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Marina Candi

Aesthetic Design as an Element
of Service Innovation in New
Technology-based Firms

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**AESTHETIC DESIGN AS AN ELEMENT OF
SERVICE INNOVATION IN NEW
TECHNOLOGY-BASED FIRMS**

THESIS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

AESTHETIC DESIGN AS AN ELEMENT OF
SERVICE INNOVATION IN NEW
TECHNOLOGY-BASED FIRMS

MARINA CANDI

DOCTORAL SCHOOL ON KNOWLEDGE AND MANAGEMENT
COPENHAGEN BUSINESS SCHOOL
2008

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ACKNOWLEDGEMENTS

What possesses an engineer to take a detour from a gratifying career in industry to pursue as unlikely an undertaking as a Ph.D. in the social sciences? I have been asked this question many times and have finally given up trying to explain myself, so my standard answer has become “a random chain of events”, an answer no less plausible than others.

Whereas a random chain of events may have brought me to the starting point there has been nothing random about the support, encouragement and guidance that have transported me to the finish line.

Firstly, I am indebted to my supervisors Rögnvaldur Sæmundsson and Mette Mönsted. Rögnvaldur allowed me the freedom to define a research topic which interested me while having the foresight to suggest a focus considerably narrower than the one I had in mind. With unflagging interest, he has read and commented on a motley queue of versions of this thesis. Additionally, co-authoring papers with Rögnvaldur has been a rewarding learning experience. Mette Mönsted, although geographically distant, has provided exactly the right support and encouragement when it was needed. Her extensive experience and practicality have contributed much to my progress. She also has read too many incomplete versions of this thesis.

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I was very fortunate to be offered the opportunity to spend a few months at the Scandinavian Consortium for Organizational Research (Scancor) at Stanford University. Besides providing an environment conducive to research and writing, my time at Scancor created the opportunity for new friendships and numerous

discussions about research, writing and the joys and frustrations of academic life. The list of names would be too long. You know who you are.

None of my research would have been possible without the assistance of over one hundred new technology-based firms' CEOs who have been willing to respond to the survey on which the quantitative part of my research is based. These busy people have been willing to sacrifice an hour every year to answer a raft of questions with only the nebulous reward of having contributed to research in return. Silja Baldursdóttir has done the lion's share of the work of recruiting participants and collecting the data. In addition to being a pleasure to work with, Silja has a meticulous attitude to data collection that has helped insure the integrity of the data. I have not found an acceptable way to account for "the Silja effect" in my methodology chapter, but it is there and it makes a difference. I am also indebted to the many people I interviewed for my case research for their willingness to candidly tell me about their work and answer my idiosyncratic questions.

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The adventure has been just that and you have all contributed to its success.

ABSTRACT

The goals of this thesis are to examine new technology-based firms' use of aesthetic design as an element of service innovation and to explore potential relationships between aesthetic design and performance in this same context.

There is a scarcity of research on aesthetic design as an element of service innovation, particularly in new technology-based firms. Because of this scarcity, a hybrid research strategy is appropriate and the empirical basis for this research encompasses multiple case studies, longitudinal quantitative data and evaluations by expert panels. The first phase of the research involves developing an operationalization of design that enables evaluation of aesthetic design as an element of innovation in technology-based firms. The second phase uses case research to explore the role and organization of aesthetic design in service innovation in new technology-based firms. The final phase explores relationships between aesthetic design and performance in the research context. Hypotheses are developed based on existing research, on one hand, and the results of the case research, on the other, and these hypotheses are tested using longitudinal survey-based data.

The operationalization of design developed is a three-dimensional model consisting of functional design, visceral design and experiential design. Functional design is concerned with utility, features and delivery; visceral design is concerned with appealing to the human senses; and experiential design is concerned with message, symbols, culture, meaning, and emotional and sociological aspects. Visceral design and experiential design are combined to yield a formative measure of aesthetic design.

The findings of the research are that new technology-based firms emphasize functional design over aesthetic design. Emphasis on aesthetic design is related positively with the importance of design in a firms' sector and founders' experience of sales and marketing, while it is negatively related with founders' technical education. In new technology-based firms, aesthetic design can be characterized as being used to exploit or counteract the characteristics that distinguish services from products, namely intangibility, inseparability, heterogeneity and perishability. The application of aesthetic design to counteract these characteristics is more prevalent than exploitation.

Aesthetic design in new technology-based firms is found to be primarily *silent*, meaning that those performing design activities are mostly managers and technical staff engaged in design activities as part of their development efforts and without these activities necessarily being acknowledged as design.

The findings regarding the relationship between aesthetic design and performance are that aesthetic design is positively related with competitive advantage, but that this relationship is dependent upon moderating factors. The effectiveness of aesthetic design in achieving competitive advantage through differentiation is found to differ depending on the current stage of commoditization. The greater the level of commoditization of a service the more effectively aesthetic design can be employed to improve competitive advantage. Furthermore, the findings suggest that the objectives underlying managers' decisions to use aesthetic design in service innovation are attracting new customers, improving firm image and/or retaining existing customers, and doing so at lower cost. Hypothesis testing using longitudinal survey-based data confirms that by and large these benefits are realized by new technology-based firms.

This research makes a number of important contributions. The research focus lies in an area where there is little existing research and, thus, the operationalization of aesthetic design developed and the characterization of aesthetic design as an element of service innovation in new technology-based firms constitute important contributions. The characterization provides a picture of the prevalence, roles, organization and actors of aesthetic design in the research context.

The research also contributes insight about the relationship between aesthetic design as an element of service innovation and performance of new technology-based firms. The research shows that various positive relationships exist but that they can be contingent upon existing conditions, which act as moderating factors.

ABSTRACT IN DANISH

Titel: *Æstetisk Design som Byggesten i Serviceinnovation i Nye Teknologibaserede Virksomheder*

Denne afhandlings mål er at undersøge brugen af æstetisk design som en byggesten i serviceinnovation i nye teknologibaserede virksomheder (new technology-based firms) og at udforske potentielle relationer mellem æstetisk design og performance i denne sammenhæng.

Forskning i æstetisk design i serviceinnovation er en mangelvare, specielt når det gælder nye teknologibaserede virksomheder. Derfor er en hybridform af forskningsstrategier passende, og nærværende forskningsempiriske grundlag omfatter adskillige casestudier, kvantitative data og evalueringer i ekspertpaneler. Forskningens første fase involverer udvikling af en operationalisering af design, der muliggør evaluering af æstetisk design i nye teknologibaserede virksomheder. Den anden fase benytter case research til at udforske æstetisk designs rolle og organisering i serviceinnovation i denne type virksomhed. I slutfasen udforskes forholdet mellem æstetisk design og performance i den pågældende sammenhæng. Hypoteser bliver udviklet på grundlag af både allerede foreliggende forskning og resultaterne af case studierne. Disse bliver så testet gennem survey-baserede data.

Den operationalisering af design, der bliver udviklet her, er en tredimensional model, som består af funktionelt design, følelsesmæssigt (visceral) design og erfaringsmæssigt design. Funktionelt design beskæftiger sig med features og levering. Følelsesmæssigt design beskæftiger sig med de menneskelige sanser, og erfaringsmæssigt design handler om budskab, symboler, kultur, mening og sociologiske aspekter. Følelses- og erfaringsmæssigt design kombineres for at udforme et mål for æstetisk design.

Denne forskning er nået frem til at nye teknologibaserede virksomheder prioriterer funktionelt design over æstetisk design. Prioritering af æstetisk design er positivt forbundet med vigtigheden af design i en virksomheds sektor, og grundlæggernes erfaring inden for salg og markedsføring, mens det er negativt forbundet med grundlæggernes tekniske uddannelse. I nye teknologibaserede virksomheder kan æstetisk design karakteriseres som en måde at udnytte eller modvirke de træk, der skelner ydelser fra produkter. Ydelser er relativt immaterielle, svære at skelne fra forbrug, heterogene og forgængelige, og æstetisk

design bliver oftere brugt til at modvirke disse karakteristika end til at udnytte dem.

Æstetisk design i nye teknologibaserede virksomheder viser sig at være primært tavs, hvilket betyder, at de, der udfører designaktiviteter, for det meste er ledere og teknisk personale, der er involveret i designaktiviteter som en del af deres udviklingsindsats, og disse aktiviteter bliver ikke nødvendigvis anerkendt som design.

Resultaterne vedrørende forholdet mellem æstetisk design og performance viser, at æstetisk design er positivt relateret til konkurrencefordele, men at dette forhold er afhængigt af mellemkommende variable. Effektiviteten af æstetisk design i opnåelse af konkurrencefordele gennem differentiering viser sig at variere med den aktuelle grad af kommodificering. Jo mere ydelsen bliver til vare, jo mere effektivt kan æstetisk design udnyttes til at forbedre konkurrencefordelen. Endvidere synes resultaterne at vise, at de mål, der ligger til grund for ledernes beslutning om at bruge æstetisk design i serviceinnovation, tiltrækker nye kunder, forbedrer virksomhedens image, og/eller bibeholder eksisterende kunder, og gør dette med færre omkostninger. Dette bekræftes af hypotesetestningen, der benytter langsigtede survey-data.

Denne forskning bidrager på en række vigtige måder. Fokus ligger på et område, hvor der kun er lidt eksisterende forskning, og operationaliseringen af æstetisk design og karakteristikken af den som en byggesten i serviceinnovation er derfor i sig selv vigtige bidrag. Karakteriseringen giver os et billede af udbredelsen, rollerne, organiseringen og aktørene i æstetisk design.

Forskningen bidrager også med indsigt i forholdet mellem æstetisk design og performance i nye teknologibaserede virksomheder. Forskningen viser, at forskellige positive forhold findes, men at de afhænger af eksisterende betingelser, som tjener som mellemkommende variable.

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1 INTRODUCTION

McDonalds, that temple of garish yellow plastic, glaring fluorescent lighting and grease, is applying aesthetic design to its retail environment and even its food to compete with Starbucks (Gogoi 2006; Werdigier 2007), and hulking grey Wal-Mart is embracing aesthetic design and environmentalism to compete with Target (arguably yet another hulk, though slightly more upscale) and Whole Foods Market (Troy 2007). These are both examples of a growing appreciation of the potential of design in the business community (e.g. Peters 1997; Ridderstrale & Nordstrom 2002; Conley 2006). In this same vein, academic research suggests that design can positively impact business performance (Hertenstein, Platt & Veryzer 2005; Gemser & Leenders 2001; Walsh, Roy, Bruce & Potter 1992; Auger 2005; Rothwell & Gardiner 1984; Moody 1984).

Gilmore and Pine (2007) present a picture of evolution in the content of economic transactions in the developed world from raw materials, to products, to services, to experiences, to transformations, and Aburdene (2005) and Crawford and Mathews (2001) argue that economic transactions increasingly hinge on personal values. As the content of economic transactions moves along the progression from fungible raw materials to experiences and transformations, the relevance of aesthetic design appealing to the human senses and human values is likely to increase.

It is against this backdrop, consisting of the idea of the potential value of aesthetic design and the apparent changes in the economy, that this research on aesthetic design as an element of service innovation in the context of new technology-based firms is positioned.

New technology-based firms (NTBFs) may seem to be unlikely places for aesthetic design. However, NTBFs are believed to be important sources of technological innovation (Spencer & Kirchoff 2006; Bollinger, Hope & Utterback 1983) and as such constitute a fruitful context in which to study innovation. Furthermore, as new firms they can be expected to base their strategies on differentiation (Carter, Stearns and Reynolds 1994) rather than strategies such as economies of scale. Aesthetic design represents a potential for competitive edge that can counteract the traditional advantages of size and scale (Bruce and Bessant 2002) and can be used to create differentiation (Gemser & Leenders 2001;

Norman 2004). If aesthetic design is indeed a fruitful means to gain advantage, NTBFs constitute a class of firms particularly sensitive to the use of aesthetic design when developing new offerings.

The importance of services has been growing since the Second World War, while the relative importance of manufacturing has been declining (Normann 2001; Coombs & Miles 2000; Von Stamm 2003). Services account for a large proportion of employment in most countries. For example, in 2000 75% of the work force in the United States was employed in service sectors (Drejer 2004). Despite the recognized importance of innovation in services (Drejer 2004; Gallouj & Weinstein 1997; Sundbo 1997), the majority of innovation studies focus on innovation in manufacturing (Tether 2005; Johnes and Storey 1998; de Jong & Vermeulen 2003). Likewise, research on design is heavily weighted on the side of product manufacture rather than service development. While there is increasing awareness in the business community about the contribution design can make to the success of tangible products, the idea that design can also play an important role in the successful development of services is less common (Von Stamm 2003). Hence, aesthetic design as an element of service innovation constitutes an important gap and an interesting opportunity for research.

As alluded to previously, talking about services may be *passé* since, as Pine and Gilmore (1998) argue the most interesting currency is experiences, or even transformations (Gilmore & Pine 2007). However, while acknowledging the validity of these ideas, the term service can be used to encompass services in the broadest sense, from “plain old” services, to experiences, to transformations, but at any rate separating these less tangible pursuits from products by referring to them as services.

In their research on service innovation Storey and Easingwood (1998) present a conceptual model of what they call the *Augmented Service Offering*. At its center is the core service functionality encompassing descriptions of the service itself and its characteristics. This can be viewed as the functional dimension of the service. In Storey and Easingwood’s model, service augmentation describes “those parts of the service offering that the customer is aware of and responds to but are not part of the product core” (p.339). Storey and Easingwood’s concept of service augmentation resonates with the notion of aesthetic design. Using Storey and Easingwood’s terminology, aesthetic design can be viewed as a way to

augment services, an important concern in view of the prevailing threat of commoditization (Christensen 1997).

From a business point of view, aesthetic design is of limited interest without an understanding of its relationships with success or performance. Before these can be explored the prevalence, roles and organization of aesthetic design as an element of service innovation in NTBFs need to be understood.

This thesis is organized into six sections. This introduction is followed by the second section where the constructs on which the research is based are developed. In section three, existing research is reviewed, gaps identified and the research questions developed to address these gaps. Section four covers the research methodology. This thesis includes six papers dealing with different parts of the research, referred to as Paper 1, 2, 3, 4, 5 and 6, respectively. In a classical monographic thesis, it would be logical to follow a description of methodology with a section on results. In lieu of a conventional coverage of results, section 5 provides brief summaries of the findings of each of the papers. For a full coverage of the findings of each paper, the reader is referred to the results sections of the papers themselves. The thesis ends with a final section where conclusions, practitioner implications, suggestions for further research and contributions are discussed.

Readers are kindly advised that the papers should not be viewed as chapters of this thesis. Through the process of writing, revising and tailoring the papers for publication in different academic journals over the course of three years, each of the papers has taken on something of a life of its own. At the same time, much of the material in this thesis is duplicated in some form in one or more of the papers. The result of this seemingly idiosyncratic overlap coupled with the lack of overarching conformity is that reading the thesis and all the papers consecutively is an exercise bound to drive the reader to somnolence at best and antisocial behavior at worst. In an attempt to anticipate the needs of different reader groups, I offer the following suggestions. For readers interested in gaining an overview of the research my suggestion is to read sections 2, 3, 5 and 6 of this thesis and the introduction to section 4. Readers interested in methodology could read chapter 4 of this thesis and Paper 6, which makes the broadest use of the data and methodological strategy. For readers interested specifically in aesthetic design, I suggest reading chapters 2.3, 3.1 and 3.2.1 and section 6 of this thesis followed by Paper 1. Those interested in service innovation could read chapters

2.2 and 3.2.2 and section 6 of this thesis and Papers 3, 5 and 6. Readers interested in NTBFs could read sections 2, 3 and 6 of this thesis as well as Papers 2, 3 and 4, which provide the most in-depth information about NTBFs. For readers interested in strategy, my suggestion is to read Papers 2 and 5 followed by section 6 of this thesis.

2 CONSTRUCTS

The constructs central to this research are new technology-based firms, service innovation and aesthetic design. The research topic, aesthetic design as an element of service innovation in new technology-based firms, lies at the intersection of these constructs. In this section, each of the constructs will be developed in turn.

2.1 NEW TECHNOLOGY-BASED FIRMS

According to the Webster's New International Dictionary (2002), technology is "the practical application of knowledge especially in a particular area" or "a manner of accomplishing a task especially using technical processes, methods, or knowledge". Technology stems from the Greek word *technologia* which is made up of the term *techne*, which means art or skill and *logia* which refers to knowledge (Webster's New International Dictionary 2002). Thus technology can be thought of as systematic knowledge about an art or skill, or "a body of knowledge about techniques" (Freeman 1982, p.4).

The concept of the new technology-based firm (NTBF) has been used in many different ways. There is potential for confusion about the term new technology-based firm because it is not obvious whether "new" refers to the technology or the firm. For the purposes of this research "new" refers to the firm, so, in longhand, NTBFs are new firms that are based on technology, which may or may not be new technology. Most researchers agree that NTBFs base their operations on technology, but make different assumptions with regards to the firms' origins. Saemundsson (2003) provides a summary of NTBFs' origins. Bollinger et al. (1983) define NTBFs as new independent firms that are established in order to exploit a technological innovation independently of the novelty of the innovation or the underlying technology.

This research focuses on service innovation, which is less likely to involve systematic and/or well defined research and development activities than product innovation (Easingwood 1986). Therefore, using the existence of (formal) research and development activities as a condition for a firm to be considered a technology-based firm, as is emphasized by Granstrand (1998) and Berry and Taggart (1998), is not appropriate for the purposes of this research. In fact,

research and development metrics by themselves do not constitute an adequate proxy for what Freeman (1994) refers to as “a wider range of technical and learning activities” (p.473). Instead, since technology is strongly related with knowledge, as was discussed above, the technology-basis of NTBFs is defined in terms of technical knowledge. Turning to a more specific concept of technical knowledge as embodied in the education system, the definition of technology-based firms for the purposes of this thesis includes a definition of specific fields of knowledge and skills.

Based on the above discussion, the following definition is used for the purposes of this research:

New technology-based firms (NTBFs) are new business entities that develop new offerings based on the knowledge and skills embodied in engineering and the natural sciences.

2.2 SERVICE INNOVATION

Before discussing the composite construct of service innovation, the component constructs, namely innovation and services, will be addressed separately.

2.2.1 INNOVATION

The Latin term *novus*, which means new, is the root of the term innovation. According to Webster's New International Dictionary (2002), the term innovation means “the introduction of something new”.

There is general agreement that innovation is important both for firms and society as a whole (Freeman & Soete 1997). This has its roots in Schumpeter's (1934) work and is reinforced by firms' need to maintain current market position and gain new markets. According to a European Commission report, “innovation is now the single most important engine of long-term competitiveness, growth and employment” (The European Commission 2000).

Innovation can be viewed along a number of dimensions, and is characterized by a multitude of classifications and definitions (Garcia & Calantone 2002; Kline & Rosenberg 1986). Commonly used dimensions of innovation are reviewed below.

The most frequently used classifications of innovation have to do with newness and the terms radical, really new, incremental and discontinuous are commonly

used to denote degrees of newness (e.g. Veryzer 1998; de Brentani 2001; Bayus, Griffin & Lehmann 1998; Freeman 1994). There is a lack of consensus regarding what distinguishes radical innovation from incremental innovation, what constitutes a true discontinuity and what it means to be really new (Garcia & Calantone 2002). Kline and Rosenberg (1986) suggest that newness should be viewed as a spectrum ranging from revolutionary to evolutionary rather than as a binary dimension and Tushman and O'Reilly (1996) suggest that it can be advantageous for firms to pursue both discontinuous and incremental innovation. Johnson, Menor, Roth and Chase (2000) span the spectrum ranging from discontinuous to incremental service innovations in their definition of a new service as “an offering not previously available to customers that results from the addition of offerings, radical changes in the service delivery processes, or incremental improvements to existing service packages or delivery processes that customers perceive as being new.” (p.2)

Salomo (2007) suggests a conceptual model of degree of innovativeness that encompasses four dimensions, the market, technology, internal resource fit and external resource fit. Thus, according to Salomo's model, newness can be defined relative to the market, relative to the technology involved, relative to a firm's internal resources and relative to external factors such as industry norms and values. Of course innovation can be new relative to more than one of these dimensions at the same time, e.g. it can be new to the market and new to the firm.

Turning specifically to technological innovation, Tether (2001) suggests five tiers of innovativeness that categorize firms as true innovators, imitators, active technology adopters, passive technology adopters and non-innovators. According to Tether's categorization true innovators are firms in which technological innovation is a core activity; imitators develop technologies only for their own new offerings; active technology adopters use technologies developed by others in creative ways; and passive technology adopters use technologies developed by others in standard ways.

The point of departure in technological innovation can be an identified market opportunity or a new technology (Ulrich & Eppinger 2003; Kline & Rosenberg 1986). When market opportunity serves as the point of departure innovation focuses on identifying or conceiving technological solutions to market needs. This is commonly referred to as market-pull diffusion of innovation. In contrast,

technology-push innovation begins with a new technology and proceeds to find an appropriate market. In a study of NTBFs in the semiconductor silicon industry Newbert, Kirchoff and Walsh (2007) found that firms started based on founders' managerial competencies, namely prior start-up experience, sales and marketing experience and industry experience, emphasize market-pull strategies, while firms started based on founders' technical competencies emphasize technology-push strategies.

Some researchers present a view of innovation which encompasses the entire range of activities from invention through commercialization, whereas others separate invention, or the creation of novel combinations of existing knowledge (Leiponen 2006), from innovation, or the development of knowledge into useful new offerings. According the PDMA Glossary for New Product Development (2007) innovation is defined as "A new idea, method, or device. The act of creating a new product or process. The act includes invention as well as the work required to bring an idea or concept into final form." This definition emphasizes the act of implementation of something new to create a new offering. In a similar vein, the following OECD (2005) definition emphasizes implementation: "An innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations." (para.146) Tidd, Bessant and Pavitt (1997) likewise define innovation as creation of new products, services or processes. Based on the aforementioned definitions the initial idea or invention is only the first step in innovation. An invention becomes an innovation only when it has been developed into an economic offering and launched in the market (Garcia & Calantone 2002).

The focus of innovation research can be on the process of developing new offerings (e.g. de Jong & Vermeulen 2003) or on the outcome, or the new offerings themselves (e.g. MacCormack, Verganti & Iansiti 2001). And, finally, research can focus on the difference between successful and unsuccessful innovations (e.g. de Brentani 1993, 1995; de Brentani & Cooper 1992; Easingwood & Storey 1995) or concentrate on one end of the spectrum (e.g. Cooper, Easingwood, Edgett, Kleinschmidt & Storey 1994).

Table 2.1 provides a summary of the dimensions outlined above with the position taken in the present research shaded.

Table 2.1: Dimensions of innovation research.

Reference	Dimension	Range from	Range to
Bayus et al. 1998	Newness of offering	Adaptations, adjustments, improvements of existing offerings; incremental innovation	Completely new offerings; radical innovation; discontinuous innovation
Garcia & Calantone 2002	Newness relative to market	Familiar to the market	New to the market
Salomo 2007	Newness relative to the firm's internal resources	Firm already owns, controls or has access to the resources needed	New relative to the firm's internal resources
Salomo 2007	Newness relative to external resources	Infrastructure, norms, regulations and values in place	Requires changes in infrastructure, norms, regulations or values
Tether 2001	Technological innovation	Non-innovators, non-technology adopters	Active technology adopters
Ulrich & Eppinger 2003; Kline & Rosenberg 1986	Diffusion	Market-pull	Technology-push
Leiponen 2006	Range of activities	Invention	Development
de Jong & Vermeulen 2003; MacCormack et al. 2001	Focus	Process, development of the offering	Outcome, the offering itself
Cooper et al. 1994; de Brentani 1989, 1993, 1995	Success	Unsuccessful	Successful

The shaded areas in Table 2.1 show the scope of this research within the various dimensions along which innovation can be viewed. A limiting position is taken with respect to the spectrum from invention to development by excluding invention and focusing instead on execution, from development through commercialization. A limiting position is also taken with respect to technological innovation. Since the research on which this thesis is based is positioned in the context of new technology-based firms, innovations involving passive adoption or no technology are not included. Putting this into words yields the following definition of innovation within the empirical context of the research:

Innovation in new technology-based firms involves the active adoption of technology to develop new offerings.

2.2.2 SERVICES

The term service has its root in the Latin term *servitium*, which means the condition of a slave, and is derived from *servus*, which means slave (Webster's Third New International Dictionary 2002). Despite this inauspicious etymological heritage, the importance of services has been growing (Normann 2001; Coombs & Miles 2000; Von Stamm 2003). At the same time, there seems to be a broad consensus that the boundary delineating services from manufactured products is quite fluid (Von Stamm 2003). Tangible products such as computers can encompass significant service components, and services such as air travel would be of little value without their tangible aspects.

The commonly accepted characteristics of services, which distinguish them from products, are well documented (for an elaboration see Fitzsimmons & Fitzsimmons 2006, chapter 2) and have been used as a framework to guide much existing research (e.g. de Brentani 1989). In the first place, services are *intangible* in the sense that they need not include any palpable material objects. Second, the production and consumption of services commonly happen concurrently; services are therefore said to be *inseparable*. Third, each time a service is delivered there will likely be variability in the service, making the service *heterogeneous*. Finally, services cannot be produced and stored for delivery when requested and, hence, services are *perishable* and concomitantly are often manpower-dependent.

Fitzsimmons and Fitzsimmons (2006), referring to earlier work by James Fitzsimmons, define a service as “a time-perishable, intangible experience

performed for a customer acting in the role of co-producer.” Grönroos (1990), in his broad definition of services, recognizes that the distinguishing characteristics of services do not always hold. According to Grönroos’s definition a service is “an activity or series of activities of more or less intangible nature that normally, but not necessarily, take place in interactions between the customer and service employees and/or physical resources or goods and/or systems of the service provider, which are provided as solutions to customer problems”. (p.27)

Gadrey, Gallouj and Weinstein (1995) define services in terms of their delivery as follows: “To produce a service is to organize a solution to a problem (a treatment, and operation) which does not principally involve supplying a good. It is to place a bundle of capabilities and competences (human, technological, organizational) at the disposal of a client and to organize a solution, which may be given to varying degrees of precision.” (p.6) Like Grönroos, Gadrey et al. reflect the recognition that the distinguishing characteristics of services are not absolute.

Shostack (1984, 1987) defines services in terms of processes, or a series of interactions between participants, processes and tangible elements. “A service is not a servant; it need not be rendered by a person. Even when people are the chosen means of execution, they are only part of the process.” (Shostack 1984, p.134)

Kotler (1986) (in Hollins & Hollins 1991, p.7) raises the issue of ownership in his definition of a service as “any activity or benefit that one party can give to another that is essentially intangible and does not result in the ownership of anything. Its production may not be tied to a physical product.”

It is interesting to note that the above definitions, although they do relate to one or more of the distinguishing characteristics of services, vary in their position regarding the characteristics, as summarized in Table 2.2. The common thread in these definitions is the role of the customer in producing services and the implicit heterogeneity that follows from customer participation. Perishability is the service characteristic least addressed by these definitions. This may be due to the perception that although there may not be a non-perishable outcome of a service, the outcome may in fact persist and have tangible effects. Good examples of this are the services of a hair salon or an airline. Although the outcomes of these services are not physical entities that can be stored, they do indeed have truly physical consequences, whether they are the style or color of hair or the

physical location of persons or goods. The issue of ownership is related to the characteristic of perishability as well as that of intangibility. In fact, assessing ownership subsequent to a transaction could be used as a test to determine if an offering should be classified as a product or a service.

Table 2.2: Definitions of services and their positions regarding the distinguishing characteristics of services.

Reference	Key term	Intangibility	Inseparability	Heterogeneity	Perishability
Shostack 1984	process		series of interactions between participants, processes and tangible elements	implied, based on customer participation	
Grönroos 1990	activity	more or less	normally, but not necessarily take place in interactions between the customer and employees, physical resources and/or systems	implied, based on customer participation	
Gadrey et al. 1995	organized solution	goods play at most a secondary role	human, technological and organizational resources placed at the disposal of the customer	implied, based on customer participation	
Fitzsimmons & Fitzsimmons 2006	experience	intangible	experience performed for a customer acting in the role of co-producer	implied, based on customer's co-producer role	time-perishable
Kotler 1986	ownership	intangible	activity or benefit that one party gives to another		no transfer of ownership

The definition of services used for the purposes of this thesis is a broad synthesis of the definitions summarized above:

Services are economic offerings consisting of processes, activities or experiences created through interactions between customers and service providers' resources, and are, to some degree, characterized by intangibility, heterogeneity, inseparability and perishability.

Services can be usefully defined in terms of the ways in which they are delivered. First, services can be delivered in direct interaction with customers, for example consulting services. However, such services often involve a large proportion of service delivery being performed without (constant) interaction with customers. Second, services such as telecommunication services can be characterized as being delivered primarily using equipment, or being equipment-based. Thirdly, services can be embodied in software, whereby the limitations of service perishability are largely surmounted, since the services can be fully defined and developed *a priori* and subsequently accessed by customers as needed. Finally, services can be delivered over the Internet, where the aforementioned advantages of software are combined with the ability to continually customize and personalize customer experiences. In fact, the delivery of services on the Internet warrants further discussion in the next chapter.

2.2.3 SERVICE DELIVERY ON THE INTERNET

Although this research is not specifically on Internet-based services, the time-frame of the empirical examination, spanning as it does the years 2004 through 2007, and the empirical context of NTBFs imply that the Internet is a key characteristic of the empirical realities studied. The Internet constitutes both a tool or platform and also a characteristic of the context or environment in which the firms studied operate.

The distinguishing characteristics of services can be thought of as imposing the liability of uncertainty on services, while technology such as the Internet can be used to diminish this uncertainty (Lievens, Moanert & Jegers 1999). Thus, technology in general, and the Internet specifically, moderate the service construct so that the distinguishing characteristics of services may be weakened.

When the Internet becomes a platform for service delivery, the equipment used to access services on the Internet, the familiar interfaces, in the form of web browsers, and the user interfaces created for Internet-based services all provide a measure of tangibility and non-perishability to these services. Delivering services on the Internet, rather than in person-to-person encounters, creates the opportunity for standardization, thus counteracting the characteristics of heterogeneity and inseparability and possibly decreasing the cost of service delivery. But, not only can the Internet counteract the distinguishing characteristics of services, it can also provide a means to exploit these characteristics. The Internet introduces the possibility of delivering enhanced services, for example by enabling the development of long-term personalized, but at the same time automated, relationships with customers (Rust & Miu 2006; Walsh & Godfrey 2000).

Menor, Tatikonda and Sampson (2002) argue that Internet-based new service development is much more “entrepreneurship intensive” (p.148) than traditional new service development. Their argument is based on the notion that the Internet dramatically reduces the barriers outlined by Porter (1985), namely economies of scale, product differentiation, capital requirements, access to distribution channels, government policy and cost advantages. One reason is that the economies of information are dramatically different than the economies of physical items. For example, information is infinitely duplicable; once it is created it can be sold again and again without cost. Also, information transactions involve very low transaction costs. These low costs mean low barriers for new entrants. With lower barriers to entry, new Internet-based services can emerge at a much greater rate than non-Internet services.

In view of the impact of the Internet it is important to keep in mind that classical models of innovation and competition may not apply in this context.

2.2.4 SERVICE INNOVATION AND NEW SERVICE DEVELOPMENT

Having defined the innovation and service constructs, respectively, we now address their intersection, namely service innovation.

The terms *service innovation* and *new service development* are sometimes used interchangeably (e.g. de Jong & Vermeulen 2003; Lievens et al. 1999). The term

new service development has its roots in the service management and marketing traditions, while the term *service innovation* has its roots in the economics and business strategy tradition that focuses on entrepreneurship and technological development (Menor et al. 2002). This thesis and the included papers use both the terms *service innovation* and *new service development (NSD)*, and the terms are used interchangeably.

The importance of innovation in services is widely recognized (Drejer 2004; Gallouj & Weinstein 1997; Sundbo 1997; Gadrey et al. 1995) and financial performance is believed to benefit from service innovation (Storey & Kelly 2001). In addition to financial benefits, the literature points to some other benefits of service innovation, such as boosting growth and firm productivity (Cainelli, Evangelista & Savona 2006). Despite the importance of service innovation, the majority of innovation studies focus on innovation in manufacturing (Tether 2005; John and Storey 1998; de Jong & Vermeulen 2003). The reasons for this lack of emphasis on service innovation fall into two categories: the sometimes less favorable reputation of service innovation compared with product innovation; and the seeming elusiveness of service innovation, which can hinder evaluation and measurement.

An example of the less favorable reputation of service innovation is expressed by den Hertog (2000) who describes the dominant view of innovation in services as “supplier-dominated, with service firms being dependent on their suppliers for innovative inputs” (p.499). Pavitt (1984), in discussing supplier dominated firms such as professional, financial and commercial services states that “They appropriate less on the basis of technological advantage, than of professional skills, aesthetic design, trademarks and advertising.” (p.356). Pavitt’s reference to aesthetic design is, of course, worth noticing here.

Endemic of the poor reputation of service innovation is a view of service innovation as unprogressive and largely dependent on adopting existing technologies to facilitate new service delivery and/or to enhance service productivity. Indeed, in addition to services based on the exploitation of technology being an important class of innovative activity, technological developments also create opportunities for service innovation (Van den Ende & Wijnberg 2001). Thus it is necessary to distinguish between technology-based services and what could be termed technology-enabled services. (Recall, that this thesis’ definition of innovation explicitly excludes mere exploitation of

technology, see Table 2.1.) An example of technology-enabled services are financial services and various government services (e.g. Van den Ende & Wijnberg 2001). Such services are increasingly based on advanced technology, but the technology is primarily an enabler in this context. The creation of such technology-enablers, which frequently happens in firms separate from those implementing the solutions, is the creation of technology-based services.

According to research reported by Atuahene-Gima (1996) service firms tend to skip idea screening and concept testing. Easingwood (1986) suggests that services tend to be launched without formal testing, since the cost of testing can be the same as the cost of launch. Easingwood further argues that the intangibility of services means that the ease of developing new services can lead to a proliferation of offerings resulting in potential confusion among customers. In the same vein, Tether (2005) suggests that the intangibility and inseparability characteristics of services may make service innovation more oriented to continuous and incremental improvements than product innovation. This, in turn, makes service innovation less noticeable than product innovation and concomitantly harder to measure and evaluate discretely.

NTBFs sometimes compete on the basis of being first to market, but according to research by Song, di Benedetto and Song (2000) such an advantage may be difficult to sustain since entry barriers to service industries, such as required investments in capital and equipment, are relatively low.

When discussing service innovation, it is important to keep in mind that “it is not the service itself that is produced but the pre-requisites for the service” (Edvardsson & Olsson, 1996, p. 1476). Hence, the interaction between service innovation and service delivery is stronger than the relationship between R&D and production in the manufacturing context.

2.2.5 DIFFERENT APPROACHES TO INNOVATION IN SERVICES

One of the prime areas of discussion in research on service innovation is how innovation in manufacturing and services differ and how they are similar (e.g. Drejer 2004; Coombs & Miles 2000; Hughes & Wood 2000; Sundbo 1997; Atuahene-Gima 1996). The debate on the difference, or the lack thereof, has

yielded three approaches used in research on service innovation: the assimilation approach, the demarcation approach and the synthesis approach.

The assimilation approach is based on the notion that the concepts developed in the product manufacturing context can be applied in the service context because of the similarity of product innovation and service innovation (Nijssen, Hillebrand, Vermeulen & Kemp 2006). In this approach, innovation in services is studied by using or adapting the concepts and tools developed for studying innovation in manufacturing. Tether (2005) provides an example of the use of the assimilation approach in the second round of the European Community Innovation Surveys (CIS-2). This involved using a tool originally conceived for manufacturing and making small changes, such as replacing the word product by the word service, where necessary.

Research based on the demarcation approach emphasizes the unique characteristics of services and the need for theories that take these characteristics into account (Nijssen et al. 2006). The research embodied in Sundbo and Gallouj (2000) is an example of research based on the demarcation approach. These researchers have specialized in the analysis of innovation in services, and argue that innovation in services is different from innovation in manufacturing (Tether 2005).

The synthesis approach is the most recent perspective on innovation in services (Coombs & Miles 2000). This approach is based on the argument that services and manufacturing do not follow entirely different approaches to innovation, but that studies of services and their innovation activities, such as those undertaken in the demarcation tradition, bring to the forefront neglected aspects of innovation, which, although most prominent in services, are increasingly distributed throughout the economy. When studying technological innovation, Sirilli and Evangelista (1998) found that the service and manufacturing sectors are more similar than they are different in terms of innovation processes. The aim of the synthesis approach is to create both theoretical and empirical approaches to innovation that can apply to all economic activities, including manufacturing and services.

Gallouj and Weinstein (1997) were among the first to suggest an integrative approach to innovation from which the synthesis approach has developed. They laid the foundation of a theory on innovation that is integrative in the sense that they do not make an *a priori* distinction between innovation in services or

manufacturing. Their analysis is in line with the general idea of convergence of services and manufacturing (Von Stamm 2003), the growing interdependence between manufacturing and services (Coombs & Miles 2000) and the idea that products and services are often sold in combination (Gadrey et al. 1995; Sundbo 1997).

In their research on global innovation programs, including both product development and service development, Kleinshmidt, de Brentani and Salomo (2007) found that these two groups showed no significant differences in terms of the variables used.

Based on the above arguments, this thesis takes a synthesis approach to innovation, viewing innovation in services and manufacturing as phenomena having more in common than not, but at the same time takes into account the distinguishing characteristics of services.

2.3 AESTHETIC DESIGN

In this chapter, the diverse meanings of the term design will be discussed, a three-dimensional model of design will be developed, and finally, the aesthetic design construct will be introduced and related to services.

2.3.1 DESIGN

The term design is broad and has diverse meanings (Stacey, Eckert, Earl, Bucciarelli & Clarkson 2002). In English, the term design is used to cover a whole range of activities and disciplines including engineering, architecture, interior design, landscape design, industrial design, graphic design, visual styling, fashion design and branding (Walsh 1996; Trueman & Jobber 1998; Von Stamm 2003). In their paper on product design, Ulrich and Pearson (1998) define product design as “the activity that transforms a set of product requirements into a specification of the geometry and material properties of an artifact.” (p.352). Crawford and Di Benedetto (2003), also define design firmly in terms of producing tangible artifacts as “the synthesis of technology and human needs into manufacturing products”. (p.278) Whyte, Davies, Salter and Gann (2003) define design, in its broadest sense as “where the intellectual content for value-added in production processes is created” (p.395).

Innovation can be thought of as encompassing both technical invention (e.g. R&D and engineering) and commercialization (Marsh & Stock 2003). Design can provide the inspiration for innovation (Utterback, Vedin, Alvarez, Ekman, Sanderson, Tether & Verganti 2007) and/or constitute an important element of the process of developing ideas and requirements into new offerings (Keller 2004). Design can also act as a bridge from technical functionalities to value in a finished product or service (Walsh 1996) by enhancing and communicating this value (Hertenstein et al. 2005; Yamamoto and Lambert 1994). In all the roles mentioned here, design is thought of as a verb, rather than a noun; a process rather than an outcome.

Existing research on design tends to focus on engineering design or include the entire spectrum of design activities without making distinctions between engineering design and aesthetic design. To further confound the issue, there is research that uses the term design as basically synonymous with development (e.g. Bruce, Daly & Kahn 2007). Therefore, an operationalization of design is needed as a basis for conducting empirical research.

2.3.2 DECONSTRUCTION OF DESIGN

The discussion in the previous chapter places design within the innovation process and gives it a purpose, but even within these boundaries design remains an elusive construct. Therefore, as a basis for empirical research, it is necessary to identify the dimensions of design so that these dimensions can be accounted for and measured.

A three-dimensional model of design is developed in Paper 1 based on several existing taxonomies as shown in Table 2.3.

Table 2.3. Development of three-dimensional model of design based on existing taxonomies.

Vitruvius	Dreyfuss (1967)	Papanek (1984)	Kotler and Rath (1984)	Ulrich and Eppinger (2003)	Norman (2004)	This article
<i>Venustas</i> (beauty)	Appearance	Aesthetics (gestalt, perception)	Appearance	Product differentiation	Visceral design	Visceral design
		Intuitiveness		Quality of user interfaces		
<i>Utilitas</i> (usefulness)	Utility Low costs	Use, method	Performance Cost	Appropriate use of resources	Behavioural design	Functional design
<i>Firmitas</i> (strength and durability)	Ease of maintenance		Durability	Ability to maintain and repair		
	Communication	Association, conditioning Needs Telesis (nature, society, technological bias)		Emotional appeal	Reflective design	Experiential design

From Paper 1.

In this model, the dimensions of design are the visceral, the experiential and the functional dimensions, respectively. This model is closely related to the design taxonomy suggested by Norman (2004) and analogous to that presented by Wickham (2006).

All three dimensions of design are, in essence, concerned with aspects of the interface between humans and products or services. Norman (2004) argues that the three dimensions of design are all important. This suggests that ideally firms' design emphasis should be a balanced blend of all three dimensions, each of which is discussed below.

2.3.2.1 FUNCTIONAL DESIGN

Functional design encompasses utility, features and performance. Papanek (1984) emphasizes the importance of utility, or the intuitiveness of user interfaces. Ulrich and Eppinger (2003) emphasize the importance of low costs and ease of maintenance facilitated by design communicating how products are to be maintained and repaired and stress the importance of taking into account environmental factors and eliminating unnecessary features. Kotler and Rath (1984) argue that design must take into account cost constraints. Papanek (1984) describes the interaction of tools, processes and materials to reach a functional goal. Kotler and Rath (1984) include quality, durability and performance as major elements of design. Norman (2002; 2004) discusses function, understandability and usability.

Just like the processes for creating a tangible product can be designed (Utterback 1994), so can the processes for delivering a service which fulfills user expectations be designed (Shostack 1984).

It can be argued that there can be no development of new services without some form of functional design, whether deliberate or not. However, according to Froehle, Roth, Chase and Voss (2000) services tend to be under-designed and inefficiently developed compared with products. Behara and Chase (1993) open their paper on service quality design with the quip, "If we designed cars the way we seem to design services, they'd probably come with one axle and five wheels" (p.87). Therefore, when studying service innovation, functional design cannot necessarily be taken as a given.

An example of a method used for the functional design of services is the method of pattern languages used in software development. The idea of documenting and

reusing successful solutions to problems was introduced by the architect Christopher Alexander (Alexander 1977) and has been successfully adapted in software development (Schmidt, Fayad, & Johnson 1996).

2.3.2.2 VISCERAL DESIGN

Visceral design, sometimes referred to as sensorial design, is design that appeals to the senses (Norman 2004). Although visceral design is commonly thought of as being limited to visual design, visceral design also encompasses the design of aural, olfactory, gustatory and tactile aspects. For example, Spangenberg, Sprott, Grohmann & Tracy (2006) report on research done on the influence of olfactory cues in a retail environment.

Ulrich and Eppinger (2003) and Kotler and Rath (1984) emphasize the importance of appearance, or the form, line, proportion and color which are used to integrate a product into a pleasing whole, with the primary goal of product differentiation. Crilly, Moultrie and Clarkson (2004), in their study of consumer response to product visual form, found that visual appearance has an important impact on customer response and that customers may interpret a product's quality based on visual information. Creusen and Schoormans (2005) identify six different roles of product appearance: communication of aesthetic, symbolic, functional, ergonomic information, attention drawing and categorization.

2.3.2.3 EXPERIENTIAL DESIGN

Experiential design is concerned with message, symbols, culture, meaning, and emotional and sociological aspects of an offering. The choice for a specific product or brand may convey the kind of person someone is, or wants to be. Consumers use products to express their, often idealized, self-image to themselves and to others (Gilmore & Pine 2007; Creusen & Schoormans 2005).

Crawford and Mathews (2001) provide an eloquent description of the trend towards the increasing importance of experiences: "Historically, product features and functions were the primary determinants of value in business. Build a better mousetrap, and the world will beat a path to your door. Today, product quality is table stakes, the ante in a high-stakes game of poker. While inferior quality will not be tolerated by today's consumer, product quality alone is not enough. Most cars run today, and do so consistently. Refrigerators keep food cold, stereos sound good, detergents get clothes clean, hotel rooms are clean and quiet.

Consumers in mature economies expect products to perform at a given level of quality. Today, it is the human values that are displayed during the provision of goods and services that provide the opportunity for extreme differentiation, branding, and building loyalty.” (p.16)

Stuart and Tax (2004) and Pine and Gilmore (1998) define the development of services as the design of customer experiences, which resonates with Norman’s (2004) concept of reflective design. Ulrich and Eppinger (2003) discuss emotional appeal which encompasses factors like attractiveness, pride of ownership and the image of quality. Papanek (1984) includes the psychological, spiritual, social and intellectual needs of human beings in his taxonomy of design.

Rayport and Jaworski (2005) argue that firms should work backward from the customer experiences they wish to deliver when developing new services. They further argue that a company’s service interfaces can be an important means by which to manage customer experience.

Whyte et al. (2003) report on design activities in new product development in a set of small manufacturing firms. The design activities examined are those that go beyond traditional engineering design and include branding, marketing and interactive web sites which can all be classified as being essentially concerned with marketing. In their research on branding in services Berry and Lampo (2004) emphasize the importance of developing a strong brand, which can be aided by using and orchestrating clues, connecting emotionally and internalizing the brand. The branding of services is very much about creating and fostering a specific customer experience (Norman 2004).

2.3.3 AESTHETIC DESIGN OF SERVICES

Referring to Moody’s (1984) dichotomous partitioning of design into engineering design and industrial design, one can say that the functional design dimension is analogous to engineering design and the visceral and experiential dimensions taken together are analogous to industrial design. Whereas Moody’s (1984) partitioning is distinctly product-focused, the model suggested by this research, being based on the synthesis approach to innovation, can be applied to both products and services.

The concept of industrial design has been defined in a number of ways but none of these definitions has been universally accepted (Gemser & Leenders 2001). For

example, Walsh et al. (1992) find that the function of industrial design may vary according to factors such as the nature of the company's business and the design experience of the company. In view of this research's focus on services, the industrial design concept, being highly associated with the creation of tangible objects, is too limiting for the purposes of this thesis, even given the breadth of existing definitions. This research seeks to define design within the context of innovation, and in keeping with the synthesis approach to innovation, in such a way that the definition can apply just as well to products and services.

Referring back to the three dimensions of design developed above, we see that functional design can be equated with engineering design, which leaves visceral and experiential design, or aesthetic design when combined, as what could be characterized as "genetically" related to industrial design but "not speaking the same language".

It should be made clear that the term aesthetic design was selected primarily for lack of a better term and is not intended to signal a desire to engage in the general discourse on aesthetics as a philosophy. Using existing terminology inevitably carries with it the baggage of common understanding and the term aesthetic design is no exception to this rule. Dictionary definitions of aesthetic include "relating to the beautiful as distinguished from the merely pleasing" and "relating to sensuous cognition" (Webster's New International Dictionary 2002) and as such emphasize the common understanding of aesthetics as having to do with visual appeal. This thesis takes a broader view of aesthetic design to encompass visceral design and experiential design as defined above, not just visual design.

Indeed, Liu (2003) takes such a broad view and describes aesthetic appraisal of offerings as "multi-modal in the sense that more than one sensory modality is likely to be involved in the process. While fine art appreciation is primarily visual, aesthetic appreciation of a product or work system may involve the interplay between a person's visual, auditory, olfactory, tactile, haptic, and even proprioceptive systems." (p.1277). This description encompasses the full range of senses addressed by visceral design as well as proprioceptive reactions which can be said to be stimulated by experiential design. "The way to reach your customers is to create an experience within them." (Gilmore & Pine 2002, p.5)

According to March (1994) designers' view of usability has changed from emphasizing look and feel to a broader concern for cognitive and emotional aspects. In the opening of his book *Redefining Designing: From Form to Experience* (1993), Mitchell quotes Andrea Branzi, architect and designer, and John Thackara, designer, and brings into focus the intangible essence of service design: "Branzi further notes that, "design today ... operates within a number of processes of change that lie completely outside the traditional activity of the formal and physical design of objects, in order to move forward into the world of services, to the interchange of information". Design is now, as John Thackara says, "beyond the object". (p.1) Mitchell (1993) argues that the focus of designers has moved from the physical product to the experience. This change in focus is also described by Redström (2006): "If design used to be a matter of physical form, its subject the material object, it now increasingly seems to be about the user and her experiences." (p.123).

3 EXISTING RESEARCH, GAPS AND RESEARCH QUESTIONS

In their paper on methodological fit, Edmondson and McManus (2007) describe three stages of theory and the kind of methodology appropriate for each stage. Firstly, there are mature theories for which quantitative methodologies are appropriate. Secondly, there are nascent theories for which qualitative methodologies are more appropriate. The third stage is the intermediate stage, described by Edmondson and McManus as one where it is commonly necessary to bring together more than one stream of research. For research where the theory is intermediate, Edmondson and McManus recommend a hybrid methodology. My research can be characterized as being based on intermediate theory. There is existing research on (industrial) design as an element of innovation, predominantly product innovation, and there is also research on success factors in service innovation. But research on aesthetic design as an element of service innovation is decidedly scant. Hence, my approach is to combine these two streams of research.

In this section, existing research on design as an element of innovation is reviewed. This is followed by reviews of two streams of research, namely research on the relationship between design and performance and research on success factors in service innovation, that when brought together, approach the potential relationship between aesthetic design and performance in service innovation. Gaps in the existing research are identified and research questions developed to address these gaps.

3.1 DESIGN AS AN ELEMENT OF INNOVATION

Existing research on design as an element of innovation is reviewed here. The research is divided into two parts, research on the role of design in innovation and research on design practice and organization.

3.1.1 RESEARCH ON THE ROLE OF DESIGN IN INNOVATION

The role of design in innovation can be viewed as one of communicating the value, quality and integrity of a firm and its offerings (Yamamoto & Lambert 1994; Trueman & Jobber 1998). Veryzer and de Mozota (2005) talk about humanizing technologies through design and Pullman and Gross (2004) point to the opportunity service providers can tap by deliberately using experience design.

In contrast to the preceding, rather idealized, descriptions, is a statement made by Donald Norman in an interview with Mark Zachry: “The way it is done today: The marketing people conceive of a product, the engineers build it, and then we call in the usability people to certify that it’s useable or to make it useable. And the design community to make it pretty.” (Zachry 2005, p.483). Moody (1984) goes so far as to venture that designers seek to rectify the omissions of engineering.

Whyte et al. (2003), in their case study of innovation award winners in the United Kingdom focus on design activities going beyond traditional engineering design. The results identified by Whyte et al. (2003) are that the successful firms studied used aesthetic design activities which complement engineering design and “wrapped” them around core engineering design.

The role of design in innovation had been found to vary depending on life cycle phase and innovation radicalness. Walsh (1996) found a shift in emphasis in the life cycle of an industry or technology, from an early period characterized by technological innovation, to a subsequent period during which improvements, lower cost and ease of manufacture are emphasized, and finally a more mature phase where design variations, fashions, styles and re-designs predominate. Reflecting these findings onto this thesis’ framework we can say that Walsh’s findings are that the early parts of the life cycle are characterized by an emphasis on functional design, whereas aesthetic design becomes more important in later stages. Veryzer (2005), in his research on new product development projects, similarly found that design is applied late in radical innovation. Despite the late arrival of design in such projects, Veryzer’s (2005) findings indicate that design makes an important contribution to the completed products.

Gemser, Jacobs and Cate (2006) conducted research on the use of design in the Dutch IT sector. They found that there was greater design consciousness in firms selling services than those selling products. They further found that firms selling services in the form of generic software showed less design consciousness than firms selling services in the form of content-driven software, such as web sites and computer games.

Turning to the research context of NTBFs, there is a respectable body of research on innovation in NTBFs and this research covers a broad range of topics. A systematic search of the NTBF literature yielded nothing dealing with design (other than instances where design was used synonymously with development), industrial design or aesthetic design. Although it is impossible to state with certainty that there is no relevant research, it can be surmised that research on design in NTBFs is scarce. Representative of the absence of a concern for aesthetic design in NTBF research is a paper by Heydebreck, Klofsten and Maier (2000) who examine the services NTBFs need for innovation. Notably missing from their list of 16 different types of services needed are design services.

Due to this gap, a reliable basis for the assumption that aesthetic design is indeed an element of innovation in NTBFs is missing. Therefore, logically, the first question to ask is, “to what extent is it there?”, or in more formal terms:

Q1. What is the prevalence of aesthetic design as an element of innovation in new technology-based firms?

This research question carries with it the assumption that design prevalence can be measured empirically. Hence, developing an appropriate measurement tool is a pre-requisite for addressing this question.

In addition to the issue of design prevalence, it is also important to consider how this role of design is manifested. When design is considered in business research it is not always viewed as an element of innovation, instead it is more commonly studied in the context of marketing and seen as relevant only for the promotion and selling of offerings (Christensen 1995). Lorenz (1994) in describing how design has been ignored by management says: “A company does itself a disservice if it sees product design, and with it the industrial designer's contribution, as merely "shape and appearance".” (p.83) Hence, the next area for examination is the role of design in NTBFs. Extant research on the manifestation of design, e.g. the research by Perks, Cooper and Jones (2005), Veryzer & de Mozota (2005),

Gorb and Dumas (1987), Walsh (1996) and Whyte et al. (2003), focuses on the role of design in product innovation leaving a gap when it comes to service innovation. Hence, the second research question puts the focus on service innovation:

Q2. What is the role of aesthetic design in service innovation in new technology-based firms?

3.1.2 RESEARCH ON THE ORGANIZATION OF DESIGN IN INNOVATION

Veryzer and de Mozota (2005) found that the role of industrial design is rarely explicitly defined in the innovation process. Instead, design activities are subsumed in the activities that make up the process. Such diffusion of design activities throughout the firm increases the difficulty of evaluation (Nixon 1999).

Sundbo (1997) and Martin and Horne (1993) found that service innovation tends to be an *ad hoc* process and Berry and Taggart (1998) suggest that new firms tend to be characterized by informality. If this is indeed the case, we can expect the organization of design in service innovation to be likewise *ad hoc*.

Most of the existing research on design organization focuses on the actors involved in design and their roles. Perks et al. (2005) conducted case research in United Kingdom manufacturing firms with the goal of characterizing the role of design in product innovation. They identified three design role profiles, in order of increasing influence: design as functional specialism; design as part of a multifunctional team; and design as process leader. An additional finding of this research was that those designers with broad business backgrounds were best fit to undertake new product development, since these broad backgrounds allowed them to take a holistic approach and exploit a wide scope of skills.

Slappendel (1996) examined the use of industrial design expertise in New Zealand product manufacturing firms. The results of this research were that larger firms use more industrial design expertise than smaller firms and that firms' extent of networking with design-related organizations also has a positive relationship with the use of industrial design expertise.

Gemser et al. (2006) in their case research on the use of design in the Dutch IT sector found that, except in firms selling content-related software, the IT firms studied employed a very limited number of designers and external consultants

were also infrequently used. In firms selling content-related software such as web sites or computer games, they found aesthetic design to be viewed as very important and designers were actively involved in the development process.

Gorb and Dumas (1987) in their paper entitled *Silent Design* found that some kind of design activity was found in almost all firms. Gorb and Dumas define *silent design* as the process by which employees are engaged in design as an adjunct to their primary roles, basically non-designers doing design. Roy and Potter (1993) found that professional design consultants were involved in development work in only a small portion of the small-to-medium firms they studied. This phenomenon can be expected to be no less in evidence in service firms than in manufacturing firms. Walsh et al. 1992 also refer to *silent design* stating that design can be performed part-time by employees with other formal roles including manual and white-collar staff. Similarly, Walsh (1996) found that the existence of design activity was far less dependent on size and sector than the existence of R&D. Some kind of design activity was carried out by almost all firms independently of size or sector. In contrast, she found that R&D was very highly concentrated in a few industrial sectors. Furthermore, Walsh found that design is taken seriously in some firms but not in others and effort spent and priority given varies greatly.

Again, much of the research reviewed above, with the exception of the research by Slappendel (1996) and Roy and Potter (1993), which include small firms, focuses on large and/or established firms and product innovation rather than service innovation. Thus, there is a need for evaluating organization of design as an element of service innovation in NTBFs and the third research question deals with this.

Even if there is little in the way of formal organization, learning who the design actors are, should shed some light on the issue of organization. Thus, the third research question seeks to explore if design in service innovation in NTBFs is *ad hoc* as suggested by previous research. Even if organization is weak, the issue of who performs aesthetic design activities in NTBFs can be addressed to look for the existence of *silent design* (Gorb & Dumas 1987) as well as other categories of design actors.

Q3. How is aesthetic design in service innovation in new technology-based firms organized and who performs aesthetic design activities?

3.2 THE RELATIONSHIP BETWEEN AESTHETIC DESIGN AND PERFORMANCE

From a pragmatic standpoint, prevalence, manifestation and organization of aesthetic design are of limited interest unless aesthetic design as an element of service innovation brings with it some benefits. The existing research on the relationship between design and performance is mostly limited to the manufacturing context. For this reason, research on the relationship between design and performance is reviewed here followed by a review of existing research on success factors in service innovation with reflections on how aesthetic design might contribute to these success factors.

3.2.1 RESEARCH ON THE RELATIONSHIP BETWEEN DESIGN AND PERFORMANCE

Research on the relationship between design and performance is reviewed in this chapter in roughly chronological order based on publication dates.

Kotler and Rath (1984), in a paper contributing management implications and prescriptions argue that design can be used as a strategic tool to gain sustainable competitive advantage. However, their paper does not report empirical findings.

Rothwell and Gardiner (1984) conducted research on agricultural equipment in the United Kingdom to examine what factors influenced customer buying decisions. For equipment manufactured in the United Kingdom, design ranked only ninth in importance with price ranking most important, but for equipment manufactured outside the United Kingdom, design ranked second in importance. A study in a similar context was conducted by Moody (1984) who asked a sample of ophthalmic opticians to identify primary and secondary factors that influenced their choice of products. According to the results of this study, general design features ranked highest.

Black & Baker (1987) examined the design orientation of 61 small manufacturing firms, using growth rate as a measure of success. They discovered that firms with high sales growth use aesthetic design to a greater extent in all stages of the innovation process than do firms with average or negative sales growth.

Based on research in the food industry, Berkowitz (1987) demonstrates that the form or shape of a product affects beliefs about the product, and these beliefs in turn are likely to affect consumer preferences.

Walsh et al. (1992) found that for a sample of firms in the United Kingdom there was a significant positive relationship between a firm's design performance, measured by its number of awards and prizes for design, and its subsequent financial performance. A number of financial performance indicators were used in this research. In a study of plastics firms, good design was found to be significantly related with turnover growth, capital growth and return on capital. In a different study reported by Walsh et al. (1992) involving United Kingdom furniture, heating and electronics firms good design was found to be significantly related with profit margin, which suggests that design adds value to offerings and hence increases profits.

Roy and Potter (1993) report on a United Kingdom government program that provided funding for small firms to hire external design expertise. They studied 221 firms that received such funding and found that 90% of those projects that were implemented were profitable within an average of 15 months. They also identified several indirect benefits, such as reduced costs, reduced stock, increased margins, improved company image and improved attitudes towards design.

Yamamoto and Lambert (1994) found that the appearance of an industrial product has an impact on its evaluation. They found that the impact of appearance was stable across organizational units and technical orientations. On a slightly different note, Roy and Riedel (1997) found that in successful product development projects more attention had been paid to genuine product improvements than only styling or cost reduction. This lends credence to the suggestion made by Crawford and Mathews (2001) that product quality constitutes "table stakes" that customers expect as a given. Design, however, constitutes the opportunity for differentiation which can increase the chances of success and competitive advantage.

Gemser and Leenders (2001) studied the impact of industrial design intensity on new product development in two industries, the furniture industry and the precision instruments industry. They used managers' ratings of firm performance against that of their competition as their measure of performance. Industrial

design intensity was measured based on factors such as the use of professional design expertise, reasons for using or not using professional design expertise and tasks performed by professional design staff in the new product development process. The findings of this research were positive relationships between industrial design and performance in the instruments industry. The fact that no significant positive relationships were found between industrial design and performance in the furniture industry may indicate that in industries where industrial design is generally accepted as important, industrial design no longer constitutes a basis for competitive advantage, becoming instead a baseline requirement for participation.

As reported by Bruce and Bessant (2002), the United Kingdom Design Council carried out research in 1999 in about 450 firms dealing with the contributions made by design. Among the results were that 91% of respondents believed design improved the image of their firms; 90% believed design improved the quality of their products; 84% believed design supported an increase in profits; and 80% believed it helped their firms enter new markets.

Norman, in his books *The Design of Everyday Things* (2002) and *Emotional Design* (2004) provides numerous examples of good and bad design and argues that a holistic approach to design, including both functional and aesthetic concerns, is required to achieve success.

Hertenstein et al. (2005) examined the relationship between industrial design effectiveness and financial performance in order to assess industrial design's contribution to performance. Their approach to measuring design was to ask a panel of industrial design experts to rank the design effectiveness of their set of 68 publicly traded firms. Their findings were that firms rated as having "good" design were stronger on most financial measures.

Turning to research on services, Pullman and Gross (2004), in their research on experience design, found that one of the key elements for success in terms of customer loyalty is designing opportunities for customers to interact with each other, to gain entry into a community. Community building has been successfully employed by product manufacturers such as General Motors, who have created and support clubs for Saturn owners (Peters 1997).

Turning to technology-based services, Van der Heijden (2003) found that the perceived visual attractiveness of web sites influences usefulness, enjoyment and

ease-of-use. Auger (2005) conducted research to examine the impact of design on web site performance. Auger used independent variables, namely level of interactivity and design sophistication. Two performance measures were used, an overall measure including such factors as sales growth and profitability, and the number of web site visitors. The results indicate that the level of interactivity of a web site is positively associated with overall performance while design sophistication is associated with a greater number of visitors. The interacting variables, market turbulence and web site age, were included in analysis and were found to moderate the relationships observed.

The empirical research reviewed above uses a number of different measures of performance. The empirical contexts of the research and the performance measures used are summarized in Table 3.1.

Table 3.1: Performance measures and contexts of existing empirical research on the relationship between design and performance.

Reference	Empirical context	Performance measures
Moody 1984	Scientific instrument development projects in the United Kingdom targeted at the industrial or professional market (B2B) (case study)	ranking of factors influencing choice when purchasing
Rothwell & Gardiner 1984	Agricultural equipment in the United Kingdom	ranking of factors affecting decisions to purchase
Black & Baker 1987	61 small manufacturing firms in Scotland	growth rate
Berkowitz 1987	Frozen food industry in the U.S.	product preference
Walsh et al. 1992	Mostly United Kingdom firms across a number of industries	profit margin, return on capital (assets), sales growth
Roy & Potter 1993	221 United Kingdom firms that received government funds to hire external designers	project profitability and project payback time
Yamamoto & Lambert 1994	33 respondents evaluated photographs of industrial products	ranking of factors influencing choice
Roy & Riedel 1997	220 development projects in United Kingdom SMEs which had received financial support for design from the government	commercial success of projects
United Kingdom Design Council 1999, as reported by Bruce & Bessant 2002	450 United Kingdom firms	firm image, quality of offerings, profits, entry into new markets
Gemser & Leenders 2001	Dutch firms in the furniture industry and the precision instruments industry	profit as a percent of turnover, sales growth, profit, profit growth, turnover growth compared with competition

Reference	Empirical context	Performance measures
Van der Heijden 2003	Over 800 respondents about a Dutch portal web site	use of web site, intentions to use web site, attitudes towards using web site
Pullman & Gross 2004	About 200 VIP hospitality tent guests	loyalty behavior
Hertenstein, Platt and Veryzer 2005	United States firms in nine manufacturing industries	returns on sales, returns on assets, growth rates of sales, net income, cash flow, stock market returns
Auger 2005	Web sites	number of web site visitors

The greater portion of the research reviewed above deals with design as an element of product innovation only. In view of this gap, a review of existing research on success factors in service innovation is undertaken in the next chapter. This is done with the goal of examining if this stream of research considers aesthetic design as a success factor and identifying success factors to which aesthetic design could potentially contribute.

3.2.2 RESEARCH ON SUCCESS FACTORS IN SERVICE INNOVATION

Existing research on success factors in service innovation is reviewed in this chapter. The reason for including this research was explained at the beginning of this Section 3 and stems from the intermediate nature of the theory on which my research is based. Examining the success factors that researchers have identified for service innovation provides a basis for considering whether and how aesthetic design might contribute to success in this context.

Identifying the factors that contribute to success in new product development (NPD) has been the subject of much research, e.g., in chronological order, Myers and Marquis (1969), Rothwell (1972, 1992), Rubenstein, Chakrabarti, O'Keefe, Maidique and Zirger (1984), Cooper and Kleinschmidt (1987), Zirger and Maidique (1990), Eisenhardt and Tabrizi (1995), Brown and Eisenhardt (1995),

Ainamo and Pantzar 2000. The success factors addressed by this research commonly include the following: market synergy (the product fits the market), firm synergy (the product fits the existing products and resources of the firm), product advantage or superiority; market orientation, marketing proficiency and quality of the new product development process.

Johne and Storey (1998) and de Jong and Vermeulen (2003) provide reviews of the literature on new service development (NSD). De Jong and Vermeulen (2003) focus specifically on the organization of NSD, whereas Johnes and Storey (1998) take a more general view of NSD. These reviews bring to light the overwhelming dominance of a focus on financial services in the research reviewed. Although financial services do tend to be heavily reliant on technology, this technology is frequently supplied by technology-based firms rather than the financial institutions themselves. In view of this empirical bias the applicability of the research on success factors in service innovation, when taken as a whole, to technology-based service innovation must be approached with caution. This bias also brings to light an important gap, which calls for research in technology-based firms.

A systematic search for existing research on success factors in NSD was undertaken and the success factors identified through this research were cataloged and grouped. The success factors were found to fall into four broad categories: factors related to management, factors related to the development process, factors related to marketing and characteristics of the offerings developed. Since the research on success factors in service innovation covers so many factors it does not lend itself to representation in a manageable table analogous to Table 3.1 and therefore, empirical contexts, performance measures and findings are cataloged in several tables in Appendix A.

In their study comparing modest successes with major successes in new financial services, Cooper et al. (1994) identified five blocks of variables expected to impact on success. The four categories identified based on my review are analogous to the blocks of variables identified by Cooper et al., but their analysis yielded a fifth block, namely the nature of the marketplace, which is external to the firm.

The success factors identified are divided into the aforementioned four categories in Appendix A. Although not unthinkable, particularly in an indirect way, aesthetic design is not considered to have important potential roles with respect

to the success factors related to the NSD process and management. This is not meant to cast aspersions on the potential weight of these success factors and the reader is referred to Appendix A for a summary of success factors related to management and the development process. On the other hand, design is seen as having potential roles with respect to many of the success factors related to marketing and service characteristics.

The reviewed research on success factors related to marketing and characteristics of services is discussed below and related to the possible role of aesthetic design in these success factors.

3.2.2.1 SUCCESS FACTORS RELATED TO MARKETING

New service success is related with effective marketing, publicity, communication and branding (de Brentani 1989; de Brentani & Cooper 1992; Easingwood & Storey 1993; Cooper et al. 1994; Storey & Easingwood 1996, 1998; Lievens et al. 1999; Henning-Thurau, Walsh & Wruck 2001)¹. These are areas where aesthetic design can play an important role (Shedroff 2001; Whyte et al. 2003), and is, in fact, quite a common area for design application, e.g. in advertising, even when aesthetic design may have been ignored up to the point of commercialization. Application of aesthetic design only at the commercialization stage is sometimes referred to as “window dressing” (Norman 2004) and may not be very effective on its own (Roy & Riedel 1997). Internal marketing can likewise play a positive role in new service success (de Brentani 1989; Easingwood & Storey 1991, 1995; Lievens et al. 1999), and aesthetic design can play a role in such communication as well.

Marketing synergy, meaning the fit between a new service and market expectations and requirements has been identified as an important success factor in NSD (Cooper & de Brentani 1991; Easingwood & Storey 1991; de Brentani 1991, 1995; de Brentani & Cooper 1992; Cooper et al. 1994; Atuahene-Gima 1996; de Brentani & Ragot 1996; Agarwal, Erramilli & Dev 2003; Van Riel, Lemmink & Ouwersloot 2004). In the same vein, recognizing market needs, e.g. through market research or other marketing inputs, can also be a success factor

¹ In this review, all references are listed in chronological order, except when one author or group of authors is referred to more than once, in which case such author(s) are ordered according to the earliest reference.

(de Brentani 1989, 2001; Martin & Horne 1993, 1995; Edgett 1994, 1996; Edgett & Parkinson 1994; Cooper et al. 1994; Easingwood & Storey 1995; Storey & Easingwood 1998; MacCormack et al. 2001; Agarwal et al. 2003). The market may have expectations about a certain level of design (Gemser & Leenders 2001) and customers may have learned to rely on improved usability engendered by design (Norman 2004), so design can play a role in meeting these expectations and, by extension, contributing to marketing synergy.

Finally, proficiency of new service launch has been identified as a success factor (Cooper & de Brentani 1991; de Brentani & Cooper 1992; de Brentani 1993, 2001; Edgett 1994; Cooper et al. 1994; Edgett & Parkinson 1994; Atuahene-Gima 1996; Storey & Easingwood 1996, 1998) and here aesthetic design of user interfaces to improve usability can play a role in insuring a smooth launch (Norman 2002, 2004).

The potential roles of aesthetic design with respect to the success factors related to marketing reviewed here are listed in Table 3.2. These are mostly extrapolated from research on design in the product innovation context and so the basis for claiming that aesthetic design could contribute to success in service innovation needs to be strengthened.

Table 3.2: The potential roles of aesthetic design with respect to the success factors related to marketing suggested by existing research.

Success factor	References	Potential role of aesthetic design
Effective marketing, publicity, communication, branding	de Brentani 1989; de Brentani & Cooper 1992; Easingwood & Storey 1993; Cooper et al. 1994; Storey & Easingwood 1996, 1998; Lievens et al. 1999; Henning-Thurau et al. 2001	creating and fostering perceptions through commercialization tools such as advertising (Shedroff 2001; Whyte et al. 2003)
Internal marketing	de Brentani 1989; Easingwood & Storey 1991, 1995; Lievens et al. 1999	creating and fostering perceptions (Shedroff 2001)
Marketing synergy, service/market fit	Cooper & de Brentani 1991; Easingwood & Storey 1991; de Brentani 1991; de Brentani & Cooper 1992; Cooper et al. 1994; de Brentani 1995; Atuahene-Gima 1996; de Brentani & Ragot 1996; Agarwal et al. 2003; Van Riel et al. 2004	meeting market expectations about visceral and experiential appeal and improving usability (Gemser & Leenders 2001; Norman 2004)
Need recognition, marketing inputs	de Brentani 1989; Martin & Horne 1993; Edgett 1994; Edgett & Parkinson 1994; Cooper et al. 1994; Martin & Horne 1995; Easingwood & Storey 1995; Edgett 1996; Storey & Easingwood 1998; MacCormack et al. 2001; Agarwal et al. 2003	meeting customer expectations about visceral and experiential appeal and improving usability (Gemser & Leenders 2001; Norman 2004)
Proficiency of launch	Cooper & de Brentani 1991; de Brentani & Cooper 1992; de Brentani 1993; Edgett 1994; Cooper et al. 1994; Edgett & Parkinson 1994; Atuahene-Gima 1996; Storey & Easingwood 1998; de Brentani 2001	design of user interfaces and design for usability (Norman 2002, 2004)

3.2.2.2 SUCCESS FACTORS RELATED TO SERVICE CHARACTERISTICS

Several success factors related to service characteristics have been identified by NSD researchers. These are listed in Appendix A and can be classified into factors related to service quality, customer experience, quality evidence, working against uncertainty, features, the delivery mechanism and isolating factors.

Service quality is a success factor identified by several researchers (de Brentani 1989; Easingwood & Storey 1991, 1993; Cooper & de Brentani 1991; Storey & Easingwood 1998). Song et al. (2000) surveyed almost 1000 managers in the service industry in nine countries about pioneering advantages. The respondents did not believe that higher quality resulting from improvements in technology led to higher price-cost margins for services. Technological advantages were seen to be relatively unimportant. These results suggest that increased quality based on technology alone is not sufficient if this quality is not communicated and perceived by customers. Aesthetic design can potentially play a role in improving and communicating quality (Yamamoto & Lambert 1994; Norman 2004).

Lepak, Smith and Taylor (2007) define use value as “the specific quality of a new job, task, product, or service as perceived by users in relation to their needs, such as the speed or quality of performance on a new task or the aesthetics or performance features of a new product or service” (p.181). Deconstructing Lepak et al.’s definition yields the terms quality, perception, needs, aesthetics, performance and features. These terms represent a logical progression from the customer’s needs through to meeting these needs. Customer needs exist or come into being externally to the service. Perceptions and aesthetics work as an intermediary to communicate the quality and features of the service to the customer, or in colloquial terms, perception and aesthetics “talk to” customer needs. Perception and aesthetics can also enhance the service performance, or delivery, e.g. through intuitiveness, clear communication or simply a customer’s positive perception. Quality and features can be thought of as the core of the service or the “nuts and bolts” that make performance possible. Finally, the customer participates in the performance or service delivery. Lepak et al.’s (2007) view of value creation resonates with the augmented service offering defined by Storey and Easingwood (1998). In the augmented service offering, perception and aesthetics are wrapped around the core service functionality. Thus, value is a multi-faceted construct and one facet of value can reinforce another.

Success factors related to customer experience are proficient service delivery, employee expertise and training (Shostack 1984; Cooper et al. 1994; Storey & Easingwood 1996, 1998; de Brentani 2001) and the quality of customer contact, encounters and experience (de Brentani 1991; Cooper et al. 1994; Storey & Easingwood 1998; Stuart & Tax 2004). Woo and Ennew (2005), in their study of business-to-business professional services, examined the interaction dimension of

service quality and found that when what is provided in a service becomes more and more similar among competitive offerings, how the service is provided, or the social exchange involved, can create a competitive edge. As discussed earlier, one of the dimensions of design is experiential design, so aesthetic design can play a role in defining and fostering customer experiences (Pullman & Gross 2004).

As defined earlier, services are to a greater or lesser degree intangible and this presents a challenge because people tend to attribute greater value to tangibles than intangibles (Von Stamm 2003). Thus one of the success factors identified by researchers is evidence of quality (de Brentani 1991), and, more specifically, tangible evidence (Shostack 1984; Easingwood & Storey 1993; de Brentani 1995, 2001; Storey & Easingwood 1996). Design can be used to create tangible objects that constitute part of a service and communicate the value of the service (Yamamoto & Lambert 2004; Rothwell & Gardiner 1984). The findings regarding the value of tangible evidence is somewhat conflicting, however. Cooper and de Brentani (1991) find that tangible evidence has only marginal influence on NSD success and Storey and Easingwood (1998) actually find that physical evidence is negatively related with success.

Another liability of intangibility is uncertainty, which can discourage customers from buying a service. Success factors related to working against such uncertainty are appealing to customers' prior experience (Storey & Easingwood 1998) and mitigating service complexity (de Brentani 1991, 2001). Design can be used to influence customers' perceptions in a way that creates positive associations between a new service and something customers are familiar with, such as the firm's brand (Bruce & Bessant 2002) or similar services. Design applied to user interfaces can be used to hide complexity and improve usability (Norman 2002, 2004).

Customizability of services is identified as a success factor by Easingwood and Storey (1993), Cooper et al. (1994) and de Brentani (1995). One form of customization relates to look-and-feel which is an area where aesthetic design can be used to influence perception and aesthetics (Lavie & Tractinsky 2004).

Services, due to their perishability and simultaneity, tend to be manpower-dependent, and having an expert-based or people-based service is, in fact, identified as a success factor by de Brentani (1991, 1995) for customized expert

services. On the other hand, delivering manpower-dependent services to a large number of customers can be fraught with problems of inconsistent quality and conflicts (Rayport & Jaworski 2005). Thus, de Brentani (1995) and Cainelli et al. (2004) find that equipment-based services are associated with success as are services that rely on technology and Easingwood and Storey (1991), Cooper et al. (1994) and Storey and Easingwood (1998) associate the use of technology with success. Whether a service is delivered by people, by systems or a combination of both, service process design, which falls under the functional design dimension, can play an important role in insuring success. Service process design is primarily concerned with the mechanics of delivering a service and so falls outside the scope of aesthetic design.

The final group of success factors related to service characteristics are collectively referred to as isolating mechanisms because they provide various measures of protection from competing firms' ability to duplicate services. Differentiation (Easingwood & Storey 1991; de Brentani & Cooper 1992) and uniqueness (Cooper & de Brentani 1991; de Brentani & Cooper 1992; Easingwood & Storey 1993; Storey & Easingwood 1998) are important success factors that aesthetic design can contribute to (Gemser & Leenders 2001). Another related success factor is creating a service that is difficult to imitate (Cooper et al. 1994). If design is viewed in a very narrow sense as having to do only with visible "surface" attributes it can be argued that design is easily imitable. But when design is viewed in a holistic way it becomes a more powerful means to isolate a service since holistic design goes beyond the surface and delves into the tacit level, which is not easily imitated (Cross 2004).

Innovativeness is identified as a success factor by de Brentani (1989 and 1991), Atuahene-Gima (1996) and de Brentani and Ragot (1996). However, Avlonitis, Papastathopoulou & Gounaris (2001), in their study of financial services, find that innovativeness is not an unqualified success factor. Avlonitis et al. find that the most and the least innovative services are relatively less successful than moderately innovative services in terms of financial performance, but the most innovative new services make the strongest contribution to non-financial performance measures. Design can serve as the inspiration for innovation (Utterback et al. 2007) and thus contribute to the success factor of innovativeness.

Service superiority compared with competitors' and value to customers not provided by competitors are identified as success factors by Cooper et al. (1994), de Brentani and Ragot (1996) and Storey and Easingwood (1998). Aesthetic design can provide this edge over competitors through superficial means and, more importantly, through a holistic approach (Norman 2004).

The potential role of aesthetic design with respect to success factors related to service characteristics suggested by existing research is summarized in Table 3.3. As was the case for the success factors related to marketing, these are mostly extrapolated from research on product design and so the basis for claiming their applicability to services needs to be strengthened.

Table 3.3: The potential roles of aesthetic design with respect to the success factors related to service characteristics suggested by existing research

Success factor (service)	References	Potential role of aesthetic design
Factors related to service quality		
Service quality	de Brentani 1989; Easingwood & Storey 1991, 1993; Cooper & de Brentani 1991; Storey & Easingwood 1998	improving and communicating quality (Yamamoto & Lambert 1994; Norman 2004)
Factors related to customer experience		
Proficient service delivery, employee expertise, training	Shostack 1984; de Brentani & Cooper 1992; Cooper et al. 1994; Storey & Easingwood 1996, 1998; de Brentani 2001	defining and fostering customer experiences through experiential design (Pullman & Gross 2004)
Quality of customer contact/encounter/experience	de Brentani 1991; Cooper et al. 1994; Storey & Easingwood 1998; Stuart & Tax 2004	defining and fostering customer experiences through experiential design (Pullman & Gross 2004)
Factors related to evidence of quality		
Tangible evidence	Shostack 1984; Easingwood & Storey 1993; de Brentani 1995; Storey & Easingwood 1996; de Brentani 2001	create tangible objects that constitute part of a service (Yamamoto & Lambert 2004; Rothwell & Gardiner 1984)
Evidence of quality	de Brentani 1991, 2001	communicate quality through aesthetic design (Yamamoto & Lambert 2004; Rothwell & Gardiner 1984)
Factors related to reducing uncertainty		
Customer prior experience, low perceived risk	Storey & Easingwood 1998	influence customers' perceptions in a way that creates positive associations between a new service and something customers are familiar with, such as the firm's brand, similar services, etc. (Bruce & Bessant 2002)

Success factor (service)	References	Potential role of aesthetic design
Mitigating service complexity	de Brentani 1991, 2001	hide complexity through user interface design to improve usability (Norman 2002, 2004)
Factors related to features		
Customizability	Easingwood & Storey 1993; Cooper et al. 1994; de Brentani 1995	look-and-feel to influence perception; implementation of custom features involving aesthetic design (Lavie & Tractinsky 2004)
Factors related to isolating mechanisms		
Differentiation	Easingwood & Storey 1991; de Brentani & Cooper 1992	differentiation through aesthetic design (Gemser & Leenders 2001; Hertenstein et al. 2005)
Uniqueness	Cooper & de Brentani 1991; de Brentani & Cooper 1992; Easingwood & Storey 1993; Storey & Easingwood 1998	uniqueness through aesthetic design (Gemser & Leenders 2001; Hertenstein et al. 2005)
Difficult to imitate	Cooper et al. 1994	design going beyond the surface and into the tacit level, which is not easily imitated (Cross 2004)
Innovativeness	de Brentani 1989, 1991; Atuahene-Gima 1996; de Brentani & Ragot 1996; Avlonitis et al. 2001	aesthetic design as an inspiration for innovation (Utterback et al. 2007)
Product superiority, value to customer	Cooper et al. 1994; de Brentani & Ragot 1996; Storey & Easingwood 1998	superficial means and holistic approach (Norman 2004)

3.2.3 AESTHETIC DESIGN AND PERFORMANCE

Research on success factors in service innovation was reviewed in the previous chapter and suggestions were made about how aesthetic design might contribute to these success factors. Based on this analysis aesthetic design can potentially contribute to service quality, customer experience, quality evidence, working against uncertainty, features, and isolating mechanisms. Aesthetic design may

also potentially play a role in marketing, particularly in communicating the value of services, meeting customer expectations and contributing to successful launch of new services. These derivations from the service innovation success factor research and the gap identified in this same research with respect to aesthetic design motivate the final research question.

Research on the relationship between design and performance was reviewed in a previous chapter and a summary is provided in Table 3.1. Although some of the research reviewed was performed in small-to-medium firms, none is specifically concerned with NTBFs. In their research of new product success and failure in small high-technology electronics firms, Yap and Souder (1994) found that technical and market uncertainties should be taken into account in determining innovation strategies and that small firms must adopt strategies different from those used by large firms. Although NTBFs are not small by definition, they do tend to at least start out small, so we can expect innovation strategies in NTBFs to be different from those of established larger firms. Hence, studying the relationship between aesthetic design and performance specifically in NTBFs is warranted.

Thus, the final research question seeks to explore the relationship between aesthetic design as an element of service innovation and performance in the specific context of NTBFs:

Q4. How is design as an element of service innovation in new technology-based firms related with firm performance?

Before moving on to a treatment of research methodology, the issue of performance needs to be addressed. As can be seen in Table 3.1, the most commonly used measures of performance in existing research on design and performance are measures of financial performance. This may be partly due to the convenience of using financial measures as they are objective and usually readily available (Venkatraman & Ramanujam 1986).

Using only financial measures of performance may not be sufficient, however. Storey and Easingwood (1999) in their study of financial consumer services in the United Kingdom found that highly successful new services must produce multiple benefits, not just financial benefits. They suggest that half of the value derived from service innovation is derived from what they refer to as company benefits that include aspects such as attracting new customers, improving the

loyalty of existing customers, improving firm image and creating new opportunities. Storey and Kelly (2001), in their research on performance measures used by firms in various service sectors in the United Kingdom, found that the least innovative firms used financial measures of performance. Moderate innovators, or “fast followers”, used measures such as customer acquisition and retention, perceived product quality and customer satisfaction. What Storey and Kelly classified as truly innovative firms used a number of internal measures such as effects on the long-term viability of the firm, effectiveness of the service innovation process, speed of development and cost of development. Along the same lines, Cooper et al. (1994), in their research on financial service firms in Canada, identified three performance dimensions: financial performance, relationship enhancement and market development.

Referring back to existing research on success factors in service innovation we see a wide spectrum of performance measures used, see Appendix A. A comparison of the two sets of performance measures, for the design research and the NSD research, respectively, yields only two measures which are represented only in the design research. In the first place, ranking of factors influencing choice when purchasing was not represented as a performance measure in the NSD success factor research reviewed. In the second place, number of web site visitors was also unique to the design research, and actually is used in only two papers (Van der Heijden 2003 and Auger 2005), which specifically study web sites.

Using the ranking of factors influencing purchase decisions as a performance measure (Moody 1984; Rothwell & Gardiner 1984; Yamamoto & Lambert 1994) suggests a somewhat superficial view of aesthetic design as having mostly to do with first impressions and controlling perceptions. This is certainly one of the ways aesthetic design can be used, but as was discussed above in relation to the success factors in service innovation, aesthetic design can also be in a more holistic way which goes beyond the superficial.

The performance measures used in the NSD research and the research on design listed in Appendix A and Table 3.1, respectively, can be grouped into two broad categories, subjective measures and objective measures. This grouping is analogous to that identified by Agarwal et al. (2003) in their study of market orientation and performance in services.

Based on the above, focusing only on financial performance may be an oversimplification that can possibly yield misleading results. Thus, it is important to consider both subjective and objective measures of performance.

Studying the relationship between aesthetic design and performance is subject to some specific challenges. March and Sutton (1997) argue that there are too many factors that can influence performance, both internal and external to firms, to make it reasonable to consider analysis of relationships without taking into account intermediate factors and interactions between factors. A further weakness in this approach is that performance is generally a state that occurs at some time after the factors that influence it come into play. Therefore, research on the relationship between aesthetic design and performance needs to examine the two variables separated by a reasonable amount of time.

There are challenges of attributing success to a single factor, and especially one that is as difficult to define and measure as aesthetic design. Hence, a means for measuring aesthetic design is needed and multiple dimensions of performance should be considered with a time lag between inputs (aesthetic design) and outputs (performance). These challenges are addressed in the Methodology section that follows.

4 METHODOLOGY

The research is organized using a hybrid strategy involving case research and quantitative survey-based research. The reason for selecting a hybrid approach is that the research topic is under-researched and existing theory draws from at least two separate streams of research, namely research on design in new product development and performance on one hand, and research on service innovation success factors, on the other. Edmondson and McManus (2007) argue that a hybrid approach is a good methodological fit when theory is intermediate.

Eisenhardt (1989) suggests that iterative strategies are particularly appropriate for under-researched topics and a hybrid strategy involving more than one round of data collection using different methods provides opportunities for such iteration. Figure 4.1 shows a depiction of the research strategy, which includes quantitative longitudinal survey-based research, case research and evaluations by expert panels. The data were collected over a period of about three years and analysis was ongoing from the time the first set of data was collected. This meant that early analyses could be used as input into strategies for later data collection. For example, the results of analysis of the first round of survey-based data were used to select subjects for the case research. In turn, the results of the case research were used to generate hypotheses which were tested using the longitudinal survey-based data.

As data collection and analysis progressed each of the research questions was addressed by the papers. Figure 4.1 provides an overview of the relationship between the various parts of the empirical research and individual papers. The relationships between the papers and the research questions (Q1, Q2, Q3 and Q4) are also shown in the figure.

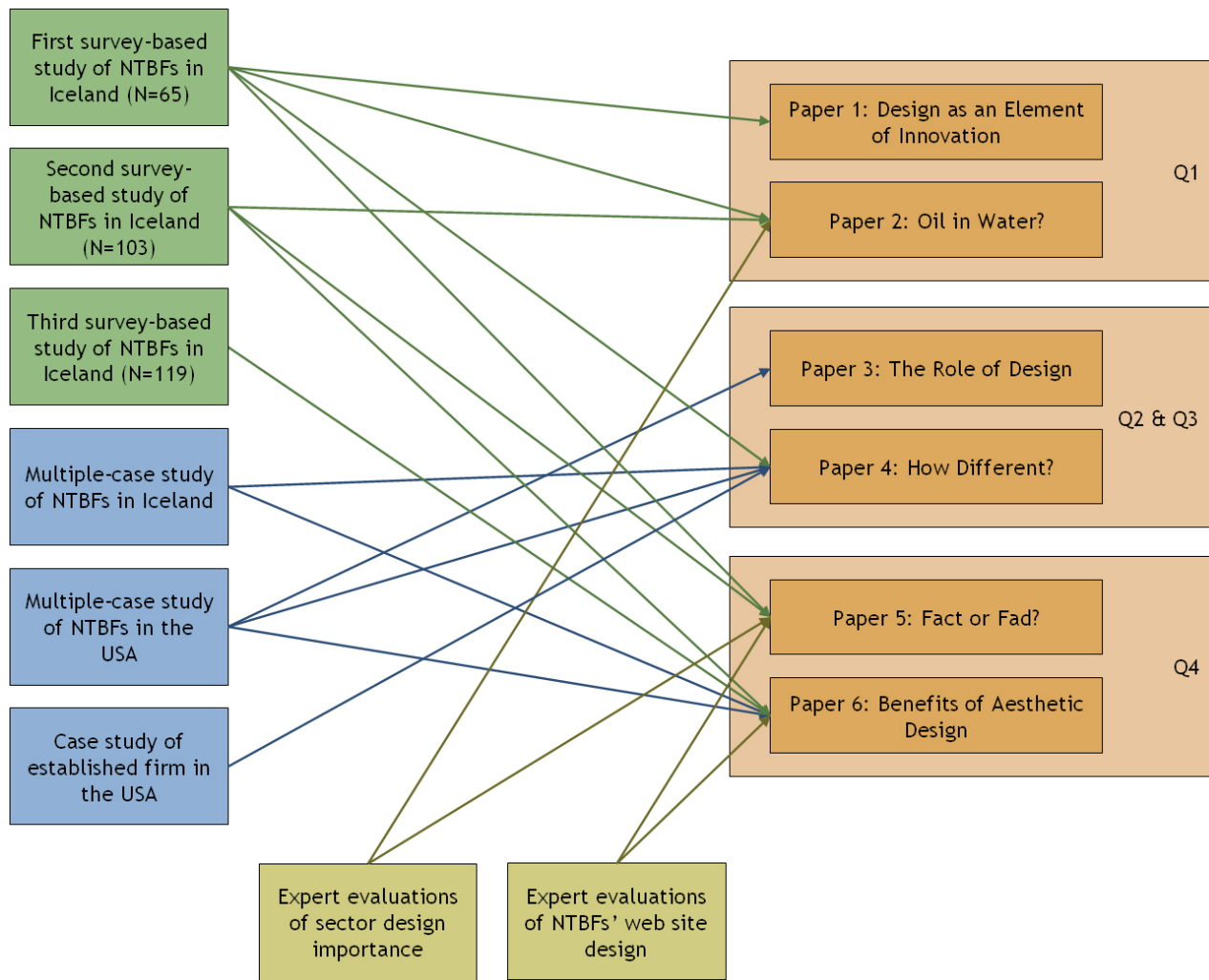


Figure 4.1: Research strategy and use of data for individual papers.

It should be mentioned for the sake of the reader that there is considerable overlap between the material in this section and the methodology sections in the papers.

4.1 QUANTITATIVE SURVEY-BASED STUDIES

The quantitative data for this research are based on questions included in an ongoing longitudinal study of NTBFs in Iceland. The study was begun in 2005 and at the time of this writing, data has been collected three times, once each year. The papers included in this thesis are based on data from the first two rounds of data collection, except Paper 6 which uses the second and third rounds of data collection.

Limiting the research to NTBFs insures a level of homogeneity among the firms studied. The ranges of firm size and age, which must usually be taken into account as control variables when studying innovation, are limited in NTBFs. Besides newness and size, NTBFs also have their technology basis in common. Hughes & Wood (2000) found that technology-based firms, whether in manufacturing or services, exhibit strong similarities in innovative behavior which is substantially different from the behavior seen in other firms. Therefore, limiting this study to technology-based firms can be expected to limit variations attributable to industry differences. This homogeneity comes at a cost of course, because limiting the research to NTBFs may limit the generalizability of the research.

4.1.1 DATA COLLECTION AND POPULATIONS

Various age cut-offs have been used in research on NTBFs. Storey and Tether (1998) point to an initial definition of NTBF which uses a 25 year cut-off and Rickne and Jacobsson (1999) use 25 years. Covin, Slevin and Covin (1990) define firms under 12 years old as new. McDougall (1989) uses 8 years, whereas Zahra, Ireland and Hitt (2000) argue for a cut-off at 6 years of age based on the theory that after 6 years a new firm will either have become established or have failed. Since the aim of the longitudinal research was to contribute specifically to knowledge about NTBFs as new firms this narrow age constraint was adopted for first time participants in the longitudinal survey.

In the beginning of 2005 a list of firms founded after 1999, which were classified as technology-based firms according to their ISAT² codes and which paid salaries in September 2004, was obtained from the Icelandic National Registry. Firms having fewer than three employees were not included, unless such firms were less than 2 years old. This was done in the interest of not including legal entities established strictly for technical or tax reasons around one or two self-employed persons, but at the same time not excluding very new firms with less than 3 employees. Background information was checked for all potential participant firms to eliminate firms not likely to meet the criteria of this thesis' definition of NTBFs as *independent firms that develop new offerings based on the knowledge*

² The Icelandic National Registry classifies firms according to the ISAT 95 coding system, which is based on the European Union's NACE 1 coding system.

and skills embodied in engineering and the natural sciences. The result was that 80 firms were identified as potential participants. When contacted, 10 of these had gone out of business, were older than their registration indicated or did not meet the criterion of being engaged in the development of new offerings based on technical knowledge. Of the remaining 70 firms, 65 agreed to participate (93%).

Prior to data collection in the spring of 2005, a draft version of the questionnaire was pre-tested on four managers from four different firms. A few changes in wording were made following the pre-test to improve clarity. The questionnaire was similarly tested again in 2006.

The survey was administered in face-to-face interviews with the firms' CEOs. The duration of each interview was approximately one hour and covered founding, development of new offerings, including design emphasis and performance as well as several other topics. Each interview was conducted by one of three persons, myself included.

A new list of firms was obtained from the Icelandic National Registry in early 2006 and the same process as described above was used to identify 133 potential participants, including the 65 participants from the previous year. When contacted 20 of the 68 potential new participants had gone out of business or did not fulfill the criteria for inclusion. Of the remaining 48 firms, 40 agreed to participate (83%). Of the 65 firms that participated in 2005, 63 agreed to participate a second time (97%). Thus, a total of 103 firms were surveyed in the spring of 2006 yielding a participation rate of 91%.

Again, the survey was administered in interviews with the firms' CEOs. For the firms participating for the second time, the interviews were administered over the phone, with the exception of those cases where there was a new CEO. New CEOs were interviewed face-to-face as were the CEOs of all the firms participating for the first time. The telephone interviews lasted about 45 minutes and included all the same questions as the initial survey except questions about founding. These interviews were all conducted by the same person.

The above process was repeated a third time in 2007. This time the number of potential participants was 122 and 119 agreed to participate (98%). Of the 103 firms that participated in 2006, 101 (98%) agreed to participate a second or third time.

Tables 4.1, 4.2 and 4.3 provide information about the sizes, ages and sectors, respectively, of the firms making up the three populations. Since a new list of firms was obtained from the Icelandic National Registry each year, and all firms younger than 6 years were considered for participation, many of the firms added each year were not founded in the previous year (see Table 4.2). Instead, these were firms that had reached the minimum size required for participation or changed their sector classification to one of the technology-based sectors in the past year.

Table 4.1: Sizes of firms participating in three rounds of data collection

Number of employees	First round, number of firms	Second round, number of firms	Third round, number of firms
3 or less	19 (29%)	29 (28%)	35 (29%)
4 to 6	21 (32%)	34 (33%)	32 (27%)
7 to 9	10 (15%)	12 (12%)	20 (17%)
10 to 19	9 (14%)	15 (15%)	16 (13%)
20 to 49	5 (8%)	7 (7%)	9 (8%)
50 or more	1 (2%)	6 (6%)	7 (6%)
Total	65	103	119

Table 4.2: Ages of firms participating in three rounds of data collection

Age	First round, number of firms	Second round, number of firms	Third round, number of firms
1 year	5 (8%)	8 (8%)	7 (6%)
2 years	18 (28%)	22 (21%)	16 (13%)
3 years	13 (20%)	20 (19%)	21 (18%)
4 years	14 (22%)	16 (16%)	22 (18%)
5 years	15 (23%)	16 (16%)	17 (14%)
6 years		21 (20%)	15 (13%)
7 years			21 (18%)
Total	65	103	119

Table 4.3: Sectors of firms participating in three rounds of data collection

Sector	First round, number of firms	Second round, number of firms	Third round, number of firms
Software development	27 (42%)	38 (37%)	44 (37%)
Engineering, technical services	15 (23%)	21 (20%)	25 (21%)
Manufacturing	6 (9%)	5 (5%)	5 (4%)
Telecommunications	2 (3%)	5 (5%)	3 (3%)
Other service sectors	15 (23%)	34 (33%)	42 (35%)
Total	65	103	119

4.1.2 SURVEY QUESTIONS TO MEASURE AESTHETIC DESIGN

As has been mentioned previously, the first task of this research was to develop a means to measure aesthetic design in NTBFs. The development of this model is the topic of Paper 1.

The model is based on an evaluation of emphasis on each of the three dimensions of functional, visceral and experiential design, respectively. An alternative

approach would be to measure exhibited performance or quality, along each of the design dimensions. Hertenstein et al. (2005), when evaluating firms' design efforts, asked a panel of experts in industrial design to rank the firms. The expert rankings were intended to reflect the cumulative industrial design reputation of a firm's products. This approach is not feasible when studying new firms whose offerings may not be fully developed and which are unlikely to have built a reputation. Because this study has NTBFs as its subject of study, third-party assessment of exhibited design performance or quality is not feasible. Therefore, this research uses as its basis respondent reports on design emphasis along the three design dimensions.

Asking managers, most of them engineers, about design is a veritable minefield of potential problems. In the first place, as has been discussed previously, the term design is "value loaded", and a typical engineer asked about the weight his or her firm places on design is fairly likely to answer "design is all we do", in all likelihood meaning engineering design. Despite a predominant representation of engineers among respondents, many respondents were not engineers, so other potential meanings and value judgments relating to the term design had to be taken into account. Hence, the first decision made was to avoid the term design altogether, except in one question where it was necessary to use the term "visual design". Alternative terms considered for visual design were too esoteric to make it reasonable to use them. Also, since the terms visceral and experiential border on the esoteric, the names of the three design dimensions, including functional, were not used in the questions. Instead, the questions asked about aspects falling under one of the design dimensions using the simplest possible terms and specifically avoiding terms with potentially conflicting meanings. English translations of the questions are provided in Appendix B.

For each of the questions, respondents were asked how much weight their firms placed on a design aspect when developing new products or services. If respondents indicated that their firms placed no weight on the design aspect, this was coded as 0. If respondents said something to the effect of "a little", they were asked "very little or rather little?"³ and the interviewer selected a coding of 1 or

³ The questions were written and used only in Icelandic. The translations provided here are intended to most accurately represent how the questions were asked, not necessarily reflect the best possible grammar.

2, respectively, based on the answer. If respondents said something to the effect of “a lot”, they were asked “rather a lot or quite a lot?” and the interviewer selected a coding of 4 or 5 as appropriate. If respondents answered something to the effect of “medium”, the interviewer selected a coding of 3. Even when interviewed in person, the respondents, with the exception of those adept at reading small print upside down, did not see the questions or the possible answers so coding was up to the interviewer and followed a detailed protocol defined prior to data collection.

Pine & Gilmore (1998, 1999) argue that a firm’s true economic offering is the economic offering for which the firm charges its customers. In the interest of capturing firms’ actual level of design emphasis with more reliability than by only using questions asking for an assessment of weight, the survey also includes questions asking for an indication of how much value respondents believe the market attributes to design. More specifically, firms were asked to rate how much more they believed their current or future customers would be willing to pay for products or services based on design. Again, the possible answers ranged from 0 (“nothing”) to 5 (“a lot more”) and the interviewer used the same coding methods as described above to select a code for each respondent.

In the first round of data collection four questions were used to measure visceral design and four questions to measure experiential design. In the second round of data collection, four new questions were added, two for visceral design and two for experiential design.

A measure of aesthetic design was generated by combining all the questions for the visceral and experiential dimensions by summation to generate a formative measure.

Formative measures are appropriate when a construct is viewed as a combination of its indicators. Following from the theoretical basis for the three-dimensional model of design discussed in chapter 2.3.2, the use of the design dimensions to generate formative measures, rather than reflective measures, is appropriate (Diamantopoulos & Siguaw 2006; Diamantopoulos & Winklhofer 2004). Therefore, all three dimensions can be combined to provide a formative measure of design and the visceral and experiential dimensions can be combined to provide a formative measure of aesthetic design.

4.1.3 RELIABILITY

The reliability of a method indicates the degree to which it supplies consistent results. Homogeneity, and hence reliability, was increased by limiting the study to firms within Iceland. This homogeneity made potential variance attributable to cultural differences or different economic environments less important, or even moot, issues than they would have been for a more heterogeneous sample.

4.1.4 VALIDITY

Internal validity deals with the ability of an instrument to measure what it is purported to measure. When using formative measures, as is the case for aesthetic design, it is inappropriate to view measures of mutual consistency of indicators, such as Cronbach alpha and factor analysis, as measures of reliability or validity (Diamantopoulos & Winkelhofer 2004). A metric that can be used to check for unacceptable multicollinearity among the indicators making up a formative measure is the variance inflation factor (Diamantopoulos & Winkelhofer 2004) which was 3.1 for the indicators making up the aesthetic design measure. The commonly accepted threshold for this value is <10, so multicollinearity among the indicators should not be a problem.

The fact that the survey data was all collected in face-to-face or telephone interviews with the NTBFS' CEOs increases the validity of the data collected by decreasing the likelihood of collecting deviant or "noise" data. CEOs of new firms, who, in many cases are also among the firms' founders, can be expected to be very knowledgeable about most, if not all, aspects of their firms' operations. By administering the interviews in person with respondents who could be assumed to be knowledgeable, a high level of validity was insured. Also, all surveys were administered from beginning to end in a single sitting and no opportunity was given for backtracking, which respondents might have wanted to do to create unfounded impressions of consistency.

Despite the respondents' qualifications, asking managers for self-evaluations of their firms inevitably entails the risk of respondents projecting a desired, but inaccurate, picture rather than a picture of how things really are. Since managers' evaluations of their firms' aesthetic design emphasis are such an important part of this research, the issue of validity was specifically addressed by comparing expert evaluations of the NTBFS' web sites, as described later in this

section, with managers' evaluations of their firms' emphasis on aesthetic design. The experts' evaluations were significantly correlated with managers' evaluations of their firms' emphasis on aesthetic design. Although managers were evaluating aesthetic design as an element of innovation and the experts were evaluating web site design, this correlation can be viewed at least as partial confirmation of the validity of managers' evaluations of aesthetic design, since aesthetic design emphasis in one area of a firm's activities is likely to be similar to its aesthetic design emphasis in another area.

The survey-based data was all collected in Icelandic NTBFs. This raises the issue of external validity, or generalizability to non-Icelandic NTBFs. This issue of external validity was addressed to some extent by including NTBFs in the United States in the case studies and a comparison is made in Paper 4. This comparison suggests that NTBFs in Iceland and the United States are more similar than they are different when it comes to aesthetic design as an element of service innovation. However, using these findings alone as a basis for claiming external validity of the quantitative studies is hardly appropriate. The issue of generalizability is further addressed in the Conclusions section of this thesis.

4.1.5 DATA ANALYSIS

The survey data were analyzed using a number of standard statistical methods including t-tests, correlation analysis, multiple linear regression analysis, hierarchical regression analysis and interaction analysis.

Paired t-tests can be used to determine the probability that two populations are the same with respect to a variable. For example, a paired t-test was used in Paper 1 to confirm that there was not a significant difference between design emphasis along the three design dimensions depending on whether firms sold products, services or both.

Correlation analysis was used before regression analysis to check for multicollinearity and make initial assessments of potential relationships among variables.

Hierarchical regression analysis involves multiple steps to generate a regression model. First, only potential control variables are included as independent variables. The purpose of this step is to determine which of the control variables are likely to contribute to the regression models used for hypothesis testing. The

available sample sizes impose a limit on the number of independent variables, or degrees of freedom, recommended for each regression model (Cohen 1992) and so, when there are several candidate control variables, it is important to include only those control variables which contribute to regression models. In the next step, the independent variable being tested is added and those control variables not contributing significantly to the model are removed one at a time.

Interaction analysis seeks to take into account possible interaction effects between variables and involves adding the product of the independent variable and the interacting variable to a regression model (Aiken & West 1991). The results of regression analysis using interacting terms can be used to plot interactions which show how the interacting variable modifies the regression results. This is done by algebraically rearranging the regression equation to represent the variable of interest and plotting this equation for values one standard deviation above and below the mean.

Papers 5 and 6 take advantage of the longitudinal nature of the data and take measures of independent variables from the first year and measures of dependent variables from the second year.

4.2 CASE STUDIES

As was discussed in the introduction to this Methodology section, a hybrid strategy was adopted for this research because the research topic is under-researched. One purpose of the case research was to gain a deeper understanding of the manifestation of aesthetic design as an element of service innovation in NTBFs than could be gained through survey-based quantitative research. Another purpose of the case research was to generate hypotheses that could be tested using the quantitative data. The final purpose of the case research was to expand the horizons of the research, firstly by moving outside the limited scope that is Iceland, and secondly by including an established technology-based firm known for aesthetic design, and thus gain a deeper understanding of aesthetic design in service innovation.

4.2.1 CASE SELECTION

While homogeneity can be useful in deductive research, such as the quantitative survey-based research described above, homogeneity is not an asset in inductive

research such as the case research described here. This was the initial motivation for including U.S. firms and an established firm to the case research as well as providing the motivation for the case selection strategy that will be described below.

Having two sets of case NTBFs in two different locations also opened the opportunity for an interesting comparison and tentative steps in speculation about the external validity of the findings of my quantitative research in Icelandic NTBFs.

There were two reasons underlying the decision to study firms in the United States, rather than firms in some other country, in addition to the Icelandic firms. In the first place, differences were sought and so it was important to insure geographical and cultural distance between the two groups of firms. A comparison with firms in Scandinavia or Northern Europe was viewed as less likely to result in interesting findings than a comparison with firms in the United States. Secondly I have worked in NTBFs in both Iceland and the United States, speak both Icelandic and English fluently, and therefore could be said to bring the same point of view into both environments. Both sets of respondents could hopefully view me in the same way, as an interested researcher with a background similar to their own, who speaks their language and understands their jargon.

The Icelandic cases were selected from the participants in the first round of the survey-based study. Criteria for selection included the requirement that case firms have at least 5 employees, base at least 50% of their revenues on the sales of services and had launched at least one new service in the last two years. Case firms reporting varying degrees of emphasis on aesthetic design in the survey were intentionally sought to provide breadth.

The United States cases were selected based on the same criteria as the Icelandic cases, although since they had not participated in the survey-based study, the initial assessment of their aesthetic design emphasis had to be done based on secondary information such as persons knowledgeable about the firms. To maintain a measure of continuity with the Icelandic firms, the CEO of each of the US case firms, each of which was also a respondent for the case research, was asked to answer a small subset of the survey questions from the quantitative survey including the questions measuring aesthetic design emphasis. Based on

this I was able to confirm that the US case firms represented considerable breadth in aesthetic design emphasis as did the Icelandic firms.

The established Silicon Valley firm was selected based on its demonstrated emphasis on design. Data were collected using the same strategy as for the NTBFs as well as from industry reports and publications.

Summary profiles of the case projects are provided in Appendix C.

4.2.2 CASE RESEARCH STRATEGY

The multiple-case research was performed in two phases, followed by analysis across the results of both. First, data were collected on eight new service development projects in four NTBFs in Iceland. In the second phase, data were collected on nine new service development projects in four NTBFs and one established firm on the West Coast of the United States, more specifically in the San Francisco Bay area. The case data were collected in late 2005 and the first half of 2006.

Existing research suggests that service innovation tends to be an *ad hoc* process (Martin & Horne 1993; Sundbo 1997; Dolfsma 2004) which contraindicates inquiring about this process solely in an open-ended manner. The phenomenon of *silent design* (Gorb & Dumas 1987) can be expected to be prevalent in new firms due to the resource constraints which characterize such firms (Garnsey 1995). If design is *silent* it may also be unacknowledged which, in turn, supports taking a pre-structured approach to the case study (Miles & Huberman 1994). This approach requires the definition of a conceptual framework prior to data collection, with the possibility of expansion or modification as data collection and analysis progress. An initial conceptual framework was developed based on existing research on new service development suggesting the aspects of services to which design might be applied, and the three-dimensional model of design. The development of this framework is described in detail in Paper 3. As data collection and analysis progressed, the initial framework was extended to accommodate emerging patterns.

Based on the above, each interview was divided into two parts, an initial open-ended part and a second more structured part. First, respondents were asked to describe how their firms develop new services and to elaborate on the services offered by their firms or under development. This part of the interview was

guided by open-ended questions. The responses to this part of the interview confirmed the informal nature of service innovation in the case firms since respondents could generally not describe step by step sequential processes.

The second half of each interview focused on a specific new service development project and the questions, although still allowing for free respondent elaboration, were more specific than in the first part of the interview. The questions followed the framework developed prior to data collection, with extensions as appropriate. A sample set of questions dealing with experiential design is shown below. If the answer to the first question was negative, the remaining questions were not discussed. “Why?” questions were asked when it seemed appropriate to do so.

In the development of {name of new service}, was definition of the desired customer experience part of the development work? (Why?)

What specifically was done to achieve the desired customer experience? (Why?)

When did this happen? (Why?)

Who was involved? (Why?)

To avoid pre-conceived notions about design and aesthetic design and/or biases for or against, and thereby increase validity, the term design was not used in the interview questions except when asking about visual design. As was discussed regarding the survey questions, the term visual design can be expected to be commonly understood by engineers and managers.

The case research strategy was based on studying multiple cases to provide rich results and a basis for qualitative comparison. The empirical focus was technology-based service development projects and the unit of analysis was the firm. Two separate service innovation projects were studied in each NTBF. This provided a richer picture of design application in each firm as well as a basis for examining the level of consistency across projects within the same firm.

4.2.3 DATA COLLECTION

Semi-structured interviews were conducted with two to three persons knowledgeable about each service innovation project. Using more than one respondent about each firm and project provided a means to check for consistency, or the lack thereof. The interview questions followed the

framework developed prior to data collection, with extensions as appropriate. The interviews were typically about 90 minutes in duration. Interviews were recorded and transcribed.

Secondary sources, such as industry reports and web sites, were examined as available to gain more information about specific projects and case firms.

4.2.4 DATA ANALYSIS

Data analysis was modeled on the methodology outlined in Eisenhardt (1989). The interview texts were coded in several passes. Initial sets of codes for aspects of services to which design might be applied, approaches to design, design actors, objectives underlying design and emphasis on design were developed. Codes were added as needed over the course of analysis. A custom database was built in Microsoft Access and all information about codes and coding of interview texts was stored and managed in this database.

In the first phase conducted in Iceland, additional data were collected for each case firm and cases were added until the point of saturation was deemed to be passed, namely the point where each additional interview or case added little in terms of new concepts and ideas and case firms with a good breadth of aesthetic design emphasis had been included. Saturation had been reached in the first phase when data collection moved to the United States. Again, cases were added one by one, and although saturation was reached sooner, the strategic decision was made to study the same number of projects in the same number of NTBFS in the United States as had been studied in Iceland. Finally, an NSD project in an established firm was added to provide further breadth.

Following coding and analysis of the interview texts a systematic comparison between the Icelandic and United States firms was performed using the comparative method (Ragin 1987). In the introduction to his work on the comparative method Ragin (1987) states as a primary goal “to formalize qualitative comparative methods without departing from the general logic of case-oriented research.” (p.10). The method Ragin proposes is based on Boolean algebra, or logic and set theory, and is well suited to analyzing case data involving a relatively large number of cases. Since my goal was to perform a systematic comparison among 16 cases, the comparative method was an appropriate analysis tool. I found that the comparative method, demanding as it

does the assignment of a Boolean value (0 or 1) to each case for each variable, leaves little danger of biases dominating analysis.

4.2.5 RELIABILITY

Reliability of case research cannot be viewed in exactly the same way as reliability of quantitative research and Miles and Huberman (1994) suggest that more appropriate concerns in case research are objectivity, confirmability, dependability and auditability. Objectivity and confirmability are external factors (external reliability), while dependability and auditability are internal factors (internal reliability).

Objectivity and confirmability are issues of neutrality and researcher bias (Miles & Huberman 1994). In the interest of establishing objectivity and confirmability permission was sought from respondents to publish the results of the case research using firms' actual names. Six out of eight NTBFs granted this permission. When interviews were transcribed they were recorded as close to verbatim as possible to avoid any editing based on unconscious bias during transcription and the research results reported in Papers 3 and 6 include quotations as appropriate. The case study data, including field notes, transcriptions and the coding database have been retained and thus, assuming permission could be secured from the case firms, this data could be re-analyzed by another researcher. As mentioned previously, using the comparative method (Ragin 1987) helped prevent biases from compromising the neutrality of the comparative analysis.

Dependability and auditability are issues of whether the study was undertaken consistently over time, methods and researchers (Miles & Huberman 1994). As there was only one researcher involved, consistency across researchers is not an issue in this case. The pre-structured nature of the case studies has the advantage of insuring a good measure of method consistency. The case data was collected over a period of about nine months and analyzed in parallel with collection and within six months of the last data collection. This relatively short time frame contributes to consistency over time.

Where available, third-party information, such as media coverage and industry press, were used to corroborate information provided by respondents.

4.2.6 VALIDITY

Internal validity of case research is an issue of credibility and authenticity (Miles & Huberman 1994). Following each interview a summary organized according to the research framework was prepared and submitted to the respondent. Follow-up phone interviews were used to collect additional information where needed and solicit comments about the summaries. In this way, I insured that my interpretations were credible to those who had provided the input for these interpretations. The follow-up interviews were also used as an opportunity to solicit further clarification and fill in information as needed.

To increase the validity of the data, the requirement was made that projects included in the study must have been recently completed or be well into development. This restriction was imposed in the interest of avoiding both the problems of extreme hindsight and wishful thinking on the part of respondents.

Just as for the quantitative part of the research, the generalizability of the case research findings, or their external validity, is an important issue. The case research has a broader scope than the quantitative research, since it includes NTBFs from two countries and this provides a measure of external validity. However, to more definitively establish external validity it would be necessary to replicate the findings.

4.3 EXPERT PANEL EVALUATIONS

4.3.1 SECTOR DESIGN IMPORTANCE

Emphasis on aesthetic design can be viewed as a competitive strategy and as such it is likely to be influenced by the environment. Gemser and Leenders (2001) found the relationships between industrial design and various performance indicators to be considerably weaker in the furniture industry than in the instruments industry. They suggested that the reason for this difference was that industrial design was well established and expected in the furniture manufacturing industry, whereas it was not as established in the instrument industry. In the former case, design can be seen as a requirement for competing in the industry, but not as a means to achieve superior performance. In the latter case, design is not needed to compete, but it may constitute a means to achieve superior performance.

Based on the above, an evaluation of design importance in the sectors represented by the NTBFs studied, see Table 4.3, was needed.

To estimate the general importance of design by sector, a panel of experts was asked to rate the importance of each of the three dimensions of design, the visceral, the functional and the experiential, for each of the sectors represented by the NTBFs included in the study. The panel consisted of three experts representing the breadth of the areas into which the NTBFs under study fell, namely engineering, architecture and information technology. The experts were selected based on having at least 10 years' experience and university degrees, at the Master of Science level or higher, in their fields. The three experts did not have a history of working on the same projects or for the same firms.

The experts were asked to rate the importance of functional, visceral and experiential design for each of the sectors on a scale from 0 to 3, where 0 indicates no importance, 1 indicates minor importance, 2 indicates some importance and 3 indicates major importance. The panel's evaluations of visceral and experiential design importance in each sector were combined to obtain an evaluation of the importance of aesthetic design by sector on a scale from 0 to 3. The result was a minimum importance of 0.67, a maximum importance of 3 and an average importance of 1.7.

4.3.2 WEB SITE DESIGN SOPHISTICATION

Although it was not feasible to rely on external evaluators to provide adequate measures of aesthetic design emphasis in the NTBFs studied due to the relative obscurity of the majority of the firms, it was realistic to ask external evaluators to evaluate the aesthetic design of the one visible presence that most NTBFs have in common, namely their web sites.

To test the validity of managers' evaluations of their firms' emphasis on aesthetic design emphasis, two professional graphic designers were asked to evaluate the firms' web sites for design sophistication. Younger experts were sought for this evaluation than in the evaluation of sector design importance in the interest of insuring experience in web site design. Both graphic designers had at least five years' experience and university degrees in design. Both had considerable experience of web site design. The two designers did not have a history of working on the same projects or the same firms.

This evaluation was performed for the second set of NTBFs (N=103). As mentioned previously, the graphic designers' evaluations were significantly correlated with managers' evaluations of their firms' emphasis on aesthetic design, which provides a measure of validity for managers' evaluations of aesthetic design emphasis.

4.4 METHODOLOGICAL STRENGTHS AND LIMITATIONS

The issues of reliability and validity have already been discussed separately for the quantitative survey-based research and the case research. In this chapter, this discussion is broadened by considering strengths and limitations of the research as a whole.

4.4.1 STRENGTHS

A hybrid method research strategy was adopted in the interest of overcoming the scarcity of literature and existing research on the research topic. This hybrid strategy constitutes an important methodological strength of the research. Combining survey-based data from a large number of firms with in-depth case study data from a smaller number of firms provides a basis for developing both descriptions of the phenomena under study based on content analysis as well as exploring relationships based on statistical analysis. This strength becomes particularly evident in Paper 6, where the results of the case studies are used to generate hypotheses which are tested using quantitative data.

The most important strengths of the empirical data are high participation rates and high reliability in the quantitative part of the research and geographic diversity in the case study part of the research. As was described above, the total participation rates in the survey-based studies were very high, namely over 90%. This means that over 90% of the population of Icelandic NTBFs is represented in the research. This high participation rate is a definite strength of the research. In fact, it might be more appropriate to view the quantitative part of the research as population research rather than research on a representative sample. This would permit the selection of a smaller confidence interval than for a sample. However, the data was conservatively treated as a sample for statistical analysis and a conventional 95% confidence interval was used.

As has already been discussed, the fact that the survey data was all collected in face-to-face or telephone interviews with the NTBFs' CEOs and that all participants were visited at least once increases the validity of the data collected.

4.4.2 LIMITATIONS

This research is potentially compromised by some limitations. The most important are potential common method bias in the survey-based data, reservations about the validity of managers' evaluations of their own firms, and the possibility of missing information in the case studies.

The same informants, namely the participant firms' CEOs answered questions measuring both independent and dependent variables. This poses a certain threat to validity since managers might consciously or unconsciously seek to be consistent in their answers. This potential problem is considerably mitigated by the fact that the survey data is longitudinal. In statistical analysis of relationships, measures of independent variables were based on data from the first round of data collection and measures of dependent variables on the second round of data collection, one year later.

Using managers' evaluations of their own firms is a potential weakness of the research. However, since the NTBFs studied were new and mostly unknown this was the only feasible method for collecting a comprehensive set of data for each firm. Perhaps the greatest weakness was in asking managers to evaluate their firms' emphasis on aesthetic design. The potential pitfalls here ranged from managers' overestimation of their firms' aesthetic design emphasis to managers' non-recognition of *silent design*. Since the evaluation of aesthetic design is central to this research, it was appropriate to seek means to validate these evaluations. This was done through expert evaluations of the design sophistication of the NTBFs' web sites. The correlation between managers' evaluations of aesthetic design emphasis and graphic designers' evaluations of the design sophistication of the firms' web sites provided a measure of reassurance that the managers' evaluations were correct.

Other manager evaluations used in analysis deal with image, pricing and isolation mechanisms compared with the competition. Managers' subjective evaluations of the goodness of their firms and offerings compared with their competitors' are likely to be skewed in favor of the respondents' firms. However,

as shown in Papers 5 and 6, the variables in question are reasonably distributed although admittedly there is poor representation in the less self-complementary ends of the scales.

Since the NTBFS studied were not publicly traded and thus are not required to make their yearly statements public it was not possible to verify the figures reported by managers. A measure of validity was insured by collecting the data at about the time of year when most small Icelandic firms hold their annual shareholder meetings and so statements for the previous year had already been prepared or were being prepared, and managers could be expected to base their answers on actual figures rather than guesswork. In fact, it was not uncommon for respondents to look up their answers in their firms' annual statements during the interviews.

No discussion of limitations would be complete without mentioning the obvious, namely that the case studies may have overlooked important information. This is offset by the fact that the research as a whole is not based only on the case studies, but rather the case studies provide a descriptive bridge between the measurements of prevalence, on one hand, and the examinations of relationships with performance, on the other.

5 RESULTS: SUMMARIES OF PAPERS

In a traditional monographic thesis this section would present the results of the research as a whole. Since this thesis is based on six papers, this section provides summaries of the findings reported in each of the papers. In addition, the connections between the papers and the papers' use of the empirical data are discussed. The numbers of the papers correspond roughly to the order in which work on each paper was begun. Table 5.1 provides basic information about the papers, their publication status and presentations.

Table 5.1: Summary information about the papers included in this thesis.

N	Title and Author(s)	Journal publication status	Presentations and publication in conference proceedings ⁴
1	Design as an Element of Innovation: Evaluating Design Emphasis in Technology-Based Firms (Marina Candi)	Published in <i>The International Journal of Innovation Management</i> Volume 10, December 2006	NFF PhD Conference in Aarhus, August 2005 Symposium of Social Science Research in Iceland in Reykjavik, October 2005 (published in proceedings)
2	Oil in water? Explaining differences in aesthetic design emphasis in new technology-based firms (Marina Candi & Rögnvaldur Sæmundsson)	A resubmitted version revised according to reviewer comments is under consideration for publication in an academic journal	European Marketing Academy Conference in Athens, Greece, May 2006 (published in proceedings) Annual Meeting of the Academy of Management in Atlanta, Georgia, August 2006
3	The Role of Design in the Development of Technology-Based Services (Marina Candi)	Published in <i>Design Studies</i> Volume 28, November 2007	The Scandinavian Consortium for Organizational Research seminar, Stanford University, August 2006 Reykjavik University School of Business research seminar, March 2007

⁴ For all the papers, presentations listed are of various versions of the papers, in some cases under different titles.

N	Title and Author(s)	Journal publication status	Presentations and publication in conference proceedings ⁴
4	How Different? Comparing the Roles of Design in Service Innovation in Nordic and American New Technology-Based Firms (Marina Candi & Rögnvaldur Sæmundsson)	Under review for publication by an academic journal	R&D, Innovation and the Dynamics of Economies (RIDE) seminar series at the Chalmers University Department of Management & Innovation Economics, September 2007. Accepted for presentation at the Nordic Academy of Management Conference (NFF), Bergen, August 2007.
5	The relationship between aesthetic design as an element of service innovation and competitive advantage, fact or fad? (Marina Candi & Rögnvaldur Sæmundsson)	In the review and resubmit process following review for publication by an academic journal	The Product Development & Management Association (PDMA) Conference Research Forum in Florida, September 2007 (published in proceedings)
6	Benefits of aesthetic design as an element of new service development (Marina Candi)	Under review for publication by an academic journal	European Marketing Academy Conference in Reykjavik, Iceland, May 2007 (published in proceedings) 14th International Product Development Management Conference, Porto, Portugal, June 2007 (published in proceedings)

In this section I have attempted to find a reasonable compromise between adequately doing justice to the results of each paper and replicating the entire contents of each paper. In doing this I inevitably run the risk that some readers will feel that more information and more detailed coverage is needed. These readers are kindly referred to the papers that are included, each in its entirety, including references and appendices, at the end of this thesis.

5.1 DESIGN AS AN ELEMENT OF INNOVATION: EVALUATING DESIGN EMPHASIS IN TECHNOLOGY-BASED FIRMS [PAPER 1]

Paper 1 uses the idea that design may be a fruitful means to improve business performance as its starting point. Thus, Paper 1 looks forward to research question 4 about the relationship between design and performance as its *raison d'être*. The motivation for this first paper was the broad definition of the term design and the need to reach a basis for operationalization before embarking on empirical research.

The goals for the paper were to deconstruct the design concept and, based on this deconstruction, to develop a methodology for measuring design in technology-based firms. An analysis and synthesis of existing taxonomies of design resulted in a deconstruction of design into three dimensions, the functional, the visceral and the experiential. Survey questions were developed to measure the weight technology-based firms place on each of the three dimensions when developing new products or services.

Following the above developments, the methodology was tested using the first round of survey-based data. This yielded two important results. In the first place, NTBFs were found, on average, to place significantly more emphasis on functional design than on visceral and experiential design. This provided input to research question 1 about the prevalence of aesthetic design. This result also provided the motivation for Paper 2, which examines possible explanations for this trend among NTBFs. Secondly, a comparison between NTBFs depending on the source of their revenues being from the sales of products, services or both, showed that there were not significant differences between these groups. This provides support for the adoption of the synthesis approach to innovation in manufacturing and services for research on design in NTBFs. Paper 1's use of the empirical data and inputs to other papers are shown in Figure 5.1.

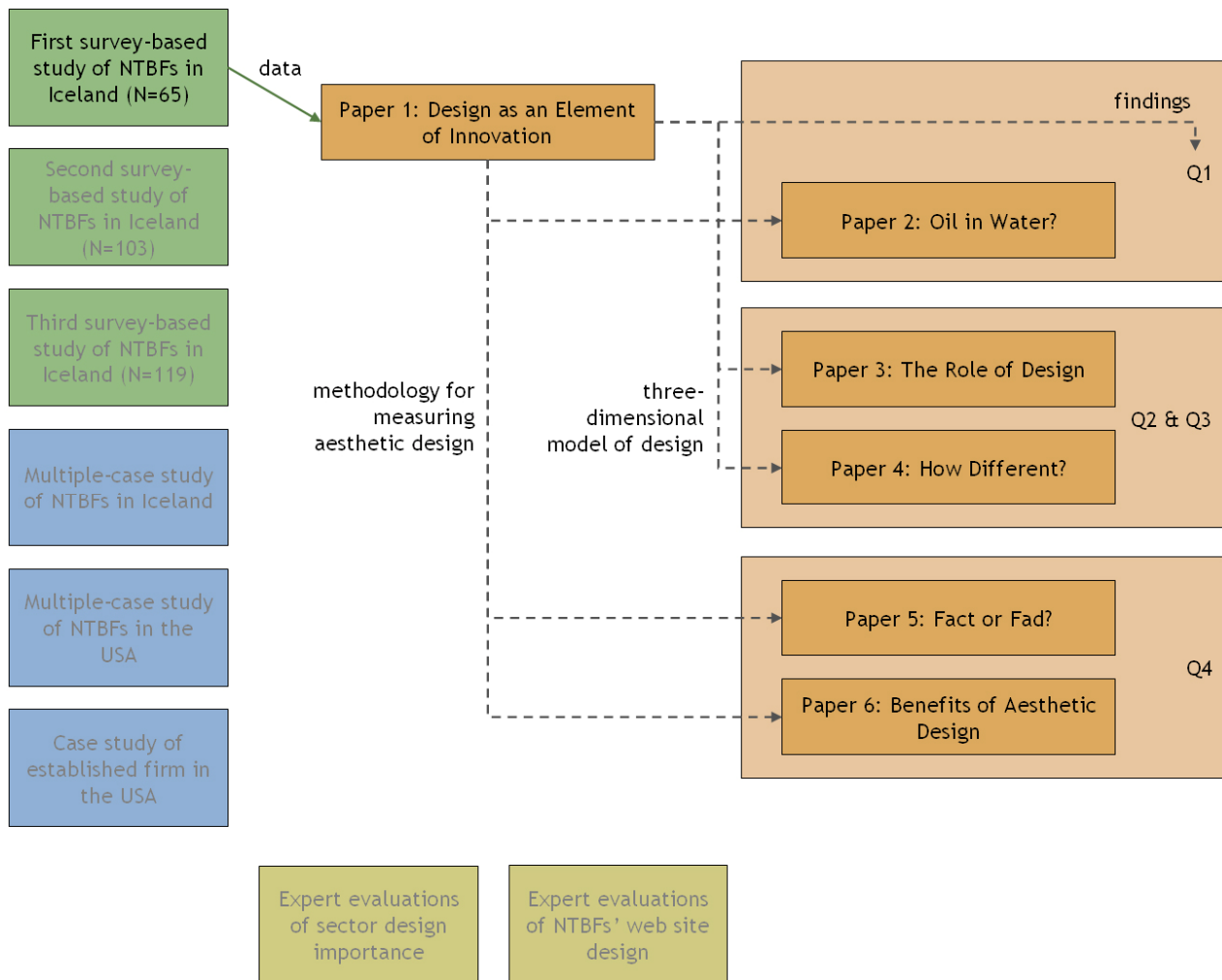


Figure 5.1: Paper 1's use of the data and connections with other papers.

The three-dimensional model of design provides an operationalization of design that is incorporated into the frameworks for all the other papers. The model provides the initial framework for the case research in Papers 3 and 4 and the method for measuring aesthetic design is used in Papers 2, 5 and 6.

Paper 1 was the first paper completed and thus reflects my least developed thinking on the research topic. However, the framework and methodology developed in this paper served me well in the later papers and this thesis. In Paper 1 I saw design as a three-dimensional construct, but as my thinking developed I ended up with two kinds of design, functional design and aesthetic design. Notwithstanding this simplification, the methodology, which is based on three dimensions, still holds because aesthetic design is appropriately viewed as a formative measure that encompasses the two dimensions of visceral and experiential design.

5.2 OIL IN WATER? EXPLAINING DIFFERENCES IN AESTHETIC DESIGN EMPHASIS IN NEW TECHNOLOGY-BASED FIRMS [PAPER 2]

The findings of Paper 1 were that NTBFs put significantly more weight on the functional design dimension than on the visceral or the experiential dimensions. These findings motivated a search for explanations, which is the concern of Paper 2. This paper examines the relationship between founder characteristics and sector characteristics, respectively, and aesthetic design.

The method for measuring weight placed on each of the three dimensions of design developed in Paper 1 is used. The formative measure of aesthetic design generated by combining the measures of visceral and experiential design is first used in Paper 2.

Four hypotheses are developed, based on a synthesis of existing research in the fields of design, strategy and entrepreneurship:

Hypothesis 1: In NTBFs started up in sectors where the use of aesthetic design is more important for developing competitive products or services, more emphasis will be placed on aesthetic design than in NTBFs starting up in sectors where the use of aesthetic design is less important.

Hypothesis 2: The education and experience of founders will influence how much emphasis is placed on aesthetic design in NTBFs.

Hypothesis 2a: The higher the proportion of founders with technology-based university degrees, the less emphasis will be placed on aesthetic design.

Hypothesis 2b: The higher the proportion of founders with prior experience of sales and marketing, the more emphasis will be placed on aesthetic design.

The independent variables for hypothesis testing are based on the information about founders collected the first time each NTBF answered the survey as well as evaluations of the importance of aesthetic design by sector by a panel of experts. Weight placed on aesthetic design (the dependent variable) was measured in the second round of survey-based data collection. Paper 2's use of the empirical data and input to other papers are shown in Figure 5.2.

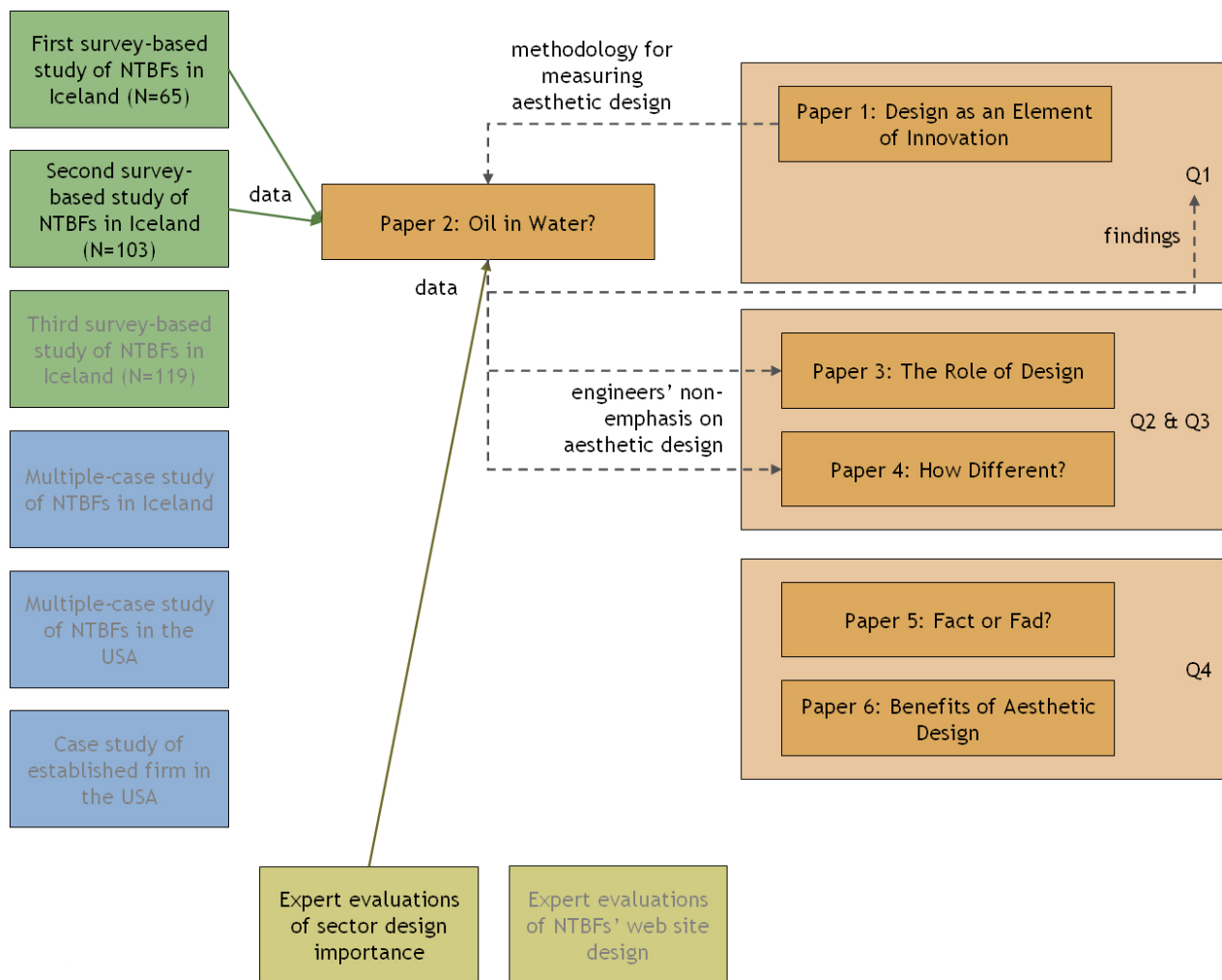


Figure 5.2: Paper 2's use of the data and connections with other papers.

All four hypotheses were supported by the data. The findings indicate that aesthetic design emphasis is significantly related with the importance of aesthetic design in a firm's chosen sector, which can be classified as a positioning factor. Aesthetic design emphasis is also significantly related to founder characteristics, which are resource factors, namely founders' technical education and founders' experience of sales and marketing, respectively. The higher the proportion of founders with university degrees in technology fields, the lower the aesthetic design emphasis and the higher the proportion of sales and marketing experience in the founder group, the greater the aesthetic design emphasis. It is the negative relationship between founder university degrees in technology fields and aesthetic design emphasis in NTBFs which prompted the primary title for this paper, *Oil in Water*.

The findings suggest that persons with a background in technology may not appreciate the potential value of aesthetic design. This suggestion provides important input to the creation of the case research protocol. The case study respondents were mostly persons with technology backgrounds and therefore it was important to word questions to avoid any potential biases against aesthetic design, or lack of interest in aesthetic design, on the part of respondents. When it came to analysis of the case data it was necessary to take into account that respondents' use of terms such as beauty, aesthetics or design, were not necessarily resonant with this thesis' definition of aesthetic design. An example is an engineer's description of software code as "beautiful" and "elegant". Here, the respondent was describing a clever technical solution to a complicated problem rather than aesthetic design attributes.

Paper 2 provides an important counterpoint to the other two quantitative hypothesis-testing papers because it treats aesthetic design as the dependent variable. Paper 2 confirms one of the initial hunches that I brought into this research, namely that engineers tend to be "aesthetically challenged".

5.3 THE ROLE OF DESIGN IN THE DEVELOPMENT OF TECHNOLOGY-BASED SERVICES [PAPER 3]

Case research was used to explore how NTBFs use design in service innovation to gain insights regarding the role and organization of design in this context. The motivation for Paper 3 was a lack of understanding regarding the role of design in the development of new services in NTBFs and the paper seeks to answer two questions:

- Question 1: To which aspects of technology-based service development is design applied in new firms?*
- Question 2: What is the role of design as an element of technology-based service development in new firms, in terms of addressing the characteristics of services that distinguish them from products?*

The role of design, not limited to aesthetic design, but including also functional design is explored. However, when the case data were subsequently used to generate hypotheses for Paper 6, only data for aesthetic design were used.

Paper 3's use of the empirical data and input to other papers are shown in Figure 5.3. Before the paper was written all the case data had been coded, but only the U.S. cases were used as a basis for Paper 3. The reason for doing this was the length limits imposed by *Design Studies* coupled by the observed lack of differences between Icelandic and U.S. projects, which justified using only half of the cases.

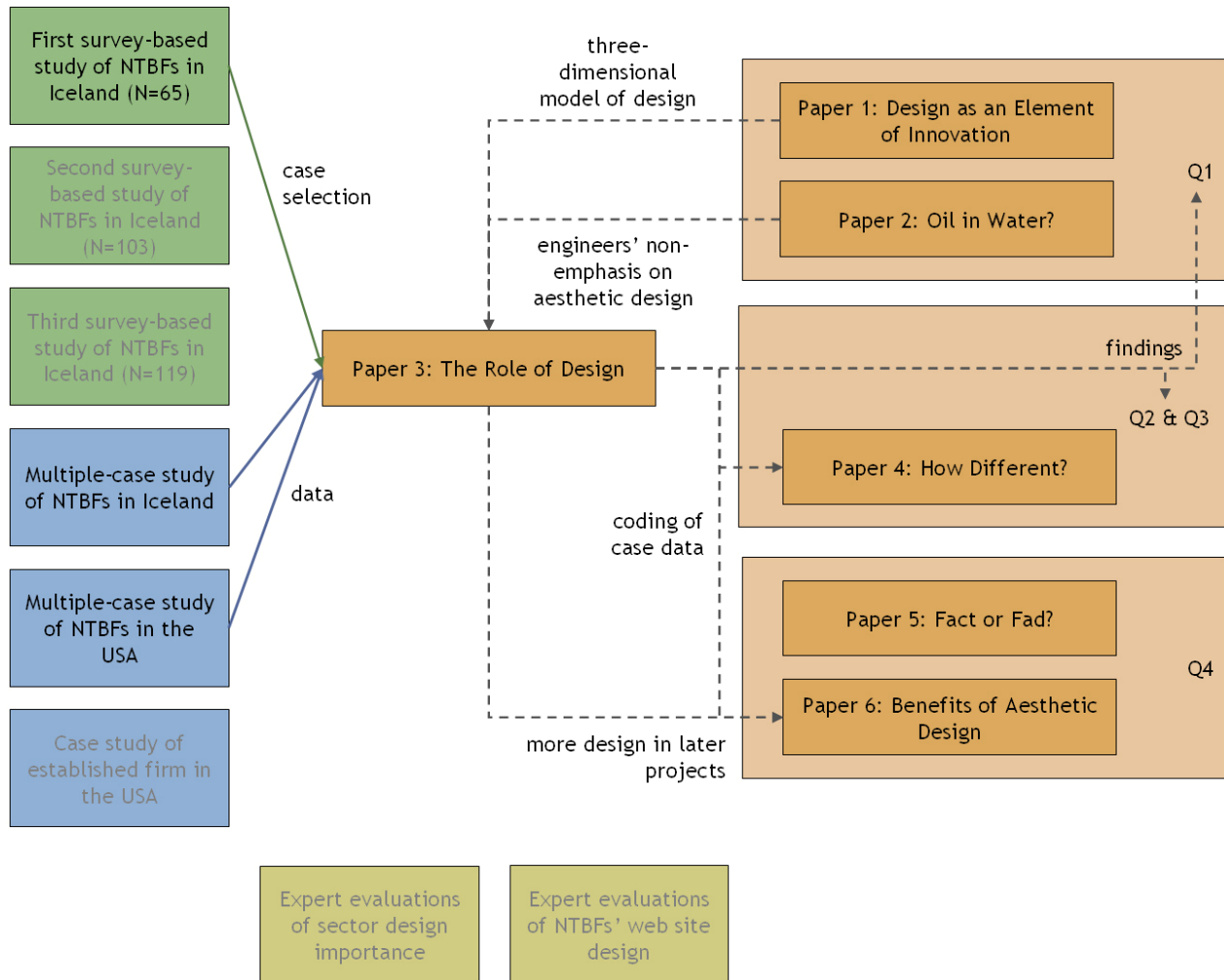


Figure 5.3: Paper 3's use of the data and connections with other papers.

The findings are that design is applied to a broad range of service aspects, namely, user interfaces, tangible artifacts, documents, usability, service processes, revenue models, communication processes, community building, customer experiences and marketing materials. The application of design in the case firms was found to be motivated in part by the desire to either counteract (more common) or exploit (less common) one or more of the distinguishing

characteristics of services, which are intangibility, inseparability, heterogeneity and perishability.

Since two projects were studied in each case firm it was possible to compare design in earlier projects with later projects. The findings were that in both sets of case firms (United States and Iceland) more emphasis and effort was put into design in the development of their later services than in their early, or initial, services. This finding provided the motivation for including new offering introductions as a control variable in the analyses in Paper 6.

The findings of the case research confirm that service innovation in NTBFs tends to be an *ad hoc* process and characterized by informality as suggested by existing research (Martin & Horne 1993; Sundbo 1997; Dolfsma 2004; Berry & Taggart 1998). It is important to consider the frame of reference for this result, however. If compared to classical stage-gate development processes service innovation in the case firms was, indeed, ill-defined to the point of nebulousness. However, if Austin and Devin's (2003a, 2003b) model of what they call the *artful process* is compared to what was observed in many of the case firms, the resemblance is apparent. Instead of carefully orchestrated steps through sequential steps, the *artful process* involves looping from communication with customers, to development of something that can be shown, to exposing the customer to the result, which again stimulates communication with customers, and so on. This *artful process* loops with no clear end point. According to Austin and Devin the *artful process* depends on low iteration costs and is ideally characterized by openness to uncertainty. With the traditional stage-gate development process as a frame of reference the *artful process* may look informal and *ad hoc*.

The findings of the case research were that the design actors fell into three groups: the unacknowledged and unsuspecting *silent designers* in the firms, by far the largest group; designers hired by the firms with the express purpose of taking responsibility for some aspects of design; and outside consultants.

The coding performed for Paper 3 was further used for identifying management objectives for aesthetic design, which was used to develop hypotheses in Paper 6, as well as providing the basis for the systematic comparison between the Icelandic and U.S. cases, on which Paper 4 is built.

5.4 HOW DIFFERENT? COMPARING THE ROLES OF DESIGN IN SERVICE INNOVATION IN NORDIC AND AMERICAN NEW TECHNOLOGY-BASED FIRMS [PAPER 4]

The goal of Paper 4 is to explore differences in the use of design in service innovation in NTBFs in Iceland and the West Coast of the United States. The paper is based on a systematic qualitative comparison (Ragin 1987) of the case data about service innovation projects in the United States and in Iceland, respectively. Differences were expected due to these two locations' disparity in terms of agglomeration of technology-based firms and access to design resources. Paper 4's use of the empirical data and input to other papers are shown in Figure 5.4.

Paper 4 uses data about 16 service innovation projects in 8 NTBFs, half of them Icelandic and the other half on the West Coast of the United States. The case data coding used as a basis for Paper 3 was used for Paper 4 also, but for Paper 4 the coding was analyzed using the comparative method (Ragin 1987).

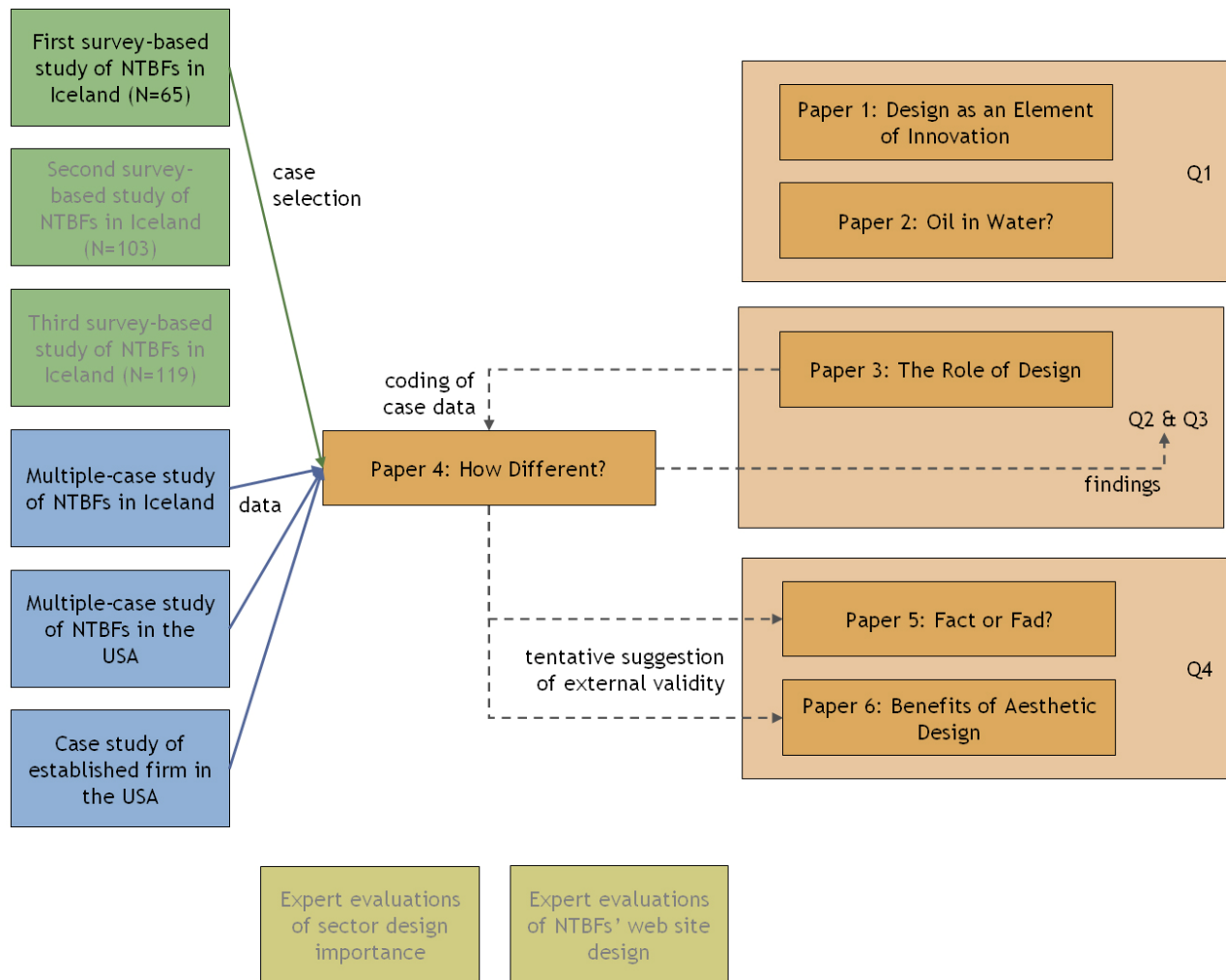


Figure 5.4: Paper 4's use of the data and connections with other papers.

The findings are that there are more similarities than there are differences in the role of design in the development of new services in NTBFs in Iceland and the United States. Possible explanations are explored in Paper 4 and the conclusion is that NTBFs have so many things in common, namely their young age, small size, educational background of their founders and the borderless and distance-neutral knowledge-sharing environment that is the Internet, that these similarities outweigh the different environments in which these firms operate in terms of proximate availability of resources and clustering of technology-based firms. When the projects in the NTBFs are compared with the service innovation project studied in an established firm, however, differences emerge. Hence, the lack of difference between NTBFs in different geographical locations may not persist when these firms mature.

Paper 4 contributes to an understanding of the roles of aesthetic design in service innovation by identifying those (very few) areas where there are differences between Iceland and the United States. The most important of these differences is that the aspiration to foster community among customers was only expressed for projects in the American firms.

These findings provide a suggestion, albeit a decidedly tentative one, of the potential external validity of the findings of Papers 2, 5 and 6 to NTBFs in the United States.

Paper 4 is somewhat tangential in nature and so is less tightly connected with the thesis than the other papers. One might almost say that Paper 4 is not necessary to answer the research questions developed in this thesis. On the other hand, Paper 4 uses a methodology different from the other papers, and thus contributes to the diversity of methods used in the research as a whole. Certainly, the findings of non-difference are interesting. Rather than representing an end point, more than anything else these findings highlight the need for further comparative research.

5.5 THE RELATIONSHIP BETWEEN AESTHETIC DESIGN AS AN ELEMENT OF SERVICE INNOVATION AND COMPETITIVE ADVANTAGE, FACT OR FAD? [PAPER 5]

The goal of Paper 5 is to begin to explore the relationship between aesthetic design and performance by examining how aesthetic design can contribute to competitive advantage of new services and how this contribution is moderated by the competitive environment. Existing research on competitive advantage, strategy, success factors in service innovation and design is used to develop four hypotheses:

Hypothesis 1a: Firms putting more emphasis on the use of aesthetic design in new service development will be more likely to gain competitive advantage through differentiation than firms putting less emphasis on the use of aesthetic design.

Hypothesis 1b: The stage of commoditization for firms' offerings will moderate the relationship between aesthetic design in new service development and competitive advantage. The higher the stage of commoditization, the stronger the relationship between aesthetic design and competitive advantage.

Hypothesis 2a: Firms putting more emphasis on the use of aesthetic design in new service development are better able to sustain competitive advantage than firms putting less emphasis on aesthetic design.

Hypothesis 2b: The relative importance of aesthetic design in a firm's sector moderates the relationship between aesthetic design in new service development and the ability to sustain competitive advantage. The greater the importance of aesthetic design in the firm's sector the weaker the relationship between aesthetic design and the ability to sustain competitive advantage.

Hypotheses 1a and 1b use the ability to command higher prices than competitors as a measure of competitive advantage. This measure is chosen because customers' willingness to pay for a service is likely to be related with perceived value and aesthetic design can contribute to and communicate such value.

There is a potential problem with using higher pricing as a dependent variable, since higher pricing can constitute a competitive strategy in its own right. For example, a firm might decide to raise its prices in an attempt to signal quality or appeal to an upscale target market. In such cases higher pricing may be completely unrelated to aesthetic design. Examining the moderating effect of pressure to reduce prices as well as the direct relationship between higher pricing and aesthetic design helps to mitigate this potential problem. Another possible strategy is to lower prices in an attempt to increase volume, which in turn can call for lowering of costs or operating with lower returns on sales. This issue is addressed in Paper 6, where the relationship between aesthetic design and sales volume and profits, respectively, is examined.

The moderating factor considered for competitive advantage is pressure to reduce prices, which is characteristic of commoditization.

Hypothesis 1a is not supported by the data, while hypothesis 1b is supported. This suggests that aesthetic design contributes to competitive advantage when pressure to reduce prices is high or, in other words, under conditions of commoditization.

Hypotheses 2a and 2b use a measure of sustainable competitive advantage as their dependent variable, namely managers' evaluations of how difficult it would be

for their competitors to imitate their firms' services. This is a measure of an isolation mechanism and is used based on the assumption that the knowledge required for aesthetic design is to a large degree tacit. The moderating factor considered for sustainable competitive advantage is the importance of aesthetic design in a firm's sector. If aesthetic design competencies are not widely used or appreciated in a sector it is likely to be difficult to imitate aesthetic design, whereas it becomes much easier to match or duplicate if industry specific aesthetic design competencies are widely available. Hence, the use of aesthetic design can itself become a minimum requirement for competition rather than a source of differentiation and the hypothesis is that the importance of aesthetic design in a firm's sector will moderate the relationship between emphasis on aesthetic design and the ability to sustain competitive advantage.

Hypotheses 2a and 2b are both supported. Aesthetic design is directly related with sustainable competitive advantage and, when aesthetic design interacts with the moderating factor of sector design importance the relationship is weaker. This suggests that aesthetic design contributes to sustainable competitive advantage as long as aesthetic design is not itself a minimum requirement for competition.

Paper 5 takes advantage of the longitudinal nature of the survey-based data and uses measures of aesthetic design in one year and measures of competitive advantage one year later. Thus the pitfalls of using cross-sectional data to measure both sides of a relationship that has an inherent time lag are avoided. Use of the empirical data for Paper 5 is shown in Figure 5.5. Paper 5 uses the first round of the survey-based data to obtain measures of aesthetic design, which is the independent variable in the analysis, as well as control variables and the first interacting variable (moderating factor) for commoditization (pressure to reduce prices). Dependent variable values, the measures of competitive advantage, are obtained from the second round of the survey-based data. Expert evaluations of sector design importance provide data for the second moderating variable.

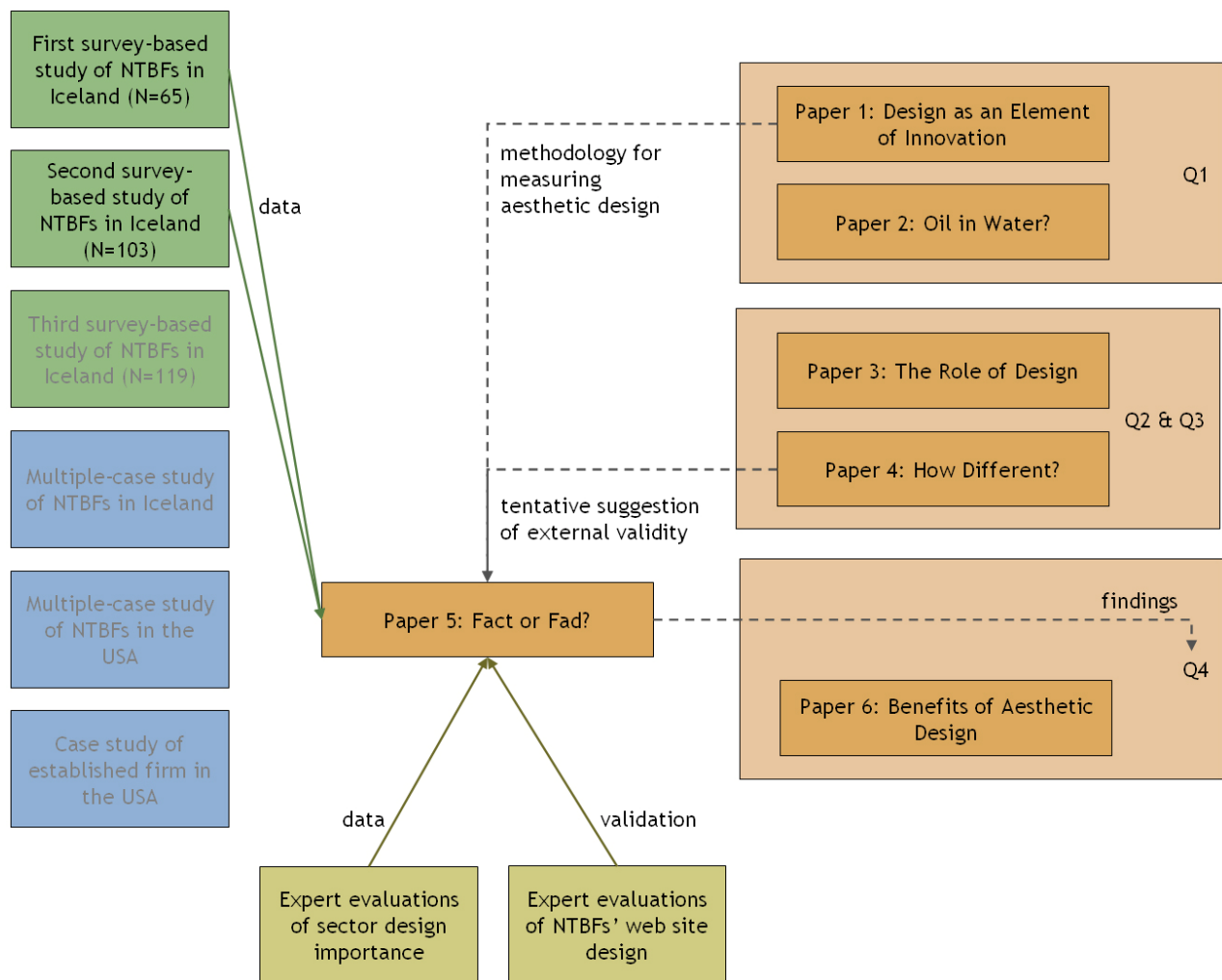


Figure 5.5: Paper 5's use of the data and connections with other papers.

As discussed previously, the issue of performance is key in this research as a whole since the issues of if and how aesthetic design is used are of little interest if using aesthetic design in service innovation is not related with positive outcomes. Paper 5 represents the first exploration of this relationship. As has been described here and as will be discussed in more detail in the Conclusions section, the findings of this paper are that there are positive relationships between aesthetic design in service innovation and competitive advantage, which in turn can contribute to performance, but these relationships are contingent upon moderating factors in the competitive environment. These moderating influences are an important discovery that highlight the necessity of considering interacting factors when examining the relationships between aesthetic design and performance.

5.6 BENEFITS OF AESTHETIC DESIGN AS AN ELEMENT OF NEW SERVICE DEVELOPMENT [PAPER 6]

The goal of Paper 6 is to further explore the relationship between aesthetic design and performance by investigating the benefits that may be gained from using aesthetic design in service innovation. More specifically, answers are sought for the following questions:

- Question 1: What are the objectives underlying NTBF managers' decisions to use aesthetic design in NSD?*
- Question 2: What are the relationships between aesthetic design in NSD and the benefits NTBF managers expect?*

An important strength of Paper 6 is that it is based on a hybrid strategy where case research is used to identify managers' objectives for using aesthetic design in service innovation and hypotheses are generated based on these objectives.

The findings based on the case research are that the objectives underlying managers' decisions to use aesthetic design in NSD are attracting new customers, creating and fostering a positive image in their market and retaining existing customers, and doing so at lower cost. These findings, along with existing research on design and success factors in service innovation, are used to develop the following hypotheses:

- Hypothesis 1: NTBFs that put more emphasis on aesthetic design in NSD will have a greater proportion of sales from new customers than NTBFs that put less emphasis on aesthetic design in NSD.*
- Hypothesis 2: NTBFs putting more emphasis on aesthetic design in NSD will have a broader customer base than NTBFs that put less emphasis on applying aesthetic design in NSD.*
- Hypothesis 3: NTBFs putting more emphasis on aesthetic design in NSD will be more successful in entering new markets than NTBFs that put less emphasis on applying aesthetic design in NSD.*
- Hypothesis 4: The firm image of NTBFs that put more emphasis on aesthetic design in NSD will compare more favorably with the firm image of competing firms than for NTBFs that put less emphasis on aesthetic design in NSD.*

- Hypothesis 5: Customers of NTBFs putting more emphasis on aesthetic design in NSD will be less inclined to take their business to competitors than customers of NTBFs putting less emphasis on aesthetic design in NSD.*
- Hypothesis 6: NTBFs that put more emphasis on aesthetic design in NSD will have greater sales growth from existing customers than NTBFs that put less emphasis on aesthetic design in NSD.*
- Hypothesis 7: NTBFs putting more emphasis on aesthetic design in NSD will have greater profits than NTBFs putting less emphasis on aesthetic design in NSD.*

The second two rounds of survey-based data are used to test the hypotheses. Paper 6's use of the empirical data is shown in Figure 5.6.

It is important to clarify that although four of the respondents for the Icelandic cases were also participants in the survey-based study, all the other case respondents were not. Additionally, the case data collection in Icelandic NTBFs was deliberately scheduled to not occur at a similar time as the survey-based data collection. Hence, although some of the respondents were the same, we can safely say that the perceived objectives for aesthetic design and managers' evaluations of design emphasis are independent of each other.

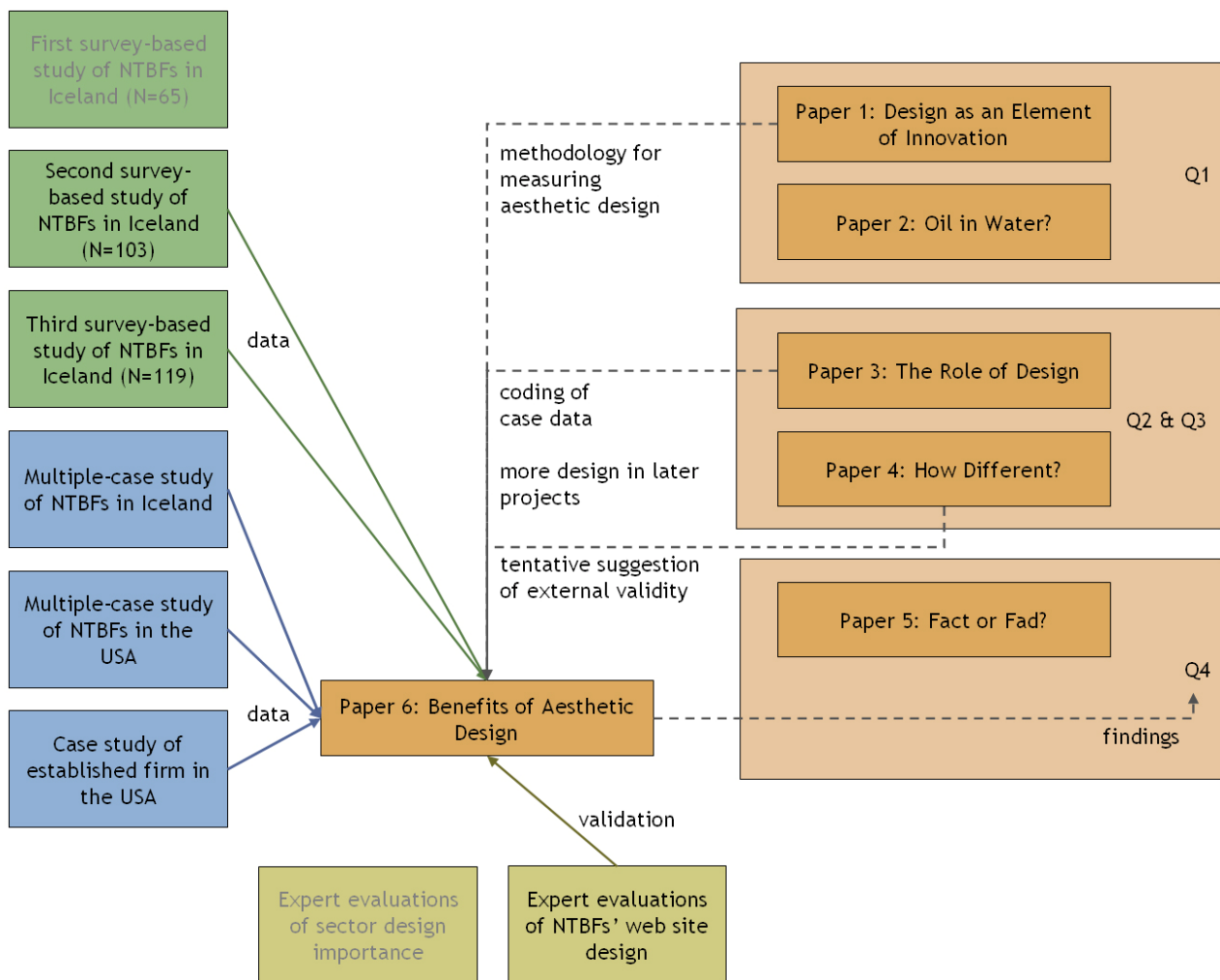


Figure 5.6: Paper 6's use of the data and connections with other papers.

The findings are that by and large the benefits expected by managers are realized. All hypotheses, except hypothesis 5 about customer loyalty, are supported by the data. As mentioned previously, a measure of firms' introduction of new offerings was included as a control variable as was a measure of expenditures for research and development (R&D). In all the models, except the one for hypothesis 5, one or both of these measures of innovation was significantly related with the dependent variable. As was to be expected, the relationship was negative for hypothesis 7, which is about profits. To confirm that the contributions of aesthetic design and innovation were not dependent on each other, all the models were tested with only aesthetic design or only measures of innovation and were found to hold.

Paper 6 constitutes the second step in exploring the relationship between aesthetic design and performance. The findings provide additional support for

the conclusion that aesthetic design can contribute to firm performance, this time through a number of benefits sought by managers when deciding to use aesthetic design.

6 CONCLUSIONS

In this section, the findings are discussed, practitioner implications are suggested and possible directions for further research are presented. Finally, the contributions of the research are summarized.

Four research questions were developed to guide the research reported in this thesis. For the reader's convenience the questions are reiterated here:

- Q1. What is the prevalence of aesthetic design as an element of innovation in new technology-based firms?*
- Q2. What is the role of aesthetic design in service innovation in new technology-based firms?*
- Q3. How is aesthetic design in service innovation in new technology-based firms organized and who performs aesthetic design activities?*
- Q4. How is design as an element of service innovation in new technology-based firms related with firm performance?*

The conclusions for each research question are discussed below.

6.1 RESEARCH QUESTION 1: PREVALENCE OF AESTHETIC DESIGN

Research question 1 is about the prevalence of aesthetic design as an element of innovation in NTBFs. The findings are that NTBFs vary with regards to the weight they place on aesthetic design, but on average place more weight on functional design than on aesthetic design. Since the firms are technology-based they can be expected to be founded by persons with a technology or engineering background with a corresponding emphasis on functionality and/or to employ a high proportion of persons with such a background. Therefore, the firms' emphasis on the functional dimension of design is not unexpected and is consistent with Moody's (1984) suggestion that engineers tend to ignore aesthetic design.

Walsh (1996) found that, unlike R&D which was highly concentrated in a few industrial sectors, some kind of design activity was carried out by almost all firms independently of size or sector. This is consistent with my findings, which

indicate that aesthetic design is used in various capacities in service innovation in NTBFs. Emphasis, effort spent and methods used differ between firms, and between projects within the same firm, which is also in accordance with Walsh's (1996) findings.

Explanations for differences in aesthetic design emphasis among NTBFs include the competitive environment in which NTBFs operate as well as the educational background and experience of their founders. Christensen (1995) suggests that design is most commonly associated with marketing and selling offerings, which resonates with the findings that founders' experience in sales and marketing is related with greater weight on aesthetic design while founders' technology education is related with less weight on aesthetic design.

An additional finding is that NTBFs emphasize aesthetic design more in their later service innovation projects than their earlier projects. This may support the notion of strategy adaptation (Andries & Debackere 2006); once new firms have introduced their initial services they become increasingly aware of the potential for using aesthetic design to increase the value of their services beyond technical characteristics. Similarly, Walsh (1996) and Veryzer (2005) found that design is emphasized to a greater extent late in the life cycle of a technology than early.

To summarize, the answer to research question 1 is that in NTBFs aesthetic design is less prevalent than functional design, but increases in prevalence as NTBFs develop more services. The prevalence of aesthetic design is related positively with the importance of design in a firms' sector and founders' experience of sales and marketing, while it is negatively related with founders' technical education. This conclusion lends support to the anecdotal notion that engineers and other "technical types" do not appreciate the value of aesthetic design and suggests that this phenomenon has its roots in engineering/technical education.

6.2 RESEARCH QUESTION 2: ROLE OF AESTHETIC DESIGN

Research question 2 is concerned with the role of aesthetic design as an element of service innovation in NTBFs. The first step in examining the role of aesthetic design was to identify the aspects of services to which design is applied. Aesthetic design was found to be applied to user interfaces, tangible artifacts

integrated with services, documents, customer experiences, processes for communicating with customers, community building, marketing materials and usability.

The role of aesthetic design was found to be either that of counteracting or exploiting the characteristics commonly thought to distinguish services from products, namely intangibility, heterogeneity, simultaneity and perishability. The more commonly observed role was one of counteracting the distinguishing characteristics of services. This could be a reflection of the perceived notion that the characteristics of services make them vulnerable, particularly in terms of establishing their value (Von Stamm 2003).

Managers' expressed objectives for using aesthetic design were attracting new customers, creating and fostering a positive image in their market and retaining existing customers, and doing so at lower cost.

To summarize, the answer to research question 2 is that aesthetic design as an element of service innovation in NTBFS is applied to user interfaces, tangible artifacts integrated with services, documents, customer experiences, processes for communicating with customers, community building and marketing materials. Aesthetic design is more commonly used to counteract the intangibility, inseparability, heterogeneity and/or perishability of services than to exploit these characteristics. The objectives underlying managers' decisions to use aesthetic design are attracting new customers, creating and fostering a positive image in their market and retaining existing customers, and doing so at lower cost.

6.3 RESEARCH QUESTION 3: ORGANIZATION OF AESTHETIC DESIGN AND ACTORS

Research question 3 examines the organization of aesthetic design and the actors involved. Two variants of organization were observed differing primarily in the degree to which customers were involved. In some of the NTBFS the organization of service innovation was reminiscent of what Austin and Devin (2003a, 2003b) call an *artful process*. Austin and Devin define the *artful process* as a cyclical process that begins with communication with customers about a solution, this is followed by generation of a solution to which the customer is exposed, thus setting off another round of communication. As Austin and Devin describe things "At some point before a deadline, the prototype will be good

enough for the customer.” (Austin & Devin 2003a, p.94). In other NTBFs a more improvisational approach to service innovation was observed, what can basically be labeled *ad hoc* service innovation. This is consistent with the observations by Sundbo (1997) and Dolfsma (2004) that service innovation tends to be an *ad hoc* process.

In their research on user-oriented design, Veryzer and de Mozota (2005) found that the role of design, specifically user-oriented design, is rarely explicitly defined in innovation. Instead, design activities are subsumed in the activities that make up the development process. Reflection on the *artful process* suggests that aesthetic design could and should be an important part of the solution generation phase of the *artful process* since the next phase is exposure to customers. The aesthetic design (or not) of each intermediate outcome, or prototype, is likely to influence customers’ evaluations (Yamamoto & Lambert 1994; Crilly et al. 2004) and, in turn, this will influence the tenor of communication with customers, and so on in a cyclical fashion.

Turning to the issue of aesthetic design actors, aesthetic design in NTBFs was found to be mostly *silent* (Gorb & Dumas 1987). Those performing aesthetic design activities were primarily managers and technical staff engaged in design as part of their development activities and without such work necessarily being acknowledged as aesthetic design. Some use of outside designers (consultants) or persons specifically hired to work as designers was observed. These actors were primarily involved in the design of user interfaces and marketing materials. Of the three roles of design in product innovation identified by Perks et al. (2005), the impression was that the aesthetic design role, when performed by professional designers, fit the profile of design as functional specialism. The other profiles identified by Perks et al. are design as part of a multifunctional team and design as process leader, both of which are classified as being more influential in innovation than design as functional specialism. When design is *silent* it fits the more influential profile of design as part of a multifunctional team, but merely by virtue of the fact that the *silent design* is being done by persons involved and influential in development projects.

NTBFs do not use outside design expertise except in a very limited way, which is consistent with Slappendel’s (1996) findings that indicate that smaller firms are less likely to make use of such outside expertise than larger firms and Gemser et

al.'s (2006) findings that IT firms tend not to use outside design expertise unless they are developing content-related services.

To summarize, the answer to research question 2 is that service innovation in NTBFs may follow a cyclical process of iterative development involving customer input in each cycle or may be more improvisational (*ad hoc*). Aesthetic design is part of the service innovation process, but is not very influential except by virtue of being mostly in the hands of managers and developers acting as *silent designers*. Use of outside professional designers and hiring of designers is limited.

6.4 RESEARCH QUESTION 4: AESTHETIC DESIGN AND PERFORMANCE

The last research question is concerned with the relationship between aesthetic design and performance. This question is addressed using two different approaches. In the first place, the relationship between aesthetic design and competitive advantage is examined, and in the second place, managers' objectives for using aesthetic design are explored followed by an examination of the relationships between aesthetic design and the benefits expected by managers. Both approaches contribute to an understanding of the relationship between aesthetic design in service innovation and performance.

Competitive advantage is a measure of the success of competitive strategy and using aesthetic design in service innovation can be part of a firm's strategy. Competitive advantage, particularly when it can be sustained, can contribute to firm performance. Aesthetic design was found to be positively related with competitive advantage under market conditions of commoditization, and with sustainable competitive advantage under conditions where aesthetic design is not widely expected and, itself, part of the baseline requirements for competition.

When NTBFs' managers choose to use aesthetic design they do so with the underlying objectives of attracting new customers, improving firm image and/or retaining existing customers, and doing so at lower cost. By and large these benefits are realized by NTBFs emphasizing aesthetic design. The measures of these benefits, namely sales from new customers, breadth of customer base, new market entry, firm image, turnover growth from existing customers and profits, are also related with innovation. Profits are negatively related with innovation as one could expect since innovation involves costs that reduce profits, while all the

other measures are positively related with innovation. This suggests that aesthetic design and innovation contribute to NTBF performance through some of the same mechanisms.

To summarize, the answer to research question 4 is that aesthetic design is positively related with factors that can contribute to firm performance including competitive advantage, sustainable competitive advantage, sales from new customers, breadth of customer base, new market entry, firm image, turnover growth from existing customers and profits. The relationships with competitive advantage and sustainable competitive advantage are moderated by the level of commoditization in a firm's markets.

6.5 DISCUSSION

Now that the research questions have been answered, the conclusions can be brought together and reflected against extant research to gain a broader view and the issue of generalizability can be addressed.

6.5.1 AESTHETIC DESIGN AND DECOMMODITIZATION

As was mentioned in the Introduction, the issue of the relationship between aesthetic design and performance is the key question addressed by this research. Answering the other research questions, about prevalence, roles and organization, are pre-requisites for addressing this final question. The research was motivated by the idea that aesthetic design can contribute to performance, and the purpose of the research was to find out if this is supported empirically and gain an understanding of the nature of such relationships. Based on the research findings, the nature of the aesthetic design's contribution to performance seems to be that aesthetic design can contribute to decommoditization.

Christensen (1997) suggests an interesting model in his paper about patterns in the evolution of competition using the disk drive industry as an example. The model is further developed in later work (e.g. Christensen & Raynor 2003). According to Christensen's model, the first phase of competition is the technological innovation phase during which a new technology is developed, which may at first under-perform existing technologies. In the disk drive industry, where storage capacity is of primary concern, this phase involves

competition based on capacity. When a new technology gets to the point where it meets market needs for functionality, the basis of competition shifts to the issue of reliability. From this point the technology may continue to improve, and indeed is likely to continue to improve, but the basis of competition has shifted. The same thing happens with reliability; once the market's requirements for reliability have been met, the competition shifts to the issue of convenience and/or flexibility. Finally, when the market's needs for functionality, reliability and convenience have been met, the next phase of competition is about price. At this point the stage commonly referred to as commoditization has been reached. The commoditization phase tends to be an undesirable phase in which to compete because the pressure to reduce prices can erode profits unless ever more efficient means to reduce costs can be implemented. Of course, this pressure to reduce costs can lead to new technological innovations.

As was described above, the findings of my research are that aesthetic design is positively related with competitive advantage under conditions of commoditization and provided aesthetic design itself has not become commoditized. Reflecting these findings onto Christensen's model suggests that aesthetic design can play an increasing role as the basis for competition evolves along the slippery slope to commoditization. This is depicted in Figure 6.1, which shows a rendition of Christensen's model with an added phase of competition labeled the symbolism phase. In the first phase, where technological innovation is the basis for competition, it is functional design, or engineering design, that contributes to competitive advantage. In this phase it is unlikely that aesthetic design will make a difference since competition is based primarily on functionality. In the improvement phase, when the market's requirements for functionality have been met, the basis for competitive advantage, or differentiation, shifts to reliability and consistency. These are still mostly issues of technology and so functional design continues to be most important. When reliability and consistency have surpassed market requirements, the issue becomes one of convenience in the maturation phase. It is at this point that aesthetic design can begin to contribute. As more and more providers offer solutions that are technologically adequate and sufficiently reliable, customers are likely to prefer solutions that are also user friendly, attractive to the human senses, intuitively documented and for which inherent value or quality is

convincingly communicated. This is where aesthetic design, particularly visceral design, can make important contributions.

The downward drag of commoditization continues and eventually providers have either fallen out of the competition or have surpassed the market's expectations for convenience. In Christensen's model, the next phase is the commoditized phase, where price is the only differentiator. It is in, or before, this phase that aesthetic design can again come into play, this time by creating symbolic value. Symbolic value is created when an offering fulfills customers' values (Aburdene 2005), their requirements for self-expression (Gilmore & Pine 2007) and social significance (Crilly et al. 2004). Aesthetic design, particularly experiential design, can contribute to creating symbolic value. Hence, Christensen's model could incorporate an additional phase, before the commoditized phase, where competitive advantage is based on symbolic value.

If aesthetic design is a capability that can be learned and disseminated in the same ways as other knowledge, aesthetic design can itself become commoditized. At such a point, all providers can fulfill the market's requirements for symbolic value, and price becomes the only basis for competition. There are, however, examples of products that can be said to have competed on the basis of aesthetic design for decades, if not longer. The Volkswagen Beetle is a well known example of such a classic design.

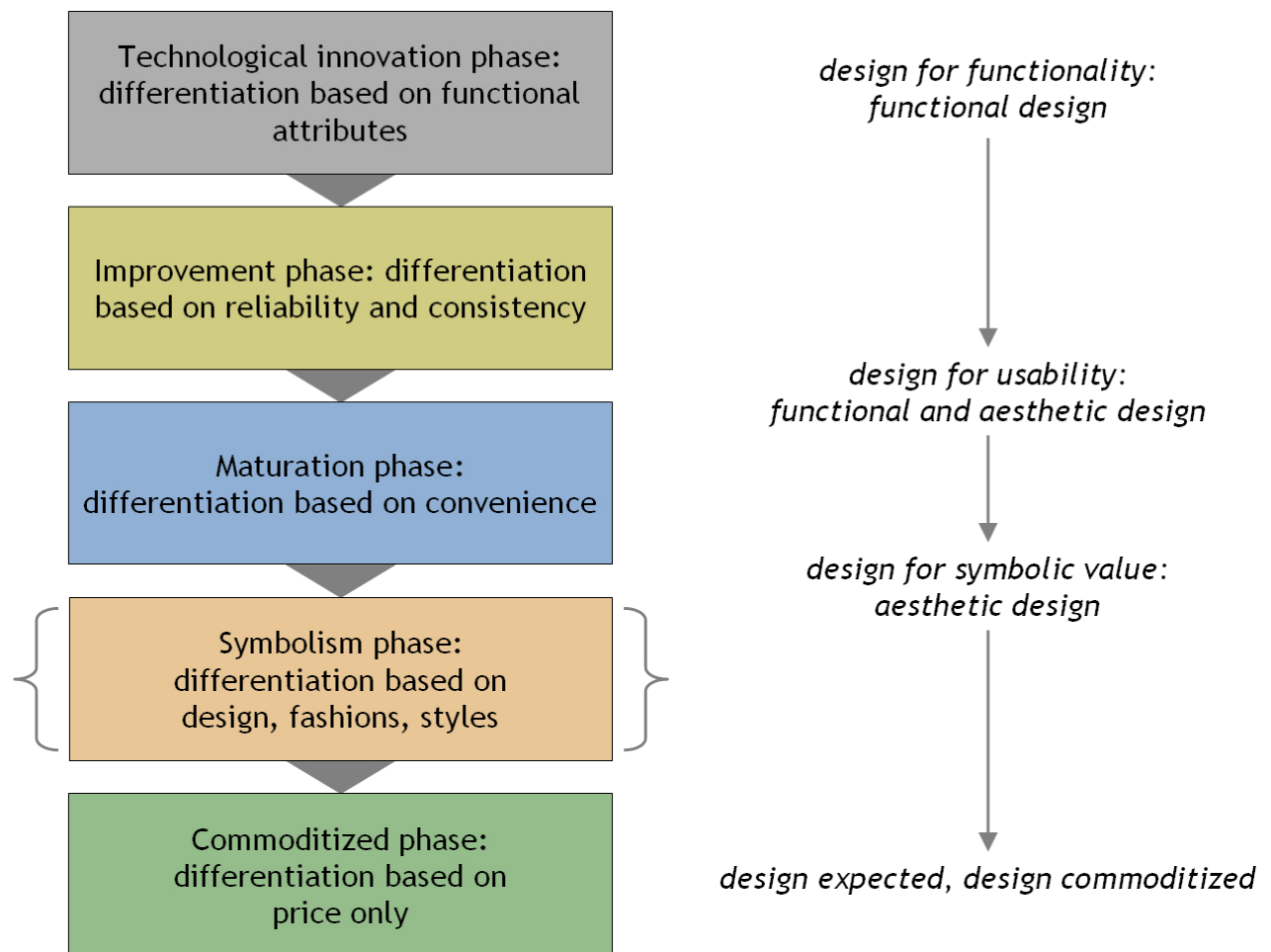


Figure 6.1: The phases of competition as developed by Christensen (1997) with the suggested addition of a Symbolism phase and the corresponding roles of functional and aesthetic design.

Gemser and Leenders (2001) studied the impact of industrial design on new product development in two industries, the furniture industry and the precision instruments industry. The findings of this research were positive relationships between industrial design and performance in the instruments industry. The fact that no relationship was found between industrial design and performance in the furniture industry may indicate that in this industry industrial design had become commoditized, and was a baseline requirement for competition rather than a source of competitive advantage. Arguing based on Christensen's model, the instruments sector had not reached this stage yet and therefore industrial design could make a difference.

Figure 6.1 also resonates with the research by Berry and Taggart (1998) who found that high-tech firms' strategic orientation evolves from being technology oriented at the early stages to being market oriented, with a focus on commercialization and customer acceptance, as the firms grow and the technology matures.

Before continuing it is necessary to clarify that firms can enter the market in any of the phases of competition. Furthermore, the representation in Figure 6.1 is highly simplified since it does not show all the loops back and dead-ends that are possible. For example, a technology can become out-dated before reaching the symbolism phase even if it surpassed earlier market requirements.

6.5.2 AESTHETIC DESIGN AND SERVICES

This research focuses on aesthetic design in service innovation, and it is interesting to consider the implications of this research in terms of understanding services. Gilmore and Pine's (2007) present a model of the progression of economic value. In their model there are five kinds of economic offerings: raw materials, products, services, experiences and transformations. There are two dynamics at work in their model, customization and commoditization, as shown in Figure 6.2. Customization is the mechanism by which economic offerings are transformed to the next stage of economic value. The exception is that raw materials cannot be customized because they are fungible. Commoditization is the mechanism by which economic offerings are transformed to the previous stage of economic value. The final stage of economic value is transformations, thus named because these offerings change the customer in some way and, hence, the customer becomes an integral part of the economic offering. Gilmore and Pine argue that transformations cannot be customized up to a next level because that would imply "perfecting human beings" (Gilmore & Pine 2007, p.49), and that transformations cannot be commoditized because of the uniqueness of humans.

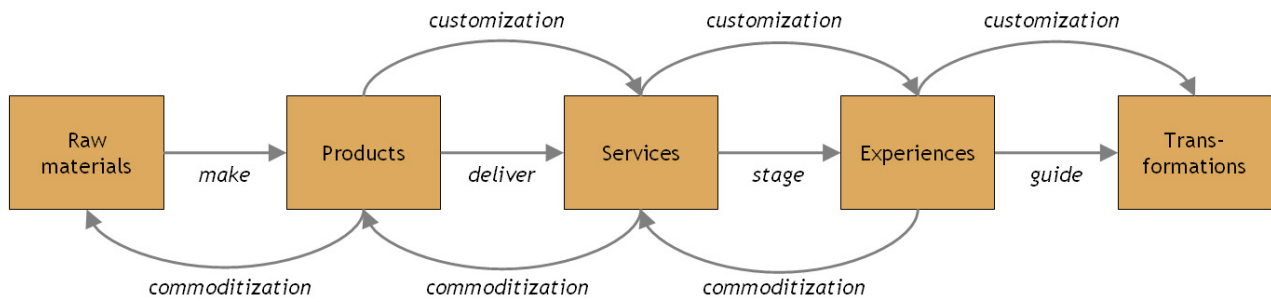


Figure 6.2: The progression of economic value as developed by Gilmore & Pine (2007).

It is interesting to consider where the technology-based services on which this research focuses are in Figure 6.2. Gilmore and Pine offer an example to explain their model: “The customers of a management consulting firm, for example, do not merely want ideas (the commodities of the industry), reports (goods), analyses and advice (services), nor even workshops (experiences); they want to transform, to become a better business as a result of purchasing consulting offerings.” (Gilmore & Pine 2007, p.47)⁵. Based on this example, and referring back to the findings of the case research, it seems that the services created by the NTBFs studied cover the range from products to transformations in Figure 6.2. This says something about the technology industry, namely that its services are not limited to the stage of being “just services” but can, in fact, provide experiences and transformations as well. Recognizing that both the opportunity for using aesthetic design and the demand for aesthetic design are likely to increase as the nature of a service moves to the right in Figure 6.2, the value of aesthetic design for service innovation becomes apparent.

According to Gilmore and Pine, the transformation stage cannot be commoditized. So, does the transformation stage represent an immunization against commoditization? It is reasonable to assume that issues of functionality, reliability and convenience can be relevant for transformations and that the role of aesthetic design could follow the pattern suggested in Figure 6.1. After all, even a transformation offering can compete based on user friendliness, attractiveness and resonance with values, self-expression and social relevance. In fact, taking Gilmore and Pine’s example of management consultancy, it seems

⁵ Gilmore & Pine use the term commodities instead of raw materials, and goods instead of products.

likely that even price can become a basis for competition once the requirements for functionality, reliability, convenience and symbolic value have been met. So, inasmuch as commoditization is taken to mean a condition under which competition is based on price only, transformation offerings can be commoditized. However, if we take into account the second dynamic in Gilmore and Pine's model, namely customization, it is also clear that the commoditized phase is not a bitter end in itself, but simply a point where customization is needed and aesthetic design can be part of such customization.

We now come to the question of the commoditizability of aesthetic design. Is there something about the penultimate stage of economic value in Gilmore and Pine's model that can render the conclusion that aesthetic design is not commoditizable? Gilmore and Pine argue that transformations are not commoditizable, but they base this argument on the notion that transformations change humans or groups of humans and that, because of the uniqueness of humans, commoditization is not possible. The aesthetic design of transformations can certainly constitute all or part of the changes created and so one might argue that a particular instance of aesthetic design is not commoditizable once it has been incorporated into a human through transformation. However, the capacity to employ aesthetic design to a transformative offering can nonetheless be commoditized according to the arguments presented earlier. Hence, the issue of the commoditizability of aesthetic design remains to be better explored.

The dynamics depicted in Figure 6.2 are repeated between each set of adjacent stages of economic value and in the context of this research can be thought of in simple terms as a cyclical model of commoditization and decommo-ditization kept in motion by the two inputs of aesthetic design and innovation. Innovation can contribute to decommo-ditization by introducing new offerings or new ways to customize existing offerings while aesthetic design can contribute to decommo-ditization by increasing the convenience and/or symbolic value of an offering. Good performance and investment in aesthetic design and innovation are likely to be mutually reinforcing. Conversely, poor performance and lack of investment in aesthetic design and innovation are likely to lead to a vicious cycle of decline.

6.5.3 GENERALIZABILITY

Turning now to the issue of the generalizability of this research, two delineations of the research need to be addressed. The first is the focus on new firms and the second is the focus on Icelandic firms. As described in the Methodology section, breadth was an important concern in selecting service innovation projects for the case research. Thus, in addition to studying service innovation projects in Icelandic NTBFs, the same number of projects in American NTBFs was included as well as a project in an established Silicon Valley firm. These sources of data support speculation on the generalizability of the findings of this research.

6.5.3.1 APPLICABILITY TO ESTABLISHED FIRMS

Comparing the findings about aesthetic design practice in service innovation in NTBFs with an established Silicon Valley firm uncovered important differences. In the established firm, aesthetic design was observed to play a key role in service innovation and was deliberately employed from the concept development phase and through commercialization while in the NTBFs, aesthetic design was less prevalent and used less deliberately.

In the established Silicon Valley firm designers were observed to be involved in the project studied from the outset. Engineers and designers worked separately, but a project manager served as liaison between the two groups. Designers had different and well defined roles. User experience architects were involved in insuring ease of use throughout the development process and graphic artists were responsible for designing packaging, screen layouts, icons, etc. In addition to working on the firm's own service innovation projects, the firm also has a design unit that sells design services on a consulting basis. The NTBFs had similar concerns regarding ease of use, visual interfaces and packaging but their approaches to addressing these concerns were much less deliberate, mostly performed by *silent designers* and in some instances neglected.

A *modus operandi* reminiscent of the *artful process* (Austin & Devin 2003) was observed in the established firm. The established firm involved customers in the development process in two ways. The firm used multiple customer visits to elicit input to the development process. During concept development, teams of people, including programmers, visited customers for focus group meetings to find out what customers' needs were. This was an iterative process that

continued through development as customers were recruited to test prototypes in various stages of development. This testing was performed in a laboratory setting, where users were observed interacting with the service from behind one-way mirrors. The *modus operandi* in some of the NTBFs also resonated with the *artful process* but on a much smaller scale, simply because there were fewer customers and development projects were smaller.

To summarize, the speculation above suggests that this research on aesthetic design as an element of service innovation in NTBFs may be generalizable to small scale service innovation projects in established firms or very explorative projects where existing processes cannot be employed.

6.5.3.2 APPLICABILITY OUTSIDE ICELAND

The comparison between findings in Icelandic NTBFs and American NTBFs was initially undertaken to explore differences. Existing research on resources (e.g. Garnsey 1998) and clustering (e.g. Utterback et al. 2007) gave no reason to expect the paucity of differences found.

Iceland has a small population and this, coupled with its remote geographical location, suggests a scarcity of the resources required by NTBFs, such as a network of service firms from which NTBFs can procure essential sophisticated services and a large community of technology-based firms creating opportunities for knowledge sharing. There are a number of regions where technology-based firms have clustered and levels of technology-based entrepreneurship are, and have been, unusually high. One of these regions is on the West Coast of the United States, particularly Silicon Valley in the San Francisco Bay area. On the surface Iceland and the United States, particularly Silicon Valley, seem to be very different in terms of firms' access to important resources.

Only a few differences were found between Icelandic and American NTBFs regarding the role of design. This raises interesting questions about possible hidden similarities between NTBFs in Iceland and the United States. Examination of existing theories and previous research on regional differences suggests two such similarities. In the first place, NTBFs are commonly founded by persons sharing similar educational backgrounds, and this background is likely to influence the competitive strategy selected by founders. NTBFs are not only similar in terms of the educational background of their founders, NTBFs are founded as venues for technological innovation (Bollinger et al. 1983) and

technological innovation is inherently uncertain (Garnsey 1995). These characteristics, further reinforced by the Internet and a converging worldwide education system, provide a common mechanism of isomorphism (DiMaggio & Powell 1991) which may explain the striking similarities across such different and distant geographical areas as Iceland and Silicon Valley.

In the second place, the converging nature of the aspects close to the surface of Hofstede, Neuijen, Ohayv and Sanders' (1990) "onion" model of manifestations of culture further suggests that activities related to aesthetic design, since their concern is with the outermost symbol layer of the model, are specifically susceptible to coercive isomorphism.

In summary, the comparison between NTBFs in Iceland and the U.S. suggests that there are more similarities than there are differences in the role of aesthetic design in service innovation in NTBFs in these two seemingly different locations and that these similarities outweigh regional differences of resource availability.

These results suggest interesting research implications and provide a basis for cautiously suggesting that research on aesthetic design as an element of service innovation performed in Icelandic NTBFs might be generalizable to NTBFs in other countries such as the United States. Venturing even further, and based on Hofstede et al.'s (1990) taxonomy of values, we might also surmise that research on other NTBF activities and practices in Iceland may also be generalizable to other countries, so long as the activities and practices under study are reasonably close to the surface of Hofstede et al.'s (1990) model, rather than being in the sphere of core values, which may be more influenced by culture.

There are, however, two important caveats to these implications. First, the observed non-difference might be specific to firms developing software-based services. The Internet plays a larger role for these businesses and the community of firms belonging to this category is likely to be better represented on the Internet compared to, for instance, biotechnology firms. Second, the observed non-difference might be due to the propensity for *silent design* (Gorb & Dumas 1987) in NTBFs, which may change as the firms grow larger or older. As mentioned previously, the findings indicate that NTBFs put less emphasis on aesthetic design in their early development projects compared to later projects. Aesthetic design was also found to be much more consciously attended to in the established Silicon Valley firm studied for comparison. One could therefore

expect the resource environment, e.g. access to design competence and resources, to play a more important role for technology-based firms as they become older and more established.

6.6 PRACTITIONER IMPLICATIONS

This research suggests a number of implications for practitioners in NTBFs and even technology-based firms in general.

This research's findings of a predominant emphasis on functional design in NTBFs point to potentially untapped opportunities for improving performance in service innovation in NTBFs through the use of aesthetic design. Before NTBF managers decide to embark on an effort to incorporate aesthetic design it may be useful to evaluate their current status with respect to design. The model developed in Paper 1 provides a straightforward way to evaluate firms with respect to their emphasis along the dimensions of visceral, functional and experiential design. Practitioners, managers and consultants could use the model for self-evaluation or third-party evaluation of current design emphases and foci, and identification of the gap between the current situation and a desirable state.

In NTBFs where the influence of founders is strong, managers should stay aware of the potential bias against aesthetic design that founders or employees with educational backgrounds in technology fields might have. Going a step further than awareness, NTBFs could seek balance in their founder teams between persons with technology backgrounds and persons with experience of sales and marketing, thus fostering increased recognition of the potential value of aesthetic design.

Extending beyond implications for managers of NTBFs, implications are also suggested for educational institutions, particularly those offering education in the fields of natural science and engineering. Such educational institutions would do well to consider including design in their curricula, not just engineering design, but also visceral design and experiential design.

The conclusions of the case research on the roles of aesthetic design suggest managerial implications for successful new service development in NTBFs. The observed tendency to counteract the very service-ness of technology-based services rather than exploiting the distinguishing characteristics of services suggests possibly untapped opportunities. Perhaps using aesthetic design to make

new services more intangible, more perishable, more inseparable and/or more heterogeneous, could contribute to success. Pine and Gilmore (1998) argue that the economy is evolving towards an experience economy where the perceived value of a product or service will be judged based on the intangible and perishable experiences created rather than on the tangible objects the customer can hold in his or her hand. Aesthetic design can be used to exploit the heterogeneity of services through customization (Bitner, Brown & Meuter 2000), which in turn makes services more heterogeneous. For technology-based services, in particular, such customization can be automated. Web sites that allow customers to customize look and feel or that modify what the customer sees based on past behavior and expressed preferences are a good example of such automated customization. This example also points to the use of technology to maintain the relationships endemic of the inseparability of services without the concomitant manpower dependence.

The extensions suggested to Christensen's (1997) framework could be helpful for practitioners since they describe how differentiation is based on different phases of competition along the process of commoditization and make explicit the role of symbolic value. Practitioners would be well advised to consider using aesthetic design to counteract commoditization when the markets in which they compete are characterized by ready access to solutions which meet customers' needs and expectations for features, performance and reliability.

There are also practitioner implications specifically relevant for NTBFs at start-up. For NTBFs that come into being with the purpose of exploiting or inventing new technology, aesthetic design may not yield advantage at the outset. As these NTBFs' offerings move beyond the initial stages of features, performance and reliability, managers should anticipate the next stages by incorporating aesthetic design, first to improve usability and later to infuse their offerings with symbolic value. At this stage, NTBFs need to be on guard against the potential detraction from aesthetic design related with founders' educational background and potentially bring in an infusion of persons with sales and marketing experience and/or designers.

For NTBFs founded with the purpose of offering improvements on services already available on the market, differentiation based on aesthetic design may be a means to achieve competitive advantage, but only if aesthetic design has itself

not already been commoditized in the NTBF's target market. In such situations, NTBFs must adopt aesthetic design to gain entry and meet base expectations.

NTBF managers can expect to gain an increase in number of customers, improve the competitive advantage of their services and strengthen customer retention through the application of aesthetic design in service innovation. All these measures can be expected to influence financial performance in the long term. Notwithstanding these conclusions regarding the value of aesthetic design for service innovation, aesthetic design should not be viewed as a silver bullet able to pierce the heart of any and all commoditizing werewolves.

Although this research suggests that NTBFs would do well to incorporate aesthetic design into their service innovation processes once they have moved from the initial technological innovation stage, it does not follow that technical staff should necessarily commit time to aesthetic design instead of technology or as a side-line (*silent design*). In fact, existing research suggests that human capital is most effectively used if tasks are allocated based on individuals' strengths (Buckingham & Clifton 2001). Based on this theory, NTBFs should hire aesthetic designers to do aesthetic design and thus free up their technical staff to excel in technological pursuits.

This research suggests that regional influences are weaker than other factors influencing NTBFs. This suggests the managerial and entrepreneurial implication that founding an NTBF in one geographical location rather than another, or moving an NTBF between locations, cannot be viewed as effective means to engender positive change, at least as far as the role of aesthetic design in service development is concerned. However, having access to superior design resources can become important when NTBFs compete in markets that are commoditized or approaching commoditization. At such a point, location may begin to matter more for NTBFs, or alternatively, NTBFs need to fully leverage the Internet to overcome the potential liability of their location in resource-poor locations.

6.7 SUGGESTIONS FOR FURTHER RESEARCH

There are several additional perspectives that could be taken into account in the analyses undertaken in this research. Most notably, the findings about the relationships between aesthetic design and competitive advantage point to the importance of further consideration of moderating influences in examining such

relationships. Based on the case research the role of aesthetic design in service innovation was found to be either that of counteracting or exploiting the characteristics commonly thought to distinguish services from products, namely intangibility, heterogeneity, simultaneity and perishability. The more commonly observed role was one of counteracting the distinguishing characteristics of services. This suggests that the potential moderating influence of services' degrees of intangibility, inseparability, heterogeneity and perishability on the realization of benefits from aesthetic design should be considered.

Validation of the case research findings about the roles and organization of aesthetic design is warranted. These findings could be validated using quantitative research on NTBFs.

Another extension to the research is suggested by the findings of the single case study of an established technology-based firm that was undertaken to explore the manifestation of aesthetic design in a firm both larger, older and having greater demonstrated success than the NTBFs studied. The findings of this study were that aesthetic design was much more in evidence in the established firm. This raises the question of aesthetic design in other established technology-based firms. In selecting this particular case for study a firm known for excellence in design was explicitly sought. Replicating the research on aesthetic design manifestation and relationships with performance in established technology-based firms having no special kudos for design would extend the applicability of the research beyond new firms.

A final suggested extension to the research is to pick up the thread where chapter 3.2.2 leaves off and develop hypotheses about specific contributions of aesthetic design to service innovation projects. Testing such hypotheses would require using the service innovation project as the unit of analysis rather than the firm.

In addition to the above extensions to the research, suggestions for new research projects also emerge from the findings. Three such suggestions are offered here.

The findings suggest that the Internet may constitute a partial explanation for the apparent location-independence of NTBFs with respect to the use of aesthetic design. Technology provides the means to standardize service delivery and increase efficiency and quality (Dolfsma 2004) as well as supporting delivery to mass markets through automation. Standardizing a service makes it less heterogeneous and automating it counteracts its perishability and inseparability

since automation constitutes a means to create service processes which can be accessed by customers as needed. The user interface through which a customer accesses a software-based service, whether the interface is accessed through the Internet or from a local software installation, lends a measure of tangibility and imperishability to the service. This raises the idea that technology-based services delivered through software, specifically if delivered on the Internet, may be different from services in general, and may not be different from products in the same way that services in general are. Hence, a suggestion for further research is for conceptual and/or explorative research about the moderating role of the Internet on service innovation, and more specifically on the manifestation of aesthetic design. Such research could be followed by validation using quantitative data.

The second suggestion is derived from the findings of the case research that suggest that design in NTBFs is mostly *silent*. This raises the question of how designer participation and/or defined aesthetic design roles might influence service innovation. To answer this question, the issue of aesthetic design as an element of service innovation should not only be examined within the context of the NTBF but also from the perspective of designers and/or design firms.

Finally, as was brought up in the previous chapter, the issue of the commoditizability of aesthetic design remains open at least from some points of view. The durability of competitive advantage based on aesthetic design could be explored through a retrospective study of technological innovations for which aesthetic design has been used as a means of differentiation. Useful empirical sources for such research would be archives of the industry or business press as well as academic research.

6.8 SUMMARY OF CONTRIBUTIONS

The research covered in this thesis and its included papers makes a number of important contributions. Firstly, as the research focus lies in an area where there is little existing research, it can be said to break new ground in understanding. The model developed for measuring the weight technology-based firms place on aesthetic design and functional design is an important contribution in view of the newness of the territory. In fact, the development of this model was a necessary pre-requisite to the subsequent phases of the research.

Secondly, the research contributes a characterization of aesthetic design as an element of service innovation in NTBFs. This characterization provides a picture of the prevalence, roles, organization and actors of aesthetic design in the research context.

The third contribution is insight about the relationship between aesthetic design as an element of service innovation and performance in NTBFs. The research shows that positive relationships exist but that they can be contingent upon existing conditions, which act as moderating factors. Following from an understanding of these relationships, the research contributes important practitioner implications.

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APPENDIX A: RESEARCH ON SUCCESS FACTORS IN NEW SERVICE DEVELOPMENT

This appendix provides an overview of research on success factors in new service development (NSD). The overview is presented in the form of six tables. The first table (Table A.1) lists references for research on success factors with information about the sectors covered, the methodologies used and the data on which the research is based. Table A.2 provides a summary of the measures of performance used in the research represented by the references, and Tables A.3, A.4, A.5 and A.6 list the success factors identified by the research related to the NSD process, management, marketing and service characteristics, respectively. In all tables references are listed in chronological order.

This overview is the result of a systematic search for research on success factors in NSD. Electronic reference databases (ProQuest and EBSCO) were searched using the search terms “new service development success”, “new service development performance”, “service innovation success” and “service innovation performance”, respectively. The initial list of references was examined and citations to earlier work traversed to yield additional references. Two review papers (Johne & Storey 1998; de Jong & Vermeulen 2003) were also used to identify relevant research.

Table A.1: Summary of research on success factors in new service development.

Reference	Empirical context	Methodology	Data
Shostack 1984		conceptual	
Reidenbach & Moak 1986	retail banks	quantitative	121 firms in the United States
de Brentani 1989	industrial services: management services, financial, transportation & communication	quantitative	276 projects in 115 firms; 150 successes and 126 failures in Canada

Reference	Empirical context	Methodology	Data
Cooper & de Brentani 1991	industrial B2B financial services	quantitative	Industrial B2B financial services
de Brentani 1991	various service sectors	quantitative	276 projects in 115 firms, 150 successes, 126 failures
Easingwood & Storey 1991	financial consumer services	quantitative	77 services, 64 broadly successful, 13 not successful
de Brentani & Cooper 1992	financial B2B services	quantitative	106 services, 56 successes and 50 failures in 37 firms
de Brentani 1993	financial services	quantitative	106 financial services thereof 56 successes and 50 failures
Easingwood & Storey 1993	financial services	quantitative	78 services in the United Kingdom, unsuccessful (14), successful (32) or very successful (32)
Cooper et al. 1994	financial services	quantitative	173 services in Canada, all considered to be successes ranging from marginal successes to spectacular winners
Edgett & Parkinson 1994	financial services	quantitative	62 successes and 56 failures in 67 firms in the United Kingdom
Edgett 1994	retail financial services	quantitative	118 projects in the United Kingdom thereof 62 successes and 56 failures
de Brentani 1995	various industrial services	quantitative	276 projects in 115 firms, 150 successes and 126 failures in Canada
Easingwood & Storey 1995	financial services	quantitative	78 services in the United Kingdom, 14 unsuccessful; 32 broadly successful; 32 very successful
Martin & Horne 1993	various service sectors	quantitative	27 successful and 37 unsuccessful firms in the United States
Martin & Horne 1995	various service sectors	quantitative	176 projects in 88 firms in the United States, most and least successful projects (end-points only)
Atuahene-Gima 1996	manufacturing and services	quantitative	117 service firms and 158 manufacturing firms in Australia
Cooper & Edgett 1996	financial services	review of extant research	about 600 “case histories” of financial service products.

Reference	Empirical context	Methodology	Data
de Brentani & Ragot 1996	professional services	quantitative	112 projects in 55 firms, 60 successes and 52 failures in Canada
Edgett 1996	B2B financial services	quantitative	82 services in the United States and Canada including successes, failures and cancelled
Storey & Easingwood 1996	financial services	quantitative	153 services in the United Kingdom
Johne & Storey 1998	mostly financial services	review of extant research	
Storey & Easingwood 1998	consumer financial services	quantitative	153 firms in the United Kingdom
Lievens et al. 1999	banking	case research	4 projects in one bank in Belgium
Song et al. 2000	various service sectors	quantitative	982 firms in 9 countries
Avlonitis et al. 2001	financial services	quantitative	132 new services in 84 firms, 80 successes and 52 failures in Greece
de Brentani 2001	various B2B services	quantitative	148 B2B services in Canada, 64 discontinuous and 84 incremental
Henning-Thurau et al. 2001	motion pictures	case research	motion pictures
MacCormack et al. 2001	Internet-based services	mixed method	29 development projects in 17 firms
Agarwal et al. 2003	travel services	quantitative	201 hotels in 46 countries
de Jong & Vermeulen 2003	various, mostly financial services	review of extant research	
Edvardsson & Gustavsson 2003	various service sectors	case research	45 service employees in 9 firms
Blazevic &	financial services	quantitative	36 firms, 37 successful projects and

Reference	Empirical context	Methodology	Data
Lievens 2004			28 failures in Belgium
Cainelli et al. 2004	various service sectors	quantitative	about 700 Italian firms from a longitudinal study
Dolfsma 2004		conceptual	
Stuart & Tax 2004	theatre	case research	case study of theatre to shed light on the design of service experiences
Van Riel et al. 2004	high-technology service sector (involving ICT)	quantitative	251 innovation projects in Europe, the United States and Japan. projects from companies in Europe, the United States, and Japan.
Nijssen et al. 2006	manufacturing and services	quantitative	217 service-based and 105 product-based companies in the Netherlands
Prajogo 2006	manufacturing and services	quantitative	194 firms in Australia, 52% manufacturing firms, 47% service firms

Table A.2: Summary of performance measures used in research on success factors in new service development.

Objective measures

Category	Objective performance measure	Shostack 1984	Reidenbach & Moak 1986	de Brentani 1989	Cooper & de Brentani 1991	Easingwood & Storey 1991	de Brentani 1991	de Brentani & Cooper 1992	Easingwood & Storey 1993	de Brentani 1993	Martin & Horne 1993
financial	assets		x								
	cost performance			x			x				
	enhanced profitability of other offerings										
	financial performance in general										
	profits		x								
	return on assets		x								
	sales / turnover			x			x				
	sales growth										
firm	sales per employee										
	stock market returns										
	growth in employment										
market	market share			x							
	new customers										
	number of web site visitors										

Table A.2: Objective measures (continued)

[illegible]

Table A.2: Objective measures (continued)

Category	Objective performance measure	Cooper & Edgett 1996	Storey & Easingwood 1998	John & Storey 1998	Lievens et al. 1999	Song et al. 2000	MacCormack et al. 2001	de Brentani 2001	Avlonitis et al. 2001	Henning-Thurau et al. 2001	Agarwal et al. 2003
financial	assets										
	cost performance										
	enhanced profitability of other offerings								x		
	financial performance in general										
	profits		x			x		x	x		x
	return on assets										
	sales / turnover		x					x	x		
	sales growth										
	sales per employee										
	stock market returns										
firm	growth in employment										
market	market share		x						x		x
	new customers								x		
	number of web site visitors										

Table A.2: Subjective measures

Category	Subjective performance measure	Shostack 1984	Reidenbach & Moak 1986	de Brentani 1989	Cooper & de Brentani 1991	Easingwood & Storey 1991	de Brentani 1991	de Brentani & Cooper 1992	Easingwood & Storey 1993	de Brentani 1993	Martin & Horne 1993
competitiveness	competitive performance			x			x				
	long-term success, sustainable comp. adv.										
customers	customer satisfaction										
	customer loyalty										
	new market opportunities										
	relationship enhancement										
firm	firm reputation										
	innovativeness, propensity for innovation										
	radicalness										
	indir. success, pre-conditions for future success										
indirect	new opportunities (window of opportunity)										
	other services sell better										
	ranking of factors influencing choice										
service quality	service quality										
	firm success rate for new introductions										x
success	project success / failure as evaluated by mgrs				x			x		x	
	quality of offerings										
	(short-term) success					x			x		

Table A.2: Subjective measures (continued)

[illegible]

Table A.2: Subjective measures (continued)

Category	Subjective performance measure	Cooper & Edgett 1996	Storey & Easingwood 1998	John & Storey 1998	Lievens et al. 1999	Song et al. 2000	MacCormack et al. 2001	de Brentani 2001	Avlonitis et al. 2001	Henning-Thurau et al. 2001	Agarwal et al. 2003
competitiveness	competitive performance								x		
	long-term success, sustainable comp. adv.										
customers	customer satisfaction										x
	customer loyalty		x						x		
	new market opportunities							x			
	relationship enhancement										
firm	firm reputation								x		
	innovativeness, propensity for innovation										
	radicalness										
	indir. success, pre-conditions for future success										
indirect	new opportunities (window of opportunity)		x								
	other services sell better										
	ranking of factors influencing choice										
service quality	service quality						x				x
	firm success rate for new introductions										
success	project success / failure as evaluated by mgrs							x			
	quality of offerings										
	(short-term) success										

Table A.2: Subjective measures (continued)

Category	Performance measure	de Jong & Vermeulen 2003	Edvardss. & Gustavss. 2003	Van Riel et al. 2004	Blazevic & Lievens 2004	Cainelli et al. 2004	Dolfsma 2004	Stuart & Tax 2004	Nijssen et al. 2006	Prajoogo 2006
competitiveness	competitive performance				x					
	long-term success, sustainable comp. adv.									
customers	customer satisfaction									
	customer loyalty									
	new market opportunities									
	relationship enhancement									
firm	firm reputation				x					
	innovativeness, propensity for innovation								x	
	radicalness								x	
	indir. success, pre-conditions for future success									
indirect	new opportunities (window of opportunity)									
	other services sell better									
	ranking of factors influencing choice									
service quality	service quality									
	firm success rate for new introductions									
success	project success / failure as evaluated by mgrs									
	quality of offerings									
	(short-term) success			x						

Table A.3: Summary of research findings on success factors in new service development related to the NSD process.

Success factor (process)	Reference	Description
Customer participation	de Brentani & Ragot 1996	customer participation
	Martin & Horne 1995	direct input from customers
Effective NSD management	Reidenbach & Moak 1986	new service manager to oversee the process
	de Brentani 1991	effective nsd management
Experienced development team, expert-driven process	de Brentani 1993	expert-driven process
	MacCormack et al. 2001	the use of a development team with greater amounts of “generational” experience
Formal NDS process, non ad-hoc	Reidenbach & Moak 1986	more formalized and better structured nsd programs
	de Brentani 1991	detailed/formal nsd process
	Edgett 1994	formalization of process
	Cooper & Edgett 1996	recommend the stage-gate approach (seems to be the underlying purpose of the paper)
	de Brentani 2001	for services involving low innovativeness: formal stage-gate nsd process
	Dolfsma 2004	proposes that a formal nsd process is desirable (not empirically based)
	Stuart & Tax 2004	formal integrating mechanisms (e.g. planning meetings, rehearsal reports)
Interactive (non-linear) models of innovation, experimentation supported	MacCormack et al. 2001	flexible development process with the ability to generate and respond to new information for a longer proportion of the development cycle
	Stuart & Tax 2004	frequent use of experimentation and late codification of results

Table A.3 (continued)

Success factor (process)	Reference	Description
Post-launch review and analysis	Edgett 1996	product development and post-launch review and analysis
Product champion	Martin & Horne 1993	product champions allowed to manage the launch phase of the process
	Shostack 1984	blueprinting
Quality execution of up-front activities, project and architecture defined up front	Cooper & de Brentani 1991	quality of execution of pre-development and technical activities (screening, drawing board approach, alternate designs considered) (secondary factor only)
	de Brentani 1993	quality of execution of up-front activities
	Edgett 1996	idea screening
	MacCormack et al. 2001	greater investments in architectural design
Teamwork	Atuahene-Gima 1996	teamwork
Testing	Edgett 1994	testing

Table A.4: Summary of research findings on success factors in new service development related to management.

Success factor (mgmt)	Reference	Description
Business / financial analysis	Edgett 1994	business/financial analysis
Corporate culture encouraging entrepreneurship and creativity	de Brentani 2001	for new-to-the world services: corporate culture encouraging entrepreneurship and creativity
	Cainelli et al. 2004	innovating firms out-perform non-innovating firms, productivity is also linked to the amount of innovation expenditures
Distribution strength, accessibility in target markets	Storey & Easingwood 1996	effective distribution
	Storey & Easingwood 1998	distribution strength (accessibility in target markets)
Firm reputation, firm positioning	Easingwood & Storey 1993	reputation of firm
	Easingwood & Storey 1993	distinct company positioning
	Storey & Easingwood 1998	reputation
Service newness to firm	de Brentani 1991	service newness to firm positively related with sales of other offerings
	de Brentani 1991	NEGATIVE relationship with cost performance and sales/turnover - service newness to firm
	Cooper & de Brentani 1991	NEGATIVE - new to the firm products entail more risks than close to home ones, but the resulting level of success is not sharply reduced
Quality employee work environment	Edvardsson & Gustavsson 2003	employee work environment factors: exercise influence and control over one's situation; experience security and meaning; develop social relations at and through work; maintain good health and avoid negative stress; work in safe physical surroundings

Table A.4 (continued)

Success factor (mgmt)	Reference	Description
Innovation treated as a corporate-wide task, management support	de Brentani 1993	supportive and high-involvement corporate cultures
	Edgett 1994	strong inter-functional co-operation and co- ordination, awareness of importance of innovation
	Martin & Horne 1995	input by senior management
	Storey & Easingwood 1996	compatibility/importance (internal to firm)
	de Brentani & Ragot 1996	effective NSD culture creating and encouraging an environment where innovation is supported, senior managers actively involved
	Atuahene-Gima 1996	importance given to innovation activity in HR strategy
	de Brentani 2001	for new-to-the world services: active management involvement and visionary leadership
	Blazevic & Lievens 2004	quality of internal as well as external communication during the NSD process
Quality of venture decision-making	Stuart & Tax 2004	leadership from the director
	Van Riel et al. 2004	how well informed and knowledgeable decision-makers are

Table A.4 (continued)

Success factor (mgmt)	Reference	Description
Synergy (technological, production, project) between new service and firm competencies, resources, experience	de Brentani 1989	new or modified services that fit with the firm's expertise and use existing production and marketing facilities
	de Brentani 1991	overall product synergy
	Cooper & de Brentani 1991	degree of fit between the needs of the project and firm resources
	de Brentani & Cooper 1992	leverage firm resources/skills
	Edgett 1994	good fit with the image of the firm
	Edgett & Parkinson 1994	fit with existing image of firm
	Cooper et al. 1994	fit between project and management and financial expertise and resources
	Easingwood & Storey 1995	synergy between new service and the organization
	Martin & Horne 1993	new services more closely aligned with current portfolio
	de Brentani 1995	one of the scenarios for success identified: customized expert service, leveraging firm's expertise and highly customized
	Atuahene-Gima 1996	technological synergy
	Storey & Easingwood 1996	overall company/product fit
Early introduction	de Brentani 2001	for services involving low innovativeness: leverage firm's competencies with strong corporate fit
	de Brentani 1995	one of the scenarios for success identified: planned "pioneering" venture aimed at attractive high volume markets, first to market, fit with customer needs, tangible evidence used

Table A.4 (continued)

Success factor (mgmt)	Reference	Description
Specialized initial market	de Brentani 1991	NEGATIVE relationship with sales/turnover - specialized initial market
	de Brentani 1991	specialized initial market positively related with sales of other offerings
Willingness to cannibalize organizational routines	Nijssen et al. 2006	willingness to cannibalize organizational routines and previous investments
Strong internal communication	Edgett & Parkinson 1994	strong inter-functional co-operation and co- ordination
	Martin & Horne 1995	input by customer contact and non-contact personnel
	Lievens et al. 1999	quality of internal as well as external communication during the NSD process
	Van Riel et al. 2004	firm culture favorable to information sharing mediates the positive effects of intelligence gathering with respect to customers and technology

Table A.5: Summary of research findings on success factors in new service development related to marketing.

Success factor (mktg)	Reference	Description
Effective marketing, publicity, communication, branding	de Brentani 1989	proficient marketing system
	Cooper & de Brentani 1991	quality of execution of marketing activities
	de Brentani & Cooper 1992	quality of execution of launch/marketing activities
	Easingwood & Storey 1993	direct mail strength; consistency in communications; strong brand image
	Cooper et al. 1994	effective marketing communication
	Edgett 1994	launch effectiveness (well coordinated with strong advertising, promotion and marketing efforts)
	Storey & Easingwood 1996	effective communication
	Storey & Easingwood 1998	effective communication
	Lievens et al. 1999	quality of internal as well as external communication during the NSD process
Internal marketing	Henning-Thurau et al. 2001	communication to provide the customer with “quasi-search qualities” (those that can be comprehended before seeing a movie) or experience qualities (those that can only be comprehended after watching), importance of translating experience qualities to “qua
	de Brentani 1989	successful internal marketing program directed at the personnel concerned with producing and delivering services to customers
	Easingwood & Storey 1991	internal marketing (new service has support from staff)
	Easingwood & Storey 1995	quality of internal marketing
	Lievens et al. 1999	quality of internal as well as external communication during the NSD process

Table A.5 (continued)

Success factor (mktg)	Reference	Description
Market attractiveness	de Brentani 1991	market attractiveness of service
	Edgett 1994	market potential
	de Brentani 2001	for new-to-the world services: good market potential
Market competitiveness	de Brentani 1991	NEGATIVE - market competitiveness (negative)
	Van Riel et al. 2004	NEGATIVE - effects of competitor orientation (negative)
Market size and growth	Cooper & de Brentani 1991	market size and growth (secondary factor only)
Marketing synergy, service/market fit	Cooper & de Brentani 1991	product/market fit
	Easingwood & Storey 1991	product fit with market
	de Brentani 1991	response to demand cycle
	de Brentani & Cooper 1992	product/market fit (meeting customer needs)
	Cooper et al. 1994	market-driven NSD process
	de Brentani 1995	one of the scenarios for success identified: planned “pioneering” venture aimed at attractive high volume markets, first to market, fit with customer needs, tangible evidence used
	Easingwood & Storey 1995	responsiveness
	Atuahene-Gima 1996	marketing synergy
	de Brentani & Ragot 1996	client and marketing fit
	Agarwal et al. 2003	market orientation
	Van Riel et al. 2004	market orientation

Table A.5 (continued)

Success factor (mktg)	Reference	Description
Need recognition, marketing inputs	de Brentani 1989	understanding customer needs
	Martin & Horne 1993	greater use made of customer information
	Edgett 1994	market research conducted throughout the development process
	Edgett & Parkinson 1994	market research early in development process
	Cooper et al. 1994	market-driven NSD process (customer needs understood)
	Martin & Horne 1995	the amount of information used about the customer at major stages of the development process
	Easingwood & Storey 1995	market research
	Edgett 1996	detailed market study/market research, market assessment
	Storey & Easingwood 1998	market knowledge (understanding customers' needs)
	MacCormack et al. 2001	earlier feedback from the market
	de Brentani 2001	ensuring customer/need fit
	Agarwal et al. 2003	market orientation

Table A.5 (continued)

Success factor (mktg)	Reference	Description
Proficiency of launch	Cooper & de Brentani 1991	quality of launch execution
	de Brentani & Cooper 1992	quality of execution of launch/marketing activities
	de Brentani 1993	quality of execution of the launch program
	Edgett 1994	given strong support once launched
	Cooper et al. 1994	launch preparation (training)
	Edgett & Parkinson 1994	strong launch support
	Atuahene-Gima 1996	proficiency of market launch
	Storey & Easingwood 1998	launch strategy
	de Brentani 2001	formal and planned launch program

Table A.6: Summary of research findings on success factors in new service development related to service characteristics.

Success factor (service)	Reference	Description
Customer prior experience, low perceived risk	Storey & Easingwood 1998	customer prior experience (familiarity), low perceived risk (the consequences of below-expectation performance are very significant to the customer)
Customizability	Easingwood & Storey 1993	adaptability
	Cooper et al. 1994	product responsiveness (adaptability)
	de Brentani 1995	scenario for success: Customized expert service, leveraging firm's expertise and highly customized
Differentiation	Easingwood & Storey 1991	differentiated product
	de Brentani & Cooper 1992	product advantage (differentiation, unique customer benefits)
Difficult to copy	Cooper et al. 1994	difficult for competition to copy
Equipment-based	de Brentani 1995	one of the scenarios identified for success: improved service experience – equipment-based new service offerings
	Cainelli et al. 2004	productivity is linked to the amount of innovation expenditures, especially those devoted to the acquisition and internal development of new software
Evidence of quality	de Brentani 1991	service quality evidence
Expert or people-based service	de Brentani 1991	expert or people-based service
	de Brentani 1995	one of the scenarios identified for success: customized expert service, leveraging firm's expertise and highly customized

Table A.6 (continued)

Success factor (service)	Reference	Description
Innovativeness	de Brentani 1989	service innovativeness
	de Brentani 1991	service innovativeness
	Atuahene-Gima 1996	service innovation advantage/quality
	de Brentani & Ragot 1996	product superiority and innovativeness
	Avlonitis et al. 2001	NEGATIVE - the most and the least innovative new services are relatively less successful in terms of financial performance compared to the moderately innovative types of new delivery processes and service modifications
	Avlonitis et al. 2001	the most innovative new service make the strongest contribution to non-financial performance
Product superiority, value to customer	Cooper et al. 1994	service encompassing true improvements
	Easingwood & Storey 1995	technological advantage
	de Brentani & Ragot 1996	product superiority
	Storey & Easingwood 1998	relative advantages
Quality of customer contact/encounter/experience	de Brentani 1991	quality of service experience
	Cooper & de Brentani 1991	quality of service delivery, better service experience (secondary factor only)
	Cooper et al. 1994	good customer service
	Storey & Easingwood 1998	staff/customer interactions
	Stuart & Tax 2004	memorable personal experiences

Table A.6 (continued)

Success factor (service)	Reference	Description
Proficient service delivery, employee expertise, training	Shostack 1984	quality staff
	Cooper & de Brentani 1991	service expertise, highly trained and skilled personnel (secondary factor only)
	de Brentani & Cooper 1992	service (personnel) expertise
	Cooper et al. 1994	launch preparation (training)
	Storey & Easingwood 1996	quality of service delivery and staff
	Storey & Easingwood 1998	staff training and skills
	de Brentani 2001	involving front line personnel in developing and helping customers appreciate distinctiveness
Service complexity	de Brentani 1991	NEGATIVE - service complexity (negative)
	de Brentani 2001	NEGATIVE - for services involving low innovativeness: ensure that efforts to differentiate service from competitive or past offering do not lead to high cost or unnecessarily complex service offerings

Table A.6 (continued)

Success factor (service)	Reference	Description
Service quality	de Brentani 1989	superior quality
	Easingwood & Storey 1991	overall quality
	Cooper & de Brentani 1991	unique/superior service
	Easingwood & Storey 1993	total quality of service
	Cooper et al. 1994	higher quality service
	Storey & Easingwood 1996; 1998	service quality
	Atuahene-Gima 1996	service innovation quality
	Song et al. 2000	NEGATIVE – service quality based on technological advantage
Uniqueness	Cooper & de Brentani 1991	unique/superior product
	de Brentani & Cooper 1992	differentiation
	Easingwood & Storey 1993	uniqueness
	Storey & Easingwood 1998	product distinctiveness/uniqueness

Table A.6 (continued)

Success factor (service)	Reference	Description
Tangible evidence	Shostack 1984	tangible evidence
	Cooper & de Brentani 1991	presence of tangible elements (only marginal benefits)
	Easingwood & Storey 1993	supporting tangible element
	de Brentani 1995	one of the scenario identified for success: planned “pioneering” venture aimed at attractive high volume markets, first to market, fit with customer needs, tangible evidence used
	Storey & Easingwood 1996	product/tangible quality
	Storey & Easingwood 1998	NEGATIVE - physical evidence (negative)
	de Brentani 2001	for new-to-the world services: marketing tactics that offset the intangibility of really new service concepts
Use of (new) technology	Easingwood & Storey 1991	use of technology
	Cooper et al. 1994	innovative technology
	de Brentani 1995	one of the scenarios identified for success: improved service experience – equipment-based new service offerings
	Storey & Easingwood 1998	investment in systems
	Cainelli et al. 2004	productivity is linked to the amount of innovation expenditures, especially those devoted to the acquisition and internal development of new software

APPENDIX B: SURVEY QUESTIONS

The survey-based research was performed in Iceland and so survey questions were written and used in Icelandic only. This appendix provides translations of the survey questions measuring design emphasis, but the reader should keep in mind that only the Icelandic versions of the questions have been tested in a survey setting.

Question text (English translation)	Answer coding	Design dimension
When your firm develops new products or services, how much weight is placed on visual design?	Weight on a scale from 0 to 5	Visceral
Do you think your customers are prepared to pay a lot more or a little more for products or services because of their visual design?	How much more on a scale from 0 to 5	Visceral
When your firm develops new products or services, how much weight is placed on sounds, textures, colors, shapes, smell or taste? ⁶	Weight on a scale from 0 to 5	Visceral
Do you think your customers are prepared to pay a lot more or a little more for products or services because of their sounds, textures, colors, shapes, smell or taste?	How much more on a scale from 0 to 5	Visceral
When your firm develops new products or services, how much weight is placed on the characteristics of the environment where the product is sold or the service is provided?	Weight on a scale from 0 to 5	Visceral
Do you think your customers are prepared to pay a lot more or a little more for products or services because of the characteristics of the environment where the product is sold or the service is provided?	How much more on a scale from 0 to 5	Visceral
When your firm develops new products or services, how much weight is placed on utility characteristics?	Weight on a scale from 0 to 5	Functional

⁶ This question and the one following it were not included in the first round of survey-based data collection.

Question text (English translation)	Answer coding	Design dimension
Do you think your customers are prepared to pay a lot more or a little more for products or services because of their utility characteristics?	How much more on a scale from 0 to 5	Functional
When your firm develops new products or services, how much weight is placed on fulfilling the customer's self-image?	Weight on a scale from 0 to 5	Experiential
Do you think your customers are prepared to pay a lot more or a little more for products or services because they fulfill their self-image?	How much more on a scale from 0 to 5	Experiential
When your firm develops new products or services, how much weight is placed on creating a specific experience for your customers? ⁷	Weight on a scale from 0 to 5	Experiential
Do you think your customers are prepared to pay a lot more or a little more for products or services because of the experience which the product or service creates for them?	How much more on a scale from 0 to 5	Experiential
When your firm develops new products or services, how much weight is placed on creating emotional value or positive memories for your customers?	Weight on a scale from 0 to 5	Experiential
Do you think your customers are prepared to pay a lot more or a little more for products or services because of the emotional value or positive memories the product or service creates for them?	How much more on a scale from 0 to 5	Experiential

⁷ In the first round of survey-based data collection, experiences, emotional value and positive memories were addressed in two questions, but in the second round, this was split into two sets of two questions as shown here.

APPENDIX C: PROFILES OF CASE PROJECTS

Firm ⁸	Project ⁹	Project description
Annata	AN1	Vertical solution for dealers in a specific segment built on top of an ERP system
Annata	AN2	Sales planning solution for supply-chain management
CAOZ	CA1	3D-character-based animated short film
CAOZ	CA2	TV interface and web site for fiber-optic TV, video, Internet and phone access
CellStory	CS1	Hosted service allowing users to take photos or videos with mobile phones and post them to a web site along with rich customized text
CellStory	CS2	Hosted service allowing users to post photos from mobile phones to blogs created using templates
Lucidoc	LU1	Compliance management solution for documents targeted for a specific niche segment
Lucidoc	LU2	Add-on to LU1 providing the ability to customize and create reports based on documents
Plinx	PL1	Photo-blogging service developed for the telecom market
Plinx	PL2	On-line community where customers can post, download and purchase music and comment on music
Quantum3D	QU1	Image generation service for visual and sensor simulation training
Quantum3D	QU2	Rapid prototyping and development of graphical user interfaces for embedded systems and simulation using a custom suite of tools
Red Condor	RC1	Hosted spam-protection for e-mail
Red Condor	RC2	A suite of bundled security services including anti-spam, anti-virus, anti-spyware, URL content filtering and asset management

⁸ All firm names, except Plinx, Valy and Aqua, are real.

⁹ Pseudonyms are used for all the TBS projects. The use of pseudonyms for the projects was necessary because some of them were still under development at the time of data collection and in some cases had only working titles

Firm ⁸	Project ⁹	Project description
Valy	VA1	Custom web site creation service with user maintainability
Valy	VA2	Electronic commerce solution for the culture and entertainment sector
Aqua	AQ1	Integrated development environment for creating platform-independent solutions. (established firm)

APPENDED PAPERS

The papers included in this thesis are appended here as follows:

- 1 Design as an Element of Innovation: Evaluating Design Emphasis in Technology-based Firms
- 2 Oil in Water? Explaining Differences in Aesthetic Design Emphasis in New Technology-based Firms
- 3 The Role of Design in the Development of Technology-Based Services
- 4 How Different? Comparing the Roles of Design in Service Innovation in Nordic and American New Technology-Based Firms
- 5 The Relationship between Aesthetic Design as an Element of Service Innovation and Competitive Advantage, Fact or Fad?
- 6 Benefits of Aesthetic Design as an Element of New Service Development

PAPER 1:
DESIGN AS AN ELEMENT OF INNOVATION:
EVALUATING DESIGN EMPHASIS IN
TECHNOLOGY-BASED FIRMS

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DESIGN AS AN ELEMENT OF INNOVATION: EVALUATING DESIGN EMPHASIS IN TECHNOLOGY-BASED FIRMS

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Design is increasingly gaining recognition as a fruitful means to improve business performance. Technology-based firms are an important source of innovation, and therefore it is important to develop a means to study the relationship between technology-based firms' emphasis on design as an element of innovation and their performance. This article develops a model for evaluating technology-based firms' design emphasis. The model is based on a synthesis approach to studying innovation in both services and manufacturing and a three-dimensional definition of design.

The application of the model is demonstrated using a set of new technology-based firms. The empirical study confirms the appropriateness of using the synthesis approach for studying design as an element of innovation in technology-based firms. The application of the model provides a classification which can be used as a basis for studying the relationship between design emphasis and performance.

Keywords: Innovation; design; technology-based firms; performance.

Introduction

There is increasing recognition that in today's highly competitive markets, where differentiation based on technological factors alone is not sufficient to ensure competitive advantage, design may provide a realistic means to avoid the debilitating effects of commoditization and to improve performance (Ridderstråle *et al.*, 2002; Walsh *et al.*, 1992; Lorenz, 1994; Kotler and Rath, 1984; Trueman and Jobber, 1998; Ulrich and Eppinger, 2003; Black and Baker, 1987; Gemser and Leenders, 2001, Hertenstein *et al.*, 2005, Roy and Riedel, 1997; Rothwell and Gardiner, 1984; Tschang, 2005). According to Tidd *et al.* (1997), the return on investment for products which have a high degree of differentiation and high perceived quality

relative to other products is typically twice that of the other products. Therefore, if design is used as a means to differentiate, it can be expected to be related to improved profitability and performance.

In most cases business performance is heavily dependent on customer acceptance leading to sales. Van der Heijden (2003) finds that the perceived visual attractiveness of web sites influences usefulness, enjoyment and ease of use; and Lavie and Tractinsky (2004) show that the visual aesthetics of computer interfaces are a strong determinant of user satisfaction. Berkowitz (1987) demonstrates that the form or shape of a product affects beliefs about the product, and these beliefs in turn are likely to affect consumer preferences. Creusen and Schoormans (2005) confirm the influence of appearance on consumer choice of products; and Yamamoto and Lambert (1994) show that appearance has an influence on customer preference even for industrial products. Norman (2004) argues that there is a strong correlation between design and usability.

Walsh (1996), Perks *et al.* (2005) and Von Stamm (2003) all argue that design should be viewed as having an important, and even leading, role in innovation. Design is important in both radical innovation and re-innovation, or incremental innovation. When a technological innovation has reached maturity, design can be employed to communicate and increase its value to customers (Walsh, 1996; Rothwell and Gardiner, 1989).

Despite its importance, design is commonly neglected in social science research (Walsh, 1996) and the role of design in innovation is under-investigated (Perks *et al.*, 2005; Trueman and Jobber, 1998; Gemser and Leenders, 2001). When design is considered in business research it is not always viewed as an element of innovation, instead it is more commonly studied in the context of marketing and seen as relevant only for the promotion and selling of products and services (Christensen, 1995).

A number of researchers have addressed the challenge of evaluating firms' technical innovation capability and performance (e.g. Chiesa *et al.*, 1996; Tether, 2001; Ulrich and Eppinger, 2003; Goswami and Mathew, 2005). In a discussion of innovation indicators, Tether (2001) argues that the existing indicators have important limitations in that they emphasise the conceptualisation of innovation as "new disembodied scientific and technological knowledge", but tend to neglect other conceptualisations such as innovation through design. Chiesa *et al.* (1996) develop a technical innovation audit framework for auditing performance and processes for technological innovation. Chiesa *et al.* include industrial design in the product development segment of their audit scorecard, however they also express the opinion that this element is highly subjective and difficult to measure.

Based on the above, there is a significant opportunity for research on design as an element of innovation, and a realistic methodology to evaluate design in this context is needed.

Technology-based firms (including, but not limited to “high tech” firms) are an important source of technological innovation and economic progress, both directly and indirectly (Smith, 1999). As argued above, design constitutes an important means for achieving differentiation which, in turn, can be expected to increase the success of innovation. This should be especially true for technology-based firms because of the critical bridging, or communication, role that design can play between technical innovation and market opportunities. The following quotation captures both the importance of design as an element of innovation and its critical bridging role:

“Design is crucial to innovation in that it is the domain of creativity where ideas are devised but also where the ‘coupling’ occurs between technical possibilities and market demands or opportunities.” (Freeman, 1983, as cited in Walsh, 1996)

There is an abundance of anecdotal evidence supporting the importance and value of design reported by the popular business press (e.g. *FastCompany* magazine). This has created the intuitive sense that design is profitable (Hertenstein *et al.*, 2005). Ultimately, for design to be of value, it must improve business performance. However, research on the relationship between design and performance is scant (Gemser and Leenders, 2001), although there have been some studies reported: for example, Gemser and Leenders (2001), Hertenstein *et al.* (2005), Walsh *et al.* (1992), Roy and Riedel (1997) Rothwell and Gardiner, (1984). Only one of these studies specifically targets technology-based firms (Rothwell and Gardiner 1984) and all the studies focus on tangible product design. Therefore, research on the relationship between design as an element of innovation in technology-based firms, including firms selling services, and performance is needed. An important prerequisite for such research is a method for operationalisation with which technology-based firm design activities and emphases can be evaluated.

The goal of this article is to contribute to the field of innovation management by developing a methodology to evaluate the emphasis on design as an element of innovation in technology-based firms, as well as demonstrating the application of this methodology.

The application of the model developed in this article is demonstrated using a set of new technology-based firms. The results of the empirical study provide insight into the prevalence of design awareness and emphasis in new technology-based firms when they develop new products and services, as well as an indicator of the focus of such design emphasis.

Following this introduction, the article is structured as follows. Firstly, the frame of reference for the model developed is presented. Secondly, the development of the

model, including a graphical representation, is described. Thirdly, the application of the model is demonstrated using an empirical study of a set new technology-based firms. Finally, conclusions are discussed and suggestions for further research are presented.

Frame of Reference

This section describes the conceptual framework on which the model developed (refer to the section entitled “Model development”) is based. Firstly, the concept of design within the context of innovation is discussed. Secondly, the synthesis approach to innovation in manufacturing and services is discussed. Finally, the issue of the relationship between design and performance is introduced.

Design in the context of innovation

The term design is quite broad and has diverse meanings (Stacey *et al.*, 2002) and is frequently used, or equated with, engineering (Veryzer, 2005). Innovation can be thought of as encompassing both technical invention (e.g. R&D and engineering) and commercialisation (Keller, 2004; Marsh and Stock, 2003). The innovation process is sometimes described as a not entirely harmonious integration of these two elements. The commercial element, which encompasses design and marketing, is concerned with providing a bridge from technical functionalities to value in a finished product or service. Thus, for the purposes of this article, design in the context of innovation is defined as *the part of the innovation process which enhances and communicates the value inherent in products or services* (Hertenstein *et al.*, 2005; Yamamoto and Lambert, 1994) and as such encompasses both functionality and aesthetics.

In the process of innovation, both functionality and aesthetics play an important role, but an unbalanced focus on one or the other is not sufficient (Norman, 2004). This is particularly relevant for technology-based firms because of the critical bridging, or communication, role that design can play between technical innovation and market opportunities (Freeman, 1983; Walsh, 1996).

Synthesis approach to innovation

Research on innovation has been characterised by a prevailing emphasis on manufacturing of tangible products (Gallouj and Weinstein, 1997). The topic of innovation in services has, however, received some attention and one of the prime areas of discussion in this research is how innovation in manufacturing and services differ and how they are similar (Drejer, 2004; Coombs and Miles, 2000; Hughes and Wood, 2000; Gallouj and Weinstein, 1997; Sundbo, 1997; Atuahene-Gima, 1996).

The boundaries between manufacturing and services, and between tangible and intangible products, are becoming blurred (Von Stamm, 2003; Gallouj and Weinstein, 1997). According to Coombs and Miles (2000), 75–85% of all value creation in manufacturing firms and a similar percentage of costs involve service activities. When studying technological innovation, Sirilli and Evangelista (1998) found that firms in the service and manufacturing sectors show more similarities than differences.

Coombs and Miles (2000), writing on innovation in service firms, claim that most of the empirical research which has been done on service innovation has either treated services as if dealing with manufacturing, or has treated service innovation as distinctly different from innovation in manufacturing. Coombs and Miles (2000), Gallouj and Weinstein (1997) and Drejer (2004) argue that a synthesis approach is preferable. This synthesis approach is based on the premise that the study of service innovation adds to the knowledge of relevant elements of innovation which have been neglected in the study of innovation in manufacturing. Conversely, innovation in services, which tends to be *ad hoc* (Sundbo, 1997) may benefit from the systematic approach which is more common in manufacturing.

The goal of this research is to study innovation in technology-based firms, regardless of whether they base their income on the sales of manufactured products or services. Therefore, a synthesis approach, which permits using the same means to evaluate design as an element of innovation for all technology-based firms, is taken based on the research mentioned above.

Design as an element of innovation and performance

Research on the relationship between design and performance is quite scant (Gemser and Leenders, 2001). Assessing the contribution of design to performance is a complex undertaking because design is only one of several factors that can contribute to success in innovation, and also because of the time lag between innovation and realisation of performance results (Hertenstein *et al.*, 2005). However, it is important to evaluate the contribution of each factor, including design, on an activity as important as the development of new products or services.

An important prerequisite for studying the relationship between design and performance in technology-based firms is an operationalisation of design which provides a means to evaluate design emphasis in these firms. This should provide the first half of the equation linking design with performance.

Model Development

This section begins with the development of the three-dimensional segmentation of design on which the model is based. A method for measuring design emphasis

along these three dimensions is presented. Finally, a graphical representation of the model is presented and used to elucidate the model.

Three-dimensional segmentation of design

A balance between the functional and aesthetic aspects of design is necessary if design is to fulfil its critical bridging role between technical innovation and market opportunities (Norman, 2004; Freeman, 1983; Walsh, 1996). Therefore, when empirically evaluating design emphasis in innovation, it is important to deconstruct the concept of design so that all its important aspects can be accounted for. This calls for an encompassing set of dimensions of design and measurement of emphasis along each of these dimensions.

In his ancient Roman work *De architectura* Vitruvius argues that a structure must exhibit three qualities: *firmitas*, *utilitas* and *venustas*, or strength and durability, usefulness and beauty, respectively. Vitruvius based this thinking on the even older basis of Plato's theory of beauty (*The New Encyclopaedia Britannica*, 1990; *Wikipedia, The Free Encyclopedia*, 2005).

Dreyfuss (1967), Ulrich and Eppinger (2003) and Kotler and Rath (1984) emphasise the importance of appearance, or the form, line, proportion and colour which are used to integrate a product into a pleasing whole, with the primary goal of product differentiation. Norman (2004) argues that design should appeal to all the senses, as appropriate, and uses the term visceral design for this dimension of design which also encompasses Vitruvius' notion of *venustas*, or beauty. Design emphasis along the *visceral* dimension, meaning design that appeals to the senses, is thus taken as the first dimension of design for the model developed here.

Dreyfuss (1967) and Papanek (1984) emphasise the importance of utility, or the intuitiveness of user interfaces. This corresponds with Vitruvius' notions of *firmitas* and *utilitas*, or strength and durability, and usefulness. Dreyfuss (1967) also emphasises the importance of low costs and ease of maintenance facilitated by design which communicates how products are to be maintained and repaired. Ulrich and Eppinger (2003) expand on Dreyfuss's concern for costs by taking into account environmental factors and unnecessary features. Kotler and Rath (1984) argue that design must take into account cost constraints. Papanek (1984) describes method as the interaction of tools, processes and materials to reach a functional goal. Kotler and Rath (1984) include quality, durability and performance as the major elements of design. Norman (2002; 2004) discusses function, understandability, usability and physical feel. For the purposes of the model developed here, the above aspects are referred to as the functional design dimension which encompasses usability and performance.

Vitruvius' taxonomy is grounded in architecture, or the design of physical artefacts. As such, it does not lend itself directly to intangible products or services.

Stuart and Tax (2004) define the design of service products as the design of customer experiences, which resonates with Norman's (2004) concept of reflective design. Dreyfuss (1967) argues that product design should communicate corporate design philosophy and mission. Ulrich and Eppinger (2003) discuss emotional appeal which encompasses factors like attractiveness, pride of ownership and the image of quality. Papanek (1984) includes the psychological, spiritual, social and intellectual needs of human beings in his taxonomy of design. Papanek also includes *telesis*, the attainment of desired ends by the application of purposeful effort, and a concern for human associations or psychological conditioning. *Experiential* design, which is concerned with message, culture and the meaning of a product or service, is taken as the third dimension of the model.

The taxonomies discussed above are summarised in Table 1, which also shows how the three-dimensional segmentation of design used as a basis for the model developed in this article is derived.

All three dimensions of design are, in essence, concerned with aspects of the interface between human beings and products or services. Norman (2004) argues that the three dimensions of design he defines are equally important. Roy and Riedel (1997) argue that a multi-dimensional approach to design is more successful than a narrow approach. In their discussion of design education, Broadbent and Cross (2003) call for a wholistic approach to design, which goes beyond the prevailing emphasis on mechanical systems. This supports examining a firm's combination of design dimension emphases when studying design as an element of innovation and suggests that ideally firms' design emphasis should be a balanced blend of all three dimensions.

Measuring design emphasis

The model is based on an evaluation of emphasis on each of the three dimensions of visceral, functional and experiential design, respectively. An alternative approach would be to measure exhibited performance, or quality, along each of the design dimensions. Hertenstein *et al.* (2005), when evaluating firms' design efforts, asked a panel of experts in industrial design to rank the firms. The expert rankings were intended to reflect the cumulative industrial design reputation of a firm's products. This approach is not feasible when studying new firms whose products and services may not be fully developed and which are unlikely to have built a reputation. Because this study has technology-based firms as its subject of study, including new and young firms, third-party assessment of exhibited performance or design quality is not feasible. Therefore, this research uses as its basis respondent reports on design emphasis along the three design dimensions.

A set of survey questions to measure emphasis on the three design dimensions was developed, (see Appendix). The terms visceral, functional and experiential are

Table 1. Derivation of three-dimensional design segmentation based on taxonomies defined by selected authorities.

Vitruvius ^a	Dreyfuss (1967) ^b	Papanek (1984)	Kotler and Rath (1984)	Ulrich and Eppinger (2003)	Norman (2004)	This article
<i>Venustas</i> (beauty)	Appearance	Aesthetics (gestalt, perception)	Appearance	Product differentiation	Visceral design	Visceral design
		Intuitiveness		Quality of user interfaces		
<i>Utilitas</i> (usefulness)	Utility Low costs	Use, method	Performance Cost	Appropriate use of resources	Behavioural design	Functional design
<i>Firmitas</i> (strength and durability)	Ease of maintenance		Durability	Ability to maintain and repair		
	Communication	Association, conditioning Needs Telesis (nature, society, technological bias)		Emotional appeal	Reflective design	Experiential design

^aIn *The New Encyclopaedia Britannica* (1990) and Wikipedia, *The Free Encyclopedia* (2005).

^bIn Ulrich and Eppinger (2003).

not used in the questions, instead the questions deal with tangible design aspects which fall under one of the three design dimensions. Pine and Gilmore (1989; 1999) argue that a firm's true economic offering is the economic offering for which the firm charges its customers. In the interest of capturing firms' actual level of design emphasis with more reliability than by only using questions asking for an assessment of emphasis specifically, the survey also includes questions asking for an indication of how much value respondents believe the market attributes to design. More specifically, firms are asked to rate how much more they believe their current or future customers are, or will be, willing to pay for products or services based on design.

The metrics of interest are firms' emphases on each of the three design dimensions. Given these metrics, firms can be classified with respect to (i) their overall design emphasis, (ii) the focus of their design emphasis and (iii) the level of balance in their design emphasis.

Graphical representation of model

Classification of firms according to overall design emphasis, design focus and balance in design emphasis are captured in the graphical representation of the model shown in Fig. 1. Overall design emphasis is plotted on the y-axis and encompasses all three dimensions of design, with all three dimensions having equal weight (Norman, 2004). The y-axis is divided into three equal segments to represent three levels of overall design emphasis ranging from the lowest possible emphasis to the highest

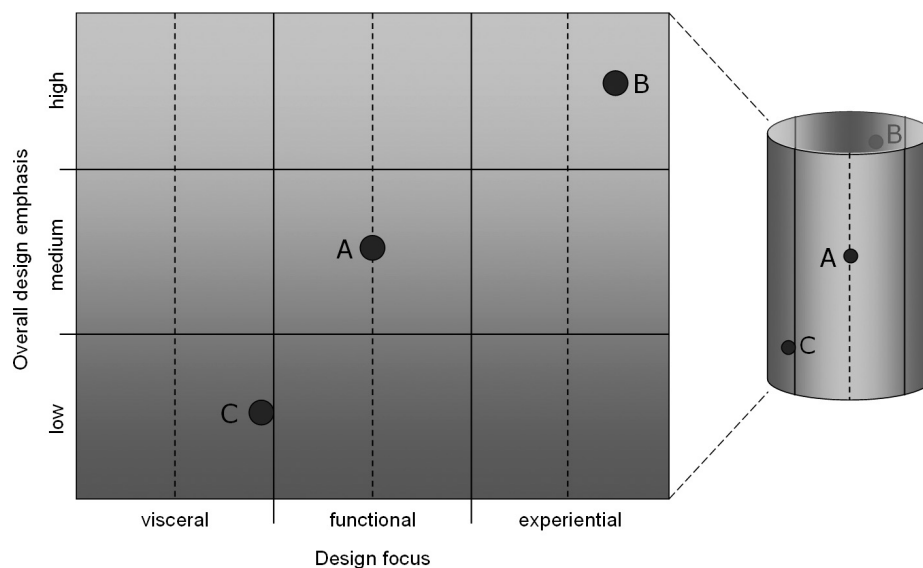


Fig. 1. Cylindrical model representing design emphasis, design focus and design balance in innovation. The figure includes three hypothetical examples.

possible emphasis. The x -axis is divided into three segments, one for each of the three design dimensions. A firm is positioned along the x -axis to represent its primary and secondary design focus. The primary focus is the design dimension on which the firm places the greatest emphasis and, likewise, the secondary focus is the design dimension on which the firm places the second to the greatest emphasis. The closer a firm is to the solid lines between the segments, the more balanced are its primary and secondary design foci. If the primary and secondary foci are balanced (close to equal) and overall design emphasis is high, it follows that emphasis along the third dimension is also reasonably high and therefore such a firm can be said to have balanced high emphasis on design.

The surface of the model should be viewed as a vertically oriented cylinder, as shown in Fig. 1, to allow for the possibility of a primary visceral focus and secondary experiential focus, or vice versa.

Figure 1 shows three hypothetical example firms to illustrate what the graphical representation of the model shows. Firm A has medium overall design emphasis in innovation and its primary design focus is functional. Its secondary design focus is much weaker than the functional focus and therefore the corresponding point is situated in the horizontal centre of the functional focus segment. Firm A can be described as having strong emphasis on functional design but low emphasis on the other dimensions which means it has an unbalanced design emphasis skewed towards the functional dimension.

Firm B has high overall design emphasis in innovation with a primary focus on the experiential dimension and a secondary focus on the visceral dimension. Since firm B's overall design emphasis is high, it follows that it must have a reasonably high emphasis on the functional design dimension also.

Firm C has low overall design emphasis and although its primary focus is on the visceral dimension, the strength of its secondary design focus (functional) is relatively close and therefore the corresponding point is situated close to the solid line separating the visceral dimension from the functional dimension. Since firm C has low overall design emphasis it follows that its emphasis along the experiential dimension is also low.

Assumptions on which the model is based

To summarise, the model developed in this article is based on the assumption that emphasis on design as an element of innovation in technology-based firms should be evaluated by considering three dimensions of design: visceral, functional and experiential. Furthermore, the model is based on the assumption that self-reported emphasis on design dimensions as well as firms' perceived market advantage of using design can be used to measure design emphasis.

Demonstration of Model Application

This section demonstrates the application of the model developed in the previous section. The empirical data set is described followed by a description of data collection. Finally, the results of the empirical study are presented including illustration using three firms selected from the data set.

Data set

To empirically demonstrate the application of the model developed, a survey of new technology-based firms in Iceland was conducted in 2005.

The opinion that design is too expensive to justify is held by some firms (Hertenstein *et al.*, 2005; Gemser and Leenders, 2001). This view can be expected to be more pervasive in new firms than in more established firms, since new firms are generally more resource constrained than established firms (Murray and Lott, 1995; Garnsey, 1995). At the same time, the ability to use design is particularly important for small firms because they seldom have the ability to compete on price, since this generally requires economies of scale (Black and Baker, 1987). Because of the specific importance of design for new, generally resource-constrained firms, the decision was made to limit the empirical study to new technology-based firms. An added advantage of limiting the study to new firms is that this increased the homogeneity of the sample.

It is common practice to view firm size and age as control variables when studying innovation, since considerable variation in innovative behaviour can be anticipated as being related to differences in size and age (Freel, 2005). By limiting this study to a set of firms similar in age and size (all of the firms studied were less than 5 years old and had fewer than 100 employees) the consideration of the effects of size and age could be eliminated. The validity of this assumption was confirmed using regression analysis to examine if size and age were significantly related to design emphasis. The result of this regression analysis was that size and age are not significantly related to design emphasis in this set of firms.

Homogeneity was also increased by limiting the study to firms in Iceland. This made it unnecessary to take into account possible variance attributable to cultural differences or different economic environments.

Hughes and Wood (2000) found that technology-based firms, whether in manufacturing or services, exhibit strong similarities in innovative behaviour which is substantially different from the behaviour seen in other firms. Therefore, it can be expected that limiting this study to technology-based firms limits variations which could be attributable to industry differences.

To summarise, limiting the empirical study to new technology-based firms in Iceland, although this does necessarily limit the size of the data set, has the offsetting advantage of ensuring a relatively homogeneous sample.

A list of firms founded after 1999, which were classified as technology-based firms according to their ISAT¹ codes and which paid salaries in September 2004, was obtained from the Icelandic National Registry. Firms having fewer than three employees were not included, unless such firms were less than 2 years old. This was done in the interest of not including legal entities established strictly for technical or tax reasons around one or two self-employed persons. Background information was checked for all remaining potential participant firms so that firms which did not engage in technology-based development despite their ISAT classification could be eliminated. The result was that 80 firms were identified as potential participants. When contacted, 10 of these had gone out of business, and of the remaining 70 firms, 65 agreed to participate (93%).

Data collection

Data collection was performed through face-to-face interviews with the CEOs of the participant firms. Each interview took about one hour. In addition to the questions shown in Appendix, the interview covered founding of the firms and their current conditions in detail.

Prior to data collection, a draft version of the questionnaire was pre-tested on four managers from four different firms. A few minor changes to wording were made following the pre-test.

Respondents were asked to rate the emphasis their firms place on various design aspects, each one falling under one of the three design dimensions, when defining and developing new products or services. Respondents were also asked to indicate how much more they thought their current or future customers would be willing to pay for products or services due to each design aspect. The possible responses ranged along a five-point Likert-scale from “very little emphasis” to “very much emphasis”.

To test the appropriateness of the synthesis approach to innovation in manufacturing and services, respondents were also asked to indicate how their firms' revenues are divided between revenues for the sale of tangible products, on one hand, and revenues for the sale of services, on the other.

¹The Icelandic National Registry classifies firms according to the ISAT 95 coding system, which is based on the European Union's NACE 1 coding system.

Results of empirical demonstration

Table 2 shows the summary statistics for design emphasis for the set of firms. T -tests² were used to ascertain if there is a significant difference between emphasis on the three dimensions. Paired t -tests confirmed that there is a significant ($p < 1\%$) difference between the emphases.

To test the appropriateness of using the synthesis approach to innovation in manufacturing and services, the design emphasis of the three groups represented by the firms surveyed, namely firms basing all of their revenues on the sale of services, firms basing part of their revenues on the sale of services and firms basing all their revenues on the sale of products, were compared. The results are shown in Table 3.

Table 2. Summary Statistics for Design Emphasis.

Design emphasis	Mean	Standard deviation	Minimum	Maximum
Visceral	0.47	0.24	0.1	1
Functional	0.77	0.23	0.2	1
Experiential	0.56	0.26	0	1

Design emphasis along each dimension can range from 0 to 1.0.

Table 3. Summary statistics for design emphasis for firms grouped according to whether their income is based on the sale of products, services or both.

Design emphasis	Mean	Standard deviation	Minimum	Maximum
<i>100% Product Firms (8% of the firms)</i>				
Visceral	0.59	0.32	0.2	1
Functional	0.70	0.12	0.5	0.8
Experiential	0.66	0.27	0.2	0.9
<i>100% Service Firms (38% of the firms)</i>				
Visceral	0.45	0.18	0.15	0.9
Functional	0.75	0.23	0.20	1
Experiential	0.59	0.27	0	1
<i>Product and Service Firms (54% of the firms)</i>				
Visceral	0.47	0.27	0.1	1
Functional	0.79	0.24	0.2	1
Experiential	0.52	0.26	0	1

Design emphasis along each dimension can range from 0 to 1.0.

²The t -test determines the probability that two populations are the same with respect to the variable tested.

Two-sample *t*-tests confirmed that there is not a significant difference between design emphases along the three dimension for firms deriving all their revenue from the sale of services, all their revenue from the sale of products, and those selling both products and services. Therefore, the appropriateness of the synthesis approach to studying innovation in technology-based firms is confirmed.

Interestingly, only five of the firms included in the study reported that all their revenues are due to sales of tangible products, while a little over half of the firms indicated that their revenues are based on a mix of sales of tangible products and services. Keeping in mind that the firms in question are less than 5 years old, this may be an indication that new technology-based firms tend to define themselves as service providers rather than manufacturers. This is in harmony with the trends observed by previous research (e.g. Von Stamm, 2003; Pine and Gilmore, 1998; 1999; Gallouj and Weinstein, 1997; Coombs and Miles, 2000; Bryson *et al.*, 1997).

Figure 2 shows a graphical representation of the results for the firms studied. The largest concentration of firms, (68%), were found to have their primary design focus on the functional design dimension. This is not surprising in view of the fact that the firms under study are technology-based firms and as such can be expected to have a foundation in engineering with a corresponding emphasis on functionality.

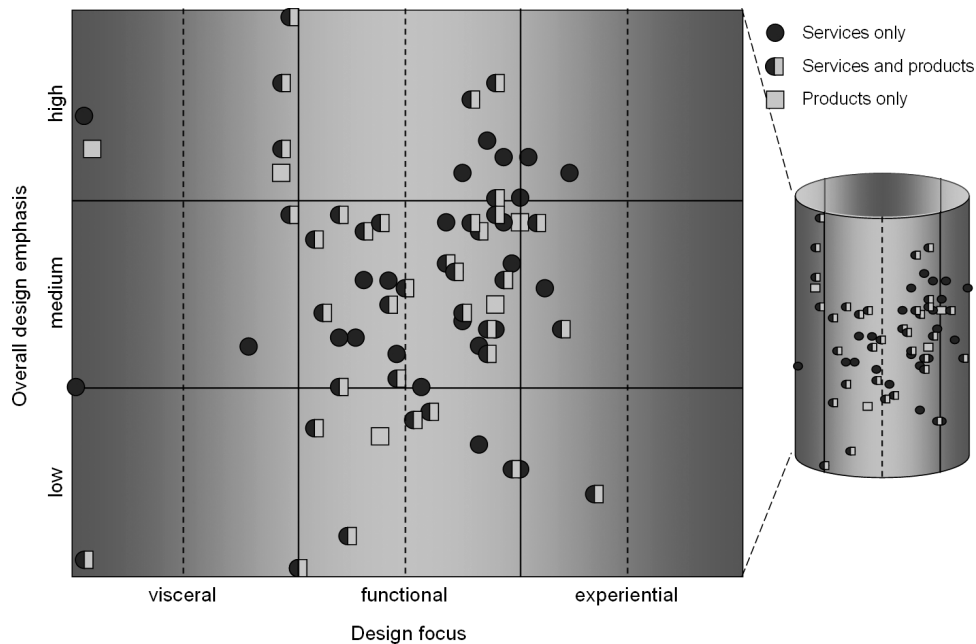


Fig. 2. Classification of firms surveyed based on design focus (*x*-axis) and overall design emphasis (*y*-axis).

Table 4. Summary statistics for design emphasis for firms grouped according to overall design emphasis.

Design emphasis	Mean	Standard deviation	Minimum	Maximum
<i>Firms with high overall design emphasis (18% of the firms)</i>				
Visceral	0.75	0.20	0.35	1
Functional	0.87	0.16	0.50	1
Experiential	0.87	0.10	0.70	1
<i>Firms with medium overall design emphasis (58% of the firms)</i>				
Visceral	0.46	0.18	0.1	0.8
Functional	0.81	0.16	0.2	1
Experiential	0.55	0.19	0.1	0.9
<i>Firms with low overall design emphasis (23% of the firms)</i>				
Visceral	0.20	0.05	0.1	0.25
Functional	0.52	0.33	0.2	1
Experiential	0.23	0.18	0.0	0.55

Design emphasis along each dimension can range from 0 to 1.0.

Table 4 shows summary statistics for three sets of firms grouped according to their overall design emphasis.

As shown in Table 4, the group of firms with a high overall design emphasis (18% of the firms) show a consistently high emphasis along all three dimensions, albeit a somewhat lower emphasis along the visceral dimension. The group of firms with low and medium overall design emphasis show considerable skewing with relatively greatest emphasis along the functional dimension.

In Fig. 3, three firms from the data set are highlighted. To further illustrate the application of the model a brief description of each of these firms and their design emphasis follows. The descriptions are based on both the survey data and related conversations with the CEOs during the interviews.

Firm X: This is a firm which manufactures consumable products for the consumer market. All the firm's income is based on product sales. This firm has high overall design emphasis and its primary focus is on the visceral design dimension with the experiential design dimension a close secondary focus. Firm X's design emphases are as follows: visceral design 1.0; functional design 0.5 and experiential design 0.9 with all design emphases measured on a scale from 0 to 1. With its relatively low emphasis on the functional dimension, firm X is atypical relative to the data set. One could venture the explanation that firm X's high emphasis on the visceral dimension of design is associated with the fact that it sells tangible products to the consumer

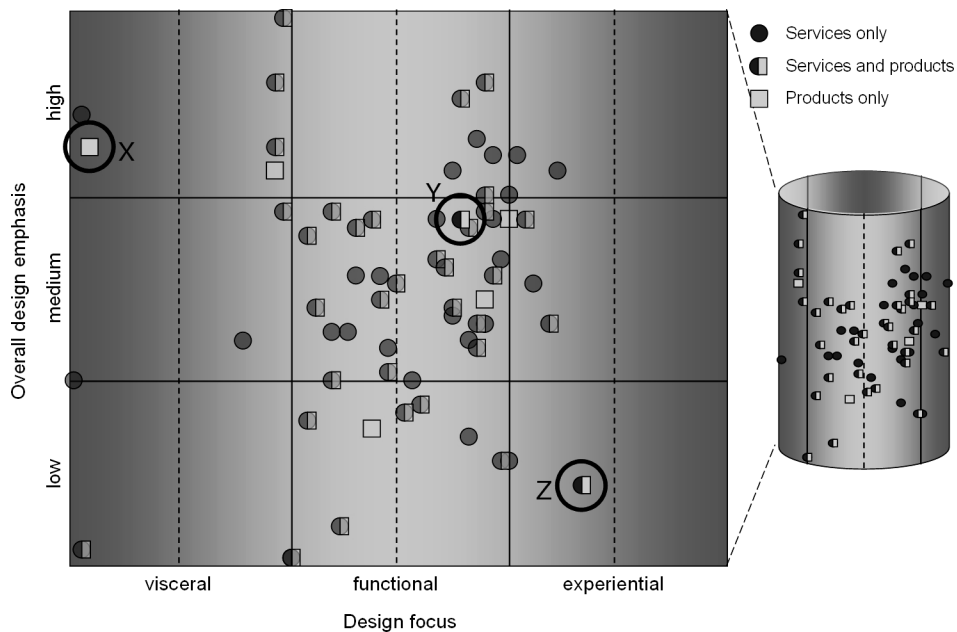


Fig. 3. Three example firms selected to illustrate the application of the model.

market whereas most of the firms in the data set (about 75%) are primarily in the business-to-business market.

Firm Y: This firm provides engineering services to industrial manufacturing firms; 75% of firm Y's income is based on the sale of services and the other 25% is based on both the sales of products produced by firm Y and the resale of third-party products. The firm falls in the medium overall design emphasis segment, and its primary focus is on the functional design dimension. Firm Y's design emphases are as follows: visceral design 0.5; functional design 0.9 and experiential design 0.7 with all design emphases measured on a scale from 0 to 1. Firm Y is close to typical for the data set, although its design emphases along the functional and experiential dimensions are above average (see Table 2). Firm Y is concerned not only with the functional aspects of its services but also with creating a positive experience for its customers, since this is likely to result in repeat business and new business opportunities. Firm Y is founded by persons with a technology background, and employs mostly persons with a technology background. As such, firm Y is highly representative of the data set.

Firm Z: This firm provides consulting in the field of information technology (IT) to a wide variety of firms; 80% of firm Z's income is based on the sale of services and the other 20% are based on the resale of IT products. Firm Z has a low overall design emphasis with a primary emphasis on the experiential dimension. Firm Z's design emphases are as follows: visceral design 0.2; functional design 0.2 and experiential design 0.55 with all design emphases measured on a scale from 0 to 1.

Firm Z is primarily concerned with creating a positive experience for its customers, probably because firm Z's consulting services involve a high level of interaction with customers.

The goal of the empirical study described in this section is to demonstrate the application of the model developed in this article. A set of data was collected using the survey questions developed to measure emphasis along the three design dimensions of visceral, functional and experiential design, respectively. Statistical summaries were presented as well as a graphical representation of the design emphasis results for the set of firms studied. Three examples were presented to illustrate the use of the model in a tangible way.

Conclusions

The stated goal of this article is to contribute to the field of innovation management by developing a methodology to evaluate the emphasis on design as an element of innovation in technology-based firms, as well as demonstrating the application of this methodology.

It is argued that design can be particularly important for technology-based firms because it can provide a bridge between technical innovations and market opportunities. Design can be used as a means to enhance and communicate the value of products or services, which might otherwise be ill understood, to customers.

This article argues that there is a need for a methodology to evaluate design emphasis in technology-based firms. The core of the argument is that whereas previous research and anecdotal evidence suggest that design can be an important means to achieve competitive advantage, ultimately, for design to be beneficial, it must have a positive influence on performance. Developing a methodology for evaluating design emphasis in technology-based firms provides one side of the equation needed to study the relationship between design and performance.

A model based on a three-dimensional segmentation of design, comprising the visceral, functional and experiential dimensions, respectively, is derived from an analysis of design taxonomies suggested by several researchers. Based on the argument that innovation should be studied in the same way across the manufacturing versus services dichotomy, the model is developed to apply to technology-based firms in general, regardless of the basis for their revenue.

The model developed is based on self-reported emphasis along the three design dimensions by firm respondents as well as their assessment of the value of design in the market. This is subject to the inescapable limitations of basing analysis on self-reported assessments. There may be a tendency among respondents to report higher than actual levels of design emphasis in an effort to represent themselves

and their firms well. This limitation is mitigated to some extent by asking for both an assessment of emphasis on specific aspects of design and of the value of the same design aspects in the market, which turns the respondents' focus outward and possibly provides a more accurate measure of true design emphasis. At least this provides two measurement points for each design aspect instead of only a self-assessment of emphasis.

As is argued in the article, basing the model on third-party evaluation of design quality is not feasible if the model is to be applicable to new and young technology-based firms. Third-party evaluation of design quality in new and young firms is infeasible since they may not have introduced any products on the market and are unlikely to have built a design reputation.

The application of the model is demonstrated using a set of new technology-based firms. The empirical study confirms the appropriateness of using the synthesis approach for studying design as an element of innovation in technology-based firms, since no significant difference is found in design emphasis based on whether firms base their revenues on the sale of manufactured products, service delivery or both.

The application of the model provides a classification which can be used as a basis for studying the relationship between design emphasis and performance. Several comparisons of firm performance in relation to design emphasis are possible using the model. In the first place, a comparison could be made between the performance of firms having low, medium and high overall design emphasis. In the second place, a comparison between the performance of firms having primary focus along each of the design dimensions could provide interesting results, particularly if the set of firms under study constitutes a homogeneous sample of similar firms. In the third place, the focus could be placed on balance between the design dimensions and the performance of firms having a balanced emphasis on the design dimensions could be compared with the performance of firms having a skewed emphasis.

Although the primary incentive for developing the model is to provide a means to study the relationship between design and performance, the operationalisation encompassed in the model provides a basis for further research on design as an element of innovation in technology-based firms in a broader sense. Comparing design emphasis with the firm's level of innovation could be of interest, to name just one example.

The application of the model also provides a classification which could be used for the purposes of selecting firms having various profiles of design emphasis and focus for in-depth research (Miles and Huberman, 1994).

Although the empirical results generated through the demonstration of the model are only a by-product of this article, some discussion of these results is warranted. The firms studied were found to vary quite widely in the intensity of their design emphasis and since the set of firms studied is homogeneous; the attribution of

this variability to differences in age, size, sector, cultural environment, economic environment or industry can be discounted. A tendency to emphasise the functional design dimension over the visceral and experiential dimensions was prevalent among the firms studied. Since the firms studied are all technology based they can be expected to be founded by persons with an engineering background with a corresponding emphasis on functionality and/or to employ a high proportion of persons with such a background. Therefore, the firm's emphasis on the functional dimension of design is not unexpected, but it would be worthwhile to empirically study the possible relationship between founder/employee background and design emphasis.

In addition to its applicability to research, the model developed could be useful for practitioners. The model provides a straightforward way to evaluate single firms or group of firms with respect to their emphasis along the dimensions of visceral, functional and experiential design. Practitioners, managers and consultants could use the model for self- or third-party evaluation of current design emphases and foci, and identification of the gap between the current situation and a desirable state.

Further research is needed on the role of design as an element of innovation in technology-based firms. Manifestation of design in the form of actual design activities practised and organisation of design activities should be studied. Classifying firms according to the nature of their design emphasis using the model developed in this chapter could provide a basis for identifying differences in the innovation processes, with respect to design manifestation, for the different classes of firms.

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Appendix: Survey Questions

Below are translations of the questions originally written in Icelandic. Only the Icelandic language version of the questions has been tested and used for empirical study.

Question text	Answer coding	Design dimension measured
When new products or services are defined and developed in your firm, how much emphasis do you place on visual design?	Emphasis on a scale from 1 to 5	Visceral
Do you think your customers are prepared to pay a lot more or a little more for products or services because of their visual design?	How much more on a scale from 1 to 5	Visceral
When new products or services are defined and developed in your firm, how much emphasis do you place on the characteristics of the environment where the product is sold or the service is provided?	Emphasis on a scale from 1 to 5	Visceral
Do you think your customers are prepared to pay a lot more or a little more for products or services because of the characteristics of the environment where the product is sold or the service is provided?	How much more on a scale from 1 to 5	Visceral
When new products or services are defined and developed in your firm, how much emphasis do you place on utility characteristics?	Emphasis on a scale from 1 to 5	Functional
Do you think your customers are prepared to pay a lot more or a little more for products or services because of their utility characteristics?	How much more on a scale from 1 to 5	Functional
When new products or services are defined and developed in your firm, how much emphasis do you place on the customer's self-image?	Emphasis on a scale from 1 to 5	Experience
Do you think your customers are prepared to pay a lot more or a little more for products or services because they fulfil their self-image?	How much more on a scale from 1 to 5	Experience
When new products or services are defined and developed in your firm, how much emphasis do you place on creating a positive experience, emotional value or positive memories for your customers?	Emphasis on a scale from 1 to 5	Experiential

(Continued)

(Continued)

Question Text	Answer Coding	Design Dimension Measured
Do you think your customers are prepared to pay a lot more or a little more for products or services because of the positive experience, emotional value or positive memories which the product or service creates for them?	How much more on a scale from 1 to 5	Experiential
How was your firm's income in the year 2004 divided between income based on the sales of services and the sales of products?	Percentage split	N/A

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PAPER 2:
**OIL IN WATER? EXPLAINING DIFFERENCES
IN AESTHETIC DESIGN EMPHASIS IN NEW
TECHNOLOGY-BASED FIRMS**

Marina Candi & Rögnvaldur Sæmundsson

Revised and resubmitted version under consideration by an academic journal

Oil in Water? Explaining Differences in Aesthetic Design Emphasis in New Technology-based Firms

Abstract

The purpose of this research is to investigate how differences in aesthetic design emphasis among new technology-based firms (NTBFs) can be explained. Four hypotheses are developed based on a synthesis of existing research in the fields of design, strategy and entrepreneurship. The hypotheses are tested based on a survey of 103 NTBFs. The results of the research indicate that aesthetic design emphasis is significantly related with the importance of aesthetic design in a firm's chosen sector, which can be classified as a positioning factor. Aesthetic design emphasis is also significantly related with founder characteristics, which are resource factors, namely founders' technical education and founders' experience of sales and marketing, respectively. The results of the research lend some support to the anecdotal notion that engineers do not appreciate the value of aesthetic design and suggest that the source of this lack of appreciation is their education.

Keywords

Innovation, design, aesthetic design, new technology-based firms

Introduction

There is increasing appreciation that differentiation based on technological factors alone is not sufficient to insure success in today's highly competitive markets. Instead, the use of aesthetic design as an element of innovation has been proposed as an important means for achieving differentiation, leading to competitive advantage and improved performance (Hertenstein, Platt and Veryzer 2005; Gemser and Leenders 2001; Norman 2004).

The opinion that aesthetic design is too expensive to justify is common (Hertenstein et al. 2005). This view can be expected to be more pervasive in new firms than in more established firms since new firms are generally more resource constrained than established firms (Murray and Lott 1995; Garnsey 1995). At the same time, the ability to use aesthetic design as an element of innovation is particularly important for start-up companies because their strategies are likely to be based on differentiation (Carter, Stearns and Reynolds 1994; Black and Baker 1987).

New technology-based firms (NTBFs) constitute a class of firms that should be especially sensitive to the use of aesthetic design to achieve competitive advantage. NTBFs base their existence and success on technological innovation and aesthetic design can create a bridge between technical functionality and the value of products and services (Walsh 1996; Hertenstein et al. 2005). To insure good design Norman (2004) argues that it is not sufficient to focus on functionality and utility, which can be expected to be quite prevalent foci in technology-based firms, but that aesthetic aspects of design are equally important. Roy and Riedel (1997) similarly found that commercially successful technological innovation projects involved a multidimensional approach to design.

Despite the importance of aesthetic design for the competitive advantage of NTBFs, little is known about these firms' emphasis on aesthetic design. The purpose of this study is to investigate how much emphasis NTBFs put on aesthetic design as an element of innovation and how differences in aesthetic design emphasis can be explained. This should contribute to an understanding of how early stage conditions influence subsequent performance in technology-based firms.

Before discussing the research methodology, the following chapter provides a brief review of the literature followed by the formulation of hypotheses regarding factors explaining variation in aesthetic design emphasis. The paper continues with a discussion of the empirical data and the variables and measures used. The results are presented, and the paper closes with a discussion of these results, the conclusions reached and their implications.

Theoretical Background and Hypotheses

The concept of the new technology-based firm (NTBF) has been used in many different ways. Most authors agree that NTBFs base their operations on technology, but make different assumptions with regards to the firms' origins and the newness of the technology. For example, Roberts (1991) refers to NTBFs as spin-offs from university settings that exploit advanced technology, Autio (1995) includes all spin-offs which exploit advanced technology, and Bollinger, Hope and Utterback (1983) define NTBFs as new firms that are established in order to exploit a technological innovation independently of the novelty of the innovation or the underlying technology. For the purposes of this study we use Bollinger's et al. (1983) definition focusing on NTBFs as venues for technological innovation, and define NTBFs as *new independent firms that develop new offerings products and services based on the technical knowledge of their founders*.

The technological innovation process is sometimes described as a not entirely harmonious integration of two factions (Marsh and Stock 2003). The first faction is primarily technical in nature (e.g. R&D and engineering), and the second is primarily commercial (e.g. design and marketing). The commercial faction is concerned with providing a bridge from technical functionalities to value in a finished product or service. Design, as part of the innovation process, includes activities which enhance and communicate the value of products or services (Hertenstein et al. 2005; Yamamoto and Lambert 1994).

As argued by Norman (2004), design encompasses both functionality and aesthetics. While functional design is concerned with the practical concerns of features and utility, aesthetic design is concerned with visceral appeal, or how products and services appeal to the senses, and the experiences created through their consumption or use. Norman further argues that there is a strong connection between aesthetic design and usability. This resonates with the research reported by Van der Heijden (2003) who finds that the perceived visual attractiveness of web sites influences usefulness, enjoyment and ease-of-use.

Firms' emphasis on the use of aesthetic design in the innovation process can be viewed as part of their competitive strategy. Activities are the basic units of competitive advantage and choosing activities and how to perform them to deliver a unique mix of value is the essence of competitive strategy (Porter 1996).

The level of emphasis on aesthetic design will influence to what degree, and how, aesthetic design is used in innovation activities and will, in turn, influence the perceived value of the products and services resulting from this innovation.

Assuming that emphasis on aesthetic design can be a part of a firm's competitive strategy it follows that differences in emphasis across firms can be explained in a similar way as differences in competitive strategy. There are two distinct perspectives within the strategy literature with regard to the sources of differences in competitive strategy. These perspectives can be labeled the *positioning perspective* (Porter 1980, 1985) and the *resource-based perspective* (Wernerfelt 1984; Barney 1991; Peteraf 1993), respectively.

According to the positioning perspective, competitive advantage is based on the underlying structure of the industry where firms compete. The primary goal of competitive strategy is to "*find a position in the industry where the company can best defend itself against these competitive forces or can influence them in its favor*" (Porter 1980, p. 4). Therefore, the sources of competitive strategy are rooted in the forces of competition within an industry, based on the assumption that managers are able to identify, and willing to secure, a favorable position with regard to these forces. Over time this will lead to relative homogeneity in competitive patterns within industries where less successful firms imitate the strategies of the more successful ones (Demsetz 1973).

Due to the homogeneity in competitive patterns some strategies may be required in order to compete in a particular industry. For example, Ford (1988) classifies 'basic' technologies as technologies on which a technology-based firm depends, and without which it would be unable to compete in its industry.

Similarly, the emphasis on design required to compete has been found to vary across industries. Gemser and Leenders (2001) found the relationship between design and various performance indicators to be considerably weaker in the furniture industry than in the instruments industry. They suggest that the reason for this difference is that design is expected in the furniture manufacturing industry, whereas it is not as established in the instrument industry. In the furniture industry, design can be viewed as a baseline requirement for competing. In the instruments industry, however, design is not required to compete, and so may constitute a means to achieve superior performance through differentiation.

Perspectives similar to the positioning perspective have been found to be highly relevant for understanding competitive strategies in new ventures. The new venture is hampered by liability of newness (Stinchcombe 1965) and is highly dependent on its environment for the resources needed for its survival (Pfeffer and Salancik 1978). To compete for these resources, e.g. through funding or sales, new venture managers need to pursue strategies that are acceptable to resource owners (Aldrich 1979). In line with this thread of reasoning Carroll and Hannan (1989) found that the environmental conditions at founding, e.g. population density, shape the organizational form of new ventures as well as their strategies. In the same vein, McDougall, Covin, Robinson and Herron (1994) found that the choice of entry strategy differs significantly between ventures established in high-growth and low-growth environments, respectively, and Carter, Stearns, Reynolds and Miller (1992) found that strategies of new ventures vary across stages in the supply-chain.

Based on the above we expect the sector in which a NTBF enters to have an influence on the NTBF's emphasis on aesthetic design and our first hypothesis becomes:

Hypothesis 1: In NTBFs started up in sectors where the use of aesthetic design is more important for developing competitive products or services, more emphasis will be placed on aesthetic design than in NTBFs starting up in sectors where the use of aesthetic design is less important.

According to the resource-based perspective on strategy, competitive advantage is based on the characteristics of the resources that are controlled by firms, including the knowledge and beliefs of management (Wernerfelt 1984; Barney 1991). These resources determine the competencies and capabilities of the firm, provide a stable sense of direction in a changing world (Grant 1991), and a bundle of skills and technologies which are used to create value for customers (Prahalad and Hamel 1990). Thus, the set of resources controlled by the firm is the main source of competitive strategy and the heterogeneity of resources the main source of differences across firms.

An important source of resource heterogeneity is the path dependent nature of firm development. Firms start out with different resource endowments which set them off along different paths of cumulative learning. The resources and activities, or routines, within the firms shape the knowledge that is developed

within firms (Nelson and Winter 1982; Helfat 1994). While cumulative learning enables effective operation of the firm and improves the firms' absorptive capacity (Cohen and Levinthal 1990), it may also cause firms to become rigid and unresponsive to changes in the environment (Leonard-Barton 1992; Saemundsson 2004).

The primary resources available to an NTBF are its founding team. The technical expertise of founders determines the types of business opportunities available to the new venture (Oakey and Cooper 1991) and defines the capability of the venture to mobilize more resources, as well as the ability to use these resources to generate revenues (Garnsey 1998) and competitive advantage (Smith and Sharif 2007). Founders also play by far the most important role in the formation of organizational culture in new firms (Schein 2004). The organizational culture consists of shared values, or assumptions, about the venture *"itself, its environment, and how to do things to survive and grow"* (Schein 2004, p. 226). These shared values, which reflect the beliefs about the elements of competitive strategy needed for survival and growth, are dependent on the prior knowledge and experience of the founders.

As aesthetic design can provide a bridge between the commercial and technological aspects of the innovation process, one would expect founders' prior knowledge and experience within these two fields to influence aesthetic design emphasis. Prior knowledge and experience will not only determine the expertise available for employing aesthetic design as an element of innovation, but also assumptions made about the importance of aesthetic design for survival and growth.

The technical background of NTBFs' founders and the high proportion of science and engineering-educated employees are likely to lead to a unique set of shared values (Roberts 1991; Slatter 1992). In many respects these values are shaped by professional norms infused through the educational system, e.g. through engineering education. Within engineering, problem-solving is the key activity and the concept of design is seen as the central mechanism for a systematic approach for solving problems (Vincenti 1990). As engineering education, at least since World War II, has focused on the theoretical and mathematical foundations of engineering, it has led to over-emphasis on the functional aspects of design, with little consideration for the aesthetic aspects of design (Seely 1999; National Research Council 1999). Engineering, as well as the practical side of the

natural sciences, have been more concerned with the exactness of their profession, which makes for “*truth and conscience*” (Hoover 1967, p. 78), than with its arts, and Moody (1984) concludes that the attitudes of engineers can be a major impediment to the use of industrial design expertise.

On the other hand, experience of sales and marketing is likely to have the opposite effect. Aesthetic aspects of design are concerned with improving customer experience (Norman 2004). As sales and marketing are concerned with understanding and fulfilling customer needs and demands one would expect founders with experience in this field to have a better understanding of the value of improving customer experience through aesthetic design.

From the arguments above we expect the education and experience of NTBFs’ founders to influence how much emphasis is placed on aesthetic design leading to the following set of hypotheses:

Hypothesis 2: The education and experience of founders will influence how much emphasis is placed on aesthetic design in NTBFs.

Hypothesis 2a: The higher the proportion of founders with technology-based university degrees, the less emphasis will be placed on aesthetic design.

Hypothesis 2b: The higher the proportion of founders with prior experience of sales and marketing, the more emphasis will be placed on aesthetic design.

In the next section the methods used to test the hypotheses are described.

Method

This chapter describes data collection, the variables used and data analysis.

Data collection

The hypotheses were tested using quantitative data from an ongoing longitudinal study of new technology-based firms. In 2006, a list of firms founded in the year 2000 or later and registered in technology-based sectors was obtained from public records in a Nordic country. Firms with less than 3 employees were omitted, unless such firms were 2 years of age or younger. Background information was checked for all potential participant firms to identify firms

likely to meet the criteria of the above definition of NTBFs. This resulted in a total of 133 firms identified as the population of technology-based firms. When contacted, 20 of the firms had gone out of business or were found to not fulfill the criteria for inclusion, i.e. were not actually, or no longer, technology-based firms. Of the remaining 113 firms, 103 agreed to participate (91%). This high participation rate is a strength of the research. In fact, it might be more appropriate to view the research as population research rather than research on a representative sample. This would permit the selection of a smaller confidence interval than for a sample. However, the data was conservatively treated as a sample for statistical analysis and a conventional 95% confidence interval was used.

The survey consisted entirely of structured questions and was administered in face-to-face interviews with the firms' CEOs. The duration of each interview was approximately one hour and each interview covered founding and current activities in detail.

To estimate the general importance of design by sector, a panel of experts was asked to rate the importance of each of the three dimensions of design, the visceral, the functional and the experiential, for each of the sectors represented by the NTBFs included in the study. The panel consisted of three experts representing the breadth of the areas into which the NTBFs under study fell, namely engineering, architecture and information technology. The experts were selected based on having at least 10 years' experience and university degrees, at the Master of Science level or higher, in their fields. The three experts did not have a history of working on the same projects or for the same firms. The experts were not among the survey participants. The panel's evaluations of visceral and experiential design importance in each sector were combined to obtain an evaluation of the importance of aesthetic design by sector.

Dependent variable

Aesthetic design applied to the development of new products or services is the dependent variable for this study.

Roy and Riedel (1997) argue that a multi-dimensional approach to design is more successful than a narrow approach. In their discussion of design education, Broadbent and Cross (2003) call for a holistic approach to design, which goes beyond the prevailing emphasis on mechanical systems. This supports taking a

broad view when studying design as an element of innovation. In a study of the prevalence of design in technology-based firms, Candi (2006) develops a three-dimensional taxonomy of design consisting of the visceral, the functional and the experiential dimensions, analogous to that presented by Norman (2004). Visceral design is concerned with appealing to the human senses, functional design is concerned with utility and performance, and experiential design is concerned with message, culture, meaning, and emotional and sociological aspects of products and services. For the purposes of this research, aesthetic design encompasses the visceral and experiential dimensions of design.

Respondents were asked to rate the emphasis their firms place on aesthetic design when defining and developing new products or services. Twelve questions were used to capture the visceral and experiential dimensions of design, and together are used as a formative measure of aesthetic design. The possible responses ranged along a 5-point Likert scale from “very little emphasis” to “very much emphasis”. For comparison with aesthetic design emphasis, two questions were used to measure emphasis on functional design.

Independent variables

The independent variables used for this study were founder characteristics, more specifically educational background in technology and sales and marketing experience, and the importance of aesthetic design in the firms’ sectors.

Survey respondents were asked to provide information about their firms’ founders’ university education. The proportion of founders having technology-based university degrees was used as a variable representing founder technology education. Degrees in the natural sciences, engineering, computer science and medicine were counted as technology-based university degrees.

Survey respondents were asked to provide information about founders’ sales and marketing experience prior to founding the firms under study. Respondents were asked to rate founders’ experience on a 5-point Likert scale ranging from “very little experience” to “very much experience”. A sixth possibility of “no experience” was also offered. The answers to these questions were used to calculate the proportion (or “concentration”) of sales and marketing experience in the founder group.

As described in chapter 3.1, a measure of the importance of design in the sectors represented by the NTBFs included in the data set was based on independent evaluations by a panel of three experts. The experts were asked to rate the importance of each of three design dimensions, visceral, functional and experiential, for the development of new products or services, on a 4-point scale ranging from “none” to “a great deal”. The ratings for visceral and experiential design were added to obtain a composite estimate of aesthetic design importance for each sector.

Control variables

As design is seen as a means for gaining competitive advantage in highly competitive markets one would expect aesthetic design emphasis to be higher in firms with stronger competitive orientation. To establish the level of competitive orientation respondents were asked to rate the emphasis their firms place on competition on a 5-point Likert scale ranging from “very little emphasis” to “very much emphasis”.

Slappendel (1996) found that firm size influences design emphasis and therefore firm size, measured as the number of employees employed by a firm, was also included as a control variable.

Data analysis

The correlation matrix for the variables used is shown in Table 1. The independent variables were centered and standardized prior to analysis (Marquardt 1980). Regression analysis was used to test the hypotheses.

Table 1. Correlation matrix.

Variables	Correlations				
	1	2	3	4	5
1 aesthetic design emphasis					
2 sector design importance	0.316 ***				
3 founder technical education	-0.296 ***	-0.143			
4 founder sales and marketing experience	0.268 ***	0.318 ***	0.018		
5 firm emphasis on competition	-0.016	-0.006	0.082	0.234 **	
6 firm size	-0.031	-0.078	-0.025	0.004	0.138

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Results

Aesthetic Design in NTBFs

Table 2 shows the summary statistics for aesthetic design emphasis and functional design emphasis for the firms studied. The average aesthetic design emphasis is 0.445 compared to 0.722 for functional design emphasis (both on a scale ranging from 0 to 1). This difference is significant at the 1% level (paired t-test) and supports the notion that NTBFs emphasize functional design over aesthetic design.

Table 2. Summary statistics for functional and aesthetic design emphasis. $N = 103$

	Mean	Std. dev.	Min.	Max.
Functional design emphasis	0.722	0.281	0	1
Aesthetic design emphasis	0.445	0.217	0	0.9

Explaining Differences in Aesthetic Design in NTBFs

The results of regression analysis to test the relationships between aesthetic design emphasis and sector design importance, on one hand, and founder education and experience, on the other are shown in Table 3.

Table 3. Results of regression analysis of factors related to aesthetic design emphasis.

Dependent variable:		
Aesthetic design emphasis		
Control variables:		
firm emphasis on competition	-.009	
firm size	-.004	
Independent variables:		
sector design importance	0.046	**
founder technical education	-0.059	***
founder sales and marketing experience	0.048	**
N	103	
F	8.33	***
R ²	20%	
Adjusted R ²	16%	

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

The R² values for the regression model are modest but this is not a concern since the purpose of this study is not to develop an encompassing model to explain

aesthetic design emphasis, but rather to explore the relationship between the specific variables developed and aesthetic design emphasis.

Contrary to what was expected, competitive emphasis was not found to have a significant relationship with aesthetic design emphasis. Likewise, no significant relationship was found between firm size and aesthetic design emphasis. A possible explanation is that since the firms are all new firms they are also all relatively small, and therefore there is limited variability in size.

Based on the regression analysis shown in Table 3 hypothesis 1 is supported. The importance of aesthetic design in a firm's sector has a significant positive relationship with aesthetic design emphasis. This indicates that firms founded in sectors in which aesthetic design is seen as being important are more likely to emphasize aesthetic design than are firms founded in sectors in which aesthetic design is not thought to be important.

Hypotheses 2, 2a and 2b are also supported by the regression analysis. Founders' technology education and experience both have a significant relationship with aesthetic design emphasis (hypothesis 2). The higher the proportion of founders with university degrees in technology fields, the lower the aesthetic design emphasis (hypothesis 2a) and the higher the proportion of sales and marketing experience in the founder group, the greater the aesthetic design emphasis (hypothesis 2b).

Conclusions and discussion

The goal of this research was to explore how much emphasis NTBFs put on aesthetic design and how differences in aesthetic design emphasis in NTBFs can be explained. The research is motivated by the importance of aesthetic design for the competitiveness of NTBFs and that too little is known about the use of aesthetic design in NTBFs.

The results of this research are that the competitive environment in which NTBFs operate as well as the background of their founders are related with aesthetic design emphasis. More specifically, the conclusions are that founders' technology education is negatively related with emphasis on aesthetic design, founders' sales and marketing experience is positively related with aesthetic design emphasis, and the overall importance of aesthetic design in the firm's sector is positively related with aesthetic design emphasis.

The results lend support to the anecdotal notion, or stereotype even, that engineers and other “technical types” do not appreciate the value of aesthetic design. Most of the founders in the sample have a background in engineering and the natural sciences but the research results indicate that sales and marketing experience is likely to improve their appreciation for aesthetic design. This suggests that the source of the lack of appreciation of aesthetic design has its roots in the education system. Considering the importance of aesthetic design for overall functionality and experience of products and services (Norman 2004) this is a concern for policy makers.

The results also provide further insights into how the composition of the founding team in NTBFs influences competitive strategy. Previous studies (e.g. Roberts 1991 and Meyer 1986) have argued for the importance of complementing technical capabilities in NTBFs with commercial capabilities for higher performance. Assuming a link between aesthetic design and performance (c.f. Hertenstein et al. 2005; Gemser and Leenders 2001) this implies that the link between founding team diversity and performance could be partly mediated through the effect on aesthetic design. Further research is needed to better establish the link between aesthetic design and performance in NTBFs.

Finally, the results of the study provide unique information on the level and variation in aesthetic design emphasis in a population of NTBFs. In order to validate the findings comparable studies need to be made on other populations.

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PAPER 3:
**THE ROLE OF DESIGN IN THE DEVELOPMENT
OF TECHNOLOGY-BASED SERVICES**

Marina Candi, 2007

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The role of design in the development of technology-based services

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The goal of this paper is to examine the role of design in the development of technology-based services and reports on case research undertaken in new firms. Design was found to be applied to a broad range of service aspects in the case firms, namely user interfaces, tangible artifacts, documents, usability, service processes, revenue models, communication processes, community building, customer experiences and marketing materials. The application of design in the case firms was found to be motivated in part by the desire to either counteract or exploit one or more of the distinguishing characteristics of services, which are intangibility, inseparability, heterogeneity and perishability.

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Keywords: case studies, design activity, design practice, innovation, service design

'One of the interesting things about the iPod, one of the things that people love most about it is not the technology; it's the box it comes in. That's because Apple really understood that the iPod was not about the iPod; it was about the entire range of experience: the way they design their stores, the box it comes in, the iTunes website, the ease of getting the user back and forth.' (Donald A. Norman, in Zachry, 2005)

The story of the phenomenal success of the design of the Apple iPod has reached almost paradigmatic status. The predominant focus of this story is the design of the tangible object, the iPod itself, but as expressed by Donald Norman above, the object may not be the only important player in the story. Indeed, the design of the services enfolding the iPod emerges as being as important as the design of the object itself. Despite the increasing importance of services (Coombs and Miles, 2000; Normann, 2001; Von Stamm, 2003), research on innovation has been characterized by a prevailing emphasis on the development of new tangible products (Gallouj and Weinstein, 1997).

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Following from the increasing importance of services and the importance of technological innovation, technology-based services (TBSs) play an

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important role in innovation and economic growth, and their development constitutes the focus of this paper.

There is increasing recognition that differentiation based on technology alone is not sufficient to insure success. Instead, design has been recognized as being an important contributor to new product development and commercial success based on differentiation, e.g. [Gemser and Leenders \(2001\)](#), [Hertenstein et al. \(2005\)](#), [Walsh et al. \(1992\)](#), [Black and Baker \(1987\)](#), [Rothwell and Gardiner \(1984\)](#). Despite its importance, design is commonly neglected in social science research ([Walsh, 1996](#)) and the role of design in innovation is under-investigated ([Trueman and Jobber, 1998](#); [Perks et al., 2005](#)). Only two of the studies listed above specifically target technology-based firms, and all focus on tangible product design rather than service design. Therefore, research on design as an element of TBS development is needed.

This paper reports on a multiple case study of TBS development projects in new firms. New firms were selected as a suitable context for the research for two reasons. New firms can be expected to be engaged in innovation, and they can be expected to base their strategy on differentiation ([Carter et al., 1994](#); [Bryson et al., 1997](#)) rather than factors such as economies of scale. If design is indeed a fruitful means to achieve differentiation, new firms should constitute a class of firms particularly sensitive to the use of design as a means to achieve success when developing new offerings.

The goal of this research is to examine the role of design in the development of TBSs in new firms to approach a characterization of design in this context and how the service context constrains or motivates design. The research goal motivates the following research questions:

Question 1: To which aspects of technology-based service development is design applied in new firms?

Question 2: What is the role of design as an element of technology-based service development in new firms, in terms of addressing the characteristics of services that distinguish them from products?

The contributions of this paper are, in the first place, a suggested framework for empirical research on design in the development of TBSs in new firms, and in the second place, managerial implications for successful development of TBSs. The research findings are that the case firms were found to apply design to a broad range of aspects of TBSs. The application of design in the case firms was found to be motivated in part by the desire to either counteract or exploit one or more of the characteristics distinguishing services from products. Of the two motivating forces, the desire to counteract the characteristics of services was more commonly observed than the desire

to exploit these characteristics. In view of the importance of services and service innovation, this is an important conclusion which points to potentially untapped opportunities for achieving success in the development of new services through design that exploits the distinguishing characteristics of services.

1 Framework

The case research on which this paper is based follows a pre-structured design (Miles and Huberman, 1994) which calls for the development of an initial conceptual framework. In this section a framework for design applied to services is developed and the distinguishing characteristics of services are described.

1.1 Design applied to services

The term design is quite broad and has diverse meanings (Stacey et al., 2002) and is frequently equated with engineering (Veryzer, 2005). The innovation process is sometimes described as a not entirely harmonious integration of technology and commercialization (Marsh and Stock, 2003). The commercial element, which encompasses design and marketing, is concerned with providing a bridge from technical functionalities to value in a finished product or service (Walsh, 1996).

Thus, for the purposes of this paper, design is defined as follows: *In the context of technology-based service development, **design** encompasses those elements of the development process which enhance and communicate the value of services* (Yamamoto and Lambert, 1994; Hertenstein et al., 2005).

Roy and Riedel (1997) argue that a multi-dimensional approach to design is more successful than a narrow approach. In their discussion of design education, Broadbent and Cross (2003) call for a holistic approach to design, which goes beyond the prevailing emphasis on mechanical systems. This supports taking a broad view when studying design as an element of innovation. In a study of the prevalence of design emphasis in technology-based firms, Candi (2006) develops a three-dimensional taxonomy of design consisting of the visceral, the functional and the experiential dimensions.

Extant research in the areas of new product and service development is used to provide an initial framework for the case research. The following three sections discuss research findings falling under each of the three design dimensions. This is followed by a summary of the kinds of things to be inquired about in the empirical setting based on extant research.

1.1.1 Visceral design

Visceral design is concerned with appealing to the human senses (Norman, 2004), and thus provides a measure of tangibility to services.

Crilly et al. (2004), in their study of consumer response to product visual form found that consumers tend to judge products' elegance, functionality and social significance based mostly on visual information. Yamamoto and Lambert (1994) show that appearance has an influence on customer preference even in the industrial market. Turning to technology-based services, Van der Heijden (2003) found that the perceived visual attractiveness of websites influences usefulness, enjoyment and ease-of-use, and Lavie and Tractinsky (2004) show that the visual aesthetics of computer interfaces are a strong determinant of user satisfaction.

In examining success factors in the development of new services, de Brentani (2001) found that the success of radical new services can be improved by creating a clear product identity and offering tangible clues to help customers visualize and evaluate services.

1.1.2 Functional design

Functional design encompasses usability and performance. According to Utterback (1994) success in continuous improvement requires equal emphasis on product and process design. This is relevant to both the development of products and services. Just as the processes for creating a tangible product can be designed, so can the processes for delivering a service that fulfills user expectations be designed.

Veryzer and de Mozota (2005) argue that a key characteristic of a successful service is that it relieves users of the frustration, confusion, and sense of helplessness which commonly plague service users, particularly users of complex technical services.

1.1.3 Experiential design

Experiential design is concerned with message, culture, meaning, and emotional and sociological aspects of a service.

Stuart and Tax (2004) and Pine and Gilmore (1998) define service design as the design of customer experiences. Rayport and Jaworski (2005) argue that firms should work backward from the customer experiences they wish to deliver when developing new services. They further argue that a company's service interfaces can be an important means by which to manage customer experience.

In their study of business-to-business professional services Woo and Ennew (2005) examined the interaction dimension of service quality and found that when what is provided in a service becomes more and more similar among competitive offerings, how the service is provided, or the social exchange involved, is what can create a competitive edge.

Pullman and Gross (2004), in their research on experience design, found that one of the key elements for success is creating opportunities for customers to interact with each other, to gain entry into a community. Community building has been successfully employed by product manufacturers such as General Motors, who have created and support clubs for Saturn owners (Peters, 1997).

Whyte et al. (2003) report on design activities and new product development in a set of small manufacturing companies. The design activities examined are those that go beyond traditional engineering design and include branding, marketing and interactive websites which can all be classified as being essentially concerned with marketing. In their research on branding in services Berry and Lampo (2004) emphasize the importance of developing a strong brand which can be aided by using clues, connecting emotionally and internalizing the brand. The branding of services is very much about creating and fostering a specific customer experience (Norman, 2004).

1.1.4 Summary of framework for application of design to services

Based on the research outlined in the sections above, the starting point for the empirical study is that the role of design in the development of TBSs could include application to the following aspects of services: User interfaces, tangible artifacts integrated with services, service processes, usability, definition of desired customer experiences, processes for communicating with customers, community building and marketing materials.

1.2 Distinguishing characteristics of services

The commonly accepted characteristics of services, which distinguish them from products, are well documented (for a summary see Fitzsimmons and Fitzsimmons, 2006) and are *intangibility*, *inseparability*, *heterogeneity* and *perishability*.

Services are intangible in the sense that they need not include any palpable objects, although they may. Production and consumption of services are concurrent and thus services are said to be inseparable. Each time a service is delivered there will be variability in the service, making the service heterogeneous. Services cannot be produced and stored for delivery when requested and, hence, are said to be perishable. This perishability of services means that services tend to be manpower-dependent.

The four characteristics described above are used as a framework for analyzing the case data to answer research question 2 about how design is used to address these characteristics of services.

2 Research methodology

Research has shown that service innovation tends to be an *ad hoc* process (Sundbo, 1997; Dolfsma, 2004) which contraindicates inquiring about this process solely in an open-ended manner. Gorb and Dumas (1987) in their paper entitled *Silent Design* found that some kind of design activity was found in almost all firms. Gorb and Dumas define silent design as the process by which employees are engaged in design as an adjunct to their primary roles, basically non-designers doing design. This phenomenon can be expected to be prevalent in new firms due to the resource constraints which characterize such firms (Garnsey, 1995; Murray and Lott, 1995). If design is 'silent' it may also be unacknowledged which, in turn, supports taking a pre-structured approach to the case study (Miles and Huberman, 1994). This approach requires the definition of a conceptual framework prior to data collection (see the previous chapter), with the possibility of expansion or modification as data collection and analysis progress.

The research strategy is based on studying multiple cases to provide rich results and a basis for qualitative comparison. The empirical focus is TBS development projects and the unit of analysis is the firm.

New firms were identified as a desirable laboratory in which to perform this research. As was discussed in the introduction to this paper, the reasons are twofold. In the first place, new firms can be expected to be engaged in innovation. In the second place, new firms can be expected to base their strategies on differentiation, which means they should be particularly sensitive to the use of design.

This paper is based on case research covering eight TBS projects in four new firms, two projects in each firm. Studying two separate TBS projects in the same firm provides a richer picture of design application in each firm and provides a basis for examining the level of consistency in design across TBS projects within the same firm.

Semi-structured interviews were conducted with at least two persons knowledgeable about each TBS project. Each interview was divided into two parts. First, respondents were asked to describe how their firms develop new services and to elaborate on the services offered by their firms or under development. This part of the interview was guided by open-ended questions. The second half of each interview focused on a specific TBS project and the questions, although still allowing for free respondent elaboration, were more specific than in the first part of the interview. The questions followed the framework developed prior to data collection, with extensions as appropriate. The interviews were typically about 90 min in duration. Interviews were recorded and transcribed.

To increase the reliability of the data, the requirement was made that TBS projects included in the study must have been recently completed or be well into development. This restriction was imposed in the interest of avoiding the problems of both extreme hindsight and wishful thinking on the part of respondents.

To further increase reliability, a summary was prepared following each interview and submitted to the respondent. Follow-up phone interviews were used to collect additional information where needed and solicit comments about the summaries. Secondary sources, such as industry reports and websites, were examined as available to gain more information about specific TBS projects and case firms. Using more than one source of information about each project allows triangulation of data, which is important to counteract the tendency toward subjectivity inherent in case research (Eisenhardt, 1989).

Data analysis was modeled on the methodology outlined in Eisenhardt (1989). The interview texts were coded in several passes. Additional data were collected for each case firm and cases were added until the point of saturation was deemed to be passed, namely the point where each additional interview or case added little in terms of new concepts and ideas.

3 Results

This chapter consists of two parts. First, the results of within-case analysis are presented in the form of brief overviews of each of the case firms and descriptions of the role of design in each firm. Second, the results of cross-case analysis are presented. The cross-case analysis deals with how design is applied to each of the aspects of services identified by the framework as well as two additional aspects which emerged in the course of the case study, namely documents and revenue models. The cross-case analysis also examines how design was used in the case firms to address the distinguishing characteristics of services. A summary of the case analysis is included in the [Appendix](#).

3.1 Results of within-case analysis

In the following sections a brief overview of each of the case firms is provided and the application of design in the firms' TBS development projects is described. The firm names are real, but pseudonyms¹ are used for the TBS projects. The use of pseudonyms for the projects was necessary because some of them were still under development at the time of data collection and in some cases had only working titles.

3.1.1 CellStory

CellStory was founded in Silicon Valley but at the time of data collection its headquarters were in New York City. The firm was 2 years old and employed

10–12 people, with part of its development work done in Rumania and Russia. The innovativeness of CellStory's services is based on a technology that makes it easy to use mobile phones to create customizable Internet content in real time. The customizability consists of the ability to pre-define a series of question-and-answer scripts that run on mobile phones and require only simple data entry at the time of content creation.

CS1 is CellStory's initial service, which is a hosted service allowing customers to take photos or videos using mobile phones and post them to a website along with rich information entered on the mobile phones at the time of posting. The initial target market for CS1 was realtors. CS2 is a simplified version of CS1 targeted at teenagers and was under development at the time of data collection. This service allows customers to create blogs by selecting from a gallery of available templates and post photos or videos taken using mobile phones to these blogs.

Design was viewed as an important means to make CellStory's services attractive to customers, to foster ease-of-use and make the service experience enjoyable. From the outset CellStory had employed a designer who was involved in the initial concept development and continued to participate in ongoing development.

Some differences were observed between the application of design to CS1 and CS2. The most important of these was that CellStory had used an informal and personal approach to communication with customers for CS1 but when moving to the consumer market with CS2 it became necessary to design an automated model for communicating with customers.

3.1.2 Lucidoc

Lucidoc was founded in the Seattle area and was 5 years old at the time of data collection. Although many of the firm's 11 employees had artistic backgrounds, including photography and music, Lucidoc had made some use of outside designers for visual design of user interfaces. The development team viewed design primarily as a means to hide complexity and elicit customer feedback in an iterative prototyping process.

Indeed, this approach was employed from the beginning. The firm was founded during a consulting project undertaken by its founder for a single customer. The project developed from the backs of napkins to mock-ups of user interfaces. Since then, the firm has been increasingly packaging and standardizing its services to make them available to a growing number of customers. Lucidoc's services are innovative in that they use a multi-cataloging system, which is an uncommon approach to document management. Also, by viewing policies and procedures within organizations as a set of protocols, Lucidoc's

method is essentially analogous to the version control systems commonly used for software development.

Lucidoc's initial service, LU1, which is a compliance management solution for documents, was targeted for the health care market. The service is provided as a hosted service with considerable customization to fulfill the requirements of each customer. LU2 is an add-on to LU1, which provides the ability to customize and create reports based on documents.

Some differences were observed between the application of design to LU1 and LU2. The target users for LU1 were health care workers, predominantly with limited technical expertise, so simplification was a top priority goal for this service. The target users for LU2 were 'power users' requiring more advanced functionality and so although shielding from complexity was emphasized, providing rich functionality was the guiding motivation.

3.1.3 Quantum3D

Quantum3D was founded in Silicon Valley and at the time of data collection it was 8 years old and employed about 100 employees who were primarily based in the firm's headquarters in San Jose or Huntsville, Alabama. Quantum3D specializes in providing custom visualization and training support services targeted at a variety of users including the military.

QU1 is an image generation service for visual and sensor simulation training. The service tends to be highly customized for each customer and delivery to end users occurs either in a customer's facility or within training or simulation equipment, such as military vehicles. QU2 is one of a newer generation of services developed by Quantum3D, which provides the ability to develop graphical user interfaces for embedded systems and simulation. Like QU1, this service tends to be highly customized for each customer.

Design was observed to take a backseat to functionality and technical concerns at Quantum3D. However, compared to QU1 an increased design emphasis was observed in the more recent project QU2. Quantum3D did not employ designers at the time of data collection.

3.1.4 Red Condor

Red Condor was founded in Santa Rosa, California and at the time of data collection was 3 years old and employed about 20 people. Red Condor offers a range of security services for e-mail and Internet browsing. Red Condor's target market is primarily small and medium-sized businesses, schools and municipalities.

RC1 is Red Condor's initial service, a hosted spam-protection service for e-mail. The service is innovative in that spam-detection is based not only on the Bayesian methods commonly used to detect spam but also on human evaluation of suspected spam senders. RC2 is a suite of bundled security services including anti-spam, anti-virus, anti-spyware, URL content filtering and asset management. All of these services are available from a number of other providers but RC2's innovation consists in bringing them together and providing integrated management of all the services.

Design was observed to take a backseat to functionality and technical concerns for the RC1 project, but design was emphasized for RC2 and recognized as an area of opportunity. At the time of data collection, Red Condor had recently hired a designer to be responsible for visual user interface design for RC2.

3.2 Results of cross-case analysis

The results of cross-case analysis are organized according to the aspects of services to which design was found to be applied in the case firms. The application of design was observed for all the service aspects identified in the framework, and additionally, evidence was found for the application of design to documents and revenue models.

The observations suggest relationships between design application and the characteristics which distinguish services from products. These relationships fall into two categories: relationships where design is applied to counteract distinguishing characteristics of services, and relationships where design is applied to exploit these characteristics.

3.2.1 Design applied to user interfaces

Design of user interfaces was something that all respondents could relate to, but the deliberateness of these design efforts varied. At one end of the spectrum user interface design happened incidentally and was driven by the desired functionality of the services, and at the other end user interface design was seen as a key aspect of the services.

'You can just see that it is supposed to look bright and modern, bright happy future. The technology is not scary, it's childish, it's so easy a child could do it.' [CellStory]

There was also evidence of user interface design used as a tool to elicit customer feedback to guide development.

'The only way that we know that we are actually solving the problem is to be able to simulate with the software, so visual design goes right up front most of the time.' [Lucidoc]

User interface design in the case firms was found to be primarily about designing visual interfaces for software. Manufactured products, if they are intended for direct human use, also have user interfaces, but these interfaces can be three-dimensional and include tactile aspects whereas the design of user interfaces for services observed in the case firms was two-dimensional and mostly non-tactile.

Where user interface design was emphasized it can be characterized as being done with the purpose of counteracting the intangibility, heterogeneity and perishability of the services. User interfaces become the persistent ‘face’ of a service thus counteracting intangibility and perishability. Additionally, one of the goals observed in user interface design was to maintain consistency, which counteracts heterogeneity.

The simultaneous production and consumption of services (the inseparability characteristic) offers opportunities for customizing services to best serve the needs of individual customers (Berry, 1980). In QU2, where ‘widget’ design is provided as a custom service, interface design can be characterized as being done to exploit the inseparability of the service, as is the case in LU1 where prototyping is used to elicit customer input.

3.2.2 Design applied to tangible artifacts

QU1 includes a tangible object, which is a piece of computer hardware required for service delivery. The hardware was designed in a cooperative effort between engineers inside the firm and an outside mechanical engineer. The primary considerations in designing the object were the environmental requirements imposed by the laboratories and training facilities where the service would be used. Some emphasis was also placed on making the object visually attractive.

A respondent at Red Condor explained that through the firm’s experience with its initial service RC1, the firm realized that customers may prefer to have a piece of hardware on site to lend an element of tangibility to what is otherwise an almost invisible service, as tends to be the nature of security-related services. So RC2 incorporated a piece of hardware, both for technical reasons and because the very fact of the tangible artifact was viewed as important. This resonates with the conclusions reached by de Brentani (2001) about the value of making services more tangible by incorporating tangible artifacts.

Where incorporated, tangible artifact design can be characterized as having been applied in the interest of counteracting the intangibility of the services as well as their perishability, since a tangible artifact persists even while the associated service is not being delivered.

3.2.3 *Design applied to documents*

When asked about tangible objects, many respondents mentioned documents such as manuals and contracts. This is an arena for design not predicted by the research framework, but which was added to the framework early in the data collection process.

A kind of document which is commonly part of TBSs is online help. Manufactured products often come with manuals and increasingly this documentation is made available in electronic form on the Internet. However, TBSs delivered in an electronic environment present a unique opportunity to provide context sensitive user assistance through electronic or online help when and where needed. Therefore, this constitutes an arena for design which could be said to distinguish TBSs from products.

CellStory's services incorporated online help conforming to the overall aesthetic of the service-delivery platforms, which were websites. The online help included animations and other visual elements to help users make the most of the services.

In the case firms, documents were viewed as necessary adjuncts to services and were authored by technical persons. In some instances documents were designed by designers; in others they were subject to review for layout and consistency by non-technical persons; and in some their design was incidental.

'It's just PDF. There's nothing fancy here.' [Quantum3D]

For RC2 documents were seen as having strategic importance in communicating the simplicity of the service and had been designed by outside designers.

'Our objective is that all documentation is step 1, step 2, step 3, you're done. Whether it's a contract for our reseller, whether it's a contract for a sale, whether it's a sign-up sheet for a customer to sign up to our service.' [Red Condor]

Visual design of documents, where observed, focused on layout and typeface issues and, in some cases, the design of visual objects (graphic design).

In each of the TBS projects which included documents, the design of documents can be characterized as having been applied in the interest of counteracting one or more of the distinguishing characteristics of services. Manuals and online help lend a measure of separability between the case firms and their customers since these documents can help make customers more self-sufficient. This also helps counteract perishability and intangibility since manuals, particularly printed manuals, and online help can be said to persist after their creation. Manuals and online help can also make services less heterogeneous since all customers can have access to the same information and directions at all times.

3.2.4 *Design for usability*

Because TBSs may be based on advanced technology, usability can be an important concern. In fact, the creators of TBSs may have to deal with the hurdle of customers' fear of technology. This can, of course, also be the case for manufactured products (Norman, 2002) as is so eloquently expressed in the oft-repeated anecdote about the difficulty of programming video recording equipment.

The key importance of usability design was emphasized by all respondents and in the TBS projects studied, usability design was found to be focused on simplification and/or complexity hiding. In fact, some of the respondents named ergonomic features as one of the primary selling points for their services as evidenced by the emphasis observed in some of the projects on communicating the message of simplicity.

'Very early on the requirements were that this needs to be a close to zero administration, no tweaking, it never gets in your way service. And so, we try to minimize the number of knobs that customers have to deal with.'
[Red Condor]

Since QU2 is targeted at training/simulation developers, it needs to include relatively complicated options, so efficiency was seen as more important than complexity hiding. Conversely, a strong simplification goal was observed for LU1, whose users are health care workers, not necessarily having a technical background. CellStory took all possible measures to make CS1 easy to use but there were some technical hindrances. CS2 is a simplified version of CS1 and a greater level of simplification was achieved in the latter service.

A respondent for Lucidoc expressed the desire to do more formal usability testing to improve usability of the firm's services.

'We would like to do more fully-blinded usability testing. And would tie that much closer into the development process. Because we don't have that, we tend to do more site visits, looking over peoples' shoulders, which is not quite as objective as I'd like to have it.' [Lucidoc]

Usability design deals with the interaction between the customer and the service. In each of the TBS projects, usability design can be characterized as having been applied in the interest of counteracting one or more of the distinguishing characteristics of services. Improved usability empowers customers to be more self-sufficient and thus counteracts inseparability and the manpower requirements for customer service that follow from perishability. Where the goal of services was for them to be transparent to customers, usability design can also be said to counteract heterogeneity.

3.2.5 *Design applied to service processes*

Of the aspects developed in the framework, service processes constitute the only aspect which is specific to services. However, product manufacture can rely heavily on processes, so even here there could be overlap in design activities between service and product development.

Service process design was described by several respondents as a collaborative effort by small teams of managers and developers around a whiteboard. The descriptions were of rather informal, but very graphical, approaches to service process design.

In QU1 the service processes emerged incidentally to development and QU2 is based on an established tradition for visual simulation and training and so there was no new service process design involved. For RC1 the service processes followed the technical architecture:

'Basically we have these capabilities that we need to expose somehow in the user interface, and so we come up with some organization that's very close to the organization that we have in the code.' [Red Condor]

Defining service processes counteracts the heterogeneity of services by making service delivery more consistent. Defining service processes can be the first step on the road to service automation and thereby counteracts perishability by making service delivery less manpower-dependent. Lucidoc includes prototyping in its service process development and thereby engages customers in the process, which can be seen as a way to exploit the inseparability characteristic.

3.2.6 Application of design to revenue models

The application of design to revenue models was one of the aspects not predicted by the initial framework for the case study, but emerged as a strategic element of service development, particularly at Red Condor.

'Our revenue model was one of the very early decisions that we made. We wanted to have a hosted service; we were not in the business of selling widgets and having one-time revenue.' [Red Condor]

Red Condor's motivation for designing their revenue model may partly be characterized as one of insuring consistent and continuous service delivery, or counteracting heterogeneity.

Some of the services studied used a standard revenue model, that is a revenue model that is commonly used for specific kinds of services, such as subscription plans for Internet access services and metered plans for telephone services. In these TBS projects there was no revenue model design. LU1 and QU2 used a revenue model constituting a customization from a standard one, such as LU1's revenue model which used a measure specific to its target market as a counter on which to base fees.

3.2.7 Application of design to communication with customers

The characteristics of services all contribute to the need for communication between firms and customers in the course of service delivery. So, whereas many product manufacturers need to consider communication processes with customers, this requirement is more acute for firms selling services.

Some of the respondents indicated that communication processes with customers were designed deliberately, whereas some described very informal and personal models where customers expected to be able to call their individual contact within the firm at almost any time. The newness of the firms studied and their relatively small number of customers came through in the descriptions of informal personal communication. However, there was a consistent tone that designing and implementing automated processes for communicating with customers becomes necessary when the number of customers increases and employees' tolerance for increasingly frequent interruptions diminishes. CellStory had used an informal and personal model for CS1 but when moving to the consumer market with CS2 it became necessary to design and adopt a more automated system for communicating with customers.

Where communication with customers was informal and personal, the firms could be said to be exploiting their ongoing relationships with customers, which are attributable to the inseparability of the services, as well as the heterogeneity of the services, which creates the opportunity to provide customized and personal service to individual customers. When firms design formal communication processes this is closely related to, and even overlaps, service process design and therefore, as for service process design, can be characterized as a means to counteract the heterogeneity and inseparability of services.

3.2.8 Application of design to community building

Quantum3D, Red Condor and Lucidoc all aspired to support and foster community building between their customers through means such as user groups and blogs although these aspirations had not been realized at the time of data collection.

'That's an area that I think we have fallen down woefully on. We should have an active user group.' [Lucidoc]

CellStory's services, particularly CS2, incorporate elements of community building between customers, since the services provide ways for customers to communicate through the Internet, particularly through the blog environment supported by CS2.

Community building can be said to exploit the inseparability and heterogeneity of services. Services are delivered simultaneously with consumption and therefore service providers have the opportunity to influence customers' direct interaction with the service as well as their interaction with other customers. Where community building is implemented, part of what makes it interesting and attractive to customers is the heterogeneity among customers and the uncertainty inherent in a heterogeneous service. A community, once established and if successful, can be said to get a life of its own and can be viewed as a means to counteract the intangibility and perishability of services.

3.2.9 *Application of design to customer experiences*

Most of the respondents were able to describe the desired customer experience for their TBSs. The experiences described can be classified as fun, simple or invisible. These experiences are supported by other aspects such as user interfaces and usability.

'Our real goal in terms of our design is to be so invisible that all we do is support the user's need for information. One of the strongest, most positive, comments that we have when we asked one of our users for a recommendation, is "I'm not sure I can actually recommend you because I never notice that I'm using you." Which means that we have emulated his knowledge acquisition need sufficiently clearly and cleanly that he doesn't see the interface of the service as being separate from himself.' [Lucidoc]

In the case of CellStory, the defined experience was fun.

'The experience should be happy, happy, fun, fun.' [CellStory]

Since the 'fun' in CellStory's services is closely tied in with their community building and user interface design, the motivation for defining the customer experience as fun is to counteract intangibility and perishability, like community building and user interface design, and to exploit inseparability and heterogeneity like community building.

In those instances where firms defined their customer experience as simple the motivation resonates with the motivation for design for improved usability. Simplicity, like improved usability, empowers customers to be more self-sufficient and thus counteracts inseparability and perishability. Where the firms defined their customer experience as invisible, design can also be said to counteract heterogeneity since what is invisible is homogenous.

The emphasis in QU2 is to exactly mirror user requirements while at the same time striving for simplicity. In this case, the service's inseparability is exploited through the firm's close interaction with customers in the interest of discerning and meeting requirements.

3.2.10 *Application of design to marketing materials*

Information about all the TBS projects was found on the Internet, except for LU2 and RC2 which were still in mid-development. These websites varied widely in their comprehensiveness and level of design.

In addition to websites, some of the case firms' marketing strategies centered on demos. Quantum3D particularly emphasized demos and put considerable effort into staging demonstrations at trade shows and similar venues. Lucidoc also used demos extensively, both to market existing services and to create and/or gauge interest in potential new services.

'Since we had several "power users" with particular requests from our customer base, we announced to them that we were working on improved functionality. As soon as things were sufficiently stable to be able to demonstrate, we did a web demo and teleconference to show the new

features and solicit comments, which we then incorporated into the design, or scheduled for later implementation.' [Lucidoc]

Outside designers were employed by Lucidoc and Red Condor to create marketing materials, CellStory relied on its internal designer and Quantum3D had an internal marketing function. Red Condor hired an outside designer to create a Flash presentation for RC1. This presentation was available on Red Condor's website and is used for trade shows. Red Condor had also hired an outside designer to create a sales kit for its services.

Red Condor's marketing materials had a tangible element to them, particularly the sales kit, which is a physical prop, and therefore Red Condor's motivation seems to be, in part, to counteract intangibility.

Demos, since they are commonly presented in an interaction setting, can be said to exploit inseparability, the opportunity created by the fact that service delivery is simultaneous with service consumption. This is particularly true when demos are deliberately used to solicit input from customers.

4 Conclusions, discussion and implications

The goal of this paper was to examine the role of design in the development of technology-based services (TBSs) in new firms to approach a characterization of design in this context and how design specifically addresses the distinguishing characteristics of services. Existing research suggesting the importance of design as a means for achieving differentiation, leading to competitive advantage and improved performance, motivates this research.

Two research questions dealing with the role of design in the development of TBSs in new firms were posed and answers were sought through a pre-structured multiple case study. Evidence of the role of design in exploiting technological innovations to create attractive and competitive services and to facilitate the management of positive relationships with customers was observed in the case firms. Emphasis, effort spent and methods used differed between firms, and even between TBS projects in the same firm.

The first research question is about the aspects of TBSs to which design is applied. An initial framework was developed based on extant research and evidence of design application to the aspects suggested by this framework was found in the case firms, namely user interfaces, tangible artifacts integrated with services, service processes, usability, definition of desired customer experiences, processes for communicating with customers, community building and marketing materials. Additionally, evidence of the application of design

to revenue models and documents, which were aspects not included in the initial framework, was found in the case firms.

Differences in design application between TBS projects within the same firm were observed in all the case firms. Interestingly, it seems that in the case firms studied, there was more emphasis on design, or more intense application of design, in more recent TBS projects. This may support the notion of strategy adaptation (Andries and Debackere, 2006) or indicate that once new firms have introduced their initial services they become increasingly aware of the value of design and therefore are more likely to apply design in subsequent TBS projects.

The second research question is about the application of design to address the distinguishing characteristics of services, which are intangibility, inseparability, heterogeneity and perishability. The observations in the case firms suggest that design is, in part, applied with the purpose of either counteracting or exploiting these characteristics.

The role of design in the case firms was found to be more commonly that of counteracting the distinguishing characteristics of services and less commonly of exploiting these characteristics. This could be a reflection of the perceived notion that the characteristics of services make them vulnerable, particularly in terms of establishing their value (Von Stamm, 2003).

Technology provides the means to standardize service delivery and increase efficiency and quality (Dolfsma, 2004) as well as support delivery to mass markets through automation. The evolution from personal service delivery to automated delivery was specifically observed in CellStory, which was moving from the business-to-business market to the consumer market. Standardizing a service makes it less heterogeneous and automating it counteracts its perishability and inseparability since automation constitutes a means to create service processes which can be accessed by customers as needed.

The contributions of this paper are: 1) A suggested framework for empirical research on design in the development of TBSs in new firms; and 2) Managerial implications for successful development of TBSs.

The framework for empirical research on design suggested by this research views design in the development of TBSs along three dimensions: 1) The aspects of TBSs to which design is applied; 2) The emphasis on, or, intensity of, design applied to each aspect; and 3) How the design applied addresses the distinguishing characteristics of services. The first two dimensions deal with what firms do as far as service design is concerned, and the third dimension deals with the motivation for service

design. This framework is reflected in the structure of the table in the [Appendix](#).

The conclusions of this research also suggest managerial implications for successful development of TBSs. Comparison of extant research with the research findings suggests a number of possibly untapped opportunities for applying design for differentiation of TBSs such as deliberate design of user interfaces for attractiveness and ease-of-use (Norman, 2004), the inclusion of tangible artifacts in services (de Brentani, 2001), the exploitation of the various documents which constitute part of the services as vehicles for differentiation through design (Norman, 2004), the use of community building as a means to foster customer emotional investment (Pullman and Gross, 2004), and the design of marketing materials in addition to information websites (Berry and Lampo, 2004). A further implication is that design can be used to standardize TBSs making them deliverable to a larger and more distributed customer base and making them less manpower-intensive. Finally, the observed emphasis on using design to counteract the very service-ness of TBSs rather than exploiting the distinguishing characteristics of services, suggests possibly untapped opportunities for using design to exploit the characteristics of services when developing new TBSs.

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Appendix. Observed application of design in case firms

Table 1 Observed application of design in the development of technology-based services in the case firms

TBS project	Characterization of observed design	Application relative to service characteristics			
		Intangibility	Inseparability	Heterogeneity	Perishability
<i>Design applied to user interfaces</i>					
LU2	Incidental				
QU1					
RC1					

(continued on next page)

Table 1 (continued)

TBS project	Characterization of observed design	Application relative to service characteristics			
		Intangibility	Inseparability	Heterogeneity	Perishability
QU2	Provided as a custom service, but low emphasis on aesthetics		Exploit		
LU1	Used as a tool for prototyping		Exploit		
CS1	Relatively important	Counteract		Counteract	Counteract
RC2		Counteract		Counteract	Counteract
CS2	High priority	Counteract		Counteract	Counteract
<i>Design applied to tangible artifacts</i>					
CS1	no tangible artifacts				
CS2					
LU1					
LU2					
QU2					
RC1					
RC2	The fact that there is a tangible artifact is important	Counteract			Counteract
QU1	Design of tangibles is important	Counteract			Counteract
<i>Design applied to documents</i>					
RC1	Few documents, low priority				
QU1	Authored by technical people, no design		Counteract	Counteract	Counteract
LU1	Authored by technical people, layout reviewed by non-technical		Counteract	Counteract	Counteract
LU2			Counteract	Counteract	Counteract
QU2		Counteract	Counteract	Counteract	Counteract
CS1	Online help integrated with user interface		Counteract	Counteract	Counteract
CS2			Counteract	Counteract	Counteract
RC2	Documents strategically important	Counteract	Counteract	Counteract	
<i>Design applied to usability</i>					
LU2	Shielding from complexity		Counteract		Counteract

Table 1 (continued)

TBS	Characterization of project observed design	Application relative to service characteristics			
		Intangibility	Inseparability	Heterogeneity	Perishability
QU1			Counteract		Counteract
RC1	Interaction elements or number of user steps minimized		Counteract	Counteract	Counteract
RC2			Counteract		Counteract
CS1	All possible measures to simplify, but some technical hindrances		Counteract		Counteract
CS2	Simplicity is a key characteristic		Counteract		Counteract
LU1			Counteract	Counteract	Counteract
<i>Design applied to service processes</i>					
QU1	Incidental				
RC1	Service processes follow technical architecture			Counteract	Counteract
QU2	Standard process used				
CS1	Service process designed deliberately			Counteract	Counteract
CS2				Counteract	Counteract
LU1		Exploit		Counteract	Counteract
LU2		Exploit		Counteract	Counteract
RC2				Counteract	Counteract
<i>Design applied to revenue models</i>					
CS1	Using standard revenue model				
CS2					
LU2					
QU1					
LU1	Some adjustment to standard model				
QU2					
RC1	Custom revenue model designed			Counteract	
RC2				Counteract	
<i>Design applied to communication with customers</i>					
CS2	Communication channels are impersonal		Counteract	Counteract	

(continued on next page)

Table 1 (continued)

TBS	Characterization of project observed design	Application relative to service characteristics			
		Intangibility	Inseparability	Heterogeneity	Perishability
CS1	Communication is informal and personal, but moving to an automated customer service model		Counteract	Counteract	
QU1	Customer support is automated but customers are able to contact individuals in the firm		Counteract	Counteract	
QU2			Counteract	Counteract	
LU1	Communication is informal and personal		Exploit	Exploit	
LU2			Exploit	Exploit	
RC1			Exploit	Exploit	
RC2			Exploit	Exploit	
<i>Design applied to community building</i>					
QU1	No communication between users supported				
RC1					
LU1	Aspirations to initiate and foster user community		Exploit		
LU2			Exploit		
QU2			Exploit		
RC2			Exploit		
CS1	Communication between users is a by-product of the service	Counteract	Exploit	Exploit	Counteract
CS2	Community building designed into the service	Counteract	Exploit	Exploit	Counteract
<i>Design applied to customer experiences</i>					
LU2	Defined experience: simple				
QU1			Counteract		Counteract
QU2			Exploit		
RC1	Defined experience: simple and invisible		Counteract	Counteract	Counteract

Table 1 (continued)

TBS project	Characterization of observed design	Application relative to service characteristics			
		Intangibility	Inseparability	Heterogeneity	Perishability
LU1	Defined experience: invisibility		Counteract	Counteract	Counteract
RC2			Counteract	Counteract	Counteract
CS1	Defined experience: fun	Counteract	Exploit	Exploit	Counteract
CS2		Counteract	Exploit	Exploit	Counteract
<i>Design applied to marketing materials</i>					
CS1	Service information on website only				
CS2					
QU1	Emphasis on demos		Exploit		
QU2			Exploit		
LU1	Marketing materials and demos		Exploit		
LU2			Exploit		
RC1		Counteract	Exploit		
RC2		Counteract	Exploit		

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1. The pseudonyms are three-character abbreviations which are based on the firms' names and the number 1 or 2, where, for each firm, the project with the number 1 in its pseudonym was started earlier than the other.

PAPER 4:
**HOW DIFFERENT? COMPARING THE USE OF
DESIGN IN SERVICE INNOVATION IN
NORDIC AND AMERICAN NEW
TECHNOLOGY-BASED FIRMS**

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Under review for publication in an academic journal

How Different? Comparing the use of Design in Service Innovation in Nordic and American New Technology-based Firms

Abstract

This paper explores differences in the use of design in service innovation in new technology-based firms in Iceland and the San Francisco Bay area of the United States. A systematic qualitative comparison of case data collected on multiple service innovation projects is used. Differences were expected due to these two locations' disparity in terms of agglomeration of technology-based firms and access to design resources. The results of the comparison indicate that there are more similarities than there are differences. Possible explanations are explored and implications of the findings for the understanding of regional path dependence are discussed.

Introduction

The geographic concentration of industries is common (c.f. Krugman, 1991), the concentrations of high-technology companies in Silicon Valley in California and Route 128 in Massachusetts being good examples

While industrial agglomeration may arise for idiosyncratic reasons there are two characteristics which could help sustain such clustering (Sorenson & Audia, 2000). First, organizations might perform better and survive longer in concentrated regions. Second, such regions might be characterized by a high frequency of new firm start-ups. Economic explanations for agglomeration typically focus on the former characteristic, namely better performance. They suggest that firms located in such regions may enjoy comparative advantage, for example by having better access to important factors for production or being closer to customers (Weber, 1928), than other firms. They also suggest that co-location itself may yield additional advantages, which are not necessarily related

to specific locations as such. These advantages include extended division of labor, common labor markets, and knowledge spillovers (Krugman, 1991; Marshall, 1920; Saxenian, 1994).

An alternative explanation, based on the nature of entrepreneurial opportunities, focuses on the latter characteristic, namely higher founding rates. Organizations provide the social context within which individuals acquire the capacities required for entrepreneurial action. Individuals acquire industry specific knowledge and information about entrepreneurial opportunities, build social networks, e.g. with customers and suppliers, that facilitate resource mobilization, and develop the confidence to start new ventures (Audia & Rider, 2005; Freeman, 1986). As concentration of firms increases, there will be a greater number of firms belonging to the same industry within a region, which in turn creates a larger pool of potential entrepreneurs and higher founding rates (Sorensen & Audia, 2000).

Both of the explanations discussed above include an element of path dependence. This means that spatial economic organization is seen both as the outcome of a process where the future is not only dependent on the current state but also on previous states, and as a determinant shaping the process (Martin & Sunley, 2006). Hence, regions move along different trajectories, each marked by differences in the context within which firms organize their activities.

While we understand that path dependence plays an important role in explaining how regions become 'locked-in' to an unfavorable trajectory we know less about how regional paths are created, and, even more importantly, what determines their persistence (Martin & Sunley, 2006). The purpose of this paper is to explore these questions through an empirical comparison of how new technology-based firms (NTBFs) in two regions use design as an element of service innovation.

In conjunction with a stream of research on design as an element of service innovation in new technology-based firms (NTBFs) in a Nordic country (Iceland), the decision was made to extend the research to include a comparison with NTBFs in the United States. More specifically, the comparison was made with NTBFs in the San Francisco Bay area. The goal was to examine differences in the use of design in NTBFs in these two geographically distant places, which are also highly disparate in terms of the concentration of technology-based firms.

The aforementioned stream of research was motivated by existing research suggesting that design can be an important means to achieve success in innovation (Auger, 2005; Gemser & Leenders, 2001; Hertenstein, Platt & Veryzer, 2005; Moody, 1984; Rothwell & Gardiner, 1984; Walsh, Roy, Bruce & Potter, 1992). There is little existing research on design in new firms, and even less in NTBFs in particular. The research was undertaken to address this gap. Also, existing research on innovation in general, and design as an element of innovation specifically, has focused on the design of tangible products rather than services, whereas in this research the focus is on the design of services, more specifically software-based services, and so again the perspective of this research is unusual.

Our initial assumption was that location would have a significant impact on NTBFs' use of design in service innovation. Not only are NTBFs more numerous in the San Francisco Bay area, but also design firms (Utterback, Vedin, Alvarez, Ekman, Sanderson, Tether & Verganti, 2007). Hence, we expected to find differences in how design was used in these two groups of NTBFs.

With this initial assumption in mind, an explorative research strategy was chosen, involving case research performed in two phases. The first phase involved research on eight service innovation projects in Iceland, and in the second phase eight comparable projects in the United States were added. Analysis was also divided into two phases. The first phase of analysis yielded a framework for empirical research on design in the development of technology-based services in new firms and managerial implications for successful development of such services. These results are reported in *Anonymous*. In this paper, we turn to the second phase of analysis, which examines the differences between the roles of design in NTBFs in Iceland and the United States.

The research was begun in Iceland with in-depth studies of eight service innovation projects in four NTBFs. This involved visits to the firms and interviews with managers and persons knowledgeable about the service innovation projects being studied. Over the course of data collection, a profile of the use of design in these firms emerged. Attitudes to design varied but fell into a number of repeating patterns. Design was found to be applied to a broad range of service aspects in the case firms, namely user interfaces, tangible artifacts, documents, usability, service processes, revenue models, communication processes, community building, customer experiences and marketing materials.

The service innovation process in the case firms was observed to be informal and customer involvement was an important element in many of the projects. Designer involvement in service innovation was limited and most design was observed to be “silent” (Gorb & Dumas, 1987), meaning non-designers engaged in design activities.

The Icelandic firms were characterized by a casual atmosphere, informality and a sense of there being a lot going on. Respondents expressed a high level of optimism regarding the opportunities they perceived, but at the same time a grounded realistic approach to service development.

A few weeks after data collection in the Icelandic firms was completed, the first of four NTBFs in the San Francisco Bay area was visited. Significant differences compared with the Icelandic firms were expected. After all, this was Silicon Valley, the *Shangri-la* of technology-based entrepreneurship and the breeding ground of such giants as Apple, Adobe and Google. Silicon Valley is a region where entrepreneurial firms have clustered and where a particularly large number of specialized firms offer a wide range of services to the technology sector, including design services (Utterback et al., 2007). Imagine our surprise when we found mostly the same patterns of design use and attitudes to design as had been observed in the Icelandic firms. The similarities were not limited to design since again we observed a casual atmosphere, informality, a sense of there being a lot going on, and respondents expressing a high level of optimism regarding the opportunities they perceived, but at the same time a grounded realistic approach to service development.

Shouldn't there have been a greater emphasis on design or a different approach to design in firms sharing U.S. highway 101 with Apple than in firms sharing the North Atlantic with a shrinking population of fish? Apparently not. In the rest of this paper, this observed lack of differences will be addressed in an attempt to find an explanation. First, the research methodology is described. Following a description of the results of the comparison between the two groups of firms, existing literature on regional variation will be examined and related to the results observed with the aim of suggesting an explanation for the observed similarity. Finally, we discuss the implications of the results for our understanding of the origins and persistence of regional path dependence.

Research methodology

The research was performed in two phases, followed by analysis across both. First, data were collected about eight technology-based service projects in four NTBFs in Iceland. The projects studied were all software-based, to a greater or lesser degree. Analysis was done in parallel so that preliminary results had been developed prior to the start of the second phase in which data were collected in the San Francisco Bay area on eight projects in four NTBFs.

Case Research Strategy

Gorb and Dumas (1987) in their paper entitled *Silent Design* found that some kind of design activity was found in almost all firms. Gorb and Dumas define silent design as the process by which employees are engaged in design as an adjunct to their primary roles, basically non-designers doing design. This phenomenon can be expected to be prevalent in new firms due to the resource constraints that characterize them (Garnsey, 1995; Murray & Lott, 1995). If design is silent it may also be unacknowledged which, in turn, supports taking a pre-structured approach to the case study (Miles & Huberman, 1994). This approach requires the definition of a conceptual framework prior to data collection, with the possibility of expansion or modification as data collection and analysis progress. The initial conceptual framework was developed based on existing research on new service development and new product development and centered on the aspects of services to which design might be applied. As data collection and analysis progressed, the initial framework was extended to accommodate emerging patterns.

The research strategy is based on studying multiple cases to provide rich results and a basis for qualitative comparison. The empirical focus is the project and the unit of analysis is the firm. Two separate development projects were studied in each case firm. This provides a richer picture of design application in each firm as well as a basis for examining the level of consistency in design across projects within the same firm.

Basic Conceptual Framework

The concepts new technology-based firms (NTBFs) and design will now be discussed briefly to set the stage for the rest of the discussion about methodology.

New technology-based firms (NTBFs) were selected as the empirical context for this research for two reasons. In the first place, new firms can be expected to be engaged in innovation and NTBFs, specifically, are important sources of technological innovation. In the second place, new firms can be expected to base their strategies on differentiation (Carter, Stearns & Reynolds, 1994) rather than factors such as economies of scale. If design is indeed a fruitful means to achieve differentiation, NTBFs should constitute a class of firms particularly sensitive to the use of design as a means to achieve success when developing new offerings. At the same time, NTBFs may not take advantage of the opportunities inherent in design due to resource constraints (Slappendel, 1996).

For the purposes of this research, Bollinger, Hope & Utterback's (1983) definition focusing on NTBFs as venues for technological innovation is used, i.e. *NTBFs are defined as firms which introduce new products and services whose creation is based on technical knowledge*. There is potential for confusion about the term new technology-based firm because it is not obvious whether "new" refers to the technology or the firm. For the purposes of this research "new" refers to the firm, so, in longhand, NTBFs are new firms that are based on technology, which may or may not be new technology.

Johnson, Menor, Roth and Chase (2000) distinguish design from new service development in that design specifies the detailed content and configuration of a service concept and operations strategy, while new service development refers to the overall process of developing new service offerings. For the purposes of this research, design is defined as follows (Hertenstein et al., 2005; Yamamoto and Lambert, 1994): *Design is the part of the innovation process encompassing activities that enhance and communicate the value of services*. It is important to understand that according to the definition above, design is a verb, rather than a noun; a process rather than an outcome.

Case Selection

The case firms for the first part of the research (Iceland) were selected from a set of NTBFs participating in a longitudinal survey-based study of Icelandic NTBFs. Criteria for selection included the requirement that case firms have at least 5 employees, base at least 50% of their revenues on the sales of services and had launched at least one new service in the last two years. Thus, firms actively involved in innovation were specifically sought. Case firms reporting varying

degrees of emphasis on design in the survey were intentionally selected to provide breadth.

The American cases were selected based on the same criteria as the Icelandic cases, although since they had not participated in the survey-based study, the initial assessment of their design emphasis had to be done based on secondary information such as persons knowledgeable about the firms. To maintain a measure of continuity with the Icelandic firms, the CEO of each of the American case firms, each of which was also a respondent for the case research, was asked to answer a small subset of the survey questions including questions measuring design emphasis. Based on this we were able to confirm that the American case firms represented considerable breadth in design emphasis as did the Icelandic firms.

To provide further comparison an established Silicon Valley firm was included in the research. The firm in question is an established technology-based firm (about 25 years old) in Silicon Valley, which was selected based on its demonstrated emphasis on design. Data were collected using the same strategy as for the NTBFs as well as from industry reports and publications.

Respondents were asked to suggest development projects to discuss, but to increase validity, the requirement was made that projects included in the study must have been recently completed or be well into development. This restriction was imposed in the interest of avoiding both the problems of extreme hindsight and wishful thinking on the part of respondents.

A summary of the firms and projects studied is provided in Appendix A. The NTBFs ranged in age from two to eight years and in size from six to one hundred employees. All the Icelandic firms were based in Reykjavik and operated there to a greater or lesser extent. All the firms in the United States had been founded in and/or were operating, at least in part, in the San Francisco Bay area at the time of data collection.

Data Collection

Semi-structured interviews were conducted with at least two persons knowledgeable about each development project. Each interview was divided into two parts. First, respondents were asked to describe how their firms develop new services and to elaborate on the services offered by their firms or under

development. This part of the interview was guided by open-ended questions. The second half of each interview focused on a specific project and the questions, although still allowing for free respondent elaboration, were more specific than in the first part of the interview. The questions followed the framework developed prior to data collection, with extensions as appropriate. The interviews were typically about 90 minutes in duration. Interviews were recorded and transcribed.

To increase validity, a summary was prepared following each interview and submitted to the respondent. Follow-up phone interviews were used to collect additional information where needed and solicit comments about the summaries. Secondary sources, such as industry reports and web sites, were examined as available to gain more information about specific projects and case firms.

Data Analysis

Data analysis was modeled on the methodology outlined in Eisenhardt (1989). The interview texts were coded in several passes. Initial sets of codes for aspects of services to which design might be applied, approaches to design, design actors, objectives underlying design and emphasis on design were developed. Codes were added as needed over the course of analysis.

In the first phase conducted in Iceland, additional data were collected for each case firm and cases were added until the point of saturation was deemed to be passed, namely the point where each additional interview or case added little in terms of new concepts and ideas. Saturation had been reached in the first phase when data collection moved to the United States. Again, cases were added one by one, and although saturation was reached sooner, the strategic decision was made to study the same number of projects in the same number of firms in the United States as had been studied in Iceland.

Following coding and analysis of the interview texts a systematic comparison between the Icelandic and United States NTBFs was performed using the comparative method (Ragin 1987). In the introduction to his work on the comparative method Ragin (1987) states as a primary goal “to formalize qualitative comparative methods without departing from the general logic of case-oriented research.” (1987: 10). The method Ragin proposes is based on

Boolean algebra, or logic and set theory, and is well suited to analyzing case data involving a relatively large number of cases.

Results

The results of the comparison between the two groups of firms are summarized in Appendix B. The tables in Appendix B list the case firms' approach to design in each of the ten aspects of services to which design was found to be applied.

There are only a few patterns which were observed only in projects in Iceland, or only in projects in the United States. These are discussed below.

Observed Differences

The only pattern observed only in projects in Iceland, more specifically the two projects at Valy, falls under the design of documents. In Valy, documents were organized and written by a non-technical person rather than technical persons, as was the case in all the other projects. This can be explained by the fact that one of the founders of Valy had degrees in literature and business rather than technology, and this person, quite logically, took on the responsibility of authoring documents. This person's participation in founding was not based on the background in literature. Thus, this pattern can be characterized as being largely coincidental.

Some of the respondents indicated that communication processes with customers were designed deliberately for automation and interchangeability of contacts, whereas others described very informal and personal models where customers expected to be able to call their individual contact within the firm at almost any time. The newness of the firms studied and their relatively small number of customers came through in the descriptions of informal personal communication. However, there was a consistent tone that designing and implementing automated processes for communicating with customers becomes necessary when the number of customers increases and employees' tolerance for increasingly frequent interruptions diminishes. CellStory (U.S.) had used an informal and personal model for its earlier service, CS1, but when moving to the consumer market with CS2 it became necessary to design and adopt a more automated system for communicating with customers. Thus, communication process design was observed along a spectrum from the informal and personal to

the formal and impersonal. On one point along this spectrum, there were only two observations, both in Quantum3D (U.S.), where customer support was observed to be automated, but customers were still able to contact individuals in the firm. There was a clear indication on the part of the respondents at Quantum3D that they would prefer a fully automated model, but at the same time they recognized the importance of maintaining positive and personal relationships with their customers. This particular variant of the trade-off between informal and personal communication, on one hand, and formal and impersonal, on the other, overlaps with other patterns found in projects both in the United States and Iceland.

Most of the respondents were able to describe the desired customer experience for their services. The experiences described can be classified as fun, simple or invisible. These experiences were supported by other aspects such as user interfaces and usability. Observations of desired customer experiences classified as fun and simple were found in projects both in Iceland and the United States. The desired experience of invisibility was observed only in projects in the United States, namely Lucidoc's LU1 and Red Condor's RC2. This could be attributable to the nature of Lucidoc's and Red Condor's services rather than different attitudes towards design.

Aspirations to initiate and foster user community were observed only in projects in the United States, namely in both of Lucidoc's projects, in Red Condor's RC2 and Quantum3D's QU2. Actual implementation of community building were observed in projects in both Iceland and the United States, but the difference was in aspirations to do something that was not currently being done. More specifically, respondents wanted to use blogs, Internet chat rooms, user groups and other user gatherings to foster community. This seemed to be the most striking difference found between the two sets of projects.

Observed Similarities

The observed differences discussed above are far outnumbered by the observed similarities between projects in Iceland and projects in the United States. Based on comparative method analysis (Ragin 1987) most of the patterns identified were observed in both Icelandic and U.S. cases. See Appendix B for a complete summary of the analysis.

Thus, the result of the case comparison is that the roles of design in the development of technology-based services in NTBFs in Iceland and the United States are quite similar.

Comparison with Established Firm

In the established Silicon Valley firm designers were observed to be involved in the project studied from the outset. Engineers and designers worked separately, but a project manager served as liaison between the two groups. Designers had different and well defined roles. User experience architects were involved in insuring ease of use throughout the development process and graphic artists were responsible for designing packaging, screen layouts, icons, etc. In addition to working on the firm's own service innovation projects, the firm also has a design unit that sells design services on a consulting basis. The NTBFs had similar concerns regarding ease of use, visual interfaces and packaging but their approaches to addressing these concerns were much less deliberate, mostly performed by silent designers and in some instances neglected. Of the NTBFs studied, only CAOZ employed in-house designers and CellStory had one designer involved in development, albeit not on a full-time basis.

A *modus operandi* reminiscent of the *Artful Process* (Austin & Devin, 2003) was observed in the established firm. The established firm involved customers in the development process in two ways. The firm used multiple customer visits to elicit input to the development process. During concept development, teams of people, including programmers, visited customers for focus group meetings to find out what customers' needs were. This was an iterative process that continued through development as customers were recruited to test prototypes in various stages of development. This testing was performed in a laboratory setting, where users were observed interacting with the service from behind one-way mirrors. The *modus operandi* in some of the NTBFs also resonated with the artful process but on a much smaller scale, simply because there were fewer customers and development projects were smaller. Of the NTBFs, Lucidoc described a similar strategy of customer involvement in development, but only the aspiration to be able to perform user testing in a controlled environment, which had not been realized at the time of data collection. Quantum3D and Valy also described a considerable amount of customer involvement particularly in

relationship to the high degree of customization that characterize these firms' services.

The established firm actively fosters community building among its customers by supporting user groups on the Internet. Employees follow the communication in these user groups. In addition, the firm holds seminars providing an opportunity for customers to interact. As was mentioned above, some of the American NTBFs had expressed aspirations to do these kinds of things but had not achieved their goals yet. The NTBFs, due to their small size and young age, had relatively few customers and in some cases had established personal relationships with many of their customers, while the established firm, whose customers number in the millions and whose employees number in the thousands, naturally has sought ways to automate its customer relationship management and community building.

Why not different? Exploration of possible explanations

In their book on design-inspired innovation Utterback et al. (2007) discuss clustering of firms. They describe the advantages of urban complexes "that include universities and other research institutions, a large pool of skilled labor, easy movement of people from universities of firms and from firm to firm, availability of grants and venture capital, the presence of many lead users emphasizing product features and functions (often including the military and other government agencies), and the availability of design tools and services and a broad scope of other complementary products" (2007: 80). Utterback et al. contrast this description with the increasingly free movement of goods and the cost-free and friction-free ability to transfer information and digital content. What they suggest might explain clustering of firms, despite the realities of the digital age, is that human capital may not be very mobile and that information moves best when carried by people. They also posit the importance of personal communication networks and contacts and argue that design, in particular, being of highly tacit nature, requires close proximity between designers. The agglomeration of design firms signals the accumulation of design competence, general awareness of design, and opportunities for using specialized design inputs to innovation. Thus, one could expect to see significant differences in how design is used as an element of innovation in regions where design firms cluster compared to regions where they do not. In addition, the concentration of NTBFs,

in and of itself, is also expected to influence innovation processes due to extended division of labor and knowledge spillovers from existing firms. We therefore expected to see significant differences in the use of design between Iceland and the United States.

Iceland, although a technologically advanced country with high GDP per capita, is a small Nordic country with a population of just over 300,000. Because of its location, Iceland is geographically isolated and access to the resources important for new firms is decidedly limited. On the West Coast of the United States, particularly in regions such as the San Francisco Bay area, NTBFs have congregated, thus creating an environment where resources are abundant and its providers are in many cases highly specialized (Saxenian, 1994).

Based on the above comparison, it is clear that there are significant differences in the availability of knowledge resources in the two locations, both for the development of NTBFs in general, and the use of design as an element of innovation in NTBFs in particular. However, the findings of this research suggest that the availability of resources or existence of clusters in close geographical proximity does not exert strong influence on NTBFs with respect to their use of design in service innovation. Therefore, we must look for other explanations.

Before launching on the search for explanations, we will briefly review existing empirical research dealing with regional differences or the lack thereof.

Souder and Jenssen (1999), in research that is possibly closest to ours, performed an explorative comparative study of U.S. and Scandinavian firms producing telecommunications products. Souder and Jenssen found both similarities and differences. The similarities were that development, marketing and customer service proficiencies were found to be important both in the U.S. and Scandinavia. In the U.S. organizational integration and project management competency were found to be important, whereas these factors were not observed to be important in Scandinavia. Conversely, customer intimacy and flexibility were emphasized much more in Scandinavia than in the U.S. In our case firms, organizational integration and project management were not found to be important since service innovation was predominantly informal. Evidence of customer intimacy and flexibility was found in both sets of our case firms. This lack of resonance with the research by Souder and Jenssen (1999) may be due to the fact that Souder and Jenssen's research is not on new firms.

Research by Harris et al. (2005), who performed a comparative analysis of innovation strategy in the different geographical regions of the United Kingdom, suggests important regional differences. They found that Northern Ireland is considerably different with regard to product innovation than the other parts of the U.K. The authors suggest a number of possible explanations for Northern Ireland's poor innovation performance such as inadequate management, distance from other regions of the U.K., over-reliance on ISO 9000 certification and government aid, and a shortage of large firms to help create and sustain a critical mass. However, Harris et al. also recognize that peripheral economies, such as Northern Ireland's, are characterized by predominantly small firm sizes and their results suggest that, in general, regional location is less important than size and industry with regards to innovation performance. Our case firms were all small and so extrapolating from Harris et al.'s (2005) research we would expect innovation performance to be similar. However, Harris et al.'s research was on firms in close geographic proximity, sharing the same language, currency and history, and so extrapolation to our findings should be approached with caution.

In a similar study focusing on different environments for small electronics firms in Mexico and the United States, Galbraith et al. (1990) found that U.S. firms selected their locations based on cultural, personnel and ambiance factors whereas Mexican firms were more concerned with the infrastructure available. Galbraith et al.'s findings are in line with the types of findings we had expected in our comparison of NTBFs in Iceland and the United States.

Karlsson and Olsson (1998) present a possible explanation for our observed lack of differences. In a comparison of innovation in small-to-medium sized firms (SMEs) and large firms, Karlsson and Olsson found that contrary to their hypothesis, firm location in a large, dense region has a significant positive effect on innovation in large firms but not for SMEs. Their results suggest that peripheral regions can provide a good environment for SMEs, but if and when these SMEs grow to become large firms, they need the richer environment of large urban areas.

In his study of systems of innovation in services, Howells (2000) suggests that the influence of sectoral systems of innovation, a normative pressure for isomorphism, has a stronger influence on firms than their geographical location. In a similar vein, Ettlie (2007) reports on research performed in university in several countries, both in Europe and in North America. MBA students were

asked to evaluate the viability of new product development projects and while there was a consistent relationship between respondents' educational background and the evaluations, there was no relationship with respondents' nationality.

In their review of literature and hypotheses on NTBFs, Bollinger et al. (1983) come to the conclusion that sector differences may be a more important influence on where firms are founded and located than are regional policies, and the related conclusion that government programs are at best marginally successful in stimulating industrial innovation.

In his study of regional innovation systems in manufacturing SMEs in the peripheral region of the Beauce in Québec, Canada, Doloreux (2003) found that many of the studied firms' external linkages appear to be similar to those observed in a metropolitan region. The firms were getting access to knowledge through external linkages reaching outside their peripheral region. Doloreux also found that local networks in the firms studied were weak. Many interactions were not local but metropolitan, national or international in character.

The examples of existing research discussed above show that our results are by no means unique. The issue of regional differences is not dominated by one point of view, and although researchers set out expecting to find differences, they sometimes end up with various qualifications and contingencies regarding these differences.

In this vein, DiMaggio and Powell (1991) address what they refer to as "the startling homogeneity of organizational forms and practices" (1991: 64). They argue for a theory of institutional isomorphism and identify three mechanisms for isomorphic change. These are *coercive isomorphism* resulting from other organizations, government or cultural expectations; *mimetic isomorphism* based on uncertainty that drive organizations to mimic other organizations; and finally, *normative isomorphism* stemming from professionalization, or the collective force of members of an occupation.

But how sensitive are NTBFs to institutional isomorphism and to what degree are NTBFs in Iceland and the United States likely to be subject to the same mechanisms for isomorphic change despite the large distance and differences between these two geographical areas?

Coercive isomorphism due to culture may influence the use of design in NTBFs. Hofstede et al. (1990) argue that there is an ongoing cultural convergence across countries at the level of artifacts, while norms, values and basic assumptions are not converging. Artifacts, e.g. symbols and designs, represent the outermost level of Hofstede et al.'s (1990) 'onion' model of culture whereas the inner core represents a system of values, norms and basic assumptions. Thus, the creation and interpretation of symbols, i.e. design, is the part of culture which is the most superficial and most open to converging isomorphic pressures across countries.

NTBFs are likely to be sensitive to mimetic isomorphism. Like all new organizations NTBFs are subject to uncertainty due to the 'liability of newness' (Stinchcombe, 1965). This uncertainty is exaggerated in technology-based firms because of the uncertainty inherent in technological development that may be required before introducing a new product or service on the market (Garnsey, 1995). Under these conditions both internal and external actors call for institutional rules for building trust and confidence about a positive outcome of a firm's innovation activities. NTBFs' success is therefore dependent on the conformity to those rules rather than efficiency, meaning that their organizational structure and behavior will "reflect socially constructed reality" (Meyer & Rowan, 1977: 346).

NTBFs in Iceland and the United States are likely to share the same mechanisms of mimetic isomorphism if they have similar opportunities to mimic other firms they believe represent the state of the art in their category. All of the case firms were developing software-based services, which in many cases were delivered on the Internet. All the firms had web sites which presented information about the firms and their service offerings, thus providing designed virtual identities of the firms and their services available for access irrespective of geographical location. Similarly, firms which are known to be exemplary in how they use design in innovation have a presence on the Internet, thus creating a common reference for other firms to mimic.

NTBFs are also likely to be sensitive to normative isomorphism. Founders play an important role in the formation of organizational culture in new firms (Schein, 2004), i.e. shared values, or assumptions, about the venture "itself, its environment, and how to do things to survive and grow" (2004: 226). NTBFs are founded by, and predominantly employ, persons with technical backgrounds such as engineering. The technical background of NTBFs' founders and the high

proportion of science and engineering educated employees are likely to lead to a unique set of shared values (Roberts, 1991; Slatter, 1992) which are shaped by professional norms infused through the educational system. *Anonymous* found that the background of founders in NTBFs influence the firms' emphasis on design.

If engineers in Iceland and the United States share a professional culture which is based on similar educational systems they are likely to be subject to similar mechanisms of normative isomorphism. While there has been a general convergence of national education systems, e.g. the standardized system of university education in Europe, engineering education, at least since World War II, has converged on emphasizing the theoretical and mathematical foundations of engineering (Seely, 1999). The engineering profession's professional norms have, therefore, been converging, at least since World War II.

As discussed above, research on regional differences has shown that firm size (Harris et al., 2005), sector (Bollinger et al., 1983; Howells, 2000) and individuals' educational backgrounds (Ettlie, 2007) are more important factors than geographical location. Our research specifically studies NTBFs, a category of firms which tend to be small due to their young age, focus their practice in specific sectors and that are more often than not founded by persons with an educational background in technology or natural sciences. As such, NTBFs can be said to constitute a homogenous group with regards to size, sector and founder education. Thus, the predominant similarity between the cases studied may be explained by the theory of organizational isomorphism (DiMaggio & Powell, 1991) and supported by the findings of extant research that suggest that these factors exert a stronger influence on firms than geographical location and ready access to regionally anchored resources.

Conclusions and implications

The goal of this research was to examine the differences between the roles of design in the development of technology-based services in new firms in Iceland and in the United States. Iceland has a small population and this, coupled with its remote geographical location, implies a scarcity of the resources required by new technology-based firms (NTBFs), such as a network of service firms from which NTBFs can procure essential sophisticated services, such as design services, and a

large community of technology-based firms creating opportunities for knowledge sharing. There are a number of regions where technology-based firms have clustered and levels of technology-based entrepreneurship are, and have been, unusually high. One of these regions is Silicon Valley in the San Francisco Bay area, where design firms have also been found to cluster. This research compares the observed roles of design as an element of service innovation in NTBFs in these two regions which, on the surface, seem to be progressing along different trajectories when it comes to the use of design as an element of innovation.

Eight development projects in NTBFs in the United States were compared with the same number of projects in Iceland with respect to the role and application of design through in-depth case research. The research findings suggest that there are more similarities than differences between the two groups. Analogously to DiMaggio and Powell (1991) we were startled by this homogeneity of organizational practices, and curious about how it could be explained.

The theory of institutional isomorphism may provide an explanation to the observed non-differences due to the firms' homogeneity with regards to size, sector, and founders' background. Additionally, we acknowledge the role of the Internet in creating proximity for mimicking. These results suggest important implications for our understanding of regional path dependence, especially its creation and dissolution. Different industries, technologies, and institutions within a region may be subject to different degrees of path dependence. These entities are likely to co-evolve (Nelson, 1994) and their path dependence is likely to be interrelated (Martin and Sunley, 2006), both regionally and across regions. We could therefore expect the development within some entity to moderate, i.e. either reinforce or reduce, the path dependence of the others.

This study points to the role of the Internet as such a moderator. The Internet serves as a common platform independent of geographical location, which may erode regional path dependencies. However, the role of the Internet is likely to be industry specific. The Internet is likely to play a larger role for firms offering software-based services as this category is likely to use the Internet as a medium of service delivery and be better represented on the Internet compared to, for instance, biotechnology firms.

Even if the Internet has reduced the likelihood of specific regional trajectories the effects may only be temporary. Scott and Storper (1997) argue that new

industries enjoy some freedom in choosing a location, which they call 'windows of locational opportunities'. It is possible that radical technological change, such as the introduction of the Internet, enhances locational freedom. In that case the findings could be interpreted as an expression of this freedom, i.e. currently there are large number of locations possessing the conditions that support the creation of a software-based service industry. There are a number of examples of regions that have benefited in different ways from this opportunity such as Ireland, a remote region formerly plagued by unemployment but recently emerging as a fast-growing region in terms of knowledge industries and high technology (Florida 2007) and Bangalore, India, where the Internet has made it possible to operate large-scale back office services for firms all over the world. From this perspective the Internet can be viewed as a 'region' of sorts, with its own regional paths. Putting things flippantly, we might say that for NTBFs there is no such place as Iceland or Silicon Valley, there is only the virtual reality of the Internet. Alternatively, we might see the creation of new regional trajectories where path dependence processes may lead to a renewed geographic organization of innovative activities.

The observed lack of difference may be less about the environment and the path dependence of the region and more about the newness of the case firms. New firms can be expected to be involved in strategic experimentation, at least those firms founded with the purpose of introducing new offerings (Nicholls-Nixon, Cooper & Woo, 2000). (Recall, that one of the criteria for selection of the case firms was innovative behavior.) Whereas location may explain founding rates, organizational practices may be very fluid in the early phase of firm existence while new ways of doing things are being established (Stinchcombe, 1965). Practices may be similar in this early phase due to institutional factors, whereas efficiency factors may become more important later, and at that point a larger difference between regions is likely. Hence, regional path dependence may have more influence on founding rates, probabilities of success, and later stage practices than on early stage practices.

The findings of this research suggest practical implications for founders and managers of NTBFs. If regional influences are indeed much weaker than other factors influencing NTBFs, founding an NTBF in one geographical location rather than another, or moving an NTBF between locations, cannot be viewed as

effective means to engender positive change, at least as far as the role of design in service development is concerned.

There are, however, two important caveats to the implications of the non-differences reported in this paper. First, as mentioned above, the observed non-difference might be specific to firms developing software-based services. Second, the observed non-difference might be due to the propensity for silent design (Gorb & Dumas, 1987) in NTBFs, which may change as the firms grow larger or older. *Anonymous* found that in the case firms, less emphasis was put on design in the firms' first development project compared to later projects. Design was also much more consciously attended to in the established Silicon Valley firm studied for comparison in this paper. Karlsson and Olsson (1998) found that location is more important to large firms than small firms, which also suggests that the importance of location may change as NTBFs become established and larger.

Additionally, as NTBFs become more established it becomes easier to evaluate their output; they become more dependent on efficiently matching their internal workings with their exchange environments and less dependent upon institutional pressures (Meyer & Rowan, 1977). One could therefore expect the resource environment, e.g. access to design competence and resources, to play a more important role for how technology-based firms use design as an element of innovation as they become older and more established.

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Appendix A: Profiles of case firms

Firm ¹⁰	Project ¹¹	Project description	Country
Annata	AN1	Vertical solution for dealers in a specific segment built on top of an ERP system	Iceland
Annata	AN2	Sales planning solution for supply-chain management	Iceland
CAOZ	CA1	3D-character-based animated short film	Iceland
CAOZ	CA2	TV interface and web site for fiber-optic TV, video, Internet and phone access	Iceland
CellStory	CS1	Hosted service allowing users to take photos or videos with mobile phones and post them to a web site along with rich customized text	United States
CellStory	CS2	Hosted service allowing users to post photos from mobile phones to blogs created using templates	United States
Lucidoc	LU1	Compliance management solution for documents targeted for a specific niche segment	United States
Lucidoc	LU2	Add-on to LU1 providing the ability to customize and create reports based on documents	United States
Plinx	PL1	Photo-blogging service developed for the telecom market	Iceland
Plinx	PL2	On-line community where customers can post, download and purchase music and comment on music	Iceland
Quantum3D	QU1	Image generation service for visual and sensor simulation training	United States
Quantum3D	QU2	Rapid prototyping and development of graphical user interfaces for embedded systems and simulation using a custom suite of tools	United States

¹⁰ All firm names, except Plinx, Valy and Aqua, are real.

¹¹ Pseudonyms are used for all the projects. The use of pseudonyms for the projects was necessary because some of them were still under development at the time of data collection and in some cases had only working titles

Firm ¹⁰	Project ¹¹	Project description	Country
Red Condor	RC1	Hosted spam-protection for e-mail	United States
Red Condor	RC2	A suite of bundled security services including anti-spam, anti-virus, anti-spyware, URL content filtering and asset management	United States
Valy	VA1	Custom web site creation service with user maintainability	Iceland
Valy	VA2	Electronic commerce solution for the culture and entertainment sector	Iceland
Aqua	AQ1	Integrated development environment for creating platform-independent solutions. (established firm)	United States

Appendix B: Comparative analysis

Table B.1 shows a comparative method analysis (Ragin 1987) of observed approaches to design application in firms in Iceland and the U.S. Approaches to design application are listed for those aspects of services identified by the case research as being those that NTBFs applied design to. These aspects fall under one of three design dimensions (Anonymous), which are the visceral, the functional, and the experiential dimensions. The visceral design dimension is concerned with appealing to the human senses (Norman 2004). Functional design encompasses utility and performance. Experiential design (Pine & Gilmore, 1998; Stuart & Tax, 2004) is concerned with message, culture, meaning, and emotional and sociological aspects of a service.

A more detailed presentation is shown in Table B.2 where observations are listed by project.

Table B.1: Observed patterns are placed in columns depending on where they were observed. Patterns observed in only one project are omitted (Ragin 1987).

observed only in Iceland	observed in Iceland and the U.S.A.	observed only in the U.S.A.
Visceral design		
Design applied to user interfaces		
	incidental	
	used as a tool for prototyping	
	relatively important	
	high priority	
Design applied to tangible artifacts		
	no tangible artifacts	
	the fact that there is a tangible artifact is important, but its design is not	
	design of tangibles is important	
Design applied to documents		
	few documents, low priority	
	authored by technical people, no design	
	authored by technical people, layout reviewed by non-technical	
authored by non-technical people, some layout design		
	documents strategically important, designed by professional designers	

observed only in Iceland	observed in Iceland and the U.S.A.	observed only in the U.S.A.
Functional design		
Design applied to usability		
efficiency is the primary concern		
shielding from complexity		
interaction elements or number of user steps minimized		
all possible measures to simplify, but some tech. hindrances		
simplicity is a key characteristic		
Design applied to service processes		
incidental		
standard process used		
service process designed deliberately		
Design applied to revenue models		
using standard revenue model		
some adjustment to standard model		
custom revenue model designed		
Experiential design		
Design applied to communication with customers		
communication channels are impersonal		
communication is informal and personal, but moving to an automated customer service model		
		customer support is automated but customers

observed only in Iceland	observed in Iceland and the U.S.A.	observed only in the U.S.A.
		are able to contact individuals in the firm
	communication is informal and personal	
Design applied to community building		
	no communication between users supported	
		aspirations to initiate and foster user community
	communication between users is a by-product of the service	
	community building designed into the service	
Design applied to customer experiences		
	defined experience: simple	
		defined experience: invisibility
	defined experience: fun	
Design applied to marketing materials		
	service information on web site only	
	emphasis on demos	
	marketing materials and demos	

Table B.2: Detailed summary of observations by project.

Projects in Iceland																	Projects in the U.S.						
	AN	AN	VA	VA	CA	CA	PL	PL	CS	CS	LU	LU	RC	RC	QU	QU							
Visceral design	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2							
Design applied to user interfaces																							
incidental	x			x								x	x		x								
provided as a custom service, but																							
low emphasis on aesthetics											x					x							
used as a tool for prototyping	x																						
relatively important			x						x					x									
high priority					x		x	x		x													
Design applied to tangible artifacts																							
no tangible artifacts	x	x	x	x			x	x	x	x	x	x	x			x							
the fact that there is a tangible																							
artifact is important, but its design																							
is not																							
design of tangibles is important					x									x		x							
Design applied to documents																							
few documents, low priority							x	x					x										
authored by technical people, no																							
design																x							
authored by technical people,		x																					
layout reviewed by non-technical																							
authored by non-technical people,	x										x		x			x							
some layout design																							

		Projects in Iceland										Projects in the U.S.									
		AN	AN	VA	VA	CA	CA	PL	PL	CS	CS	LU	LU	RC	RC	QU	QU				
		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2				
documents strategically important, designed by professional designers																					
Functional design																					
Design applied to usability																					
familiarity is more of a concern than simplicity			x																		
efficiency is the primary concern		x																			
shielding from complexity									x												
interaction elements or number of user steps minimized					x			x							x						
all possible measures to simplify, but some tech. hindrances							x														
simplicity is a key characteristic				x																	
Design applied to service processes																					
incidental		x																			
service processes follow technical architecture																					
standard process used			x				x														
service process designed deliberately																					
Design applied to revenue models																					
using standard revenue model		x		x			x														
some adjustment to standard model			x																		
custom revenue model designed																					

	Projects in Iceland										Projects in the U.S.					
	AN	AN	VA	VA	CA	CA	PL	PL	CS	CS	LU	LU	RC	RC	QU	QU
Experiential design	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Design applied to communication with customers																
communication channels are impersonal				x			x	x		x						
communication is informal and personal, but moving to an automated customer service model																
customer support is automated but customers are able to contact individuals in the firm			x						x							
communication processes are informal and impersonal										x						
communication is informal and personal	x	x									x	x	x	x		
Design applied to community building																
no communication between users supported			x	x	x	x							x		x	
aspirations to initiate and foster user community												x		x		
communication between users is a by-product of the service	x	x														
community building designed into the service							x	x								

		Projects in Iceland										Projects in the U.S.							
	AN	AN	VA	VA	CA	CA	PL	PL	CS	CS	LU	LU	RC	RC	QU	QU			
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2			
Design applied to customer experiences																			
no defined experience		x																	
defined experience: simple	x		x	x								x			x	x			
defined experience: simple and invisible																			
defined experience: invisibility																			
defined experience: fun																			
Design applied to marketing materials																			
service information on web site only	x	x	x	x			x	x	x	x									
emphasis on demos																			
marketing materials and demos																			

PAPER 5:
**THE RELATIONSHIP BETWEEN AESTHETIC
DESIGN AS AN ELEMENT OF NEW SERVICE
DEVELOPMENT AND COMPETITIVE
ADVANTAGE, FACT OR FAD?**

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In review and resubmit process following review by an academic journal

The relationship between aesthetic design as an element of new service development and competitive advantage, fact or fad?

Abstract

The purpose of this research is to investigate the conditions under which the use of aesthetic design as an element of new service development is likely to improve performance. Using a sample of new technology-based firms we empirically examine how aesthetic design can contribute to and sustain competitive advantage of new services and how this contribution is moderated by the competitive environment. The empirical findings suggest that the effectiveness of using aesthetic design to achieve competitive advantage through differentiation differs depending on the stage of commoditization.

We found positive relationships between the use of aesthetic design and competitive advantage when there is strong pressure to reduce prices in the competitive environment and between aesthetic design and sustainable competitive advantage when the relative importance of aesthetic design in the competitive environment is low. The results suggest practitioner guidelines for the conditions under which aesthetic design could be employed to gain competitive advantage, the conditions under which it may be pre-mature and the conditions under which aesthetic design is expected and thereby constitutes a required condition for entry.

Introduction

There are indications that differentiation based on technological and functional factors alone is not sufficient to insure competitive advantage of new products and services (Norman 2004; Crawford & Mathews 2001). At the same time, there

is a growing belief that industrial design as an element of innovation can contribute to competitive advantage (Gemser & Leenders 2001) and superior financial performance (Hertenstein, Platt & Veryzer 2005). The results of this research are mixed, however, and Gemser and Leenders (2001) suggest that the relationship is not unconditional. A better understanding of these conditions is needed in order to determine if the relationship is closer to being a fact or a fad.

The increasing importance of services is widely recognized (Normann 2001; Von Stamm 2003). Evidence for the importance of services can be seen in the shift from the traditional notion of products to, so called, “service products”. According to Coombs and Miles (2000), even in manufacturing firms, 75% to 85% of all value creation and a similar percentage of costs, involves service activities. However, research on innovation has been characterized by a prevailing emphasis on the manufacture of tangible products (Gallouj and Weinstein 1997) as is the case for research on design as an element of innovation. In their study of new business-to-business service development, de Brentani and Ragot (1996) found that innovativeness and uniqueness are important success factors. Norman (2004) argues that uniqueness, or differentiation, can be achieved through a combination of functional design and aesthetic design.

The purpose of this research is to investigate the conditions under which the use of aesthetic design as an element of new service development is likely to improve performance. More specifically, we empirically examine how aesthetic design can contribute to and sustain competitive advantage of new services and how this contribution is moderated by the competitive environment.

Before proceeding, it is necessary to explain what is meant by aesthetic design and how it relates to industrial design. The reason we use the term aesthetic design instead of industrial design, which is used by Gemser and Leenders (2001), Hertenstein et al (2005) and Veryzer (2005) as well as many others, is that we believe it is important to avoid terminology which is commonly associated primarily with product manufacture, as is the case for industrial design. In an earlier paper, one of the authors (Anonymous) developed a model for evaluating design emphasis that is based on a three-dimensional definition of design. These three dimensions are the functional, the visceral and the experiential dimensions. Functional design encompasses utility and performance. Visceral design is concerned with appealing to the human senses (Norman 2004). Experiential design is concerned with message, symbols, culture, meaning and emotional and

sociological aspects of a service (Pine & Gilmore 1998; Stuart & Tax 2004). For the purposes of this research, visceral design and experiential design are collectively referred to as aesthetic design. The term aesthetic design can be thought of as being to functional design what industrial design is to engineering design (Moody 1984).

This paper is structured as follows. First, the theoretical background of the research is established and hypotheses are developed about the relationship between aesthetic design in the development of new services and competitive advantage. Second, the data and variables used to test the hypotheses are described along with the methods of analysis. Third, the results of data analysis are presented. Finally, the results and their implications for academic research and practitioners are discussed.

Theoretical background and development of hypotheses

Design can provide the inspiration for innovation (Utterback, Vedin, Alvarez, Ekman, Sanderson, Tether & Verganti 2007) and constitutes an important element in the process of developing new offerings (Bruce & Bessant 2002; Keller 2004). Technological innovation can be thought of as encompassing both technical invention (e.g. R&D and engineering) and commercialization (Marsh & Stock 2003). Design is concerned with creating a bridge between technical possibilities and market demands or opportunities (Walsh 1996). Thus, for the purposes of this research, design is defined as that part of the new service development process encompassing activities that enhance and communicate the value of services (Hertenstein et al 2005; Yamamoto & Lambert 1994). Design as defined here encompasses both functionality and aesthetics. While functional design is concerned with the practical concerns of features and utility, aesthetic design is concerned with visceral appeal, or how products and services appeal to the senses (Norman 2004), and the experiences created through their consumption or use (Pine & Gilmore 1998; Stuart & Tax 2004).

Activities are the basic units of competitive strategy and selecting activities and determining how to perform them to deliver value is the essence of competitive strategy (Porter 1996). Emphasis on aesthetic design in the new service development process can be viewed as part of a firm's competitive strategy. Such

a strategy will influence how and to what degree aesthetic design is used in developing new services.

Competitive advantage is the measure of the success of competitive strategy (Porter 1985, 1996; Barney 1991) and is not an absolute measure of firm performance, but rather a relative advantage over competitors. Competitive advantage is gained if a firm is able to achieve above average economic performance by offering the same benefits to customers as competitors, but at lower prices, or alternatively, by providing greater benefits justifying higher prices, but at costs similar to competitors'. In both cases customers get more 'value for money', i.e. the customer surplus is higher.

In order to generate higher customer surplus more profitably than competitors, firms need to both create and capture added value (Bowman & Ambrosini 2000; Brandenburger & Stuart 1996; Lepak, Smith & Taylor 2007). While the creation of added value is a necessary condition for profits, it is generally not sufficient.¹² Customers value a service offering based on how they perceive its usefulness, i.e. how the specific qualities, or attributes of the service are perceived in relation to their needs and goals (Bowman & Ambrosini 2000; Woodruff 1997). The monetary value of a service, or what is referred to as customers' willingness to pay, is the price customers are prepared to pay if there is a single source of supply. While the monetary value is closely related to how customers value the service it is also dependent on their financial status. The exchange value, i.e. the price of actual exchange, may deviate from the monetary value based on the degree of competition, the relationships between the firm, its customers and its suppliers, and the bargaining power of each of these parties (Bowman & Ambrosini 2000; Brandenburger & Nalebuff 1996; Brandenburger & Stuart 1996). While the value created by the firm is dependent on customers' willingness to pay for its services, the value captured by the firm, i.e. the firms' profitability, is dependent on the price of the exchange between customers and the firm, on one hand, and between the firm's costs, on the other hand.

The durability of competitive advantage is also important. A temporary advantage, e.g. one obtained through innovation (Schumpeter 1934), can quickly

¹² While this holds under the conditions of unconstrained bargaining, there are various frictions in the market, which violate this assumption. If bargaining is constrained, firms may capture value without creating any added value (Brandenburger & Stuart 1996).

erode as competitors imitate the innovation. In order for competitive advantage to persist, it must be the result of the implementation of a value creating strategy which is *“not simultaneously being implemented by any current or potential competitors and when these other firms are unable to duplicate the benefits of this strategy.”* (Barney 1991, p. 102). Thus, there can be said to be two aspects of competitive advantage. First, to gain competitive advantage, firms need to offer customers more ‘value for money’, and do so more profitably, than competing firms. The activities that make this possible are potential sources of competitive advantage. Second, to maintain competitive advantage, firms must be able to defend their competitive position. This entails using means that cannot be readily imitated by competing firms.

Below, hypotheses about the relationship between the use of aesthetic design as an element of new service development and competitive advantage are developed, both in terms of aesthetic design as a source of competitive advantage and as the means to sustain competitive advantage. Hypotheses about the moderating influence of the competitive environment on these relationships are also developed.

Aesthetic design as a source of competitive advantage

Research on the development of new products (Cooper & Kleinschmidt 1987) and new services (de Brentani & Ragot 1996; Storey & Easingwood 1998; Cooper et al 1994; Easingwood & Storey 1991, 1993; Cooper & de Brentani 1991; de Brentani 1989) has identified value to customers or product/service quality as an important success factor. Song, di Benedetto and Song (2000) surveyed almost 1000 managers in the service industry in nine countries about pioneering advantages. Their respondents did not believe that higher quality resulting from improvements in technology led to higher price-cost margins for services. Technological advantages were seen to be relatively unimportant. These results suggest that increased quality based on technology alone is not sufficient if this quality is not communicated and perceived by customers.

The motivation for the use of aesthetic design in new service development is to enhance and communicate the value of services (Hertenstein et al 2005; Yamamoto & Lambert 1994). The use of aesthetic design can therefore be viewed as an attempt to increase customers’ willingness to pay for services and thus constitutes a differentiation strategy (Brandenburger & Stuart 1996; Porter 1985).

The use of aesthetic design can increase customers' willingness to pay in two basic ways. First, aesthetic design can be used as a way to extend the functional benefits of services through improved usability (Norman 2002, 2004). Through aesthetic design, customers are better able to understand how the attributes of a service can meet their needs and goals. While functional design is concerned with the workings of a service, aesthetic design can be used to communicate the functional attributes of a service to customers to make them more accessible and improve usability, thus better fulfilling customers' needs and expectations (Norman 2002; Shedroff 2001).

Second, aesthetic design can be a means to enhance customer benefits through the creation of symbolic value. Khalifa (2004) argues that customer needs range from purely utilitarian needs to needs originating and existing only in the mind and that these needs can be met through benefits which range from being purely tangible to being purely intangible. Additionally, Khalifa (2004) argues that the nature of the relationship between a customer and a firm can range from being a mere transaction between anonymous agents to meaningful interactions between persons. Value is accrued as the satisfied needs advance from utilitarian to psychological, the benefits from tangible to intangible, and the relationships from anonymous transactions to meaningful interactions. A good example of this phenomenon is the difference between a fast-food franchise restaurant (utilitarian, tangible, anonymous) and a local gourmet restaurant where the food and drink fulfill visceral and experiential needs as well as the purely functional need of a satisfied appetite; where intangible attributes such as the character of the proprietor or the association of the restaurant with a specific cuisine or gastronomic philosophy add value to the basic activity of ingesting sustenance; and where the entire restaurant visit can involve personal interactions with staff and proprietors, not to mention other customers. Thus, through the use of aesthetic design, firms are likely to be better able to offer intangible benefits that fulfill psychological needs in addition to the tangible benefits provided by the functionality, or utility, of their services.

A set of success factors identified by new service development researchers are related to customer experience and include proficient service delivery, employee expertise and training (Shostack 1984; Easingwood & Storey 1993; Cooper et al 1994; Storey & Easingwood 1996, 1998; de Brentani 2001) and the quality of customer contact, encounters and experience (de Brentani 1991; Cooper et al

1994; Storey & Easingwood 1998; Stuart & Tax 2004). Woo and Ennew (2005), in their study of business-to-business professional services, examined the interaction dimension of service quality and found that when what is provided in a service becomes more and more similar among competitive offerings, how the service is provided, or the social exchange involved, can create competitive advantage. As discussed earlier, one of the elements of aesthetic design is experiential design, which Pullman and Gross (2004) found can play a role in fostering customer loyalty. Thus, aesthetic design can be used to create symbolic value and move the satisfaction of needs from the utilitarian to the psychological realm (Khalifa 2004).

Based on the above, we hypothesize that emphasis on the use of aesthetic design in new service development can be a source of competitive advantage as it creates opportunities to increase customers' willingness to pay for firms' services through differentiation and based on improved usability and symbolic value:

Hypothesis 1a: Firms putting more emphasis on the use of aesthetic design in new service development will be more likely to gain competitive advantage through differentiation than firms putting less emphasis on the use of aesthetic design.

It is likely that increased willingness to pay will vary according to customers' expectations and the perception of the relative importance of the enhanced benefits provided by aesthetic design. Based on a review of the literature Khalifa (2004) groups features, or benefits, of offerings into three categories based on their relative importance in the creation of added value. *Basic features* are the taken-for-granted attributes and consequences which are required if an offering is to have any value to customers or whose absence will make customers dissatisfied. *Expected features* are attributes and consequences which are explicitly required by customers. These attributes typically meet performance related needs, and customer satisfaction is dependent on how well offerings perform relative to these needs. *Innovative features* are attributes and consequences that customers do not expect, but fulfill latent needs. Customers will not be dissatisfied if they are missing, but their presence surprises customers in a positive way.

Expectations about features and attributes and their relative importance in influencing purchase vary across customer groups and time. Functional thresholds, i.e. the basic features needed if offerings are to have any value to a

customer, are determined by explicit customer requirements or the demands of customers' customers (Adner & Levinthal 2001). Furthermore, customers differ in their ability to exploit different features and attributes and have different performance requirements. Finally, with time, as performance improves beyond what is required by customers, their willingness to pay for further improvements diminishes.

The diminishing marginal value attributed to performance improvements of expected features creates shifts in the basis of competition in an industry (Adner & Levinthal 2001; Adner & Zemsky 2006; Christensen 1997; Christensen & Raynor 2003). Christensen and Raynor (2003) argue that these shifts follow a consistent pattern of commoditization and decommoditization as the locus of the ability to differentiate products and services shifts. Christensen (1997) identifies four stages in the pattern of commoditization with concomitant increased pressure to decrease prices: differentiation based on functional attributes, differentiation based on reliability, differentiation based on convenience, and, finally, differentiation based on price only. As the performance of offerings 'overshoots' what is required by customers at each stage, firms seeking means for differentiation are forced to move to the next stage. However, as firms strive to lower costs, such improvements are dependent on their suppliers' performance improvements, which in turn, create new opportunities for differentiation based on performance improvements, but in a different part of the value chain.

If we superimpose the two different ways in which the use of aesthetic design may increase customers' willingness to pay on Christensen's (1997) stages of commoditization we see that opportunities for using aesthetic design as a source of differentiation may increase with increased commoditization. In the first two stages of commoditization in which functionality and reliability are most important, added value is primarily created through improving functional characteristics of services in the interest of fulfilling explicitly defined customer performance requirements in a reliable manner. In the third stage, where convenience becomes a primary concern, added value is primarily created through improving convenience of use, i.e. the usability of services, which is one of two ways in which aesthetic design can increase customers' willingness to pay. In the fourth and final stage, price is considered to be the only possible basis for differentiation. However, at or before this stage, the use of aesthetic design can provide symbolic value, i.e. offer intangible benefits corresponding to

psychological needs in addition to other benefits. An example is using visual information to signify elegance, functionality and social significance (Crilly, Moultrie & Clarkson 2004).

In her study of design and innovation in manufacturing, Walsh (1996) found a shift in emphasis in the life cycle of an industry or technology, reminiscent of Christensen's (1997) stages of commoditization. Walsh identifies the progression from an early period characterized by technological innovation, to a subsequent period during which improvements, lower cost and ease of manufacture are emphasized, and finally a more mature phase where design variations, fashions, styles and re-designs predominate. A well known example of an offering where symbolic value has been successfully added to sufficient, reliable and convenient functionality is Apple's iPod (Cruikshank 2006).

Based on the above, one can expect that an emphasis on the use of aesthetic design in new service development will be more likely to be a source of competitive advantage as commoditization increases. Thus, we propose the following moderation to our first hypothesis:

Hypothesis 1b: The stage of commoditization for firms' offerings will moderate the relationship between aesthetic design in new service development and competitive advantage. The higher the stage of commoditization, the stronger the relationship between aesthetic design and competitive advantage.

Aesthetic design as a source of sustainable competitive advantage

While the use of aesthetic design as an element of innovation can increase customers' willingness to pay and thereby constitute a source of competitive advantage, it is important to be able to sustain this advantage to ensure long term performance. This entails implementing a competitive strategy which is not easily imitated by competitors (Barney 1991; Cooper, Easingwood, Edgett, Kleinschmidt & Storey 1994).

One way of sustaining competitive advantage based on a value strategy, as opposed to a price strategy, is to simultaneously create switching costs the discourage customers' willingness to pay for competitors' offerings (Brandenburger & Stuart 1996). This can be achieved either by using aesthetic

design to create value through improved usability, or by using aesthetic design to create symbolic value.

As argued previously, improved usability through the use of aesthetic design is likely to help customers to better understand how the attributes of services create the consequences required to fulfill their needs. Not only may these benefits be more easily perceived by the customer at the point of purchase, but customers will be more likely to actually experience, or realize, the value of a service through its use or consumption. This is likely to increase customer satisfaction and loyalty. Similarly, if customers experience and identify themselves with the symbolic value perceived at the point of purchase, that symbolic value becomes more important in future purchases. Thus, improving usability and creating symbolic value through aesthetic design play the dual roles of increasing customers' willingness to pay and creating switching costs.

Switching costs due to superior usability or symbolic value are not sustainable in and of themselves, but rather their sustainability depends on to what degree, and at what price, the resources that are used to create them can be imitated, substituted, or transferred to competitors (Peteraf 1997). The most important resource used in aesthetic design activities is the designers themselves (Utterback et al 2007), whether these are professional designers with explicit responsibility for design or "silent" designers (Gorb & Dumas 1987), i.e. non-designers engaged in design even if their design role is unacknowledged. These designers have engineering and/or aesthetic skills and knowledge, which enable them to create a bridge between the practical concerns of features and performance with visceral appeal, or how offerings appeal to the senses, and the experiences created through their consumption or use (Norman 2004; Pine & Gilmore 1998). While the output of aesthetic design is in many ways explicit and codified, especially its visual aspects (e.g. Lidwell, Holden & Butler, 2003), the knowledge needed to perform aesthetic design is to a large degree tacit and firm specific as expressed by Cross (2004): "*Studies of design activity have frequently found 'intuitive' features of design behavior to be the most effective and relevant to the intrinsic nature of design.*".

Just like engineering design knowledge (Vincenti 1990), aesthetic design knowledge includes fundamental design concepts, design instrumentalities and roles (Perks, Cooper & Jones 2005). Fundamental design concepts include forms and shapes with known functional and aesthetic properties. These design

concepts are the subject of formal design education, and are mostly shared within the design community. Design instrumentalities include procedural knowledge related to the ability to carry out design tasks. This knowledge includes ways of thinking, e.g. less tangible ways of formulation, which are often difficult to articulate but can be visualized in models, sketches and drawings (Cardella, Altman & Adams 2006). It also includes judgmental skills in making design decisions, e.g. in relation to human and social demands and constraints. Design instrumentalities are skills which are to some degree shared within the design community, but they are more firm specific and personal than design concepts. They are firm specific in that they are shaped by the context in which they are developed and personal in the sense that they are expressions of the individuality of the designer. Vincenti (1990) argues that knowledge of design instrumentalities is what separates an outstanding design(er) from an ordinary one.

As the use of aesthetic design in new service development cannot be easily imitated or transferred to competitors due to the tacit nature of designer knowledge, and thus constitutes a switching cost for customers, we propose the following hypothesis:

Hypothesis 2a: Firms putting more emphasis on the use of aesthetic design in new service development are better able to sustain competitive advantage than firms putting less emphasis on aesthetic design.

Just as heterogeneity of demand, i.e. variation in customers' perception of the relative value of aesthetic design, was expected to moderate how aesthetic design can be used to contribute to competitive advantage, heterogeneity of design competencies can be expected to influence the sustainability of such an advantage. If aesthetic design competencies are not widely used or appreciated in an industry it is likely to be difficult to imitate aesthetic design, whereas it becomes much easier to match or duplicate if industry specific aesthetic design competencies are widely available. Hence, the use of aesthetic design can itself become a minimum requirement for competition rather than a source of differentiation. An example of an industry where emphasis on aesthetic design is established and expected is the furniture industry (Gemser & Leenders 2001). Gemser and Leenders found that the relationships between industrial design and various performance indicators were considerably weaker in the furniture industry than in the precision instruments industry. This leads to the hypothesis

that the importance of aesthetic design in a firm's sector will moderate the relationship between emphasis on aesthetic design and the ability to sustain competitive advantage.

Hypothesis 2b: The relative importance of aesthetic design in a firm's sector moderates the relationship between aesthetic design in new service development and the ability to sustain competitive advantage. The greater the importance of aesthetic design in the firm's sector the weaker the relationship between aesthetic design and the ability to sustain competitive advantage.

Methodology

Data collection

The hypotheses were tested using quantitative data from an ongoing longitudinal study of new technology-based firms (NTBFs) in a Nordic country. NTBFs were selected as the empirical context for this research for three reasons. In the first place, new firms can be expected to be engaged in innovation and NTBFs, specifically, are important sources of technological innovation (Bollinger, Hope & Utterback 1983). In the second place, new firms can be expected to base their strategies on differentiation (Carter, Stearns & Reynolds 1994) and as platforms for technological innovation (Bollinger et al 1983) they need to create a bridge from technical functionalities to value in new products and services (Walsh 1996). If aesthetic design is indeed a fruitful means to achieve differentiation, NTBFs should constitute a class of firms particularly sensitive to the use of aesthetic design as a means to achieve success when developing new offerings. The third reason for limiting the empirical context to NTBFs is that this insures a level the homogeneity among the firms studied.

In early 2005, a list of firms founded in the year 2000 or later, which were classified as technology-based firms according to a coding system based on the European Union's Nace 1 coding system, and which paid salaries in 2004, was obtained from public records. Firms having fewer than three employees were not included, unless such firms were less than 2 years old. This was done in the interest of not including legal entities established primarily for tax reasons around one or two self-employed persons. Background information was checked

for all remaining potential participant firms so that firms which did not engage in technology-based development despite their formal classification could be eliminated. The result was that 80 firms were identified as potential participants. When contacted, 10 of these had gone out of business, were older than their registration indicated or were not actually technology-based firms despite their formal classification. Of the remaining 70 firms, 65 agreed to participate (93%). These firms were surveyed in early 2005. The survey consisted entirely of structured questions and was administered in face-to-face interviews with the firms' CEOs. The duration of each interview was approximately one hour and covered founding, development of new services, design emphasis and performance, as well as several other topics. CEOs of new firms who, in many cases are also among the firms' founders, can be expected to be very knowledgeable about most, if not all, aspects of their firms' operations. By administering the interviews in person with respondents who could be assumed to be knowledgeable, a high level of reliability was insured.

In 2006, 63 (97%) of the original firms were surveyed again. The survey was administrated through telephone interviews with the firms' CEOs which lasted about 45 minutes and included all the same questions as the initial survey, except questions about founding.

The hypotheses were tested using data for the 58 out of the 63 NTBFs that based part or all of their revenue on the sales of services. The average percentage of these firms' income from the sales of services was 82.4%.

The participating firms belonged to a total of 19 industrial sectors. To estimate the general importance of aesthetic design by sector, a panel of experts was asked to rate the importance of aesthetic design for each of the sectors represented by the NTBFs included in the study.

Dependent variables

Competitive advantage (hypotheses 1a and 1b): Survey respondents were asked to compare themselves with the firms they define as their competition on a number of dimensions. Competitive advantage can manifest itself in a number of ways. In this study, in which the focus is on differentiation based on aesthetic design, competitive advantage is expected to manifest itself in the form of higher prices at similar costs. Therefore, pricing compared to competitors was used as a proxy for competitive advantage while cost positions compared to competitors were used as control variables (see below). Pricing compared to competitors was measured by asking respondents to rate the price for their firms' services compared with the price for comparable competitors' services using a five point scale.

Sustained competitive advantage (hypotheses 2a and 2b): We have argued that competitive advantage created through aesthetic design could be sustained through switching costs not easily reduced by competitors due to the tacitness of designer knowledge. In line with that argument switching costs were used as a proxy for the sustainability of firms' competitive advantage. Switching costs were measured by asking respondents how easy it would be for their competitors to offer the same services as their firms, if the competitors had similar facilities or equipment.

Independent variable

The weight firms place on aesthetic design as an element of new service development is the independent variable for this study. One of the authors (Anonymous) developed a method for evaluating technology-based firms' design emphasis that is used in this research. The method is based on the synthesis approach to studying innovation in services and manufacturing (Coombs & Miles 2000; Gallouj & Weinstein 1997; Drejer 2004) and, therefore, is applicable to firms selling products, services or a mix of both.

Respondents were asked to rate the weight their firms place on aesthetic design when developing new services. Eight questions were used to measure aesthetic design. The questions were based on the three-dimensional model of design described earlier. The questions dealt with design aspects which fall under visceral and experiential design. Pine & Gilmore (1998 and 1999) argue that a firm's true economic offering is the economic offering for which the firm charges

its customers. In the interest of capturing firms' actual level of aesthetic design emphasis with more reliability than by only using questions asking for an assessment of emphasis specifically, questions asking for an indication of how much value respondents believed the market attributes to aesthetic design aspects were included. More specifically, firms were asked to rate how much more they believe their current or future customers would be willing to pay for their offerings based on aesthetic design aspects.

To test the validity of managers' evaluation of their firms' emphasis on aesthetic design, two professional graphic designers were asked to evaluate the firms' web sites for design sophistication. The graphic designers' evaluations were significantly correlated with managers' evaluations of their firms' emphasis on aesthetic design. Although managers were evaluating aesthetic design as an element of innovation and the graphic designers were evaluating web site design, this correlation can be viewed at least as partial confirmation of the validity of managers' evaluations of aesthetic design, since aesthetic design emphasis in one area of a firm's activities is likely to be similar to its aesthetic design emphasis in another area.

Interacting terms

As described earlier, two moderating influences were hypothesized. The first of these (hypothesis 1b) is the influence of commoditization. Christensen (1997) describes the process of commoditization as a process progressing in four stages. During these four stages pressure to decrease prices increases until price is the only discriminator. As a measure of commoditization, respondents were asked to rate the level of pressure experienced by their firms to reduce prices on a five item scale ranging from price pressure being a very insubstantial threat to the performance of the firm, to price pressure being a very substantial threat.

The second moderating influence hypothesized (2b) is the relative importance of aesthetic design in a firm's sector. As described under Data collection above, evaluations by a panel of experts were used to create this measure. The panel consisted of three experts representing the breadth of the areas into which the NTBFs under study fell, namely engineering, architecture and information technology. The experts were selected based on having at least 10 years' experience and university degrees, at the Master of Science level or higher, in

their fields. The three experts did not have a history of working on the same projects or for the same firms.

The experts were asked to rate the importance of each of the three design dimensions, visceral, functional and experiential, for the development of new offerings in each sector, on a 4-point scale ranging from “none” to “a great deal”. The ratings for visceral and experiential design were combined to obtain an estimate of aesthetic design importance for each sector.

Control variables

The focus of this research is aesthetic design in new service development. The contribution of aesthetic design is thus dependent on the extent of innovative behavior in a firm. Two control variables which capture the extent of innovative behavior were considered. Respondents were asked what proportion of turnover their firms spent on research and development and respondents were also asked if their firms had introduced a new offering in the past year.

Slappendel (1996) found that firm size influences design emphasis and so firm size, measured as the number of employees, was considered as a control variable.

As mentioned earlier, aesthetic design is likely to increase customers’ willingness to pay. The use of aesthetic design, however, comes at a cost which needs to be taken into account when investigating the relationship between aesthetic design and competitive advantage. To control for increased cost due to emphasis on aesthetic design respondents were asked to evaluate their firms’ costs for salaries, equipment and facilities and financing, respectively, compared with their competitors’.

Data analysis

The independent variables were centered and standardized prior to analysis (Marquardt 1980). Correlations between variables were examined to check for potential multicollinearity, see Table 1. Although the variables do suffer from the usual handicaps of variables based on subjective ratings of a respondent’s own goodness they are reasonably distributed as shown in Table 2.

Table 1. Correlation matrix. The independent variable and control variables are centered and standardized.

	1	2	3	4	5	6	7	8	9	10	11	12
ability to charge higher prices	1											
1												
2 difficulty of imitation	0.062	1										
3 aesthetic design	-0.027	0.211	1									
		*										
4 price pressure	0.246	0.030	0.019	1								
	**											
aesthetic design x price pressure	0.230	0.017	-0.034	0.054	1							
	*											
6 sector design importance	-0.003	0.051	0.086	-0.257	-0.060	1						
				**								
aesthetic design x sector design importance	-0.022	-0.336	-0.162	-0.069	-0.073	0.179	1					

8 R&D expenditure	-0.008	0.177	0.109	0.008	-0.181	0.176	-0.188	1				
9 new offerings introduced	0.016	-0.215	0.150	-0.025	-0.098	0.031	0.317	0.239	1			
							**	*				

	1	2	3	4	5	6	7	8	9	10	11	12
10 firm size	0.258 **	-0.153	0.081	0.187	-0.052	-0.238	0.015	-0.141	0.176	1		
11 salary costs	-0.194	0.097	0.001	0.092	0.028	-0.085	0.135	-0.376 ***	-0.216	-0.051	1	
equipment and facility												
12 costs	-0.190	0.294 **	-0.117	-0.133	0.098	0.370 ***	0.026	0.070	-0.083	-0.151	0.196	1
13 finance costs	0.001	-0.301 **	0.077	-0.016	0.049	-0.056	0.162	-0.269 **	-0.036	0.110	-0.143	-0.240 *

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 2. Summary statistics. The independent variable and control variables are centered and standardized.

	Mean	Std. Dev.	Min	Max
Dependent variables:				
ability to charge higher prices	2.83	0.94	1	5
difficulty of imitation	3.70	1.30	1	5
Independent variable:				
aesthetic design	0	1	-2.12	1.93
Interacting variables:				
price pressure	0	1	-1.15	2.09
sector design importance	0	1	-4.29	1.51
Control variables:				
R&D expenditure	0	1	-0.96	2.85
new offerings introduced	0	1	-1.56	1.40
firm size	0	1	-0.61	6.17
salary costs	0	1	-1.98	2.65
equipment and facility costs	0	1	-2.44	1.74
finance costs	0	1	-2.21	2.34

The firms included in analysis based, on average, 82.4% of their revenues on the sales of services and the rest on the sales of products. 84% of the firms sold their products and services to other firms (business-to-business), 10% sold to the consumer market (business-to-consumer), and the remaining 6% sold to both markets. The average firm size, at the time of the second round of data collection in 2006, was 13 employees and the firms ranged in age from one to six years.

To test the hypotheses, hierarchical regression analysis was performed for each of the dependent variables. Each regression tests the relationship between firms' aesthetic design in one year and the dependent variables in the following year.

Hierarchical regression analysis was performed in five steps. In the first step regression analysis was performed using all candidate control variables, but without the independent variable. The purpose of this step is to determine which of the control variables are likely to contribute to the regression models used for

hypothesis testing. The available sample size imposes a limit on the number of independent variables for each regression model (Cohen 1992) and so it was important to include only those control variables which contribute to the model.

In the second step, the independent variable was added to the model and those control variables which step 1 indicated would not contribute to the model were removed, one at a time. Changes in model and variable significance were carefully monitored during this process to insure that significant control variables were not being omitted.

In the third and fourth steps an interacting term was added to test the hypotheses about moderating factors (hypotheses 1b and 2b). First, the interacting variable was added (step 3) and then the interacting term obtained by multiplying aesthetic design by the interacting variable (step 4).

The fifth step involved regression diagnostics which were performed after the second, third and fourth steps, respectively. Added-variable plots were examined to ascertain if there were outliers and leverage versus residual squared plots were examined to look for data points having high leverage in the models. Correlations between variables (see Table 1) were checked to confirm the absence of multi-collinearity in each model.

This five-step process was repeated for both the dependent variables.

Limitations

When evaluating the results of this research, it is important to keep in mind that the data used for hypothesis testing are primarily based on information collected from managers and so are subject to bias owing to managers' possible efforts to maintain consistency in their responses. However, since the data for the dependent and independent variables were collected at two respective points of time, one year apart, this potential problem is mitigated.

There is a potential problem with using higher pricing as a dependent variable, since higher pricing can constitute a competitive strategy in its own right. For example, a firm might decide to raise the price for its service in an attempt to signal quality or appeal to an upscale target market. In such cases higher pricing may be completely unrelated to aesthetic design. Examining the moderating effect of pressure to reduce prices as well as the direct relationship between higher pricing and aesthetic design helps to mitigate this potential problem.

The unit of analysis in this research is the firm. When examining relationships between aesthetic design and competitive advantage it would probably be more appropriate to use individual new service development projects as the unit of analysis. However, since the firms studied are new and, concomitantly, mostly small, they are not likely to be engaged in several new service development projects. In fact, the survey included a question about number of innovation projects and 65% of the CEOs reported that their firms worked on only one such project at a time. Additionally, due to their small size, NTBFs are likely to use the same resources and methods for all projects. These characteristics of the firms studied lend support to the appropriateness of using the firm as the unit of analysis.

Results

The results of regression analysis for testing hypotheses 1a and 1b, are shown in Table 3. Models are significant at the 1% ($p < 0.01$) level.

Hypothesis 1a is not supported by the data since there is not a significant relationship between aesthetic design and the ability to charge higher prices in step 2. A significant positive relationship was observed in step 4 between the ability to charge higher prices and the interaction term obtained by multiplying aesthetic design by price pressure. This provides support for hypothesis 1b. The interaction is plotted in Figure 1 for the mean and values one standard deviation above and below the means for price pressure and aesthetic design, respectively (Aiken & West 1991). The plot shows a steep positive relationship for higher levels of price pressure and a slightly negative relationship for lower levels, providing support for hypothesis 1b and also shedding light on the reason why hypothesis 1a is not supported.

Table 3. Results of regression analysis for testing hypotheses 1a and 1b.

	Step 1	Step 2 Hypothesis 1a	Step 3	Step 4 Hypothesis 1b
Independent variable:				
aesthetic design		-0.022	-0.020	-0.015
Control variables:				
R&D expenditure	-0.014			
new offerings introduced	-0.073			
firm size	0.245 **	0.245 **	0.194 **	0.206 **
salary costs	-0.195 *	-0.185 *	-0.214 **	-0.216 **
equipment and facility costs	-0.116			
finance costs	-0.088			
Interaction term:				
price pressure			0.268 **	0.253 **
aesthetic design x price pressure				0.188 **
F	1.45	2.48 *	3.40 **	3.45 ***
R ²	15%	12%	20%	25%
Adjusted R ²	4%	7%	14%	18%

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

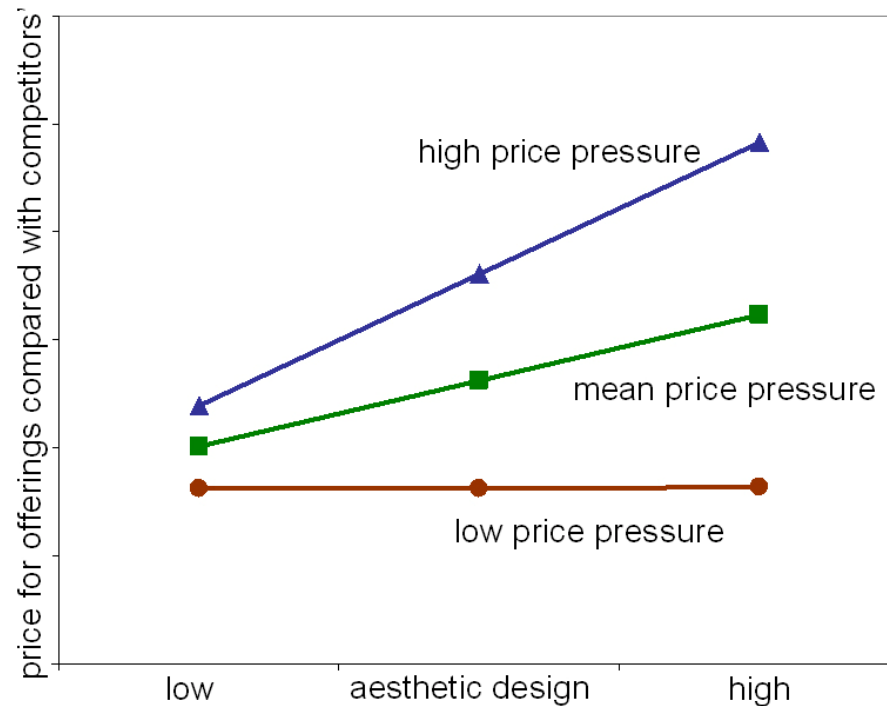


Figure 1. Interactions for aesthetic design and the ability to charge more for offerings depending on level of price pressure. Low and high refer to values one standard deviation above and below the means for price pressure and aesthetic design, respectively.

The results of hierarchical regression analysis for testing hypotheses 2a and 2b are shown in Table 4. Hypothesis 2a is supported by the data since there is a significant positive relationship between aesthetic design and difficulty of imitation in step 2. A significant positive relationship was observed in step 4 between difficulty of imitation and the interaction term obtained by multiplying aesthetic design by sector design importance. This provides support for hypothesis 2b. The interaction is plotted in Figure 2 for the mean and values one standard deviation above and below the means for sector design importance and aesthetic design, respectively (Aiken & West 1991). The plot shows a stronger relationship (a steeper slope) for lower sector design importance than for higher sector design importance, as hypothesized.

Table 4. Results of regression analysis for testing hypotheses 2a and 2b.

	Step 1	Step 2		Step 3		Step 4		
		Hypothesis 2a				Hypothesis 2b		
Independent variable:								
aesthetic design		0.447	***	0.465	***	0.405	***	
Control variables:								
R&D expenditure	0.210							
new offerings introduced	-0.209	-0.268	**	-0.260	**	-0.180		
firm size	-0.065							
salary costs	0.182							
equipment and facility costs	0.318	**	0.408	***	0.463	***	0.460	***
finance costs	-0.296	**	-0.407	***	-0.404	***	-0.354	**
Interaction term:								
sector design importance				-0.135		-0.088		
aesthetic design x sector design importance						-0.263	*	
F	2.86	**	6.77	***	5.54	***	5.05	***
R ²	25%		34%		35%		37%	
Adjusted R ²	16%		29%		28%		30%	

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

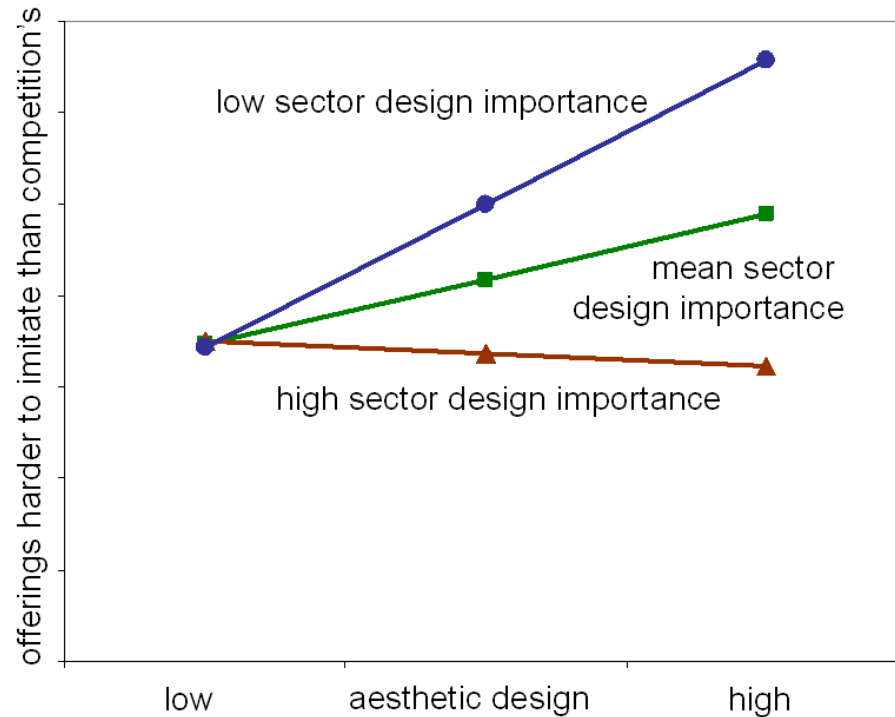


Figure 2. Interactions for aesthetic design emphasis and switching costs (difficulty of imitation) depending on sector design importance. Low and high refer to values one standard deviation above and below the means for sector design importance and aesthetic design, respectively.

Conclusions and management implications

The goal of this research was to examine the relationship between the use of aesthetic design as an element of new service development and performance. Examining the relationship between aesthetic design and competitive advantage is an important step in developing a richer understanding of the relationship between aesthetic design and performance, which to date may be based more on wishful thinking and anecdote than empirical facts.

Four hypotheses about the relationship between aesthetic design and competitive advantage were tested using quantitative data from a longitudinal survey of new technology-based firms (NTBFs). Positive relationships were found between the use of aesthetic design and competitive advantage when there is strong pressure to reduce prices in firms' markets, and between aesthetic design and sustainable competitive advantage when the relative importance of aesthetic design in firms' sectors is low. Conversely, weaker relationships were found between the use of aesthetic design and competitive advantage and sustainable competitive

advantage, respectively, under conditions of weak price pressures and in sectors where the relative importance of aesthetic design is high, respectively.

The findings of this research contribute to knowledge about different stages of competition, more specifically about the process of commoditization and the contribution of aesthetic design with respect to counteracting commoditization. The empirical findings suggest that the effectiveness of using aesthetic design to achieve competitive advantage through differentiation in new service development differs depending on the current stage of commoditization. In the first two stages of commoditization, of four as defined by Christensen (1997), technological factors are the main source of competitive advantage. In the third stage, when customers' requirements for performance and reliability have been met, aesthetic design can become a source of competitive advantage. The role of aesthetic design is twofold, firstly aesthetic design can be used to improve the usability of services and, secondly, to create symbolic value. The results further suggest that aesthetic design itself can also become the victim of commoditization under conditions where the symbolic value of aesthetic design is widely recognized and design competencies are available to all competitors.

The different roles of aesthetic design in the different stages of commoditization suggest that Christensen's (1997) framework could be extended to take into account how different categories of value creation can be used as means for differentiation in each of the stages and when aesthetic design can be used to counteract commoditization. This is depicted in Figure 3. In the first two stages, the creation of utility value is the main source of competitive advantage and the importance of functional design is greatest. In the third stage the creation of usability value is the most important source of competitive advantage, and here a combination of functional and aesthetic design can be used to improve usability (Norman 2004). Finally, in the fourth stage, the creation of symbolic value based on aesthetic design, can contribute to competitive advantage. It could also be suggested that an additional stage should be added between stage three ('convenience') and stage four ('price') to represent the conditions under which symbolic value can be a source of differentiation, before the final stage of commoditization where price alone constitutes a basis for differentiation.

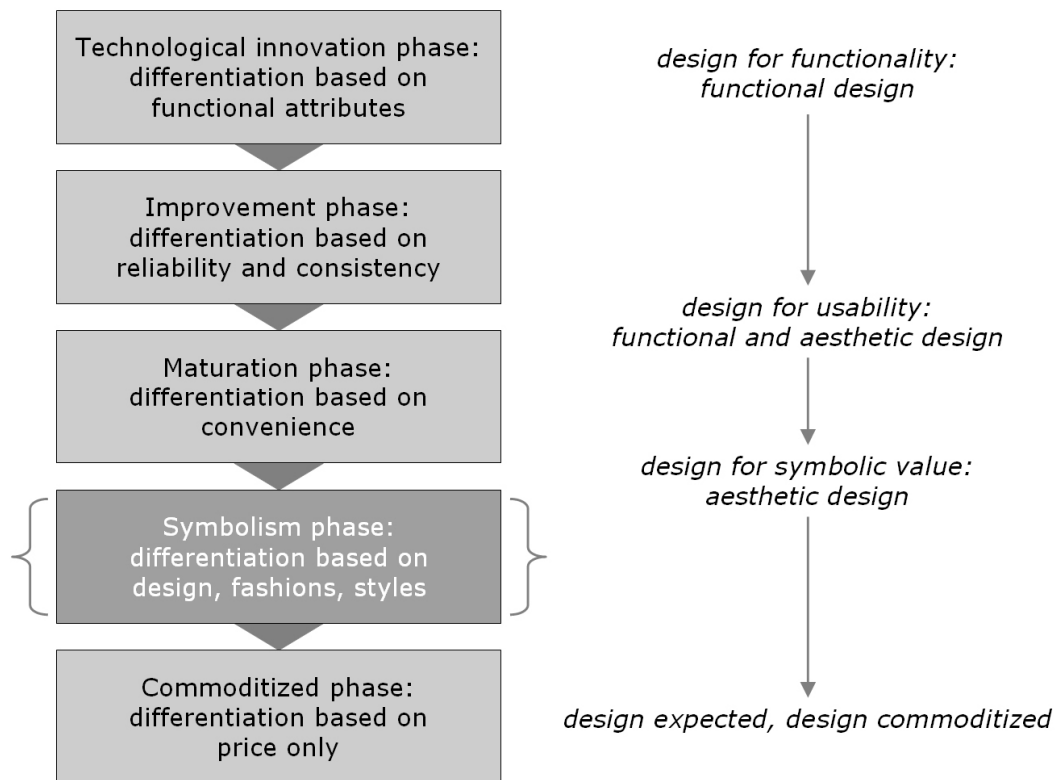


Figure 3: The stages of competition based on Christensen (1997) with the suggested addition of a Symbolism phase. The changing roles of functional and aesthetic design are also shown.

Figure 3 resonates with the research by Veryzer (2005) who finds that the use of industrial design is delayed in radical innovation projects as well as the research by Berry and Taggart (1998) who find that high-technology firms' strategic orientation evolves from being technology oriented at the early stages to being market oriented, with a focus on commercialization and customer acceptance, as the firms grow and the technology matures.

Figure 3 is, of course, highly simplified since it shows only one possible path from technological innovation to commoditization. In reality, innovations may skip phases, loop back to previous phases or disappear in any phase. Figure 3 does, however, provide a convenient framework for interpreting the results of this research.

At the beginning of this paper, we referred to research by Gemser and Leenders (2001) and Hertenstein et al (2005) about the relationship between industrial design and performance. In this paper, the concept of aesthetic design is used in

lieu of the industrial design concept, which although quite broad is firmly rooted in the tangible product space, which must be viewed as a liability when studying aesthetic design as an element of new service development. The goal of this paper is to expand on the aforementioned research by examining moderating factors, and extending the empirical context to the development of new services. Both of these goals are motivated by the lack of empirical evidence for the relationship between design and performance and the need to broaden the scope of this inquiry to encompass services as well as products.

The findings of this research suggest that examination of the relationship between aesthetic design and performance needs to take contextual factors into account. Only when the contingencies have been identified and taken into account can research on aesthetic design and performance begin to claim factual relationships. Until then, we are left with mostly anecdote based primarily on outstanding, but not necessarily typical or transferable, cases – in essence, all the makings of a fad.

This paper also suggests implications for practitioners, particularly practitioners who are attempting to counteract the debilitating effects of commoditization or see this threat on the horizon. The extensions suggested to Christensen's (1997) framework could be helpful for practitioners since they elucidate how differentiation is based on different categories of value along the process of commoditization and make explicit the role of symbolic value. Practitioners would be well advised to consider using aesthetic design to counteract commoditization when the markets in which they compete are characterized by ready access to services that meet customers' needs and expectations for features, performance and reliability, and expectations for aesthetic design have not already become established.

There are also practitioner implications specifically relevant for NTBFs. For NTBFs that come into being with the purpose of exploiting or inventing new technology, aesthetic design may not yield advantage at the outset. As these NTBFs' offerings move beyond the initial stages of features, performance and reliability, managers should anticipate the next stages by incorporating aesthetic design, first to improve usability and later to infuse their offerings with symbolic value.

For NTBFs founded with the purpose of offering improvements on services already available on the market, differentiation based on aesthetic design may be a means to achieve competitive advantage, but only if aesthetic design has itself not already been commoditized in the NTBF's target market. In such situations, NTBFs must adopt aesthetic design to gain entry and meet base expectations.

So, is the value of aesthetic design applied to the development of new services fact or fad? Based on this research, the answer is "both". The value of aesthetic design under conditions of commoditization and provided aesthetic design is not part of the commoditization is supported by this research. The unqualified value of aesthetic design under all conditions, however, is likely to be a fad.

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PAPER 6:
**BENEFITS OF AESTHETIC DESIGN AS AN
ELEMENT OF NEW SERVICE DEVELOPMENT**

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Under review for publication in an academic journal

Benefits of aesthetic design as an element of new service development

Abstract

The goal of this research is to investigate the benefits that may be gained from using aesthetic design in new service development (NSD). Case research is used to identify the objectives underlying new technology-based firms' managers' decisions to use aesthetic design in NSD. The results suggest that the objectives underlying managers' decisions to use aesthetic design in NSD are attracting new customers, creating and fostering a positive image in their market and retaining existing customers, and doing so at lower cost. These results are tested using quantitative data collected in new technology-based firms and the findings suggest that by and large the benefits expected by managers are realized.

Introduction

There is increasing recognition that differentiation based on technology alone is not sufficient to insure success in innovation (Norman 2004; Crawford and Mathews 2001). Instead, the use of design has been suggested as a means for achieving such success (Hertenstein, Platt and Veryzer 2005; Gemser and Leenders 2001; Walsh, Roy, Bruce and Potter (1992); Roy and Riedel (1997). Design can play an important role in innovation, not only as a creative domain for generating ideas but also as a domain concerned with creating a bridge between technical features and functionality, on one hand, and market opportunities and acceptance, on the other (Walsh 1996). The research mentioned above primarily focuses on tangible product development rather than service development. This is typical of research on innovation in general, which has been characterized by a prevailing emphasis on the manufacture of tangible

products (Gallouj and Weinstein 1997). Therefore, research on design as an element of new service development (NSD) is warranted.

In their study of new business-to-business service development, de Brentani and Ragot (1996) found that innovativeness and uniqueness of services are important success factors. Norman (2004) argues that uniqueness, or differentiation, is best achieved through a combination of functional design and aesthetic design. Song, di Benedetto and Song (2000) surveyed managers in the service industry in nine countries about pioneering advantages. The respondents did not believe that higher quality resulting from improvements in technology led to higher price-cost margins for services. Technological advantages were seen to be relatively unimportant. These results suggest that increased quality based on technology alone is not sufficient if this quality is not communicated and perceived by customers. Aesthetic design can potentially play a role in improving and communicating quality (Yamamoto & Lambert 1994; Norman 2004).

Before proceeding, it is necessary to explain what is meant by aesthetic design and how it relates to industrial design. The reason for using the term aesthetic design instead of industrial design, which is used by Gemser and Leenders (2001), Hertenstein et al (2005) and Veryzer (2005) as well as many others, is a desire to avoid terminology which is commonly associated primarily with product manufacture, as is the case for industrial design. Anonymous (yr) developed a model for evaluating design emphasis that is based on a three-dimensional deconstruction of design. These three dimensions are the functional, the visceral and the experiential dimensions. Functional design encompasses utility and performance. Visceral design is concerned with appealing to the human senses (Norman 2004). Experiential design is concerned with message, symbols, culture, meaning and emotional and sociological aspects of a service (Pine & Gilmore 1998; Stuart & Tax 2004). For the purposes of this research, visceral design and experiential design are collectively referred to as aesthetic design. The term aesthetic design can be thought of as being to functional design what industrial design is to engineering design (Moody 1984).

The goal of this research is to investigate the benefits that may be gained by using aesthetic design in NSD. Since such benefits are likely to contribute to performance, this research will contribute to an understanding of the relationship between aesthetic design and performance.

New technology-based firms (NTBFs) were selected as the empirical context for this research for three reasons. In the first place, new firms can be expected to be engaged in innovation and NTBFs, specifically, are important sources of technological innovation (Bollinger, Hope & Utterback 1983). In the second place, new firms can be expected to base their strategies on differentiation (Carter, Stearns & Reynolds 1994) and as platforms for technological innovation (Bollinger, et. al. 1983) they need to create a bridge from technical functionalities to value in new products and services (Marsh & Stock 2003; Walsh 1996). If design is indeed a fruitful means to achieve differentiation, NTBFs should constitute a class of firms particularly sensitive to the use of design as a means to achieve success when developing new offerings. The third reason for limiting the research to NTBFs is that this insures a level the homogeneity among the firms studied. Such homogeneity can be beneficial in quantitative hypothesis testing as it diminishes concerns about results confounded by heterogeneity among the firms used for analysis.

For the purposes of this research, NTBFs are defined as *new firms that are established in order to exploit a technological innovation independently of the novelty of the innovation or the underlying technology* (Bollinger et al 1983), i.e., NTBFs are new firms that introduce new offerings whose creation is based on technical knowledge.

This paper is organized as follows. The research questions and research strategy are discussed following this introduction. The research strategy encompasses two distinct phases of empirical research, which calls for a non-traditional organization of the paper. The first phase involves case research and the methodology, analysis and results of this phase are discussed in turn before proceeding to a discussion of the second phase. Coverage of the second phase includes development of hypotheses, research methodology and results. The paper closes with a discussion of conclusions, implications and suggestions for further research.

Research questions and research strategy

NTBFs base their success on technological capabilities and the ability to transform these capabilities into valuable offerings. NTBFs' managers can be expected to seek ways to improve the outcome of these transformations and,

thereby, contribute to success. This provides the basis for the first research question about the objectives underlying managers' decisions to use aesthetic design:

Question 1: What are the objectives underlying NTBF managers' decisions to use aesthetic design in NSD?

The second research question follows from the first and examines whether the benefits implied by the underlying objectives are actually gained through the application of aesthetic design:

Question 2: What are the relationships between aesthetic design in NSD and the benefits NTBF managers expect?

The research is based on a hybrid strategy involving case research and quantitative survey-based research. The reason for selecting a hybrid approach is that aesthetic design as an element of service innovation is an under-researched topic. Although the topic is under-researched, there are at least two relevant streams of research, namely research on the relationship between design in new product development (NPD) and performance on one hand, and research on NSD success factors, on the other. Hence, the theory on which this research is based can be said to be intermediate making a hybrid approach a good methodological fit (Edmondson & McManus 2007).

Johne and Storey (1998) and de Jong and Vermeulen (2003) provide reviews of the literature on NSD. De Jong and Vermeulen (2003) focus specifically on the organization of NSD, whereas John and Storey (1998) take a more general view of NSD. These reviews bring to light the overwhelming dominance of a focus on financial services in the research reviewed. Although financial services do tend to be heavily reliant on technology, this technology is frequently supplied by technology-based firms rather than the financial institutions themselves. In view of this empirical bias the applicability of the research on success factors in NSD, when taken as a whole, to technology-based service innovation must be approached with caution. This bias also brings to light an important gap, which calls for research in technology-based firms.

Eisenhardt (1989) suggests that iterative strategies are particularly appropriate for under-researched topics and a hybrid strategy involving more than one round of data collection using different methods provides opportunities for such iteration. Figure 1 shows a block diagram of the research strategy. The results of a

multiple-case study of sixteen NSD projects are used along with extant research to generate hypotheses about benefits of aesthetic design in NSD in NTBFs. Longitudinal quantitative data collected in NTBFs is used to test the relationship between aesthetic design use in one year and hypothesized benefits in the next year.

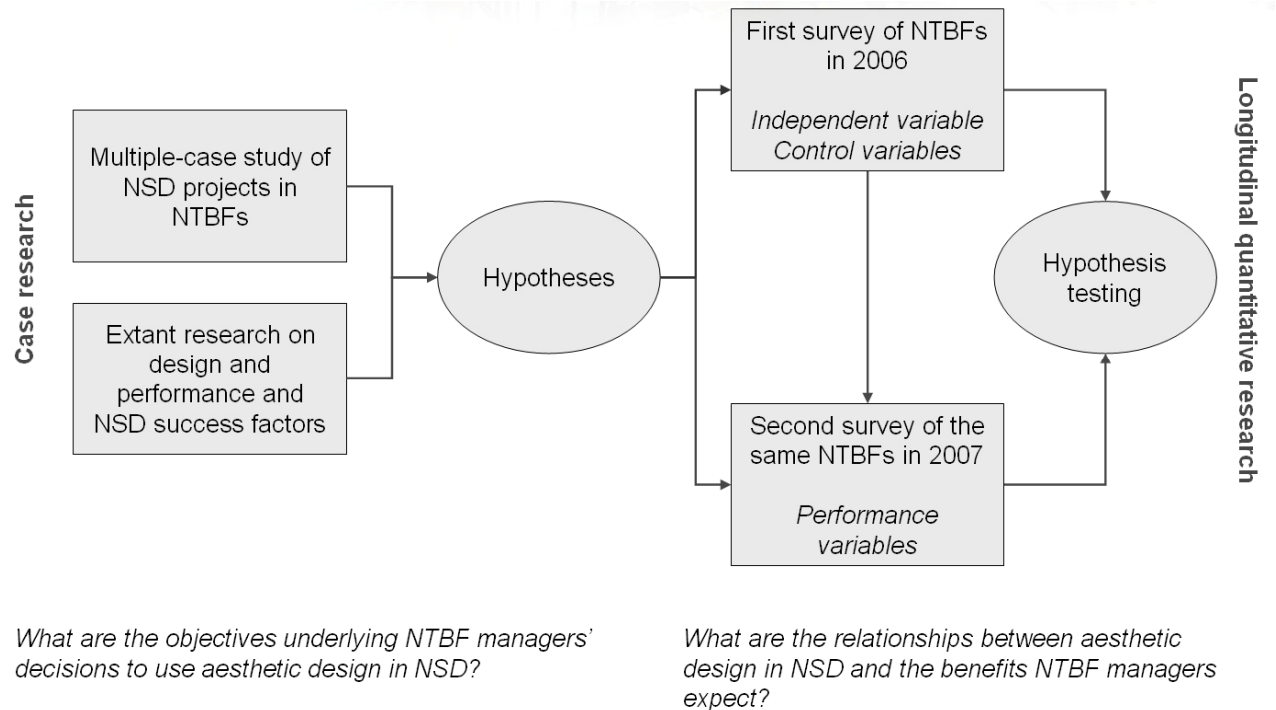


Figure 1. Research strategy

Phase 1: Case research

The methodology and results of the multiple-case study are discussed in this section.

Case research methodology

Case studies were conducted examining the application of design¹³ in sixteen NSD projects in eight NTBFs on the West Coast of the U.S.A. and in Northern Europe. Multiple cases were used to provide rich results and to provide a basis for qualitative comparison. While homogeneity can be beneficial in quantitative analysis, as discussed above, it can be a liability in case research, where breadth is

¹³ The case research examined the use of both functional and aesthetic design in the development of new services. The analysis used for this research is based on the data about aesthetic design only.

sought as well as depth. This was the reason for conducting the case research in NTBFs in two geographically and culturally different locations. Also, deliberate measures were taken to select diverse case projects. NSD projects targeted for the business-to-business market were included as well as projects targeted for the business-to-consumer market. NSD projects that represented NTBFs' first development projects as well as later projects were included, this being the rationale for studying two projects in each firm. Potential participants were asked about their firms' emphasis on design when developing new services and a broad range of design emphases along the three dimensions of visceral design, experiential design and functional design (see Anonymous (yr) for a detailed discussion of dimensions of design) was sought among case participants. In addition, a few basic criteria were set for participating firms, including the requirement of at least five employees, at least half of revenues from the sales of services and at least one new service launch in the last two years.

NSD projects within the case firms were selected to include only NSD projects recently completed or well into development. These criteria for NSD projects were set to avoid the problems of extreme hindsight, on one hand, and wishful thinking, on the other. Brief profiles of the case NSD projects are listed in the Appendix.

Gorb and Dumas (1987) in their paper entitled *Silent Design* found that some kind of design activity was found in almost all firms. Gorb and Dumas define silent design as the process by which employees are engaged in design as an adjunct to their primary roles, basically non-designers doing design. The phenomenon of silent design can be expected to be prevalent in new firms due to the resource constraints which characterize such firms (Garnsey 1995). If design is silent it may also be unacknowledged which, in turn, supports taking a pre-structured approach to the case study (Miles & Huberman 1994) rather than conducting case interviews in a completely open-ended manner. A pre-structured approach requires the definition of a framework prior to data collection, with the possibility of expansion or modification as data collection and analysis progress.

Based on the above, each interview was divided into two parts, an initial open-ended part and a second more structured part. First, respondents were asked to describe how their firms develop new services and to elaborate on the services offered by their firms or under development. This part of the interview was

guided by open-ended questions. The responses to this part of the interview confirmed the somewhat *ad hoc* nature of NSD suggested by previous research (Martin & Horne 1993; Sundbo 1997; Dolfma 2004) and the predominance of silent design.

The second half of each interview focused on a specific NSD project and the questions, although still allowing for free respondent elaboration, were more specific than in the first part of the interview. The questions followed the framework developed prior to data collection, with extensions as appropriate. A sample set of questions dealing with experiential design is shown below. If the answer to the first question was negative, the remaining questions were not discussed. “Why?” questions were asked when it seemed appropriate to do so.

In the development of {name of new service}, was definition of the desired customer experience part of the development work? (Why?)

What specifically was done to achieve the desired customer experience? (Why?)

When did this happen? (Why?)

Who was involved? (Why?)

To avoid pre-conceived notions about design and aesthetic design and/or biases for or against, and thereby increase validity, the term design was not used in the interview questions.

Two to three persons knowledgeable about each NSD project were interviewed. Using more than one respondent about each firm and project provided a means to check for consistency, or the lack thereof (Eisenhardt 1989). The interviews were typically about 90 minutes in duration. Interviews were recorded and transcribed. When interviews were transcribed they were recorded as close to verbatim as possible to avoid any editing based on unconscious bias during transcription.

To increase reliability, a summary was prepared following each interview and submitted to the respondent. Follow-up phone interviews were used to gather additional information where needed and solicit comments about the summaries. Secondary sources, such as industry reports and web sites, were examined as available to gain more information about specific NSD projects and case firms. The follow-up interviews and secondary sources yielded more reliable and more complete data.

Case data were analyzed as soon as possible following interviews and cases were added until the point of saturation was deemed to be passed, i.e., the point where each additional interview added little in terms of new concepts and ideas. Data analysis was modeled on the methodology outlined in Eisenhardt (1989). The interview texts were coded in several passes. Initial sets of codes for aspects of services to which design might be applied, approaches to design, design actors and objectives underlying decisions to use aesthetic design were developed. For each aesthetic design activity, underlying objectives were sought in the texts and grouped into categories.

In the interest of establishing objectivity and confirmability permission was sought from respondents to publish the results of the case research using firms' actual names. Six out of eight NTBFs granted this permission.

Case research results

A number of common themes for underlying objectives were discovered based on the coding described above. The result was three categories of manager objectives for using aesthetic design: attracting new customers, creating and fostering a positive firm image and retaining existing customers. In some instances, there was more than one underlying objective for a specific use of aesthetic design.

Respondents expressed the goal of appealing to their target markets' visual aesthetic sensibilities to attract customers and convince them that using the new service would be aesthetically pleasing and enjoyable.

"You always have to do something that appeals to the eye. Something that is seen. This is the method we use to appeal to customers." [Plinx]

"Indeed, visual design is a key element of our service design and even plays a part in our concept development phase." [CAOZ]

"The things that the end user can do are orange and fun." [Plinx]

Aesthetic design use to communicate the advantages and quality of services was much in evidence in the case projects. Some of the mediums used for such communication were marketing materials and demos. The objectives for communicating advantages and quality were improving firm image, attracting new customers and/or retaining existing customers.

“You can just see that it [the web site describing the service] is supposed to look bright and modern, bright happy future. The technology is not scary, it’s childish, it’s so easy a child could do it. These were the kinds of things we wanted to say.” [CellStory]

“We have various ways of communicating that [the value of the service]. We are heavily demonstration oriented. If we are going after a specific market, meaning a specific type of user or a specific environment, we will create demonstration versions. We have the capability to do that quite quickly. We’ll just show up at a targeted tradeshow with a demonstration that shows what we can do to service that market.” [Quantum3D]

Ease of use was an important concern for many of the respondents. Since all the case projects were, at least to some extent, software-based, concerns about ease of use were couched in this context.

“Our real goal in terms of our design is to be so invisible that all we do is support the user’s need for information. One of the strongest, most positive, comments that we have when we asked one of our users for a recommendation, is “I’m not sure I can actually recommend you because I never notice that I’m using you.” Which means that we have emulated his knowledge acquisition need sufficiently clearly and cleanly that he doesn’t see the interface of the service as being separate from himself.” [Lucidoc]

Ease of use is related to the goals of attracting new customers and retaining customers at lower cost. A service that is complicated to use and bewilders customers can be harder to sell than an easy-to-use service and it also brings with it increased costs for supporting existing customers in their struggle. The heterogeneity and inseparability of services contribute to the need for communication between firms and customers. Such communication can be very manpower-dependent, and concomitantly costly, particularly if firms opt for the strategy of providing tailored services and personal contacts. There was a consistent theme across the cases that automated processes for communicating with customers become necessary when the number of customers increases and employees’ tolerance for increasingly frequent interruptions diminishes. At the same time, respondents expressed the concern that such automation should not compromise customer engagement.

“Our objective is that all documentation is step 1, step 2, step 3, you’re done.” [Red Condor]

“We are packaging technology to make it less scary.” [CellStory]

“We have our brand in there [the customer support system]. So we have the service and the firm itself in there”. [CAOZ]

Creating and fostering a positive image is an important concern for NTBFs particularly since they usually start out without much visibility in the market.

“An area that we’re not good at yet is marketing, and one of the things that’s amazing, one of the opportunities that we just haven’t capitalized on, is that we do interact with the customer on a regular basis. We send them these periodic digests and say “hey, this is what we did for you” and in that periodic digest we have the opportunity to build brand and to establish a relationship.” [Red Condor]

Respondents expressed at least three different means to engage customers: based on a specific experience inherent in a service, through community with other customers and through participation in the new service development process. The underlying objectives for engaging customers are to attract new customers and to retain existing customers.

“Up until now we have come up with all our ideas ourselves but we are now going to send a survey out to our customers to ask them what new features and services they would like. What are their wild ideas? What would they like to be able to do?” [Valy]

“Our service is addictive because there is a constant supply of new content from other customers. There is always new content to experience and new opportunities to vote on content.” [Plinx]

“Our new technology should be happy, happy, fun, fun. So the experience should be happy, happy, fun, fun. The design should reinforce a certain security, you don’t want it dark and scary. We wanted to have something that was near childish. That was our design.” [CellStory]

Based on the expressed goals and concerns, the answer to research question 1 is that the objectives underlying NTBF managers’ decisions to use aesthetic design in NSD are attracting new customers, creating and fostering a positive image of their firms within their target market and/or retaining existing customers, and doing so at lower cost.

Since two projects were studied in each case firm it was possible to compare aesthetic design in earlier projects with later projects. The findings were that more emphasis and effort was put into design in the development of later services than in early, or initial, services. This finding provides the motivation

for including new offering introductions as a control variable in the quantitative hypothesis testing that follows.

Phase 2: Quantitative hypothesis testing

The second phase of this research seeks to ascertain if the benefits that managers expect from using aesthetic design are actually realized in NTBFs.

Development of hypotheses

In this chapter the results of the case research and two streams of existing research are brought together to develop hypotheses about relationships between aesthetic design and benefits. The two streams of research are research on design in NPD and performance, on one hand, and research on success factors in NSD, on the other.

The first of three underlying management objectives for using aesthetic design identified by the case research is attracting new customers. One measure of new customer attraction is sales growth from new customers.

Turning first to research on the relationship between design and performance, Hertenstein, et. al. (2005), Auger (2005) and Walsh, et. al. (1992) found positive relationships between design, or industrial design, and sales growth.

Several NSD researchers have used sales growth as a measure of success. Storey and Easingwood (1996) associated effective marketing communication with sales growth. Aesthetic design can be used to create and foster perceptions through commercialization tools such as advertising (Shedroff 2001; Whyte et al 2003). Atuahene-Gima (1996) and de Brentani (2001) associated marketing synergy with sales growth. Aesthetic design can be used to meet market expectations about aesthetic appeal (Gemser & Leenders 2001) and improve usability (Norman 2004). Atuahene-Gima (1996) and Storey and Easingwood (1996) found relationships between proficiency of new service launch and sales growth. New service launch can benefit from aesthetic design for usability (Norman 2004). De Brentani (2001) associates evidence of service quality with sales and quality can be communicated through aesthetic design (Yamamoto & Lambert 1994; Rothwell & Gardiner 1984). Atuahene-Gima (1996) and de Brentani and Ragot (1996) associate innovativeness with new service success and Utterback et al (2007) argue that design can provide an important inspiration for innovation.

Based on the observed management objective of attracting new customers and existing research suggesting that aesthetic design may contribute to sales growth, the first hypothesis is about sales from new customers.

Hypothesis 1: NTBFs that put more emphasis on aesthetic design in NSD will have a greater proportion of sales from new customers than NTBFs that put less emphasis on aesthetic design in NSD.

In addition to increase in sales from new customers, NTBFs can be concerned about increasing their number of customers and spreading the source of their revenues among a greater number of customers. An NTBF which relies on just one or very few customers for the greatest part of its revenues can be vulnerable, since its success is closely related to its customers' success. Also, one or a few customers may have too much influence on the NTBF's innovative activities, channeling the NTBF's efforts entirely to these customers' wishes and thus narrowing its scope.

Cooper et al (1994) found that effective marketing communication is related with the opportunity to attract new customers. As argued above, aesthetic design can be used to create and foster perceptions through commercialization tools such as advertising (Shedroff 2001; Whyte et al 2003). Marketing synergy, which can be aided by using aesthetic design to meet market expectations about aesthetic appeal and usability (Norman 2004), and evidence of quality, which can be communicated through aesthetic design (Yamamoto & Lambert 1994; Rothwell & Gardiner 1984) have been associated with market expansion (de Brentani 2001).

Based on the observed management objective of attracting new customers and existing research suggesting that aesthetic design may contribute to market expansion, the second hypothesis is about breadth of customer base.

Hypothesis 2: NTBFs putting more emphasis on aesthetic design in NSD will have a broader customer base than NTBFs that put less emphasis on applying aesthetic design in NSD.

The U.K. Design Council (2000) found a positive relationship between design and entry into new markets. Entry into new markets is among the measures used in NSD success factor research. Among the factors associated with new market opportunities in NSD success research are effective marketing communication (Cooper et al 1994), marketing synergy (Atuahene-Gima 1996, de Brentani 2001) and proficiency of new service launch (Atuahene-Gima 1996). The potential

contribution of aesthetic design to these factors was discussed above. Storey and Easingwood (1996) found a relationship between tangible evidence of services and opening up new markets. Aesthetic design can be used to communicate value through tangible objects (Yamamoto & Lambert 1994; Rothwell & Gardiner 1984).

Based on the observed management objective of attracting new customers and existing research suggesting that aesthetic design may contribute to new market opportunities, the third hypothesis is about entry into new markets.

Hypothesis 3: NTBFs putting more emphasis on aesthetic design in NSD will be more successful in entering new markets than NTBFs that put less emphasis on applying aesthetic design in NSD.

The second of three underlying management objectives for using aesthetic design identified by the case research was creating and fostering a positive image of the firm within its target markets.

The UK Design Council (2000) found a positive relationship between design and firm image. Firm image, or reputation, is not commonly used as a measure of success in NSD success factor research. An exception is research by Storey and Easingwood (1996), who found that tangible evidence of service quality was related with enhanced firm image. As was discussed above, aesthetic design can be used to create compelling tangible evidence. Hence, the fourth hypothesis is about comparative firm image.

Hypothesis 4: The firm image of NTBFs that put more emphasis on aesthetic design in NSD will compare more favorably with the firm image of competing firms than for NTBFs that put less emphasis on aesthetic design in NSD.

The third underlying management objective for using aesthetic design identified by the case research was retaining existing customers and doing so at lower cost. The next three hypotheses address this objective.

Storey and Easingwood (1998) found positive relationships between quality of service delivery and performance measures including customer loyalty. Pullman and Gross (2004) found a positive relationship between experience design and customer loyalty. Hence, the next hypothesis is about the relationship between aesthetic design, of which experience design is one dimension, and customer loyalty.

Hypothesis 5: Customers of NTBFs putting more emphasis on aesthetic design in NSD will be less inclined to take their business to competitors than customers of NTBFs putting less emphasis on aesthetic design in NSD.

As was discussed in the arguments for the first hypothesis, existing research suggests that aesthetic design is related with sales growth. Sales growth can come from new customers or existing customers, and so, based on the same arguments as for hypothesis 1 and the observed management objective of retaining existing customers, the sixth hypothesis is about sales growth from existing customers.

Hypothesis 6: NTBFs that put more emphasis on aesthetic design in NSD will have greater sales growth from existing customers than NTBFs that put less emphasis on aesthetic design in NSD.

Retaining customers at lower cost implies that firms can earn greater profits from the retained customers. Hertenstein et. al. (2005), Auger (2005), Gemser and Leenders (2001), the UK Design Council (2000) and Walsh et. al. (1992) found positive relationships between design, or industrial design, and return on sales or profits.

Several NSD researchers have used profits as a measure of success. Storey and Easingwood (1998) found a relationship between effective marketing communication and profits. Atuahene-Gima (1996), Agarwal et al (2003), Storey and Easingwood (1998) and de Brentani (2001) found relationships between marketing synergy and profits. Atuahene-Gima (1996) and Storey and Easingwood (1998) associate proficiency of new service launch with profits and Storey and Easingwood (1996, 1998) also associate proficient service delivery with profits. De Brentani (2001) found that evidence of quality contributed to profits and Atuahene-Gima (1996) associates innovativeness with profits. The possible contributions of aesthetic design to these success factors were discussed in the arguments above.

A firm's profits result from all the firm's activities, not only sales to existing customers. However, attracting new customers is often a costly pursuit and so, if a firm is profitable, at least a good portion of those profits can reasonably be attributed to existing customers. Hence, the final hypothesis is about firm profits.

Hypothesis 7: NTBFs putting more emphasis on aesthetic design in NSD will have greater profits than NTBFs putting less emphasis on aesthetic design in NSD.

Quantitative survey-based study methodology

This section describes the methodology and results of the quantitative study used to test the hypotheses developed above.

Data collection

The quantitative data for this research are based on questions included in an ongoing longitudinal study of NTBFs in a Northern European country. The study was begun in 2005 and at the time of this writing, data has been collected three times, once each year. This research uses data from the second and third years of the study.

In late 2005, a list of firms founded in the year 2001 or later, which were classified as technology-based firms according to a coding system based on the European Union's Nace 1 coding system, and which paid salaries in September 2005, was obtained from public records. Firms having fewer than three employees were not included, unless such firms were less than 2 years old. This was done in the interest of not including legal entities established primarily for tax reasons around one or two self-employed persons. Background information was checked for all remaining potential participant firms so that firms which did not appear to engage in technology-based development despite their formal classification could be eliminated. The result was that 118 firms were identified as potential participants. When contacted, 10 of these had gone out of business, were older than their registration indicated or were not actually technology-based firms despite their formal classification. Of the remaining 108 firms, 103 agreed to participate (95%). These firms were surveyed in the spring of 2006. As mentioned above, this was the second round of data collection in a longitudinal study and 63 of the 65 firms that participated in the first year made up part of the total of 103 participants in 2006.

The survey consisted entirely of structured questions and was administered in face-to-face interviews with the firms' CEOs. The duration of each interview was approximately one hour and covered founding, development of new products and services, including aesthetic design, measures of performance as well as several other topics.

In 2007, 101 (98%) of the firms surveyed in 2006 were surveyed again. The survey was administrated through telephone interviews with the firms' CEOs

which lasted about 45 minutes and included all the same questions as the initial survey, except questions about founding.

The hypotheses were tested using data for the 98 of the 101 NTBFs that based all or part of the revenue on the sales of services. The average percentage of these firms' income from the sales of services was 84%. Thus, the hypotheses were tested using data collected in 98 out of a maximum potential number of participants of 108, or 91% of the population of NTBFs basing all or part of their revenue on the sales of services in the Northern European country. This high participation rate is definitely a strength of the research. In fact, it might be more appropriate to view the research as population research rather than research on a representative sample. This would permit the selection of a smaller confidence interval than for a sample. However, the data was conservatively treated as a sample for statistical analysis and a conventional 95% confidence interval was used.

Variables

Benefits generally appear at some time after the factors that contribute to them come into play. Therefore, research on the relationship between aesthetic design and benefits needs to examine the two variables separated by a reasonable amount of time. In this research, independent variables were measured in early 2006 and dependent variables were measured one year later, in 2007. This longitudinal nature of the research is an important strength since it recognizes that the benefits of aesthetic design are not likely to be realized immediately.

Studying the relationship between aesthetic design and measures of financial outcomes is subject to some specific challenges. March and Sutton (1997) argue that there are too many factors that can influence financial outcomes, both internal and external to firms, to make it reasonable to consider analysis of relationships without taking into account intermediate factors. Hence, the decision was made to use a time lapse of only one year, in the interest of minimizing the potential issues of intermediate factors while still gaining the benefits of longitudinal analysis.

The same informants, namely the participant firms' CEOs answered questions measuring both independent and dependent variables. This poses a certain threat to validity since managers might consciously or unconsciously seek to be consistent in their answers. This potential problem is considerably mitigated by

the fact that the survey data is longitudinal so that dependent variables are measured a year later than independent variables.

Dependent variables

To test hypothesis 1, respondents were asked to provide information about the proportion of sales coming from new customers, which were not customers in the previous year. To test hypothesis 2 by assessing the size of firms' customer bases, respondents were asked to provide information about the proportion of sales coming from customers other than their three largest customers. Since the NTBFs studied are not publicly traded and thus are not required to make their yearly statements public it was not possible to verify the figures reported by managers. A measure of validity was insured by collecting the data at about the time of year when most of the NTBFs hold their annual shareholder meetings and so statements for the previous year had already been prepared or were being prepared, and managers could be expected to base their answers on actual figures rather than guesswork. In fact, it was noted quite frequently that respondents looked up their answers in their firms' annual statements.

To test hypothesis 3, respondents were asked if their firms had started selling services in new markets in the last year. New markets were defined as being geographically different from current markets.

To test hypothesis 4, respondents were asked to subjectively rate the quality of their firm's image in their target market(s) compared with their competitors. This rating was on a scale from 1 to 5, where 1 meant that the quality of competitors' image was much better, 5 meant that the quality of the firm's image was much better, and 3 meant that the image was about the same. To test hypothesis 5, respondents were asked how easy it would be for their customers to stop buying services from their firms and switch to a competitor. This rating was also on a scale from 1 to 5, where 1 meant that customers could very easily switch to a competitor's service and 5 meant that it would be very difficult. The means and standard deviations of both these variables are shown in Table 3 and although they do suffer from the usual handicaps of variables based on subjective ratings of a respondent's own goodness they are reasonably distributed.

To test hypothesis 6, respondents were asked to provide information about their total turnover for the previous year. Respondents provided this information in both rounds of data collection and so their turnover growth could be calculated.

As was described for hypothesis 1 above, respondents also provided information about the percentage of their sales that came from new customers. Based on this information it was possible to calculate growth in sales from existing customers.

To test hypothesis 7, respondents were asked if their firms had been operated at a profit or loss in the last year. They were also asked to indicate if the profit or loss was more or less than 10% of the firm's turnover for the year. This resulted in a scale from 1 to 5, where 1 meant that a firm was operated at a loss of more than 10% of its turnover, 3 meant that a firm was operated at or close to break-even, and 5 meant that a firm was operated at a profit of more than 10% of its turnover.

Independent variable

Respondents were asked to rate the emphasis, or weight, placed on applying aesthetic design when developing new offerings. Twelve questions were used to capture aesthetic design emphasis (Anonymous). The possible responses ranged from "no weight" to "very much weight" and were coded 0 to 5. To avoid potential inconsistencies stemming from the different meanings respondents, most of who had an engineering background, might attribute to the term design, the term itself was not used in the questions. Instead, the questions dealt with aspects of design falling under visceral or experiential design. The questions were combined to obtain a formative measure of aesthetic design.

When using formative measures, it is inappropriate to view mutual consistency of indicators as a measure of reliability or validity (Diamantopoulos & Winkelhofer 2004). An indicator that can be used to check for unacceptable multicollinearity among the indicators making up a formative measure is the variance inflation factor (Diamantopoulos & Winkelhofer 2004) which was 3.1 for the indicators making up the aesthetic design measure. The commonly accepted threshold for this value is <10 , so multicollinearity among the indicators should not be a problem.

Although it was not feasible to rely on external evaluators to provide adequate measures of aesthetic design emphasis in the NTBFs studied, due to the relative obscurity of the majority of the firms, it was realistic to ask external evaluators to evaluate the aesthetic design of the one visible presence that most NTBFs have in common, namely their web sites. To test the validity of managers' evaluations of their firms' emphasis on aesthetic design emphasis, two professional graphic

designers were asked to evaluate the firms' web sites for design sophistication. The experts' evaluations were significantly correlated with managers' evaluations of their firms' emphasis on aesthetic design. Although managers were evaluating aesthetic design as an element of innovation and the experts were evaluating web site design, this correlation can be viewed at least as partial confirmation of the validity of managers' evaluations of aesthetic design, since aesthetic design emphasis in one area of a firm's activities is likely to be similar to its aesthetic design emphasis in another area.

Control variables

The focus of the study is aesthetic design in NSD. If aesthetic design in NSD is related to the anticipated benefits, a relationship with the level of NSD effort, or level of innovation effort, is also to be expected. Therefore, firm expenditure for research and development as a proportion of turnover was included as a control variable.

As mentioned previously, the case firms were found to place more emphasis and effort into aesthetic design in the development of their later services than in their early, or initial, services. Hence, new offering introduction, as a measure of innovation output was included as a control variable.

Finally, firm size and age were considered as a control variables since new and young firms can be expected to grow faster than older firms, and so have a sharper increase in number of customers than older firms (Roberts 1991).

Data analysis

Pairwise correlations and summary statistics for all variables are shown in Table 3.

To test the hypotheses, regression analysis was performed for each of the dependent variables. Each regression tests the relationship between the weight placed on aesthetic design in NSD in one year and measures of the hypothesized benefits of applying aesthetic design in the following year. The number of data points included in analysis varies between models due to missing values.

The robustness of the regression models was confirmed by removing significant control variables and confirming that relationships with aesthetic design persisted in the absence of these control variables.

Results of hypothesis testing

The results of the regression analyses are shown in Table 4. The empirical data encompass two rounds of data collection, separated by one year. The regression analyses are for aesthetic design application measured in the first year and dependent variables measured in the second year.

Table 3. Pairwise correlations and summary statistics for variables.

Summary statistics						Pairwise correlations										
	mean	std.dev.	min.	max.	1	2	3	4	5	6	7	8	9	10	11	
1 Aesthetic design	0.43	0.22	0.02	0.88	1											
2 firm age	0.48	0.26	0	1	-0.07	1										
3 firm size	0.19	0.24	0.02	1	-0.10	0.16	1									
4 R&D expenditures	0.28	0.27	0	1	0.04	-0.03	-0.13	1								
5 new offering introduction	0.48	0.33	0	1	0.04	0.23	0.15	0.17	1							
6 Sales from new customers	0.33	0.28	0	1	0.25	-0.49	-0.14	0.35	-0.19	1						
7 Non-dependence on 3 largest customers	0.50	0.29	0	1	0.33	0.11	-0.01	0.03	0.18	0.04	1					
8 Sales in new markets	0.39	0.49	0	1	0.21	0.12	-0.09	0.35	0.14	0.27	0.15	1				
9 Firm image	3.91	0.70	2	5	0.19	-0.08	0.13	0.13	0.26	0.03	-0.09	0.15	1			
10 Customer loyalty	2.94	1.44	1	5	0.09	-0.05	-0.04	0.02	0.11	0.04	0.10	-0.02	-0.11	1		
11 Sales growth from existing customers	0.51	0.99	-1	8	0.11	-0.12	-0.02	0.10	-0.06	0.02	0.03	0.14	0.01	-0.08	1	
12 Profit	3.48	1.55	1	5	0.21	-0.15	0.06	-0.36	-0.08	-0.09	-0.25	-0.09	0.12	0.18	0.10	

Table 4. Regression results with the independent variable for aesthetic design measured in one year and the dependent hypothesized benefit variables measured in the following year.

Dependent variable:	sales from new customers	non- dependence on 3 largest customers	sales in new markets	firm image	customer loyalty	profits	sales growth from existing customers
Hypothesis	1	2	3	4	5	6	7
Independent variable:							
Aesthetic design	0.247 ***	0.485 ***	0.486 **	0.655 **	0.399	2.026 ***	1.017 **
Control variables:							
firm age	-0.308 ***	0.111	0.385 **	-0.352	-1.031	-1.143 **	-0.498
firm size	0.000	-0.147	-0.124	0.480 **	-0.368	0.506	0.404
R&D expenditures	0.292 ***	-0.101	0.652 ***	0.148	0.896	-2.039 ***	1.069 **
new offering introduction	-0.007	0.252 ***	0.121	0.599 ***	0.644	-0.318	-0.259
Model metrics:							
Number of data points (N)	91	91	91	85	91	87	86
Model significance (F)	8.11 ***	4.62 ***	4.60 ***	3.6 ***	1.65	3.44 ***	2.38 **
Proportion of variance explained (R ²)	32%	21%	21%	19%	9%	18%	13%

* $p<0.1$, ** $p<0.05$, *** $p<0.01$

As can be seen in Table 4, all hypotheses except hypothesis 6 about customer loyalty are supported with models significant at the 1% ($p < 0.01$) or 5% ($p < 0.05$) level.

The control variable contributions shown in Table 4 indicate that innovation, either innovation activity as measured by expenditures for R&D, or innovation output as measured by the introduction of new offerings, contributes significantly to the hypothesized benefits. The only exception is profits, where the relationship between profits and R&D expenditures is negative, as could intuitively be expected. As mentioned previously, the regression models were tested without significant control variables to confirm that the relationships with aesthetic design persisted in the absence of these controls.

Conclusions and Implications

Existing research has provided evidence of a positive relationship between design and performance in new product development (NPD). The present research makes an important contribution to knowledge about this relationship for new service development (NSD) in new technology-based firms (NTBFs).

The goal of this research was to investigate the benefits that may be gained from using aesthetic design in NSD. Case research in NTBFs was used to identify the objectives underlying managers' decisions to use aesthetic design in NSD. The case research results suggest that the objectives underlying managers' decisions to use aesthetic design in NSD are 1) attracting new customers, 2) creating and fostering a positive image in their market(s) and 3) retaining existing customers and doing so at lower cost. Hypotheses were developed based on the underlying objectives identified and existing research on design and performance, on one hand, and NSD success factors, on the other. The hypotheses were tested using longitudinal survey-based data collected in NTBFs.

Six out of seven of the hypotheses were supported by the quantitative data. The three hypotheses relating to the management objective of attracting new customers were all supported. The hypothesis relating to the management objective of creating and fostering a positive image of the firm in its target market(s) was also supported. Two hypotheses were developed relating to the third management objective of retaining existing customers. The first of these used a measure of customer loyalty and was not supported by the data. The

second related aesthetic design with growth in turnover from existing customers and was supported by the data. Finally, a hypothesis related to retaining existing customers at lower cost was developed and a measure of firm profits was used. This hypothesis was supported by the data.

To summarize, this research suggests that by and large managers' expectations regarding the benefits of emphasizing aesthetic design in NSD are realized. This research contributes to an understanding of the relationship between aesthetic design and firm performance by suggesting a number of benefits that can be gained from using aesthetic design in NSD and that are likely to contribute to firm performance.

The practitioner implications of this research are that NTBFs that emphasize the use of aesthetic design in NSD can expect to have a greater proportion of sales from new customers, be less dependent on a few large customers, be more successful in entering new markets, have a better quality firm image in their target market(s), enjoy higher turnover growth from existing customers and higher profits than NTBFs not using aesthetic design in NSD. The research does not support the hypothesis that NTBFs using aesthetic design in NSD have customers that are less inclined to switch their allegiance to competitors while it does support the hypothesis that NTBFs using aesthetic design enjoy higher turnover growth from existing customers. This could indicate that while NTBFs cannot expect to retain customer loyalty based on aesthetic design, they can expect to earn greater revenues from those customers that remain loyal, by using aesthetic design.

It is interesting to compare the management objectives identified by this research with the findings of existing research on design and performance. There is existing design research supporting each of the hypotheses tested in the present research but the existing research on design and performance also suggests a number of benefits of design that were not among those expressed by the managers in the case firms.

Ranking of factors influencing choice when purchasing is used as a measure of performance in design research by Moody (1984), Rothwell and Gardiner (1984) and Yamamoto and Lambert (1994) and product preference is used by Berkowitz (1987). Managers in the case firms did not seem to be directly concerned with comparisons between their services and those of their competitors, at least not within the context of the interview discussions. The findings of existing design

research suggest that relationships between aesthetic design and comparison with competitors' services should be examined as well as the practitioner implications that aesthetic design may contribute to service attractiveness relative to competitors.

In their research on Internet-based services Van der Heijden (2003) found that the perceived attractiveness of web sites was positively related with use of web sites, intentions to use web sites and attitudes towards using web sites. Similarly, Auger (2005) found that design sophistication was associated with an increased number of web site visitors. All the case firms had web sites and over half of the NSD projects studied were for services to be delivered over the Internet. Nevertheless, most managers did not express much concern with their firms' web sites. This suggests the practitioner implication that aesthetic design may be useful in creating attractive web sites and that web sites constitute an untapped opportunity for attracting new customers and building firm image. This also suggests that web site traffic should be included as a dependent variable when studying the relationship between aesthetic design and performance in NTBFs.

An additional conclusion of this research, based on the results with respect to the control variables used, is that innovation also contributes to all the benefits, except for customer loyalty and profits. Hence, we can conclude that good performance and investment in aesthetic design and innovation in NTBFs are likely to be mutually reinforcing. Conversely, poor performance and lack of investment in aesthetic design and innovation are likely to lead to a vicious cycle of decline.

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Appendix: Profiles of case projects

Firm	Project	Project description
Annata	AN1	Vertical solution for dealers in a specific segment built on top of an ERP system
Annata	AN2	Sales planning solution for supply-chain management
CAOZ	CA1	3D-character-based animated short film
CAOZ	CA2	TV interface and web site for fiber-optic TV, video, Internet and phone access
CellStory	CS1	Hosted service allowing users to take photos or videos with mobile phones and post them to a web site along with rich customized text
CellStory	CS2	Hosted service allowing users to post photos from mobile phones to blogs created using templates
Lucidoc	LU1	Compliance management solution for documents targeted for a specific niche segment
Lucidoc	LU2	Add-on to LU1 providing the ability to customize and create reports based on documents
Plinx	PL1	Photo-blogging service developed for the telecom market

Firm	Project	Project description
Plinx	PL2	On-line community where customers can post, download and purchase music and comment on music
Quantum3D	QU1	Image generation service for visual and sensor simulation training
Quantum3D	QU2	Rapid prototyping and development of graphical user interfaces for embedded systems and simulation using a custom suite of tools
Red Condor	RC1	Hosted spam-protection for e-mail
Red Condor	RC2	A suite of bundled security services including anti-spam, anti-virus, anti-spyware, URL content filtering and asset management
Valy	VA1	Custom web site creation service with user maintainability
Valy	VA2	Electronic commerce solution for the culture and entertainment sector

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