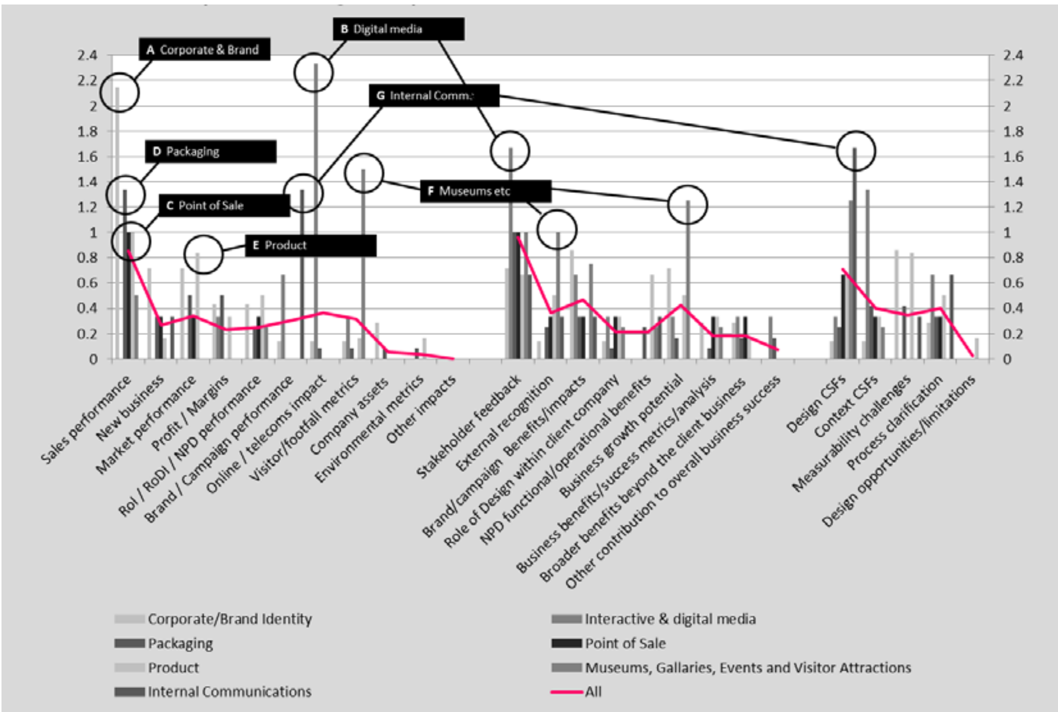

Figure B.41 *All discipline averages*

Reviewing all the discipline averages in chart form (*Figure 6.15*) highlights how each discipline demonstrates one or more distinctive applications of metrics or output factors in relation to overall averages. In summary these are:

- Corporate & Brand Identity, Packaging and Point of Sale: Sales performance
- Interactive & Digital Media: Online/telecoms impact, Stakeholder feedback
- Product: Market Performance
- Museums, Galleries, Events and Visitor Attractions: Visitor/Footfall metrics, External recognition and Business Growth Potential
- Internal Communications: Brand/campaign Performance, D-CSFs

Appendix H STUDY 1.2 Report to the DBA

DBA Design Effectiveness Awards review

March 2013

Summary report of a review of 45 DBA DEA case studies
Completed by Brunel Design at Brunel University

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DBA Design Effectiveness Awards review

INTRODUCTION

Since their foundation in 1986 the DBA Design Effectiveness Awards (DEAs) have played an important role in promoting the value of good design in business success. Winning entries are judged by an expert panel to provide clear evidence of this success. Almost alone amongst design awards this success is evaluated in terms of commercial or organisational benefits. Collectively and individually the entries provide rich validation and powerful communication of the variety of ways in which design can transform products, brands, services and market performance.

The purpose of this review has a different overall goal. It aims to explore and understand the factors and metrics which can be used to define this design success and to identify the Critical Success Factors (CSFs) which underpin design impact. Therefore the results of the review do not necessarily directly support the goals of the DEAs. Likewise the results of the review are not a criticism of this excellent initiative, but might nonetheless provide useful insights to the DBA for the ongoing development of the awards and the broader challenges of the design profession of promoting the value of design.

This summary report is produced for the DBA to feedback the main findings resulting from a review of 46 case studies. These have been selected equally over 3 years of the awards scheme (2009,10,11) and from the spectrum of design disciplines covered by the awards; from brand identity to design for the environment. Table 1 provides an overview of the selection.

The DEAs represent the activities of design consultancy or outsourced design industry. This sector is estimated to have a turnover of £7.5bn and the qualities and factors identified here can have parallels in the wider sphere of 'in-house' design activity or the professional practice of design generally within a sector with a total turnover £57.6bn (Livesey & Moultrie, 2008)[1].

Developing greater understanding of the potential for design impact in a wide range of scenarios together with the need to better communicate this potential for added value have been widely recognised as crucial issues for the design profession in order to consolidate and enhance the UK design profession's global standing (eg Tether, 2005)[2]

[1]Livesey & Moultrie, Company Spending on Design: Exploratory survey of UK firms, Cambridge University Institute of Manufacturing & the Design Council, 2008. (the research extrapolated the national value of design spending from a survey of 358 companies

[2]Tether, B, Think Piece on the Role of Design in Business Performance, DTI, HM Government, 2005)

Table 1 | Selected Case Studies

Discipline		DBA main category	DBA sub-category	All DBA entries 2009	2010	2011	Selected case studies 2009	2010	2011	% of total
2D Graphic Communications	1.1	Corporate/Brand Identity	> £100K design fee	10	4	4	1	1	1	17%
	1.2	Corporate/Brand Identity	< £100K design fee	10	19	13	1	2	1	10%
	2.1	Print				3				0%
	2.2	Print	Consumer	1	1	6	1			13%
	2.3	Print	Corporate	2	2				1	25%
	3.1	Interactive & digital media	Consumer websites	1		1				0%
	3.2	Interactive & digital media				2	1		1	100%
	3.3	Interactive & digital media	Community	1						0%
	3.4	Interactive & digital media	Online viral promotion	1	1			1		50%
		Sub totals		**26**	**27**	**29**	**4**	**4**	**4**	15%
3D Packaging & Product	4.1	Packaging	Branded - Food and Drink	21	13	20	3	1	1	9%
	4.2		Branded - Non Food	2	6	15		2	3	22%
	4.3		Own Brand - Food and Drink	2	8	8	1			6%
	4.4		Own Brand - Non Food	1	3	1		1		20%
	4.5		Structural	1	3	1				0%
	4.6					2				0%
	5.0	Point of sale		1	3	1	1	1	1	60%
	6.1	Product	Consumer >£30K design fee	2	3	1	1	1	1	50%
	6.2	Product	Professional	1	2	1	1	1	1	75%
		Sub totals		**31**	**41**	**50**	**7**	**7**	**7**	17%
Environments	7.2	Interiors	Retail	2	4	1		1		14%
	7.3	Interiors	Leisure	1	1					0%
	8.0	Temporary exhibitors & experiential environments			1	1		1	1	100%
	9.0	Museums, Gallaries, Events and Visitor Attractions		2	3	3	2	1	1	50%
		Sub totals		**5**	**9**	**5**	**2**	**3**	**2**	37%
Strategy	10.0	Internal Communications		3	6	3	1	1	1	25%
	11.0	Communications Design			1					0%
	12.0	Design Management		3	2	2		1		14%
	13.0	Design for Society		7	5	4			1	6%
	14.0	Environment		3	3		1			17%
		Sub totals		**16**	**17**	**9**	**2**	**2**	**2**	14%
		Total entries		**78**	**94**	**93**	**15**	**16**	**15**	17%

EXPLORATION AND ANALYSIS OF OUTPUT METRICS

The study categorised 157 output metrics identified within the 46 case studies into two main groups: Those concerned with quantifiable data (Hard outputs) and qualitative metrics describing the broader impacts of the output (Wider impacts). The 71 types of hard output were further categorised into 11 subcategories. Likewise 86 types of wider impact descriptions were organised into 9 subcategories. Ref tables 2 and 3.

Hard Outputs

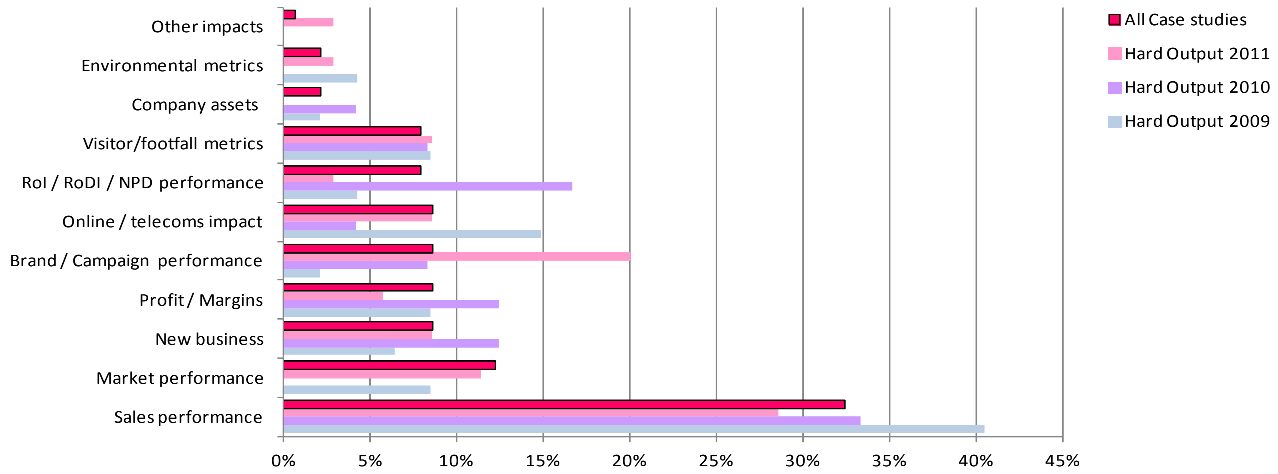
The DEAs almost uniquely gather industry wide case studies containing the quantifiable data (Hard outputs) which are generally considered most meaningful to the business community in terms of validating claims of design effectiveness. The most frequently occurring category of hard output metric was, as would be expected; sales performance (32% or 19 of the case studies sampled). Within sales performance metrics, sales growth percentage and sales growth amount were the most frequently used metrics. Ref table 3

The average figures from case studies including these key metrics were 163% sales growth and nearly £16m increase in sales.

Table 2 | Hard impact categories and sub-categories

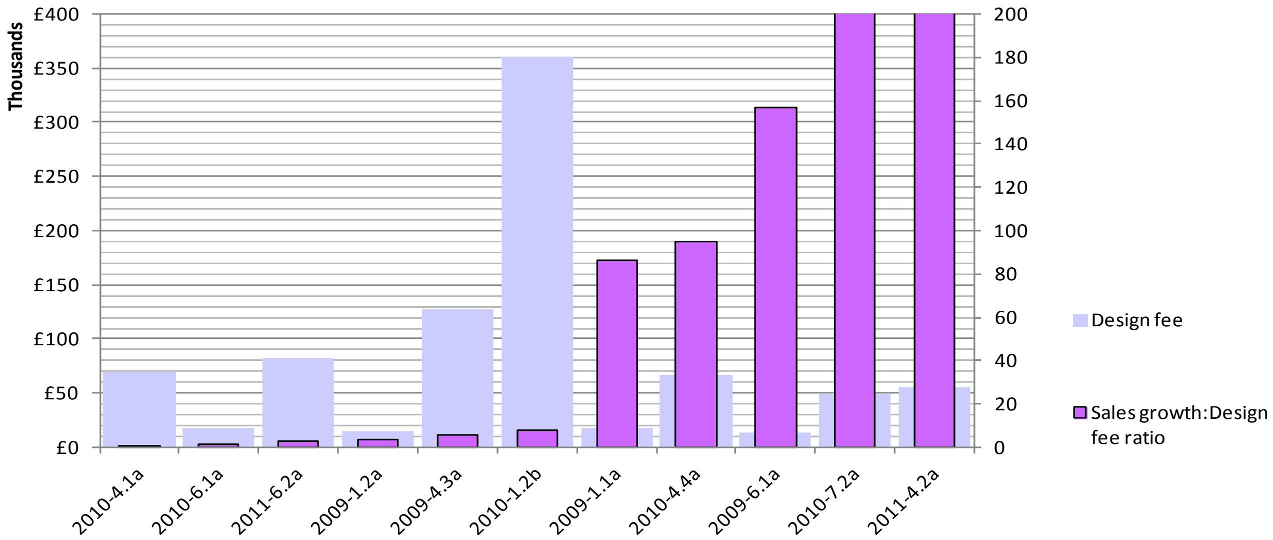
Hard impact category	Code	sub category (metric)
Sales performance	1a	Sales growth (Value and % increase)
	1b	Sales growth against target (% above target)
	1c	Sales growth compared to sector
	1d	Sales growth analysis (Penetration vs frequency - new customers vs customers buying more)
	1e	Sales growth analysis (by key customer segment, region, product)
	1f	Sales growth forecast (further value and % increases)
	1g	Sales value (from the NPD)
	1h	Sales value (in new teritories)
	1i	Sales volume (% increase)
	1j	Sales volume (number and % of total market)
	1k	Sales volume (Exemplar individual item sales)
	1l	Sales volume - charity benefit
New business	2a	New business wins (contracts/trade customers/customers)
	2b	New business wins/Sales growth (future orders, % increase)
	2c	New business /sales conversion rates (different stages of New Biz process)(%)
	2d	New business/Customer contacts - enquiries (% increase)
	2e	New business/Target customers (% increase)
Market performance	3a	Market share growth (% increase by value)
	3b	Market share growth (% increase by volume)
	3c	Market growth (% share of total sector growth)
	3d	Productivity - Production (% improvement and volumes)
	3e	Productivity - Sales/New business process (per person) (value)
	3f	Sterling weighted distribution (% distribution within a retailer by total value)
	3g	Increased product/brand distribution (numbers of stores)
	3h	Market Penetration (% increase in households)
	3i	Market share - internal (within specific territory and category)
	3j	Market share ranking (change in position)
Profit / Margins	4a	Price premium / increased margin (Unit price and % increase)
	4b	Cost reductions/margin increase (% and total value)
	4c	Design costs reduced
	4d	Marketing costs (reduction amount)
	4e	Increased profitability (% reduction in discounted prices)
	4f	Profit (amount)
	4g	New business overhead/cost (% reduction)
	4h	New business productivity (per person)(% increase)
	4i	Profit Margin Growth (compared to sector) (% increase)
RoI / RoDI / NPD performance	5a	Numbers of new products introduced (number and % increase)
	5b	Time to market (%reduction and budget saving)
	5c	RoI (Return on investment)(method/basis?)
	5d	RoI - Return on investment (timescale)
	5e	RoDI - Return on Design Investment
	5f	Number of Patents awarded
Brand / Campaign performance	6a	Audience database growth
	6b	Brand/Campaign impact (increased knowledge/expertise)
	6c	Brand/Campaign impact (Increase in desired behavior)
	6d	Brand/Campaign penetration (% of target audience reached)
	6e	Brand/Campaign awareness
	6f	PR generated (estimated value)
	6g	Brand/Campaign materials (volume of orders Vs benchmark)
	6h	Brand/Campaign materials (touchpoint numbers - promotional items)
	6i	Brand/Campaign responses (Student applications, % increase and volume)
	6j	Brand/Campaign impact (numbers of petition signatures)
	6k	Brand/Campaign impact (Numbers of national markets launching the campaign)
Online / telecoms impact	7a	Website traffic (% increase and numbers)(by target segments)(% bounce rate reduction)
	7b	Online traffic click through rate - CTR (volume and/or % of target market)
	7c	Online spend (% increase and value)
	7d	App. download 'aquisition' rate (volume)
Visitor/footfall metrics	8a	Sales events held (number and % increase)
	8b	Visitor numbers / footfall (eg exhibition, event etc)(% increase or % above target)
	8c	Visitor spending (per person - retail, catering vs industry benchmarks)
	8d	Visitor pre-registration (% increase)
	8e	'customer occasions' (% increase and number)
Company assets	9a	Employees (% increase and numbers)
Environmental metrics	10a	Material content reduction (value, % weight saving)
	10b	Proportion of recycling from domestic waste (weight and % increase)
	10c	Trade customer benefits (cost and environmental savings)
Other impacts	11a	Corporate sponsorship (% increase and value)

Figure 1 | % Instances of hard output metrics



Within the case studies which include sales growth and design fee data the Design Council's measure of ratio of design cost, or fee, to sales growth is shown in figure 2. The average from these 19 case studies is £179 for every £1 spent. This is significantly more impressive than the Design Council's figure of £20 increase in turnover for every £1 spent on design. However it should be noted that the DEAs are exemplars of award winning performance, and that there is limited reliability in this methodology. Across this small data set there is no obvious correlation between sales growth:design fee ratio and design fee. Eg we cannot deduce that spending more on design necessarily increases sales proportionally.

Figure 2 | Case studies with sales growth and design fee figures



As one would expect, there is also no correlation between sales growth % and amount of sales growth (ref figure 3). For example case studies 2009 4.1a and 4.1c both achieve sales growth of around 20%, but 4.1a achieves sales growth of £2,8m and 4.1c £56k. Or put another way, very dramatic sales growth (eg of 20% or above) can be achieved irrespective of the size of the market.

Other metrics aiming to illuminate the effectiveness of Design - or NPD investment - are Return on Investment (RoI) and Return on Design Investment (RoDI). These are not widely used in the design community as a whole and within the sample there were questions arising from the specific calculation methods used. From the full sample of 46 case studies, there were 11 instances of use of these metrics, or 8%. There was a noticeable spike in these measures in the 2010 awards (8 and 17%)

Showing a more consistent growth, in terms of its use as a metric, is the grouping of methods generating hard data to quantify the impact of brand or campaign activity. The full sample shows the number of instances growing from 1 in 2009, 4 in 2010 to 7 in 2011 or 20% of the sample. However the variety of factors being measured with these metrics means there is no value in correlations across this sub-set.

Figure 3 | Case studies with sales growth figures

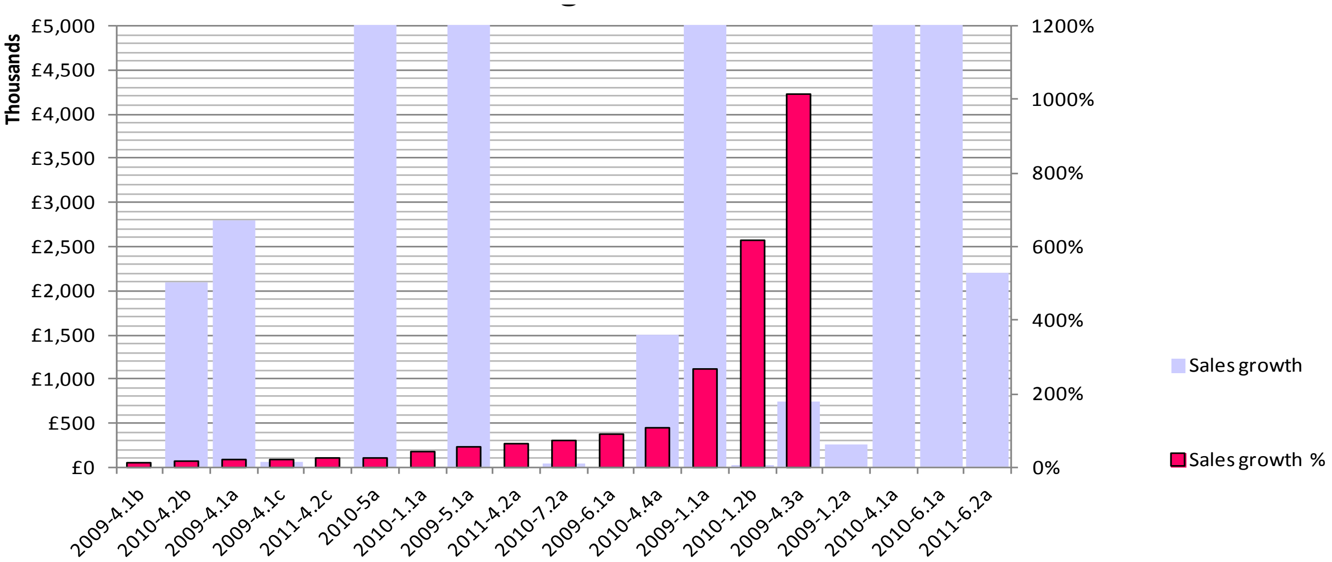


Table 3 | Wider impact categories and factors

Wider impact category	Code	Factor
Stakeholder feedback	1a	Client's employees' moral/confidence transformed/boosted
	1b	Client's employee feedback - positive (eg from client's staff questionnaire)
	1c	Client comments - positive
	1d	Customer feedback - positive
	1e	Customer survey results - positive
	1f	Customer feedback - positive (online eg via Twitter or website)
	1g	Online customer survey
	1h	Online ranking (tripadvisor)
	1i	key stakeholders/beneficiaries (eg retailers) - positive feedback
	1j	Target audience feedback - positive (client survey)
	1k	Absence of negative staff or customer feedback
	1l	Visitor satisfaction: Feefo rating
External recognition	2a	Competition wins - recognition by industry peers
	2b	High profile endorsements
	2c	Performance endorsed by professional/Government bodies
	2d	Press/media Coverage
	2e	Press/media coverage (exceeding target readership)
	2f	Press/media feedback - positive
	2g	Press/media ranking (Observer)
Brand/campaign Benefits/impacts	3a	Brand building benefits - general (eg from independant audience survey analysis)
	3b	Brand building benefits - awareness of brand (from independant audience survey)
	3c	Brand building benefits - increase in Word of Mouth recommendations (from independant audience survey)
	3d	Brand building benefits - consumers rate the brand values
	3e	Brand building benefits - overall perception of product (food)
	3f	Brand/campaign impact - increased awareness amoungst peer companies
	3g	Brand/campaign impact - influencing Government policy
	3h	Brand/design impact - improved customer perceptions
	3i	Brand building benefits - Audience rating in relation to competition (from independant audience survey)
	3j	Customer profile improvement
	3k	Positive behavior change in trade customers
	3l	Brand building benefits - environmental positioning
	3m	Brand building benefits - increase in brand awareness
	3n	Positive visitor behavior
	3o	Reduction in absenteeism
	3p	'Trading up' benefits
Role of Design within client company	4a	Design as the central co-ordinating/management principle
	4b	Design spend Vs Advertising spend advantages
	4c	Development has led to improved role for design within the organisation
	4d	Effectiveness of design spend vs competitor's design spend (from independant audience survey)
	4e	Influencing future strategy
	4f	Longer term savings in design costs
	4g	Repeat business for agency from client
	4h	Transformed sceptical attitude to consultant input
NPD functional/operational benefits	6a	Functional benefits in relation to industry benchmarks
	6b	Functional features/benefits added/created
	6c	No production cost penalties for new design
	6d	Operational benefits
	6e	Other production efficiencies
	6f	Overhead reductions - recruitment costs
	6g	Product range rationalisation benefits
	6h	Project lead time - inception to product on shelves
	6i	Successful design roll out
Business growth potential	7a	Further business growth potential
	7b	Future business/growth potential
	7c	Future sales growth predictions
	7d	Increases in distribution
	7e	Market performance predictions
	7f	New Business - International distribution
	7g	New Business - International expansion plans
	7h	New business - International opportunities
	7i	Ongoing growth forcasts (market ranking)
	7j	Other business opportunities identified
	7k	Overseas sales growth potential
	7l	Predicted annual rise in customers
	7m	Predicted annual rise in visitors
	7n	Predicted annual sales growth for customers
	7o	Sales growth in related product range/s
Business benefits/success metrics/analysis	8a	Estimated visitor numbers
	8b	Improvement in national ranking
	8c	Market analysis statistics benchmarks (Current market share in sub-sector %) (sub-sector price point benchmarks)
	8d	National ranking against sector specific benchmarks
	8e	Patents awarded
	8f	Sales growth achieved without displacement from other lines
	8g	Sector specific sales benchmark beaten (sales value in number of weeks)
	8h	Trading space/footfall ratio
	8i	What if - potential negative impact of doing 'nothing'
Broader benefits beyond the client business	9a	Benefits to supply chain
	9b	Sales opportunities in related areas (for retailers)
	9c	Broad claims of sector-wide influence
	9d	Broader impact/influence on market sector
	9e	Estimated sales volume increase in target audience' spend with key stakeholders/beneficiaries (retailers)
	9f	Paradigm shifting
Other contribution to overall business success	10a	Contribution to general sales success
	10b	Design project influenced company sale
	10c	General success claims
	10d	Indirect savings in overheads

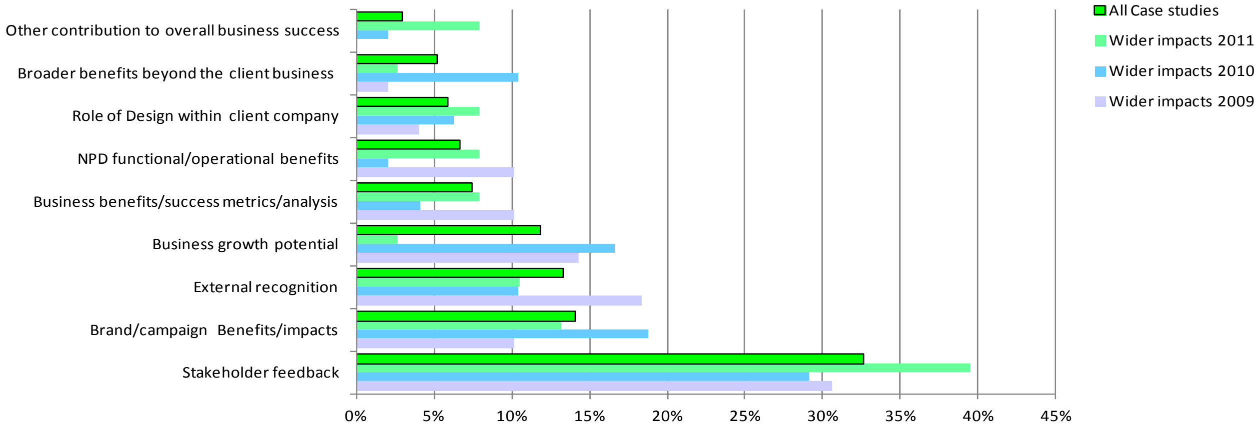
Wider impacts

33% of identified wider impact metrics used some form of stakeholder feedback to validate the impact of the design work, this could be from consumers, the supply chain, the client company employees or management. Verbatim quotes from stakeholders are a very cost effective, simple and clear way of communicating the wider impacts of design activity.

Amongst the other categories of wider impact identified, reported instances of a positive change in the role of design within companies shows a steady rise over the 3 year sample period; 4% in 2009, 6% in 2010 to 8% of the cited wider impacts in 2011. This is potentially a very positive indicator for the design profession who have long argued for a stronger role within organisations.

Two categories; *Broader benefits beyond the client business* and *Other contribution to overall business success* which together make up 8% of the total cited wider impact factors demonstrate two points which are critical to an exploration of design impact. Firstly that there are strong incentives amongst the design community to make broad claims for the value of design impact, coupled with recognised difficulties with providing objective evidence of the specific design component of successful activities.

Figure 4 | % Instances of wider impact metrics



CRITICAL SUCCESS FACTORS AND OTHER ANALYSIS

In addition to the identification of ways of describing the impact of design activity with a range of metrics and methods for validating and describing design impact, the study has also generated an analysis of a range of factors associated with understanding design impact. Using a similar analysis methodology, descriptions of outputs have been reviewed and statements have been extracted from each case study. These statements have then been categorised with traceability of the statements back to the original cases. Table 4 provides a summary of the categories used and the numbers of instances within the 46 case studies reviewed. Summary commentaries on the factors within each category are as follows:

Design Critical Success Factors (CSFs)

An important recommendation arising from this review is that design should always be considered as an ingredient rather than a silver bullet. This acknowledges that it is extremely difficult to separate the specific impact that professional design activity makes within any given product, service or brand development scenario. However what the analysis of the 46 case studies does reveal and confirm, is that there are a number of core of qualities or Design CSFs which can be evidenced which are specific to what professional design activity adds to a scenario. Perhaps the most universally recognised of these factors is (1)the ability to create transformative visual qualities. Other Design CSFs and benefits identified in the study are; (2)design as an alternative to other professional/management activities, (3)embedding design practice within an organisation, (4)the consistent application of design, (5) a focus on user/customer insights and (6)the ability to use these qualities in combination. Recognition of specific Design CSFs, individually or in combination can provide a basis for more clearly and effectively exploring these aspects of the design ingredient to impact.

Table 5 | Output comments, categories and sub categories

Output summary category	Output summary sub category	Review citations
Design CSFs	Benefits of design over alternative approaches - benchmarking?	10
	Innovative / transformative visual solution - CSF	5
	Close client relationship/design embedded within an organisation - CSF	4
	Consistent application of design CSF	3
	User/customer insight focus CSF	3
	CSFs in combination (visual innovation plus new features)	1
		26
Context CSFs	Timing - opportunity and implementation factors	10
	Low baseline design standards?	8
		18
Measurability challenges	Dissagregation difficulty	8
	Acknowledgement of influencing factors? Design as an ingredient or silver bullet	6
	Issues with calculating ROI/RoDI or related factors	6
	Issues with fully validating claims	4
	Under reporting potential impacts	2
	Measurability of functional benefits	1
		27
Process clarification	Nexus of strategic approach?	9
	Origin of a key creative/strategic element?	5
		14
Design opportunities/limitations	Depth of involvement with broader investment decisions?	2
	Creating design specific terminology/added value concepts	1
	Need for effective CSF identification/communication	1
		4

Context CSFs

The DEAs are promoting the overall success of initiatives where design is a key ingredient. From the review of the case studies a second category of CSFs can also be identified; those instances where a significant element of the success is associated with the context of the design activity rather than, necessarily, the design activity itself. Two main subcategories are identified: Firstly, the timing of the project – for example if a project coincides with a significant consumer trend, secondly, if there are low baseline design standards – for example if an existing FMCG product has particularly poorly designed packaging. In both cases there is greater potential for design to have a significant impact.

The DEAs do aim to acknowledge these factors with the suggested inclusion of a ‘other influencing factors’ section of the case studies. For the purposes of acknowledging overall success where design is an ingredient, understanding or attempting to quantify the contribution of these context CSFs in detail is perhaps not significant. But for the purposes of this study they appear critical.

Measurability challenges

The close study of the 46 case studies has, to an extent, facilitated the disaggregation of CSFs within the overall success of the projects. However a number of factors emerge which limit the reliability, granularity and measurability of the case study data. Six sub-categories of measurability challenges are defined: (1) Difficulties with disaggregating complex scenarios, (2) incomplete recognition and acknowledgment of all influencing factors, (3) inconsistent or faulty calculations of ROI or RoDI, (4) claims of impact which are not fully validated, (5) Under reporting of all the potential positive impacts, (6) Overlooking the potential measurability of functional benefits within certain types of project.

In the context of the DEAs there are many highly valid reasons for these challenges. Likewise, for the purposes of this study, the overall headings allude to many factors which require further examination. For example, there is potential value in exploring, developing and disseminating a robust methodology for calculating RoDI which might be adopted by the industry and support building a larger data set for benchmarking purposes.

Process clarification
It is clear from a number of the studies that there can be a core strategic or creative idea which is at the heart of the project success. Sometimes this core idea might fall into the Design CSF category of transformative visual quality. However often the core idea might be associated with, what in design terms, might be described as the 'brief'. In these examples it is not always clear if the designers have defined this core strategic idea or if this has come from the client. As with the other points, this doesn't necessarily negate claims of verified design success, but in terms of understanding the real nexus of added value derived from design activity further investigation needs to take place. The instances of this phenomena have been divided into ones associated with the strategic underpinning (such as those contained within a brief or early foundation to the work) and those associated with a 'downstream' creative or strategic idea.

Design opportunities/limitations
This final category has the smallest number of instances and has been used to incorporate a number of statements which raise questions which may be worth further consideration in the context of enhancing aspects of professional design practice: (1) There may be opportunities for designers to be involved with the strategic investment decisions associated with design and NPD, however it is not clear to what extent designers are actively involved with these decisions with their clients, or to what extent they have in-depth sector experience in these issues. For example can retail designers contribute to the business planning of refurbishment cycles, roll-outs and budget setting of retail design schemes? (2)It is noted within the case studies and corroborated by research studies that divergent sector specific terminology and professional theories can be barriers to effective communication and collaboration between professionals working in a multidisciplinary environment. This is highly relevant to the subject of this study, where there is value in understanding the concepts and communication which can effectively bridge between designers and the wider business and organisation communities. (3) Linked to the first two categories covering Design and Context CSFs, the review reveals that there is scope for more accurate definition and communication of the CSFs which underpin these impressive case studies of design effectiveness.

CONSIDERATIONS FOR THE DBA

The DBA are unique in the World in having pioneered and built up - over 27 years - an impressive library of case studies focused on communicating design effectiveness. This information is more relevant than ever as the design profession faces a number of pressures to evolve and, in the UK at least, maintain its pre-eminent global position.

Therefore as a result of this review of the sample of 46 case studies, we believe the DBA is in a strong position to develop this asset and to continue to evolve the approach for the benefit of DBA members and the profession as a whole.

The following are initial thoughts on actions which might result from an active approach to developing the DEA asset:

- Review the briefing information/template provided to entrants to more easily facilitate deriving ongoing value from the case studies
- Reviewing the guidance given to entrants to better accommodate emerging issues and methodologies (for example specific RoDI calculation methods or rationalising metrics used)
- Consideration of work amongst DBA members, Universities and research funding bodies to further develop relevant design effectiveness metrics
- Giving consideration to developing a managed open source platform for building a comprehensive library of design effectiveness case studies (eg providing ready access to sector, product, service or brand specific benchmarks of good practice) for the purposes of professional development within the profession and general promotion of the profession.

Appendix I STUDY 1.2 An Exploration of Design Project Output Factors & Metrics – Conference paper

AN EXPLORATION OF DESIGN PROJECT OUTPUT FACTORS & METRICS

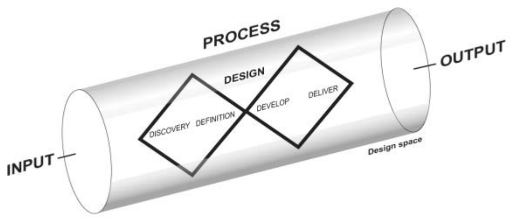
Stephen Green, 1st Supervisor – Prof. Graeme Evans, 2nd Supervisor - Dr Hua Dong
Design Subject Area
Year 4 of part time PhD

***Keywords*— Design effectiveness, Design impact, Design metrics, Design ontology, Design process,**

INTRODUCTION

The work summarised within this abstract is a component of a larger PhD study titled *Predicting Design Impact*. There is considerable interest in quantifying the impact of professional design activity: At a policy level the UK Design Council identify that 80% of UK business agrees that design will help them stay competitive in the current economic climate[1]. The UK DCMS identifies that design contributes £1.6bn of the £59.1bn GVA generated by UK Creative industries[2] and various government reports highlight the potential of design and the creative industries to contribute to the future economic wellbeing of the UK, eg Cox[5], Sainsbury[3] and Dyson[4]. Although it is noted that nearly 80% of businesses surveyed stated that designers are only; ‘*quite good*’, through to; ‘*not good at all*’, at communicating the value of design activity[6]. At firm level the DBA’s Design Effectiveness Awards or the European Design Management Award aim to highlight individual cases of the positive impact of design activity. But these initiatives do not necessarily lead to a finer grain understanding of the ingredients and recipe for design impact[7] This is identified as an important research challenge; eg ‘metrics have generally proven elusive for design processes as a whole’[8].

Establishing a robust foundation to better facilitate identification and communication of the factors which determine design impact has been the subject of earlier work. As part of the initial literature review an interim ontology of design process or terminological framework, was developed which can accommodate the significant developments in design process modeling of the last 50 years. Within the resulting ontology class hierarchy; *design process* is placed within the wider context of *design domain* or *design space* and an *Input-Process-Output* classification (Figure 1).



Input-Process-Output schematic incorporating the Double Diamond design process model [7]

The work to be presented has the overall aim to explore and understand the OUTPUT factors and metrics which can be used to define design success and to identify the Critical Success Factors (CSFs) which underpin design impact. This information can then be used to expand the interim ontology to include output factors and as a basis for formulating concepts and strategies for communicating and *Predicting Design Impact*

DESIGN/METHODOLOGY/APPROACH

In 1986 The Design Business Association (DBA) founded the DBA Design Effectiveness Awards (DEAs). Running annually, they have played an important role in promoting the value of good design in business success. Winning entries are judged by an expert panel to provide clear evidence of this success. Almost alone amongst design awards, success is evaluated in terms of commercial or organisational benefits. The entries provide rich validation and powerful communication of the variety of ways in which design can transform products, brands, services and market performance. Working in collaboration with the DBA, detailed data was made available for a sample of 46 case studies selected from the 265 submitted in the three years 2009-11. Table I shows how the selected sample also represents a spectrum of 14 design disciplines.

DBA DEA DISCIPLINE CATEGORIES AND ENTRY NUMBERS

Discipline	**DBA main category**	**All 2009-11**	**Selected cases**	**% of total**
2D Graphic Comms	1. Corporate/Brand Identity	60	7	12%
	2. Print	15	2	13%
	3. Interactive & digital media	7	3	43%
3D Packaging & Product	4. Packaging	107	12	11%
	5. Point of Sale	5	3	60%
	6. Product	10	6	60%
Environments	7. Interiors	9	1	11%
	8. Temporary exhibitors & experiential environments	2	2	100%
	9. Museums, Galleries, Events and Visitor Attractions	8	4	50%
Strategy	10.Internal Communications	12	3	25%
	11.Communications Design	1	0	0%
	12.Design Management	7	1	14%
	13.Design for Society	16	1	6%

	14.Environment	6	1	17%
	Total entries	**265**	**46**	**17%**

The DBA data for the case studies is written up by the entrant in a variety of forms to highlight the individual project attributes. The first phase of data processing was to standardise the information into categories and to compile this in a spreadsheet. Each case study can then be re-compiled/merged into a standard format from the categorised data. The second phase of data processing rationalised the descriptors for factors within the complete set of case studies. The final phase of data processing coded the rationalised descriptors as a basis for analysing the complete dataset.

Table II summarises the categories of data and the analysis questions which were applied to the complete rationalised and coded data for all 46 case studies

DBA DEA DATA CATEGORIES AND ANALYSIS APPLIED

Data category	**Analysis**
1. Rationalised hard outputs (eg quantitative data and related descriptors)	a) Categorisation of Hard output factors and metrics b) Instances of the use of different factors within the data-set c) Comparisons of specific output metrics such as sales growth d) Comparisons between design disciplines
2. Rationalised wider impacts (eg qualitative output data and related descriptors)	a) Categorisation of Wider impacts b) Instances of the use of different factors within the data-set c) Comparisons between design disciplines
3. Comments and Questions arising from the case study outputs	a) Rationalisation of comment & question factors b) Categorisation of output factors c) Review of output factors identified in comparison to the literature

FINDINGS/RESULTS

The significant quantity of data available (ref Table I & II) has facilitated production of a wide range of results for example: the initial analysis work identified 71 types of hard output categorised into 11 subcategories. Likewise 86 types of wider impact descriptions were organised into 9 subcategories. The most frequently occurring category of hard output metric was, as would be expected; sales performance (32% or 19 of the case studies sampled). The average figures from case studies including these key metrics were 163% sales growth and nearly £16m increase in sales. Within the case studies which include sales growth and design fee data the Design Council's measure of ratio of design cost, or fee, to sales growth can be calculated. The average from these 19 case studies is £179 for every £1 spent. This is significantly more impressive than the Design Council's figure of £20 increase in turnover for every £1 spent on design. However it should be noted that the DEAs are exemplars of award winning performance, and that there is limited reliability in this methodology. Across this small data set there is no obvious correlation between sales growth: design fee ratio and design fee. Eg we cannot deduce that spending more on design necessarily increases sales proportionally. These examples represent a small part of all the results generated from the data with further analysis possible

CONCLUSION/DISCUSSION

The sample size and reliability of the underlying data means that the quantitative analysis possible is of limited value. Further work could explore these findings in relation to other micro economic or company level studies of design impact. However for the purposes of the wider *Predicting Design Impact* study the value of the work is in the identification and classification of design impact factors and metrics. The DBA DEA study of 46 case studies has generated a considerable amount of analysis which can be used to populate an expansion of the interim design ontology and as a basis for further studies. It is noted that with a focus on commercial success the DBA DEA data does not comprehensively capture impact covering a broader range of outcomes. For example factors covered by a Triple Bottom Line approach. Therefore further work is required to fully populate a design process *output* ontology

FUTURE PLAN/ DIRECTIONS

Along with the earlier studies (eg the interim design ontology, HEET radar and Design process maps[7]) there is now a basis for generating concepts for communicating and predicting design impact. Future activity will follow the pattern of an iterative design process with input from design professionals and design researchers (eg in workshop events). Prototype methods will be tested and evaluated with live design project case studies including design student work (pedagogic application), design consultancy work and in-house design work (professional applications). For the purposes of the completion of the PhD, this work will conclude in early summer 2014, with completion of the associated thesis in early 2015.

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Appendix J STUDY 1.3 Interview Guide

Understanding Design Impact

Expert Interview guide | 07/02/14, updated 16/02/14

Introduction
I am interviewing 10 design industry experts as part of an overall study exploring design impact (for example the economic benefit from a specific design project). More specifically, the idea that designers can benefit from presenting stronger arguments for the value of their design input, based on better understanding of design impact. The work has involved various studies, including an analysis of 45 case studies from the DBA Design Effectiveness Awards. This interview is formally described as a semi structured interview, meaning that we don't have to stay precisely on topic, or answer all the questions!

All participant information will be anonymous

Objectives

Part 1 Background information

1.1 Company/organisation and Job title?

1.2 Main activity?

1.3 How many years doing this, and total years experience (approx)?

1.4 General comments about your possible interest in the topic?

Part 2 relates to the broader research topic

2.1 What is your organisations approach to communicating the value/potential value of design to your clients?

2.2 Your views about how effectively the profession as a whole is able to articulate added value or design impact? Eg a)the consultancy sector, b) the in-house sector and c) professional bodies/policy makers?

2.3 Can you comment on relevant methods, knowledge, resources to address the issues? Eg a)within the consultancy sector, b) the in-house sector and c) professional bodies/policy makers?

2.4 Considering the various reports and initiatives on this issue, what are your views and ideas about the relevant importance of the subject to the evolution of the profession? (show summary)

Part 3 Comment on the outline framework derived from the earlier work

3.1 What features would you point out as relevant, or areas to focus on?

3.2 Where might Critical Success Factors occur?

3.3 What about Design Critical Success Factors?

Part 4 relates directly to the specific case study submitted to the DEAs (other participants could describe a specific example from their experience)

Views about the **'inputs'** to project success'

4.1 How detailed was the client brief?

4.2 Was additional work done to refine the brief?

4.3 Were there notable contextual factors a) in the market, b) within the client company, c) with the subject of the project?

Views about the **'Process'**

4.4 Was there significant research or 'discovery' work in the early stages of the project?

4.5 Was this important to the subsequent project success?

4.6 Where do you think the nexus of the success lies: a) in terms of the design component, b) the project as a whole?

Views about the project **'Outputs'**

4.7 How do the outputs compare to other projects completed by the company – are these results exceptional?

4.8 Are there metrics you'd like to use, but don't have access to the data/the data doesn't exist?

4.9 Do you consider all possible impacts from the project? (intentionally open question)

4.10 Were there other points relating to the case study which are relevant and haven't been covered within the Input-Process-Output framework?

Understanding Design Impact

BACKGROUND

‘A nationwide programme should be introduced and supported to engage SMEs and demonstrate the practical benefits of applying creativity.’

‘Steps should be taken to get greater understanding of creativity and innovation into the boardroom by recruiting people with creative experience onto company boards’
Cox Review Recommendations (2005)

BUT

‘The question of what design is worth in the modern economy has been addressed in a hundred different ways and in voices ranging from the coolly measured and metaphysical to the sputteringly impassioned,’

Hertenstein et al. (2001, p10)

AND

‘In a business world largely driven by the quantifiable assessments of success, the contribution of industrial design to a specific business’s financial performance has stubbornly resisted measurement.’

Hertenstein (2005, p5)

AND STILL

‘There is a lack of reliable, comparable statistical evidence demonstrating design’s contribution to the economy and its impact on return on investment.’
European Commision 14 point action plan for Design-Driven Innovation (2013)

THIS RESEARCH IS BASED ON

the idea that designers can benefit from presenting stronger arguments for the value of their design input, based on better understanding of design impact

Design Council Value of Design animation | Example of online materials to promote the added value of design

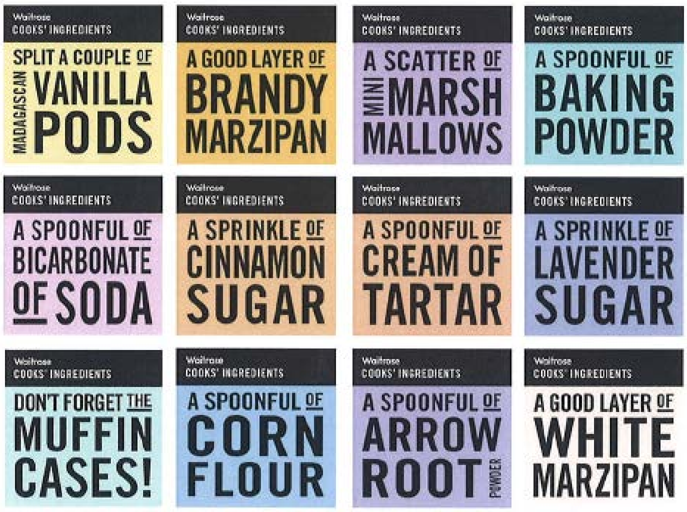
www.designcouncil.org.uk/news-opinion/animation-value-design-growing-businesses

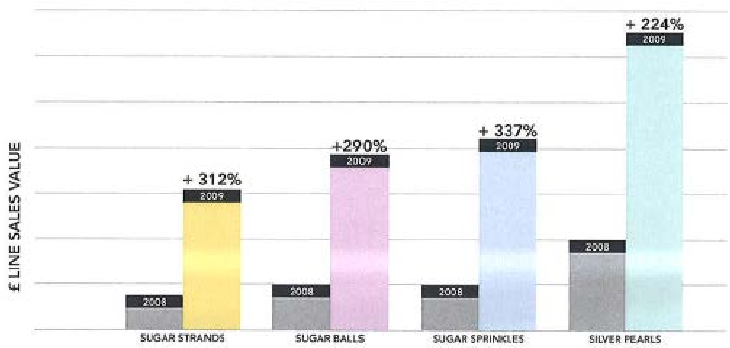
DBA Design Effectiveness Awards|linking design peer reviewed ‘good design’ with business orientated metrics of success

Lewis Moberly Packaging Design for Waitrose, 2010 Gold Packaging Award

Information available online via the DBA website

109% Year on Year sales increase against a sector average of 4%





Packaging Design Economic impact example

NHS / Design Council Design Bugs out project| Commode | Project and report aiming to demonstrate the broader socio-economic value of design

Overall, 68% of staff thought that the new chair was better than the old one.

Patients were almost unanimous in considering the chair to be clean and found the chair easy to use and adjustable enough. They found it comfortable, supportive, stable, safe and the right size. Some 91% of them liked it.

Visitors' views were similar to those of patients, with 88% liking it.
NHS project evaluation report

'We've currently made a 30 per cent reduction on last year's infection figures which is fantastic and the commode is definitely part of that. The CQC (Care

Quality Commission) who regulate us and assess us against the hygiene code have been in and carried out a thorough audit and they're very happy with the commodes.'
Donna Winter, Infection Prevention and Control Clinical Nurse Specialist for Scarborough and North East Yorkshire NHS Trust

Design Bugs Out

Product Design Social impact example

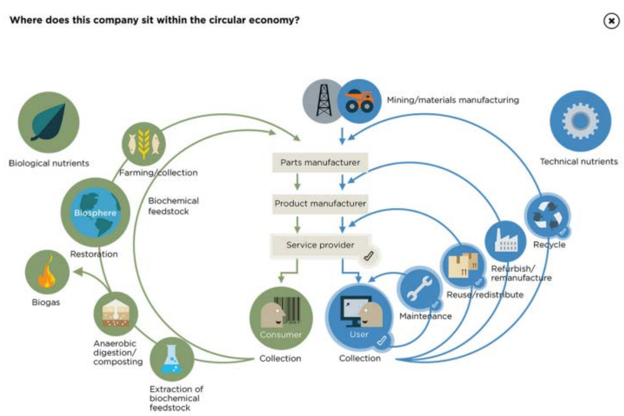
Ellen Macarthur Circular Economy Foundation | Mud Jeans | Work based on promoting and demonstrating environ-economic value in circular economy based approaches

Online Case studies

In a trend found with other commodities, cotton prices have become more volatile in recent years, seeing a recent peak when prices tripled from 2010 to 2011. Mud Jeans are made with 30% recycled content and 70% organic cotton

Recovery rates in the textiles industry tend to be low, with around 25% of textiles recovered per year in the EU

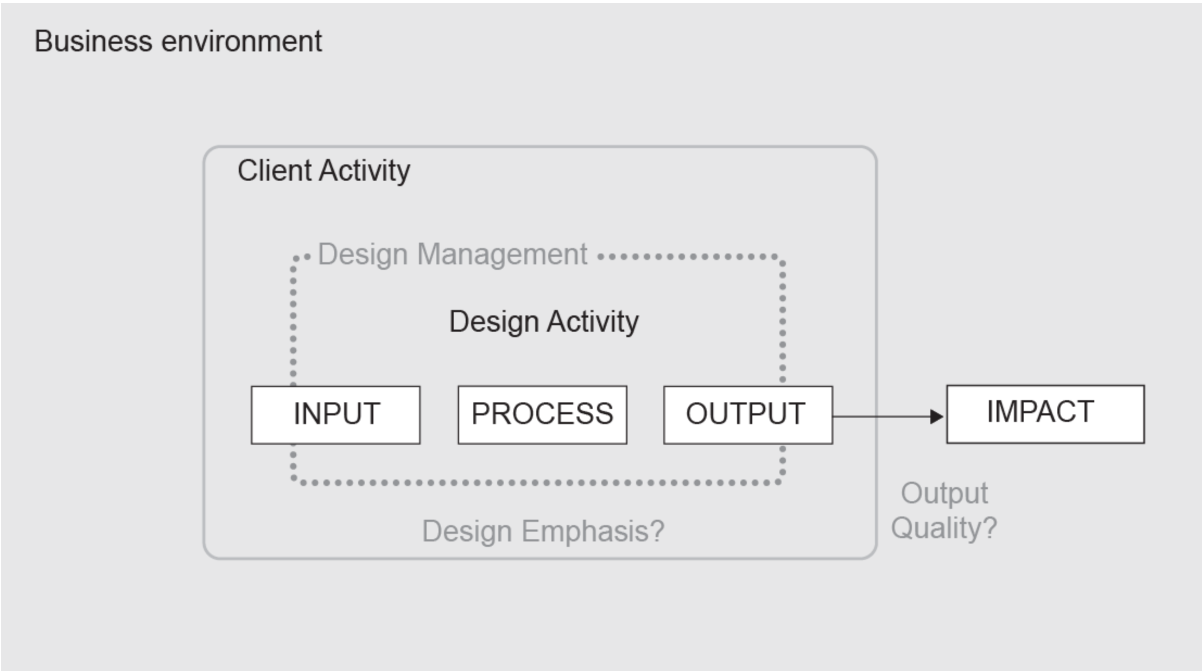
users can choose to lease Mud Jeans for €5 / month



Brand and Service Design Environmental impact example

Input-Process-Output Design activity model

Feel free to scribble on here to highlight any particular points



Version B

Appendix K STUDY 1.3 Sample interview transcript

<u>INTERVIEW WITH BM 24/07/14</u>

So just to kick off; some very brief background information for the record, so your organisation and job title within it is?

My organisation is at the moment called The Work Room and my job, I'm the founder of it, but my day to day job is really creative strategy director, that's how I would describe it.

And your main activity? As a company I guess for that question?

Oh as a company we focus predominantly around brand communications, so brand strategy, branding as in complete overhauls or evolution of a brand for example. Different forms of communication, so marketing, digital, web, recruitment, different topics, sustainability…

But presumably coming from a design perspective?

From I would say a communications and design perspective, in that order.

Right okay, that's interesting. And how many years has The Work Room been operating for?

Since 1990, so quite a long time.

Impressive.Any general comments about possible interest in this topic of design impact?

Absolutely, hugely, it's something we talk about all the time, it's something we encourage our clients to measure, something that we try proactively to put measurements in place at the beginning of a job, put them right into the brief if we can, we encourage the clients to think about it, think about what targets we could potentially achieve, what we should be looking to change etc.

And has that been a characteristic of what you've done from the beginning or?

We've always been keen to measure the effectiveness of what we do, we've always been chivvying clients if you like to give us feedback, whether it be anecdotal or statistical and to a greater or lesser extent we've had some feedback always in terms of results, but it's not really until the last maybe five or six years I suppose for us, perhaps slightly longer, where we've managed to get very robust quite broad detailed results on many different measures.

Okay excellent, so I'm talking to the right person then. And you've already said a little bit about your organisations interests and focus on those issues, I mean is there anything general to say about your companies approach to communicating the value or potential value of design to your clients?

So the question again?

As a company would it be possible to say that you have an approach to communicating the value of design? I mean for example if a sceptical firm comes to you and says 'Should I really be investing this money in reviewing the brand and the brand positioning etc', how do you…

Yes, how do we respond to that or do we highlight the…

Yes or is the idea of design and value how you respond to that sort of question?

I think we make it very explicit that what we do is to deliver. We in our introductory way of describing what we do, we generally talk about the fact that our purpose is to elevate our clients brands above anybody else's. So our aim is to always create competitive, what we describe as devastating competitive advantage for the clients. And so if we have a discussion about that we usually use a number of examples to help illustrate that. Sometimes it will be our own because as you've seen from the DBA thing I mean the Balfour Beaty one is a good example but we have others and we also might refer to things like the brand Z report that WPP produce every year, which talks about the value, the worlds' top 100 valued brands and why. Because a lot of what we do isn't just about the design, I mean this is where us and the DBA kind of part ways slightly.

Yes I realised when I asked the question.

We are a creative agency and design is definitely one of our core tools. I don't think design on its own necessarily has the same level of impact as what we provide, which is the brand strategy part. Now I do see that being part of the design remit but not all design agencies, especially smaller ones provide that, if you see what I mean?

Yes I can see that. And just out of interest is design your own background, you mentioned that you had worked at Fitch in the past?

Yeah I trained as a designer, I did a BA in information and communication design.

So that title suggests something slightly broader than perhaps a narrower view of what design is about.

Yes I think it probably does make a big difference what your background is, but it is also is very much dependent on what you then are particularly interested in yourself and if you like ideas driven design and you like the challenge of understanding strategy, I mean that's if you've been I think exposed to strategy early on enough to understand what a difference it can make.

No I completely understand that. So your views about how effectively the profession as a whole is able to articulate that added value of design or design impact? Don't be swayed too much by what I said earlier that result from the design council survey.

I mean the trouble is the design world or creative world, creative industries, is so broad, it's so enormous and disparate and fragmented that I think I can't honestly say whether I think people do it well or not. It's easier for some than others. I think if you are a packaging company for example and your clients share their sales with you, then you probably have a much easier more direct correlation between what you've given them and their success of it. Which means that probably it's true to say that people in the packaging world, of which there are many, probably have the ability to prove the ethicacy of what they do more easily than others, I suppose I would say.

Yes I see.

So then they're probably quite good at it. Advertising agencies on the whole have done well in the past, haven't they, because again they've got metrics and measures and research that shows the sales go up like that.

And in that context would you put yourself within a group of sort of brand strategy or communication consultancies?

Yes, yeah I would. I mean I think we, as a smaller agency, I think we probably put quite a lot of effort into getting the results. The kind of effort I think the bigger agencies often do, if they have more man power they probably find it easier as well, like a club, so they have maybe that relationship with their client where they can get more results anyway, it's easier for them. So the answer, the long winded answer is probably our industry isn't that great on doing it and needs to work a lot harder at it, but for smaller agencies it's quite a task.

Yes, but for the time being I'm seeing that there might be part of how you're differentiating yourself as a small business and that you might be doing this better than some of your similar size competitors?

Yes, I mean we certainly feel we hit above our weight, put it that way.

Yes, that's good. And in terms of approaches and methods that you use you've already mentioned that you make a particular point of gathering relevant data beginning, during and after project activities. Are there any other things that you would particularly pick out as methods or resources which are useful in this context? I mean you've also mentioned the difficulty of gathering…

This is the main problem. As you'll see from that Balfour Beaty entry, I mean we were extremely and almost totally reliant on the client to put those measures in place. We were just very lucky that they happened to measure a lot of things anyway. A lot of clients that we come across, especially mid size clients tend to hardly measure anything. And it's quite hard to encourage them or persuade them to put measurements in place even though they get even….

Is that because they see it as a cost to their business to spend time?

Yes, and there is just more time, more effort, whether they genuinely think it's going to be of benefit to them in the end I don't know. I mean if they saw it as an enhancement of their career in that company, which is often what it's about, if we're brutal…

And I guess a lot of value is attached to people being able to make instinctive decisions about things without…

I think they're all under resourced to be honest, most of the companies on the corporate side definitely. Too few people chasing big KPI's, not very much time, not very much resource and very little planning. I don't think they tend to be very efficient with their own time, so they don't… I think giving them an extra task like this to put measurements in place is just yet another thing for them to organise.

Yes, okay and I mean I think you've partially answered this but considering this is, take my word for it, it's quite a hot topic, when you look at the profession as a whole and perhaps linked to some of the DBA activities do you think that it is an important subject for the evolution of the profession?

Definitely.Definitely. I think the DBA could do more to help people understand how to put measurements in place.

Although I think other things I've seen, as a profession the profession is relatively resistant to what we're describing as professional development and again that's a resourcing thing isn't it because it's difficult to justify the cost and time?

Maybe, is that what DBA have said as well? They find the industry resistant do they?

Well I think I probably have heard it from them as well, I mean definitely the design council have sort of found that it's an issue for the profession.

Oh that's interesting.

Which is different to professions like medicine, law, where it's a sort of professional requirement to continually update your skills.

Yes.

Okay so I mean…

Maybe that's why we're more keen on measuring results then because we're also quite keen on professional development. Perhaps they do go together?

Yes, no I think they could do, I mean I think it's sort of, maybe I'm biased as well but it suggests a more analytical, strategic approach, which is obviously part of what you're about as a business. So some people I've shown this to have taken a positive distaste but for me it just serves as a basis for having a bit of a discussion about how do we try and get some sort of overview of the things that we're talking about, so a business environment, developing everything, client activity, design activity within that, typically there is some input and process and output and then there is some impact, so it's just a canvas if you like for having a discussion about things. So if you can get your head around that are there particular areas around this canvas that you would particularly sort of focus on as important to this subject of design impact?

In terms of how we go about what we do or in terms of the kind of interactions we have with our clients for example or?

Yes, because I think those things are linked aren't they because the interaction with the client at this front end stage, I would argue is quite critical to what comes out at the end and I might imagine that you would feel the same, that this front end is incredibly important.

Absolutely, I think that sums it up really. I think that first part of it is probably the most important, so client input and our ability also to question them rigorously on what they're doing, understanding the business strategy, making them understand that looking beyond their own little world is very important as well, so looking outside of their peer group and looking at other benchmark examples for example in other industries and things like that, it's often something that they don't really do much of because like us they have their heads down doing their day to day business, so when you get the opportunity to open their eyes to what else is happening, that makes a huge difference.

Good, music to my ears but many more enlightened people in the industry I think probably would agree with that. So linked to my next question then, so would you agree that quite a lot of the ultimate success of a particular activity is determined here or is it impossible to generalise, is it throughout the whole process?

I would say it's a combination of through understanding and setting the scene well at the beginning of a job, any job, branding in particular. And then our ability to translate that into a creative output which really reflects that style point well but that does it in a very unique ownable way.

Yes and I definitely like the translation of that analysis into some creative relevant output, which I suppose then is sort of like the answer to my next question, which is a question

about the design ingredient of that. So would you then agree that the design bit is about, well in this case about that creativity, it is about that creative translation of some of that front end analysis?

Yeah definitely I would call it creative intelligence I suppose. It's making sure that your creative ideas, whether they be design or, I mean design is such a broad word and that's another conversation altogether, it is a problem. I don't know what to say? Creative interpretation of all of these inputs has to be bedded in sort of commercial nowse. So I think that is what creative intelligence is, making that leap from something which is very concentre and business like and commercial, to something which is a creative interpretation that will help that business. That's the link, it's knowing what is going to be a successful idea or contribution.

Yes, I guess it's a sort of business criticism sometimes of the design business is that the design business doesn't understand business well enough.

That's probably very true. That's because designers don't really…

And the designers will say 'Trust us we're designers, we know'.

Yes, that's probably true yeah.

And how significant do you feel is say for example the business environment. One of the things I've found from looking at the DBA case studies is that often you can sort of see that the particular prevailing business environment was quite crucial to the success of the design. I mean the best example I found of that and of all the case studies I looked at the best returns on design investment, but it was a point of sale for low energy light bulbs, but it just came in at a point when legislation was demanding it and consumers were realising the significance of it. so it was a coming together of a number of things which I can think can be underplayed a bit in the recognition of how design impact works. Okay so think about the Balfour Beaty project. One of the things I've been quite interested in reading in these studies, and of course really they are case studies of overall success for businesses and actually maybe it's wrong to try and separate out the design element of that, I mean in a way we should consider it overall a success but for my purposes I'm quite interested in trying to separate out the design or communications in your case, part. So what I was not so sure about was how much of a brief was in place when Balfour Beaty came to you?

God, let's see, well just trying to remember, I'm not actually even sure there was a written brief at the beginning. It was Hayden Building Management when we first knew them and they had been doing some internal research themselves already, from memory, so they had done for example employee satisfaction survey, they had done some client satisfaction work. They had got a new Chief Exec whose vision was to build the business substantially from, what were the figures, something like 500 million or something, to I think his target was something billion.

I can't remember exactly but it was something like that yes, 411 to a billion?

Oh yes that's it. So the point is, as with all these things there is a business imperative, so what do we need to do in order to help them move from there to there? Like all, certainly branding jobs that we've come across anyway, generally speaking there is a commercial driver for making any change.

Yes, there was some discussion in here about the extent to which renaming Hayden's as Balfour Beaty was a good or a bad thing, which was quite interesting.

Yes, that was debated quite a lot.

And was that part of your activity then to have that strategic discussion?

Yes. So the reason, I think we've highlighted actually a lot of pros and cons in there, there was at the time the notion and the perception that being called Balfour Beaty anything could be quite a negative thing, because Balfour Beaty are very big, they're very corporate, they were perceived to be a bit arrogant, they were perceived to be only a construction company and therefore what on earth would they know about professional services. So it wasn't a straightforward case of saying 'Being called Balfour Beaty is definitely the way to go' it was part of a bigger discussion about what are the pros, what are the cons, what do our clients think, is staying with our current name going to limit us commercially, if there are negatives associated with Balfour Beaty the name, what can we do to mitigate those when we rebrand as Balfour Beaty something. So all of those things were taken into account while we were evolving the creative brief if you like.

Yes, although if I remember the general tone of that is as you were describing a bit there, overall you did present it as a sort of quite balanced picture, it wasn't either a huge negative but it wasn't necessarily because of some negatives, it wasn't a massive positive either. But I think probably from what I've discovered so far with looking at these things, the fact that you were involved with that sort of strategic level discussion is probably an aspect of the success of this, it's not just rebadging the company, it is more fundamental repositioning?

Yeah I think that was the whole point really. I think when the client first came to us they probably didn't really get what brand strategy was. They probably didn't really understand positioning until we started going through the process with them and the journey with them and then they realised how significant that thinking could be, as it started to unfold, they got more and more interested and more excited by it I suppose, which I think is quite common. I think most companies, most businesses that we have interaction with do not get what brand strategy is or how it drives a business. I mean a lot of people in our industry don't, so it's not surprising, people use branding as though that applies to logo and ends there.

Yes and the argument is that if you're in at the beginning and having a strategic level discussion it makes it easier to do that. Of course you have to follow up with the quality of delivery as well.

Absolutely.

Unfortunately I come from a university where they've gone through a branding exercise with no reference to people within the university who might be experts, including expert head of designer branding at BA, but…

Marvellous.

Then of course the implementation is dreadful, but I mean for what it's worth my take on this (the Balfour Beaty work) is that it's a great example of where there is a genuine sort of brand repositioning where a big part of that, I'm guessing but a different sort of personality for companies in that sector, which was probably very fresh and interesting for that area.

Yeah and I mean I think the thing about the position it's that's really what drives the creative anyway. So I mean you could argue that the visual, that the creative solution, we might have come up with something like that, we haven't done the positioning work. But because we did the positioning work and we had this idea of freedom to perform, which was really driving everything, it made all of the subsequent brand design so much more meaningful because we had communications and headlining which supported that idea, we had the strapline 'We work you excel' which was fantastically a simple way of expressing that positioning as well.

So the classic branding type approach where there is the background strategy which has, as you say, translated into this core creative idea that then can lead onto everything else and then presumably the idea is that is where the success of something like this lies, is the strategic upfront work and then the translation into the strong creative idea.

Exactly.

So in relation to, I mean if we put this project alongside other projects that your company have completed, was this project exceptional, were there particular characteristics in play here which might have been to do with the business environment or your process? What were the… Well the first bit is was it exceptional and is it possible to identify any particular things about it which made it exceptional?

I suppose one thing that was exceptional was the fact that we had as part of our creative brief, part of the strategy was to move this business upstream and you don't necessarily get an opportunity to do that sort of task very often. So even if we were doing a rebranding for another, I mean we did [0:30:18:3] global rebranding as well which was actually a much bigger programme than that, but it didn't really have a definitive kind of end game as it were. So I think what was driving that was understanding that there was a need to move them up stream in the marketplace, from just a deliverer, to being a knowledgeable, insightful, strategic partner themselves to their clients.

And was part of that coming from, you mentioned that there was a new Chief Executive or some senior management person that was setting this ambitious business target, was that also part of his vision or was that a vision that you implanted in him?

Well…

I mean partly the reason I ask that is because one of the characteristics I have found from talking to other people is that quite often you see on a client side that there is an individual, maybe an individual who is quite influential within the organisation that it then becomes a really important part of how the success is tuned?

I agree, that is definitely the case I would say. And that is always I think why we've positioned ourselves as do they, as a strategic partner, a creative strategic partner, because we know how important that is to be and have the relationship with the main driver, the main decision maker. And that's really why our whole business model I suppose has evolved into doing branding as a discipline more than anything else, because that's where you get to have those one to one intelligent conversations about how to drive a business forward and the more knowledge you have about that, the more that influences how you deliver it.

Okay, well that's a very interesting aspect of it which is this idea of experience because funnily enough in a lot of the academic literature on these topics, experience doesn't figure anything like as highly as I would imagine it should do.

Yes.

Because I think that, well that's a good thing about looking at the DBA case studies and particularly any case studies that year in year out are winning awards is that you can see that the experience and level of creative ability or design ability or however you want to describe it is an important aspect.

Your question was if there is anything exceptional about that one wasn't there?

It was yes. But you've sort of answered it.

One thing is the moving upstream, that's unusual, the other part of that is that we already knew because we had already been working on projects with them as they unfolded, so we were working on big tenders and pitches with them to help them win new business, prior to that rebranding project. So that gave us a level of insight into the kind of challenges that they were facing, in that highly competitive and extremely expensive mega bid process that can take up to a year. They were bidding already on projects over value, we helped them with one that was worth three billion for example. So we understood the significance of them being able to have a brand story and a positioning and a creative delivery of that, that would really stand out in the marketplace and help them win business.

Okay.

So that in itself was probably rather more exceptional than is usually the case.

Yes, so if you unpick that puzzle, what you've said there is again it's quite familiar, that idea of a company earning their place in that strategic discussion through an earlier relationship.

Yes definitely. It's very difficult, I certainly think it's quite hard for agencies of some sorts to be able to have those kind of meaningful conversations with clients early on in the process because you don't know them well enough.

Yes, that relationship, definitely I would agree with that. So thinking about it and you've touched on it, but the metrics side of this and your case study was particularly impressive with a whole range of different measures, including some of these softer ones which I quite like, like happier clients and measuring staff absenteeism, particularly good. So I think that idea of a basket of metrics, that makes good sense. But when you're talking to companies and you've said it's part of what you do as a business is always aim to gather data. I mean are there particular metrics that you're consistently interested in?

Well I guess it would be a cross section of what you've just highlighted, so the hard data are things like uplift in turnover, profitability, brand value, if you can even work out how to measure it.

Do you have a consistent formula that you use?

No, no, but I'm trying to learn from Interbrand and WPP, the Millwood Brown, the brand thing is quite an interesting way, it's quite complicated that's the trouble. So for a small agency it's hard to.

Yes, but I think sometimes that's done just to blind people with science isn't it.

Probably.

Or there is an aspect of that.

Yes. But I think I mean those are the obvious commercial things but then as we know if you're creating a corporate brand, which is the completely different exercise from doing a piece of packaging, I mean it couldn't be more different in a way, you've got massive diverse stakeholder groups for a start and one of the key outputs, one of the key things that you would like to see an impact in is the internal attitude and spirit because I think things like absenteeism and employing the wrong people, so retention rates are not good and all that stuff, that's generally because there isn't clarification around the brand, so people don't know what it stands for. If there was a purpose for the business nobody told them.

Yes, thinking about it that's a massively important point because as you say brand is about, when it's working most effectively it's about repositioning the company and its activities and therefore it's culture, what metrics are available for evaluating a company culture.

Well I think one of the key things for Balfour Beaty, because it's completely, all businesses are people businesses and we always say that and it sounds really naff, but from their point of view they're in a service industry, so they're quality of their people, their ability to deliver, their needs to care about their clients business in order to do a good job, is very embedded in the business and so it's really important for them to retract and retain the right people and good people. And the way we made sure that the brand was meaningful for them was when we articulated the vision and in particular the values. We worked with their HR team on translating how the values would, or what that would look like in terms of behaviours and so they were then instilled in people's performance reviews.

Okay, excellent.

So to my mind that is the most fundamental way of being able to measure the effectiveness of whether people get what the brand is about.

So you are creating this virtuous loop then I guess that you've set the benchmark for the brand but you are finding the ways to make sure that that feeds back in on itself.

Well I think it's fairly pointless doing brand exercise which is basically just top down because your business is your people, so if you don't communicate what the brands about well then you might as well not have bothered, then it's just superficial lipstick on a gorilla exercise isn't it.

Yes you did say that once or twice.

Yes, it's one of our favourite expressions actually.

Yes, so thinking about metrics, you have covered a particularly wide range there, but you know, are you finding that that sort of list of possible metrics is expanding? So for example I'm thinking of traditionally design impact would be just about sort of economic impact, but now we can also consider environmental impact or social impact, you've sort of touched a little bit on social impact, are those coming onto your horizon at all?

I think the topic certainly of sustainability generally and responsibility and things like that, they are topics that most companies are discussing, if not doing something fairly significant about. So that should be embedded in the brand strategy really, you know what a business believes is important for it and how it's going to behave, is just as much about building that into the brand story and the brand positioning is something that's quite important and it can help certainly drive corporate responsibilities, behaviours and things like that.

But would you in your strategic consulting role, would you be making those arguments to the company, that they should be for example paying more attention to environmental impacts and here's the evidence to demonstrate why they should be?

It's certainly part of the conversation. I mean it's an area that we're I suppose you could say finding out more and more about and in particular sort of the sorts of measures and things that can be put in place. I mean we help our clients on the whole with lots of different aspects of corporate responsibility and sustainability and things like that but really if you haven't been involved in the beginning of a brand strategy programme it's difficult to embed it afterwards. I mean you'd have to make a radical shift like Unilever have done if you were going to retrospectively or basically remodel your business on a sustainable model, which is what they've done, Unilever I mean. So we're not, I suppose we touch on it put it that way, but we're not really experts in all aspects of corporate and social responsibility. I guess we have an intuitive understanding of it.

Yes, but it's not necessarily a part of how you're positioning yourself as a business?

No, not at the moment. I do think however, I should say, I do think that doing a thorough rebranding programme in the way that we do, is in itself a much more sustainable way of doing business because if you do that well at the beginning, you don't need to keep tinkering with it and changing it.

Yes exactly and through our organisations, we've had some dealings with the Ellen McArthur corporation that has signed up big corporates all over the world to the concept of the circular economy but what's nice about that is that they've from the outset made the argument that there is a direct correlation between the economic success of the company and their paying attention to environmental…

Yes, their impacts, yes.

Which is good, but then they've sort of set out from day one as that is their positioning. So you're absolutely right to say that in many client situations you're just not in a position to have that discussion, which I suppose comes back to part of the success of this one was that you were in at a particular point, where you were able to move the company in a way that many other perhaps situations wouldn't allow you to, which again is another factor I've found about quite a few of those DBA case studies is that you can look at the brief

and you can say 'Well this isn't a typical brief, it is an exceptional set of circumstances' and another one which I really liked was the Design Bridge one where they had spotted the opportunity with the Kate and Will wedding to bring out a unique icing sugar pack and they pitched it to Tate and Lyle and Tate and Lyle went with it and it was fantastically successful.

And another Marmite one as well, wasn't that one? Didn't they do, not for Kate and Will's wedding but wasn't there for the Queens jubilee, they bought out a Marmite, a special one, and they did a play on words that said 'Maam' and I thought that was very clever. I don't know if Marmite themselves did it or whether their agency came up with that and suggested it. I thought that was really good as well.

Right, well I don't know if anything else springs to mind. My last question is do you think there is anything around this topic that is a burning issue that you want to get out or do you think we've done a good broad brush stroke through all of the issues?

I think that the main thing for me I suppose is the lack of understanding about how brand positioning and having a strong well thought through, well crafted brand, can fundamentally change the way you do business. And I think that's not understood at all, on the whole. And maybe some of the bigger agencies do, maybe some of the people like Landor and perhaps a few, but I don't think…

Are you saying the agencies themselves don't know them that well?

I think some agencies probably do but I don't know how far they go in helping the customer beyond just the usual deliverables of design things, which are tools and stuff. I mean obviously there's a lot of useful thinking around all sorts of different guidelines and things and the governance of the brand I mean, but the idea, if the brand idea is really strong and fundamental to the business and truly reflects what the business is and distils it really well into this big idea, that's something that can help drive all sorts of parts of the business. It can even drive operational or organisational make up and it can help drive the development of products and services to make sure they're on brand. But I don't ever see much discussion or many examples of that, but I don't think clients understand at all that it has the ability to help them in that way.

Yes and going back to my first point, I think probably on the whole agencies aren't that brilliant at articulating that.

And I wonder if they're that interested in it as well though, because I think that agencies probably fall between two stools in the sense that agencies which are predominantly strategy probably find that quite interesting. Agencies which are predominantly creative don't really want to touch that because it's not really their thing, they can't get very excited about it because it's not a creative deliverable.

Yes, well I mean I think that's also a very good point because when you start to dig into this whole topic there's quite a lot of antagonism against people trying to disaggregate what design and branding is all about because there is a whole group of people that do want it to be an emperor's new clothes or smoke and mirrors, or whatever metaphor you want to use, type activity.

That's probably true. Although obviously I haven't had the benefit as you have of interviewing a variety of different people, so I can only go on what I hear from others.

Yes, but as you can imagine there is a spectrum of views. Excellent, really interesting to talk to you and thank you for your time.

Appendix L STUDY 1.3 Secondary coding categories mapped to tertiary categories

Secondary coding (codes and categories)		Tertiary coding (codes & categories)		Freq. (code 2)	Rank
Ee	Consensus as a framework for discussing design input and impact	1	FRAMEWORK/Process structure/Design activity/Path: Models have a value, but their purpose in specific contexts needs to be clear	1	
Ef	Designers need to accurately tailor their input - a consultant approach - it might not just be a design challenge			10	8=
Gf	Different levels of adoption of models/methods according to context			1	
Gg	Generic principles from models and frameworks are used - tailored			11	7=
Ha	Benefits of models: (various)			5	12=
Hb	Business & Design profession benefits from models to help understanding - but acknowledging difficulties			3	
Hd	Business is not interested models - only the results			1	
Hi	Models can obfuscate difficult issues: oversimplify complexity			5	12=
Hj	The Design Council double diamond model has positive and negative associations			6	11=
Be	Divergent views on topic between different types of designers and with other stakeholders	2	INPUT/Moderating factors/Context CSFs/Motivation/Design emphasis: The importance of the socio-cultural drivers in a design impact context - Design authority	4	
Bg	Impact only of interest if it is linked to career advancement			1	
Dd	Difficulties building/maintaining relationships with business			4	
De	Industry split between creative/intuitive and strategic/creative			7	10=
Eh	Effective communication with client organisations is essential			8	9=
Ej	Importance of deep engagement and long term relationships with client			19	1
Ek	Importance of design management - effectively combining strategy and tactical inputs			4	
Jd	Client managers: senior staff more likely to understand design impact			5	12=
Ji	Lack of continuity across managers of design within organisations (multi-functions, job changing)			1	
Bc	Confirmation that 'design' can be a hard sell (especially to SMEs)	3	INPUT/Moderating factors: The complexity of FEI and the difficulties of designers making an input at this stage - Design Authority	1	
Bj	Reliance on the magic/smoke and mirrors approach			1	
Cc	Like to challenge client briefs			1	
Cd	Participant's work and interests have moved from tactical to strategic			2	
Da	Aptitude and experience needed to do strategic work			5	12=
Db	Business does not consider/rate/value the contribution of designers to strategy			7	10=
Di	Designers as a whole not good at understanding / communicating impact			11	7=
Ed	Possible role for risk management approach - but prediction cannot completely de-risk design			2	
Eo	Strategic (design) work needs an evidence based approach			1	

Secondary coding (codes and categories)		Tertiary coding (codes & categories)		Freq. (code 2)	Rank
Hf	General importance of the FEI/Input: contextual factors			8	9=
Hk	The FEI/Input aspect is too complex to imply it can be easily tackled by designers			1	
Ib	Design is typically a small proportion of total spend needed for NPD/Innovation and seen as tactical requirement			2	
Ie	Designers need to accurately tailor their input - a consultant approach - it might not just be a design challenge (ref Ef)			1	
Ig	Innovation is difficult in established businesses - companies are risk adverse			3	
Ik	Open Innovation concepts are not being adopted across all business functions			2	
Jc	Business need to define the outcome at the beginning of a process (risk adverse, control, taking the credit)			2	
Ld	Key front end work can be quite simple			1	
Ac	Designer's have not been listened to - other professions have	4	PROCESS/Design Management/Scale/Strategic-Tactical: The importance of design leadership/authority for determining design impact - Design Authority	1	
Af	Importance of both designers and client organisations understanding design impact			2	
Eg	Designers need to demonstrate stronger interest, knowledge and empathy for business issues			8	9=
Eq	The importance of 'Design Leadership' and internal 'Design Champions'			18	2
Er	The need for more designers 'client side'			1	
Ij	Most companies know what design service they want - a barrier to other types of engagement			2	
Jk	The commissioners of design determine if the approach is strategic or tactical			1	
Mb	Consensus and 'buy-in' within an organisation is critical to success			2	
Nb	Benefit of initiatives which demonstrate the wider impacts of design			1	
Nf	Importance of experience at senior business management levels			1	
Nj	The value of 'T' shaped designers			1	
Bl	The long term nature of design and brand impact - not a snapshot - especially for social and environmental impacts	5	PROCESS/Design CSFs/strategic tactical: The value of integrative approaches (eg branding) – Design Value	5	12=
Cf	Strengths in the successful implementation of design ideas			1	
Ei	Importance and value of a strategic 'big idea' - eg a brand led approach			8	9=
Ge	Design process CSF: 'Foresight' activities			5	12=
He	Confirmation that design 'insights' are not linear			1	
Ic	Designers differentiated by ability to translate ideas into products, services, brands			1	
Jh	Lack of business orientated evidence of how brand led approaches can impact business			1	
Ma	Combination of factors and consistency of elements leading to quality experience for customers			2	
Nc	Brand valuation useful but complicated			2	

Secondary coding (codes and categories)		Tertiary coding (codes & categories)		Freq. (code 2)	Rank
Ne	Example of impact assessment: Valuing differences in desirability			1	
Ai	UDI important - various: Hugely important - what drives the (design) business	6	OUTPUT/ Moderating factors/Design CSFs/Operationalisation: The need for better recognition of quality factors within the design profession - Design value	5	12=
Ch	The design company focuses on what they are familiar with - including impact aspects			2	
Dh	Personality traits of designers/design profession can be a barrier			13	5
Dj	Profession evolving, but limited professional development			15	4
Dk	Quality issues: consideration of good and bad design			2	
Ea	A role for professional bodies in professional development?			1	
El	Linking Professional development/process improvement (through metrics) to enhancing impact			3	
Ia	Design companies with a heritage of 'traditional' approaches to design			1	
Ih	Mention of the role of quality standards - indirectly related to design quality			1	
Le	Linking professional development and benefiting from a focus on impact			1	
Md	The importance of quality people to creating success			1	
Aa	Confirmation of lack of clear evidence - in business terms - of the design component of impact	7	IMPACT/Moderating factors/Design CSFs: Limited understanding of design impact metrics and not valued in business contexts - Design Value	5	12=
Ae	Impact is THE key measure of the success of design			1	
Bb	Clients not interested in measuring design impact			8	9=
Es	The need for 'smarter' company research on impact issues			2	
Ja	Business finds out about design impact through experience			1	
Jb	Business may not understand the strategic value of a brand led approach			1	
Jj	Non design-led companies don't understand how design works within a system (eg Apple)			1	
Kb	Effectively disagregated, objective and quantative metrics have a high value (but don't exist for design impact)			2	
Of	Effective tools for understanding social and environmental design impact are needed			1	
Oj	Social and environmental benefits can be seen as 'trade-offs' against economic benefits			1	
Ab	Critically engaged with Understanding Design Impact	8	IMPACT/Design activity/Operationalisation/wider impacts: Recognition of the value of enhanced practice, but also the difficulties – Disaggregation Challenge	3	
Ad	Historically designers have not had a value proposition for design			1	
Bd	Difficulty of getting access to impact data			6	11=
Bf	Evaluation methods/metrics have to be recognised by others			1	
Bh	Important but difficult factors to evaluate within design impact			11	7=
Cg	The consultant's adopt/work with their client's metrics - overall impact is key			2	
Df	Lack of effective tools and methods for designers			5	12=
Ec	Avoid 'formal' methods for impact assessment			2	

Secondary coding (codes and categories)		Tertiary coding (codes & categories)		Freq. (code 2)	Rank
Ep	The design profession can gain respect through effective articulation of impact			1	
Gc	Communicating Design added value: Case studies - with impact metrics when available			10	8=
Gd	Company is putting more emphasis on gathering impact data			1	
Lh	The designer's own positioning contributing to impact			1	
Mc	Providing reassurance - eg evidence as a basis for managing risk - is key			1	
Ag	Querying why design impact is such a hot topic in relation to other issues	9	IMPACT/Hard outputs/Wider impacts: Confirmation of complexity and antipathy – Disaggregation Challenge	1	
Ba	Antipathy to the topic (eg too complex, lacking objectivity, not relevant)			12	6
Bk	The disaggregation difficulty			16	3
Ca	Consultant's work is broader than 'Design' - eg Branding is related but distinct			2	
Dc	Challenges/weaknesses because of the range of design disciplines and applications			2	
Dg	Other sectors share these issues			1	
Eb	Advocating focus on 'innovation' in relation to impact, rather than 'design'			2	
Fa	Individual designers want - various: Respect is desired, but ultimately it is influence			2	
Hg	Highlighting the key role of creativity to translate strategy concepts into tactical ideas			2	
Je	Client side political and cultural issues can be barriers to recognising design impact			2	
Jf	Emerging signs of an increase in (large) companies adopting a design led approach			3	
Jl	The complexity of the topic means business is unwilling to engage - 'intellectually lazy'			1	
Bi	Precedent for Metrics/Impact assessment in other fields such as advertising	10	IMPACT/Hard outputs/Wider impacts/Operationalisation: Recommendations for impact metrics - Disaggregation Challenge	6	11=
Dl	Some disciplines (eg Packaging) easier to evaluate impact than others			5	12=
Em	Means to make intangible aspects more tangible or 'real' - eg 'desirability' or 'wow factor'			3	
En	Service design is a useful test case for identifying multiple impacts			2	
Lg	Tactical design (implementation) is more straight forward			1	
Na	Award schemes have a value in highlighting design impact			3	
Nh	Possible metrics - various: Identifying 'early adopters' in 'what if' evaluation			4	
Od	Design approaches to social and environmental impact should be tailored and avoid design tropes			2	
Ah	Terminology issues: 'Impact' is often used in relation to social and environmental impact rather than economic impact	11	IMPACT/Design Domain/Moderating	1	

Secondary coding (codes and categories)		Tertiary coding (codes & categories)		Freq. (code 2)	Rank
Hc	Business factors are the main drivers for most design		factors/circularity: Consideration of social and environmental factors highlights many of the overall issues for design impact – Circularity of design impact	1	
Lb	Client/brief responding to wider contextual issues			1	
Oa	A more enlightened approach must recognise a triple bottom line			2	
Ob	Business needs objective measures to be persuaded of social and environmental impacts			1	
Oc	Consideration of social and environmental impacts driven by client company			1	
Oe	Designers may adopt a 'rule of thumb' type approach to considering social and environmental impacts			1	
Og	Increasing awareness of the need to consider social and environmental impacts			2	
Oh	Larger companies do now have to consider social and environmental impacts			3	
Oi	Like innovation, social & environmental considerations can be top down and poorly adopted			2	
Ok	Social and environmental issues suffer from 'silo mentalities' - design could help			2	
Ol	Social impact is enhanced by involving users at the FEI			1	
Om	Successful social innovation requires difficult to achieve changes to company cultures			1	
On	Sustainablity is considered as part of the design consultancy's process			1	
Oq	Very limited knowledge/limited interest in social or environmental impacts			2	
Gb	Aim to put impact metrics in place from the outset	12	IMPACT/Feedback/Circularity: Impact metrics can link impact back to input and create 'design circularity' - Circularity of design impact	2	
Gi	Some consideration of future impact in their practice			1	
Hh	Highlights the need for designers to link input factors to impact			2	
If	Innovation can enhance the profile of individual managers, but whole cultures need to change			2	
La	Benefiting from some focus on design impact			1	
Lf	Successful work leading to increased design activity (circular and referal benefits)			4	
Nd	Desired metrics - various: Repeatability / sustainability			7	10=
Ni	Problems with, or use of existing metrics: GVA won't show repeatability			4	
Fb	Design businesses want - various: competition wins validate designers' success	13	Competition reference	3	
Ga	A relatively small % of their work is award winning			1	
Ng	Possible downsides to a focus on winning competitions			1	
Cb	Design business has grown to other aspects from core packaging expertise	14	Participant specific comment	1	
Ce	Research interests in communications for designers, policy and impact evaluation			2	
Gh	Impact validation is implicit with methods used - but maybe of			4	

Secondary coding (codes and categories)		Tertiary coding (codes & categories)		Freq. (code 2)	Rank
	dubious value				
Id	Designers don't have a monopoly on creativity			1	
Jg	Importance of advertising within the 'mix' - for communication to audiences			1	
Ka	Traditionally, advertising can be a significant factor in success			1	
Lc	Evidence of designer's success - various: % of successfully implemented projects			4	

WHAT WE DON'T KNOW ABOUT DESIGN IMPACT

Stephen Green, 1st Supervisor – Professor David Harrison, 2nd Supervisor – Dr Farnaz Nickpour
Design Subject area
Year 5 of part time PhD

***Keywords*— Design effectiveness, Design impact, Design metrics, Design ontology, Design process.**

I. INTRODUCTION

This abstract describes an aspect of an overall PhD study titled *Understanding Design Impact (UDI)*. In summary; an analysis of an earlier core descriptive study,combined with initial literature review conclusions.This facilitates a new overview of *what we DON'T know about design impact.*

Although design impact has been explored as a discrete research activity since 1980 [1], the term 'impact' in relation to commercial performance only emerged in 1993[2] and, as late as 2005, leading researchers in the field continued to report: 'relatively little work appears to have been done on the economic or commercial impact of investments in design'[3].The design community have long argued - relatively ineffectively - about the 'Power of Design'[4]. The Design Council reported that nearly 88% of businesses surveyed stated that designers are only; '*quite good'*, through to; '*not good at all'*, at communicating the value of design activity[5]. However a growing body of research,has identified the importance of design;for example as a differentiator[6], or as an ingredient of innovation[7]. In parallel with this body of research, policy level work and grey literature in Europe and in the UK is reporting on the potential of design to contribute to the economy; for example Cox[8], Sainsbury[9] and Dyson[10]. The UK DCMS identifies that design contributes £1.6bn of the £59.1bn GVA generated by UK Creative industries[11].However design impact is particularly resistant to analysis, with issues including; defining what is meant by design[12] and conflating design with many other disciplines[13]. Some notable work has attempted to contribute to these issues with concepts for disaggregating design such as *Silent Design*[14] meaning differentiating between design conducted by professional designers and design which is an integral –*Silent*- element of the work of others, or the *Danish Design Ladder*[15] a metric demonstrating that companies with more intensive use of design were more successful than those with little or no use of design.

The earlier empirical study of 45 cases studies from the Design Business Association Design Effectiveness Awards (DBA DEA) was conceived with the aim: To develop a detailed understanding of current best practice for describing and quantifying design impact, and for the findings to contribute to a useful holistic model of the FEI (Front End of Innovation) to IMPACT journey.

II. DESIGN/METHODOLOGY/APPROACH

The overall approach is based on the Design Research Methodology (DRM)[16] whereby a series of descriptive studies, combined with literature review and feedback loops, inform the development of an overview of an 'existing situation' and a 'desired situation'. This subsequently leads to a prescriptive study phase where design ideas, in response to the hypothesised desired situation, can be developed, tested and evaluated (ref Figure 1).

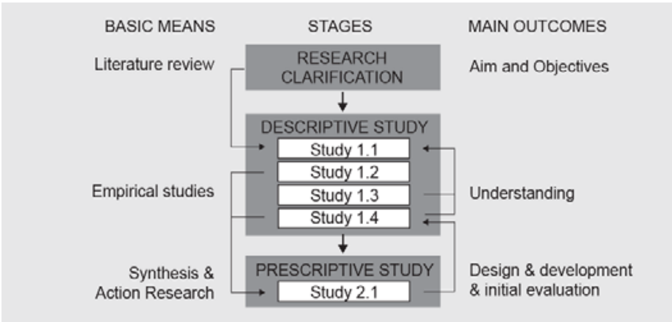


Figure 1 DRM structure for the complete UDI study

The DBA DEA work is Study 1.3 in the sequence shown. This included content analysis of 45 case studies selected from a cross section of design disciplines and business sectors and three years of entries (2009,10,11). Coding conformed to three phases[17]:1) *Descriptive coding* – converting the case study data into a standard format, 2) *Topic coding* – identifying the main themes and categories of information relevant to the study and 3) *Analytic coding*– linking key data to the identified themes and categories. The results generated through this process can be viewed in isolation, but for the purposes of the overall study the results can be explored in relation to the relevant literature review findings (*Research Clarification* stage). A conceptual model emerging from Study 1.1[18] can be updated to reflect the combined findings.

III. FINDINGS/RESULTS

A. *DBA DEA findings/results*

From the Topic coding phase,four main categories were defined. Points of note from the subsequent analytic phase include; 1) *Hard Output metrics;* 71 metrics were identified, sorted into 11 subcategories; for example12 different metrics for sales performance. This subcategory had the highest frequency within the sample (32%, or 19 case studies). The average performance figure from this sub-set was 163% sales growth and nearly £16m increase in sales. Within the case studies which include sales growth and design fee data, the RoDI ratiometric (design cost, to sales growth) could be calculated. The average figure was £179 for every £1 spent. This is considerably more impressive than the Design Council's figure of £1:20. But significantly there is no clear correlation of these ratios across the sample. 2) *Wider Impact*: 81 factors - 9 sub-categories. Across the whole sample the average frequency of hard impact and wider impact data was just under three of each type for each case study. 3)*Observations*: 19 sub categories - 5 overall categories(Context Critical Success Factors (CSFs), Design CSFs, Operationalization challenges, Strategic-Tactical-clarity? and Other opportunities and challenges). Considered together these highlight the challenges associated with defining and communicating design impact, combined with an emerging view of how to understand the nexus of design impact; for example through clearer understanding of Context and Design CSFs. 4) *Discipline specific factors:*Certain disciplines, particularly Packaging, appear more straight forward to operationalize and identify design impact. And certain business sectors have well established metrics, such as *footfall* for environmental design, or *click through rates* for online digital design.

B Literature Review findings

Over 30 empirical studies of design impact have been reviewed together with three literature reviews of design impact studies. The simple overall analysis from this work is that there is good evidence that companies who invest in, and fully integrate design into their businesses, are more successful than those which do not. Beyond this the picture is considerably less clear. However existing research does begin to highlight factors which are significant in creating impact; for example the concept of design emphasis captured within the *Danish Design Ladder*[15]. A relatively recent literature review on the topic [19] provides a useful framework for exploring the areas where understanding is limited. Figure 2 shows these factors in combination with the earlier model development [18] and the analysis from the DBA DEA study.

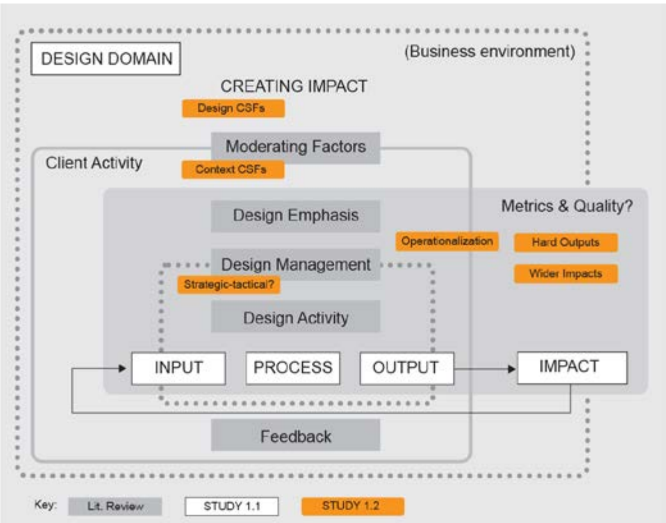


Figure 2 Emerging framework for Understanding Design Impact

IV. CONCLUSION/DISCUSSION

In keeping with the DRM approach, the overall study is concerned with developing practical support for designers. Conducting empirical studies relating directly to design impact quantification are highly problematic in the absence of any clear framework. The work to-date provides some validation for combining existing academic and practice based studies to produce a more robust framework for future practical use.

V. FUTURE PLAN/ DIRECTIONS

Study 1.4 (ref Figure 1) is nearing completion and adds an element of triangulation to the existing studies through a series of semi-structured interviews. All the descriptive study work will inform work underway to develop and test tools and methods for exploring and communicating potential design impact in professional design contexts. The thesis write up is continuing in parallel, with completion planned for late 2014.

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Appendix N STUDY 2.2 Evaluation workshop - participant information

Understanding Design Impact

UDI Framework Evaluation workshop |6:00-9:00, 15/04/15

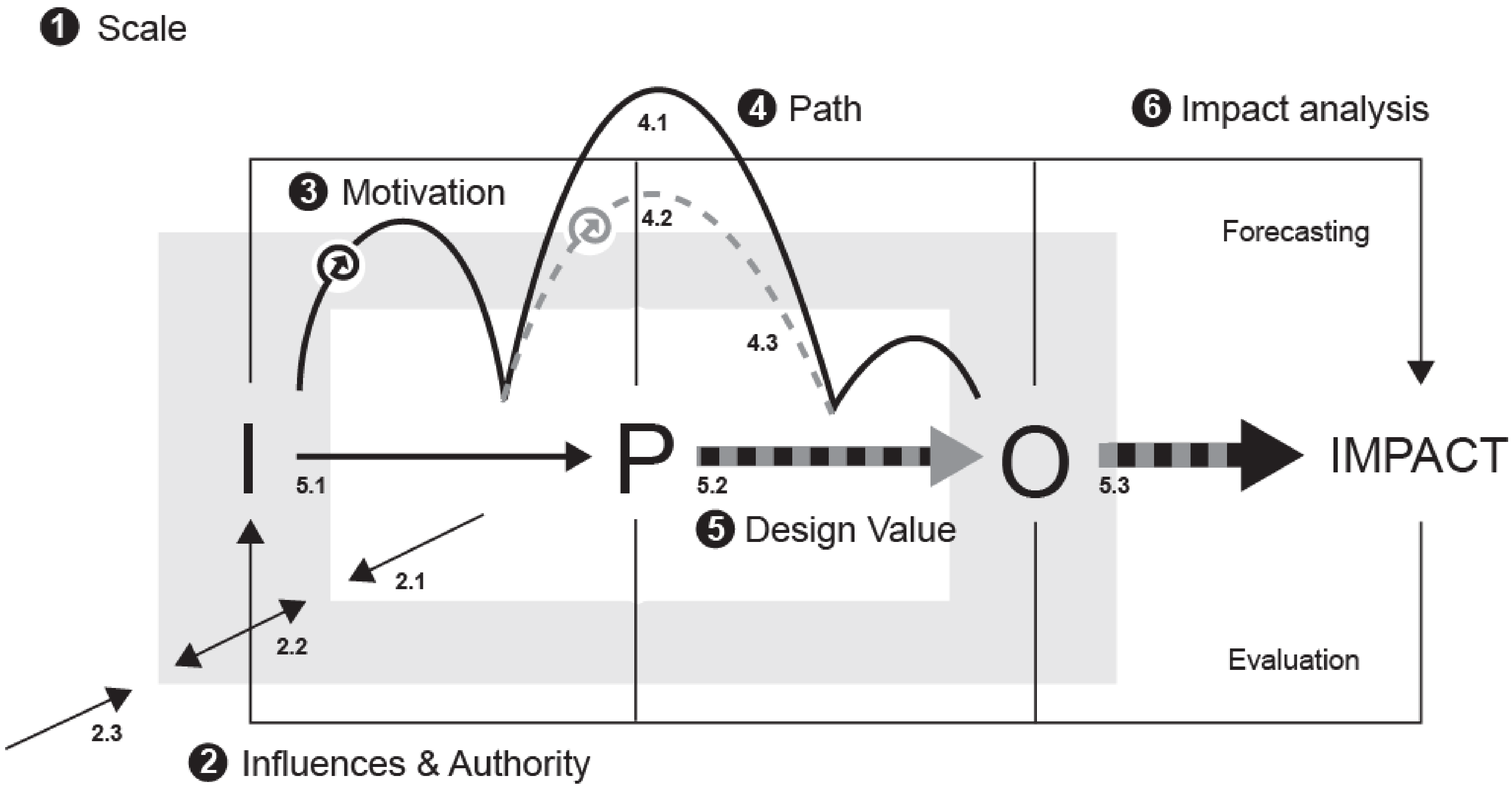
Workshop participants

Introduction

Earlier work included an analysis of 45 case studies from the DBA Design Effectiveness Awards and in-depth interviews with industry and research experts on the topic of Design Impact. Findings from these studies, plus a review of related literature have been rationalised into a new framework for understanding design impact. From this, tools and methods for use in professional practice might evolve. The purpose of the evaluation workshop is to: 1) review the framework, 2) provide feedback,3) explore how the framework relates to professional practice and, 4) discuss the potential for tools and methods which might lead to benefits for the professional practice of design.

Workshop schedule

Workshop questions/activities	Support materials / Output	Timing– minutes – start time
1 Discuss correlation between terms used by participants and the key terms in the framework?	Introductory presentation Hand out with list of key terms with a likert scale and space for alternative terms	20 6:00 – 6:40 20
2.1 What examples of relevant professional instances can you think of? 2.2 How would a selected instance map onto the framework?	UDI framework canvas and guidance notes as a basis for mapping the selected examples (discussion to identify key points of interest) Use red pens to map the instance to the framework 'canvas'	20 6:40 – 7:30 30
Comfort break / open discussion		20 7:30– 8:00
3.1 What issues and challenges does the instance present? 3.2 Could the framework help with these instances in any way?	Number top 3 most significant points and transfer to overall canvas on post-it notes Post-its to capture ideas about how the issues and challenges might be addressed by the framework (with a focus on professional practice and impact)	30 8:00 – 8:40 20
4 Discussion about how the framework could translate into methods to improve professional practice?	Handout with initial examples to score	20 8:40 – 9:00 (180)



KEY:

2.1 Designing context
2.2 Key stakeholder context
2.3 Wider context

4.1 Key stakeholders' path
4.2 Design path
4.3 Activity capability

5.1 Potential Design value
5.2 Designing value
5.3 Design ingredient value

6.1 Human & Social impact
6.2 Economic impact
6.3 Environmental impact
6.4 Technological impact

UDI Framework Evaluation workshop | **Activity 1**

Review of **key terms/concepts**: score these according to their **clarity** in relation to your **existing understanding** of design impact factors (rather than the importance of the factor). Place a tick or cross in one box for each row.

Concept / Term		Very clear	Clear	Neutral	Unclear	Very unclear	Alternatives / note
1	Scale Of the context, subject for design, resources, timescale						
2	Influences and Authority Contexts: a) Designing, b) Key stakeholders, c) wider context						
	Contextual factors (Human & Social, Economic, Environmental, Technological)						
	Design Influence & Authority (Design emphasis, Design management and leadership)						
3	Motivation a)Key stakeholders' opportunity, aim & objectives b) Designing opportunity, aim & objectives						
4	Path a)Key stakeholders' path, b) Design path c) Capabilities						
5	Design Value Added value of designing (Four Powers eg Transforming, Differentiating, Integrating)						
	Added value of designing (UDI Model eg a) Potential design value, b) Designing value c) Design ingredient value						
6	Impact Analysis Types of impact; a)Human & social, b) Economic, c) Environmental, d) Technological						
	Operationalisation: a) Methods, b) Metrics, c) Adoption						
	Forecasting and Evaluation						

UDI Framework Evaluation workshop |**Activity 2**

Check list of UDI framework factors and notes to prompt thoughts on considerations to note on the framework 'canvas'

Factor	Notes on considerations
INPUT	
1 Scale Of the context	What descriptor would best describe the **overall** context and sector? (eg; Product design for a ball point pen in the European stationary market)
Subject for design	Is there a specific focus for design activity? (eg a simple restyling exercise)
Resources	Is there any indication of the scale of the overall resources within the context including the design aspect? (eg an in-house design activity for 1 person for a product selling 50,000 units pa
Timescale	What is the relevant timescale/s within the scenario? (eg restyling exercises link to an annual NPD cycle)
2 Influences and Authority Contexts: a) Designing, b) Key stakeholders, c) wider context	What descriptors would best describe each stakeholder context? (eg; consultancy design team, project managers in client organisation, UK self assessment tax payers)of activity)
Contextual factors	Are there contextual factors which are significant 'drivers' for activity in the scenario? (eg historical lack of 'user focus', technological opportunities etc)
Design Influence & Authority (Design emphasis, Design management and leadership)	At what **'level'** is design being considered by the key stakeholders **and** the designing stakeholders? (eg the client may see this as 'styling' the design team may see it as 'strategy')
PROCESS	
3 Motivation a)Key stakeholders' opportunity, aim & objectives, b) Designing opportunity, aim & objectives	Who identified the opportunity aim & objectives – are there separate agendas? (eg the client produced the initial brief)
4 Path a)Key stakeholders' path, b) Design path	What is the path for the key stakeholders and the design activity; are they different? (eg the designers contributed 'design styling' within a longer process)
a) Key stakeholders' capabilities, b) Designing capabilities	What are the capabilities of the key stakeholders and the designing team? (eg did the key stakeholders recognise a need to have an external professional design perspective to supplement their capabiliities)
OUTPUT	
5 Design Value Added value of designing (Four Powers, eg Transforming, Differentiating, Integrating)	In general terms, what are the ways in which **designing** has added value in this scenario? (eg the outcome was a **transformation** of the earlier design and more effectively **integrated** the communication)

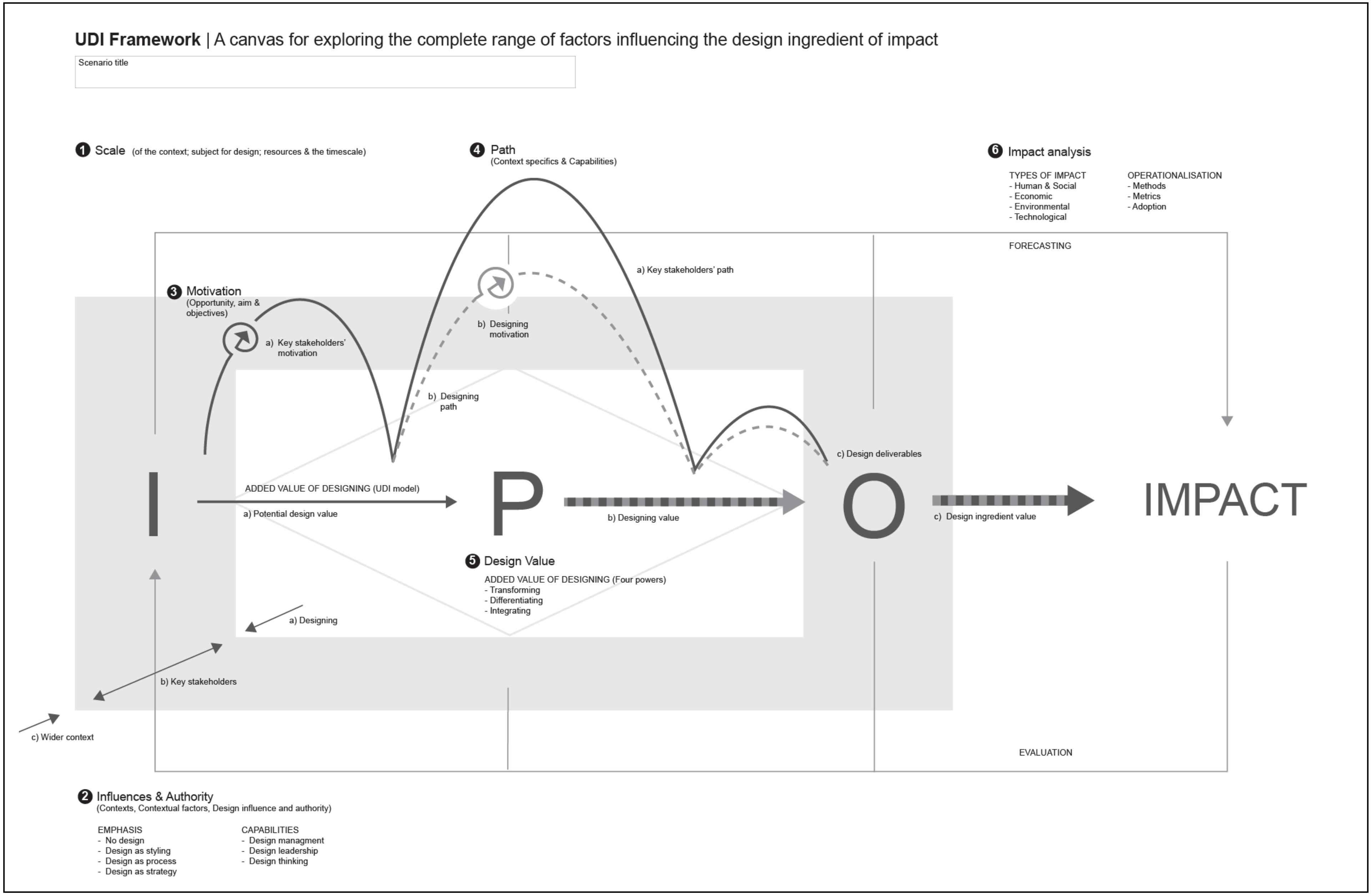
Added value of designing (UDI Model eg; a) Potential design value, b) Designing value c) Design ingredient value	In the chronology of the scenario, where has design value been added? (eg potential value from the identification of the opportunity, value from effective transformation and integration, and successful implementation
6 Impact Analysis Types of impact; a)Human & social, b) Economic, c) Environmental, d) Technological	What are the main types of impact in this scenario – are they 'recognised'? (eg the results imply an in-direct economic benefit as a result of a direct human (end user benefit)
Forecasting and Evaluation	What, if any, design impact forecasting and evaluation is there within the scenario? (eg evaluation of the results of the re-design were used in an award winning Design Effectiveness Awards entry)
Operationalisation: a) Methods, b) Metrics, c) Adoption	What, if any, were the methods and metrics used in the scenario for forecasting or evaluation? (eg the evaluation used a scenario specific metric of volume/% increase of responses to the re-designed communication compared to the original – required historic dataset)

UDI Framework Evaluation Development workshop |**Activity 4**

Review initial ideas about Methods and Communication which could be derived from the UDI framework - and rate them.

Concept / Term	Very useful	Useful	Neutral	Could be useful	Not useful at all	Note
METHODS/TOOLS						
1 UDI Canvas Development of the UDI framework to work like the Business Model Canvas & Value Proposition Canvas						
2 Design 'co-efficient' A metric to indicate how a combination of design factors (such as emphasis, capability and added value) produce a 'Co-efficient' that then effects overall impact						
3 Design impact mapping A visualisation technique to show how design value develops over time (in a specific project, product portfolio, company context etc)						
4 Other concept						
5 Other concept						
6 Other concept						
DIFFUSION OF IDEAS						
A Use at an organisation level as a point of differentiation (eg design consultancy, company, HEI)						
B Aim to Integrate into a national or international protocol (eg DBA Awards, Professional Accreditation)						
C Aim to develop as an open source and/or commercial multi-channel initiative (ref Business Model Canvas)						
D Other approach						

Appendix O STUDY 2.2 UDI Framework – Canvas variant used in review workshops



Appendix P STUDY 2.2 Collated workshop comments and analysis

Code	Point		Position on canvas	Analysis	Implication for framework
(W1, JB)	A one off project with very large scale - long time to implement, long time for impact to be felt	1	Scale	Demonstrates diversity of scales, and often unique nature of every instance	Scale is an effective primary factor to consider
(W1, FV)	Complexity of stakeholder interests and spread of disciplines involved - understanding this landscape is important	1	Scale	Confirmation of complexity in emerging areas of service design	Scale confirmed as an important factor (in this case complexity scale - ref Jones & VanPatter (2009)
(W1, IA)	Instance is fully integrated in 'key stakeholder' contect - involving all business functions and planned from the outset as a long term initiative	1	Scale/Influence & Authority	An unusual situation - trust was built over time, long term nature was acknowledged.	Nested contexts allows the context to be explored, scale allows long term impact to be considered at the outset
(W1, BC)	Being able to 'Frame' and 'Reframe' contexts for projects is valuable in practice	1	Scale/Motivation/design value	Endorses points about 'designerly' approaches and value of involvement at the front end (planning stage) of initiatives	Placed across a number of factors this point demonstrates the value of 'seeing' the bigger picture - exploring a point from a number of perspectives
(W2, AP2)	Ref litter: Key people in the context recognised the opportunity for the initiative. Designers have the potential to spot opportunities, but these can be missed if designers are not 'embedded'	1	Scale	Endorses the general point made by others about the value of designers at the FEI.	Opportunity identification is an important point which might be supported by the framework/canvas
(W1, AP)	The big organisations involved with the initiative are a significant 'Influence', which is this case was positive	2	Influence and Authority	Effectively 'channelling' the influence and authority of a major stakeholder can be valuable - eg rather than fighting it.	Endorses value of exploring influences and authority, but shows the benefit of looking at this from varying perspectives
(W1, JB)	Was their a 'design manager' involved in this major context?	2	Influence and Authority	Unlikely that there was a senior role for a design manager, but this flags up the issue of capabilities - how many design managers are there with capability on this scale - ref Raymond Turner and Heathrow T5	Need to revisit capabilities issue to see how it spans across Influences and authority and Path
(W1, IA)	The context of impact needs capabilities beyond disciplines and designerly notions - leadership and advocacy, knowledge from other disciplines, the ability to reformulate practice	2	Influence and authority	Interesting counterpoint to an emphasis on 'designerly' qualities and the idea of broader cultural transformation qualities	Does the framework imply designerly approaches too strongly - is there flexibility for 'new practice'
(W1, ALL 1.2)	Aggregation of factors (eg contextual factors) seems important to impact - can the framework help with this	2	Influence and authority	It seems important that there is a wide ranging, but objective overview of potential impact factors	The UDI framework potentially helps with this
(W1, ALL 1.3)	Designerly thinking includes consideration of diverse factors - can the framework help with this	2	Influence and authority	There are well documented designerly qualities, but there are also well documented limitations in designerly approaches	Wider consideration of impact (eg longditudinally) is an example of how the framework can help to broaden thinking

Code	Point		Position on canvas	Analysis	Implication for framework
(W1, ALL 1.8)	Designers do want effective ways to argue the case for design. Understanding the 'whole picture' seems a useful starting point	2	Influence and authority	Endorsement of the need for methods and communication to support designers	Endorsement of the framework as a benefit for understanding the 'big picture' - eg education/professional development benefit
(W2, JB2)	Ref Swatch: The context provided strong drivers (motivation) for innovation, plus a dynamic individual	2	Influence and authority	In any context there are likely to be a combinatin of key drivers or motivations	Clarify the relationship between drivers and motivation which is currently linked to paths
(W2, PL)	Ref Kia: The incoming head of design had it written into his contract that the internal teams wouldn't interfere with his vision	2	Influence and Authority	A good example of influence and authority - in this case using this in a way which supports design. These forces can be negative and positive	How are negative and positive influences incorporated into the framework thinking?
(W2, YK)	Ref book: A strong influencing factor was the personal story of the author	2	Influence and Authority	Underlines the value of understanding these forces - the human aspect seems to have amplified the impact	Ref other influence and authority points - how might these factors be operationalised?
(W2, YK)	Ref book: There were a number of strong stakeholder views (publisher, author, editor/designer) each with different motivations	2	Influence and Authority	Validates the idea/importance of recognising different motivations	Ref other points - how do multiple motivations of participants relate to contextual drivers?
(W2, ALL 2.1)	The value of quick cycles of activity to build trust and influence and authority was endorsed. This led to the strong strategic role for one of the participant companies	2	Influence and Authority	Useful indorsement of the link between impact and increasing influence and authority (also ref Candi & Gemser, 2010)	Ref other points underlining the value of making the circular aspect prominent in any diffusion of the framework
(W2, ALL 2.2)	Interesting use of the term 'project governence'. The framework was endorsed for setting out the basis for gaining empathy amoungst stakeholders and accurately tailoring the 'offer'	2	Influence and Authority	The point reflects the importance of tailored approaches linking to points from study 1.3 about 'true consulting'	The framework needs to be seen as flexible and neutral in order to work in the way envisaged
(W1, AC)	Significantly higher motivation (than typical projects) within the context because of the topic	3	Motivation	Good example of how motivation (not necessarily economic) can be a positive influence	Identifying levels of motivation early in the scenario could be useful (eg for maximising the benefit of this element?)
(W1, AP)	Challenges of converting motivation (for this social benefit project) into tangible impact metrics	3	Motivation	Likely that strong influences and authority overcame this issue, but highlights potential for a missmatch in motivations in social impact cases	Interesting to consider how 'motivation' might be operationalised
(W1, ALL 1.1)	It would be a benefit to have a 'neutral' approach to showing motivations on a UDI canvas - eg to mitigate against the politics of multi-stakeholder contexts	3	Motivation	More effective recognition of multiple view points seems important - eg to counter percieved ego of designers	Consider point in relation to development of a 'canvas' version of the framework
(W2, JB2)	Ref LTM: In a multistakeholder context barriers to innovation can be multiplied, for example risk aversion	3	Motivation	Better understanding of multiple stakeholder motivations might help to overcome barriers to innovation.	The concept of 'risk management' should have an identified place within the framework.

Code	Point		Position on canvas	Analysis	Implication for framework
(W2, JB2)	Ref LTM: The multistakeholder context and multiple motivations can cancel each other out	3	Motivation	Endorses the value of understanding the range of stakeholder motivations (eg as in stakeholder analysis)	A further level of development could explore how to operationalise motivation as an ingredient in impact
(W1, AC)	The designers' involvement in the implementation of the initiative meant they had a stronger interest and commitment to successful impact	4	Path	Endorses the point about divergent paths and 'embeddedness' being important for effective impact	Endorses value of highlighting the possibility of divergent paths
(W1, IA)	Multiple stakeholder context required design to be effectively integrated - eg many design paths in this context, but they should not be considered as seperate.	4	Path	Who's responsibility is it to embed design (a design management point)? A complex context may never have design as a significant influence and authority	The alignment of multiple paths can be mapped across a whole initiative along the lines of project management techniques
(W1, BC)	Synthesising, pattern finding, abductive reasoning, problem solving are characteristic added values of design - and translate into choices about methods used (path)	4	Path/Design Value	Endorses points about 'designerly' approaches adding value	Need to clarify how 'planning' activity links design value and path
(W1, JB)	Radical vs non radical - or radical innovation vs incremental innovation is a key descision - how makes this decision	4	Path/Design Value/Influence and authority	This dichotomy features in innovation literature. It's an example of a factor which spans a number of areas of the framework	Need to clarify how the degree of innovation fits on the framework
(W2, YK)	Ref book: Example of divergent views between main pathway views - relative impact of decisions was not fully evaluated	4	Path	How are issues linked to <u>potential</u> impact resolved? This can be an arguement for better UDI	A general point is that the framework/canvas is also a starting point for helping decision making - eg at the potential impact stage. This overarching function/benefit should be clear
(W1, ALL 1.4)	A number of these case studies either demonstrate the benefit of integrating design or indicate the potential for integration	5	Design value	Integration and embeddedness are well supported by research	The framework can help to identify the different dimensions to integration (the 'emphasis' dimension to integration is only one aspect of integration) eg ref Four Powers
(W2, YK)	Ref book: How is the design ingredient element of design impact disagregated? Although there were two covers sold, evaluation of the design element would still be problematic	5	Design value	Correctly identifies the complexity of identifying design ingredient impact even when evaluation was possible.	Does the framework offer any new ways to disagreegate design, or only offer better understanding of the factors
(W2, DN)	Ref Amstel: There was no clear integration of the design input in this case study - but the approach was successful	5	Design value	There can be times when design at lower levels of emphasis can be effective. Maybe this could be linked to the virtuous circle idea - that to move up the 'ladder' design impact has to be demonstrated at lower levels?	Is there potential to indicate the potential for individual factors (eg level of emphasis) to be 'linked' to impact - this is the implecation of the framework - is it explict?
(W2, DN)	Ref Amstel: Based on the case study the local research was crucial to the impact, but this might not be how other key stakeholders viewed the case	5	Design value	The politics of impact analysis could be an influence on objective assessments of impact	The framework could help to put political issues in a wider context to neutralise this effect.

Code	Point		Position on canvas	Analysis	Implication for framework
(W1, BC)	Recognition of the link between data, insight, before and after value, future value creation	6	Impact analsis	Discussed that this idea is accomodated with the 'virtual loop' lines on the canvas - that understanding impact can lead to future activities in a virtual loop	Virtual loop aspect not emphasised in briefing, but the point independently validates the importance of this.
(W1, FV)	The period for analysis is important (eg on the Boris bike case study) - longditudinal evaluation	6	Impact analsis	Highlights that long term analysis is not always considered - the cost of analysis was discussed. But this can be countered by the idea that analysis can leat to cost benefits.	
(W1, FV)	Important to collect negative and positive impacts	6	Impact analsis	Relates to literature flagging up 'good and bad' questions having been overlooked	Consider how the framework can encourage consideration of good and bad impacts
(W1, AP)	The issue of what the focus of any impact analysis should be?	6	Impact analsis	Links to points about divergent paths and different stakeholder perspectives. The logical approach is that the purpose of impact analysis is aligned	Recognition of different paths and contexts is central to the framework - this also needs to be reflected in the impact aspects - eg mapping perspectives to the types of impact.
(W1, AC)	Case study example of a long term impact aim	6	Impact analsis	Underlines the point about the importance of considering the complete range of timeframes for initiatives	Framework could be simply enhanced by suggesting possible time frames
(W1, ALL 1.5)	Wherever impact can be evaluated this should be captured - eg some situations are simpler and do have data	6	Impact analsis	As shown, impact evaluation is not established practice	Simple to adopt methods and clear benefits derived from the framework will be important to address this point
(W1, ALL 1.6)	In the absence of operationalisation and data for quantitative impact analysis, qualitative approaches still have a value	6	Impact analsis	Correct to a point. Quantitative analysis still appears to 'trump' qualitative analysis in many situations	The framework can provide a foundation for qual and quant operationalisation - depending on the scenario
(W1, ALL 1.7)	Wherever there are benchmarks of design impact these are useful - although benchmarks are poor for evaluating disruptive innovation such as i-tunes	6	Impact analsis	There are limited useful detailed benchmarks for design impact. The diversity of the figures from the DBA DEAs for instance tend to reflect the complexity rather than create useful benchmarks	Can the framework provide a basis for very simple operationalisation?
(W1, ALL 1.9)	Endorsement for 'seeing' the whole picture of design impact factors combined with virtuous circle idea - in this case how the virtuous circle can relate to motivation	6	Impact analsis	The circular aspects of the framework seem important. This also relates to the learning cycle view of designerly approaches	Ensure that the circular aspects are emphasised in any developments
(W2, YK)	Ref book: There was limited evaluation of impact even though analysis could have been done	6	Impact analsis	Research (eg Micheli) shows that evaluation of design impact is rare. This endorses the general point that an impact perspective is rare and could be valuable.	
(W2, YK)	Ref book: Ref point about lack of evaluation of impact. Without this, understanding of what effects impact does not develop	6	Impact analsis	Endorses general point about lack of understanding of design impact - eg no impact analysis = limited understanding of what creates impact.	This general point can relate to the virtuous circle aspect. Greater understanding will lead to greater impact

Code	Point		Position on canvas	Analysis	Implication for framework
(W2, DN)	Ref Amstel: There is a cost to impact analysis, and this is a barrier	6	Impact analsis	Confirms the point made in Study 1.3 and (Micheli) about lack of evaluation	This can support the idea of benefits derived from a simple to adopt approach to UDI
(W2, YK)	Ref book: At a crucial stage - when decisions were being made about design directions, it was 'impossible' to determine the potential impact of alternative routes	6	Impact analysis/path	Endorses both the complexity of the topic and designer's sceptism	What would impact forecasting look like at the potential design impact stage?