Design in ICT:

An Exploratory Study on the Value Added of Design in the Dutch ICT Sector

Position paper for the Premsela Foundation

dr. Gerda Gemser
prof. dr. Dany Jacobs
drs. Ritzo ten Cate

with the help of dr. Mark Leenders, dr. René Spijkerman, Geert Jan van Dam and Zhen Chih Tan

Strategy and Environment Group
Faculty of Management and Organisation
University of Groningen

Contents

Design in ICT:
An Exploratory Study on the Value Added of Design in the Dutch ICT Sector

Preface

In 1997, Gemser performed a study for the Association of Dutch Designers (BNO), and the Ministry of Economic Affairs on the added value of design in two sectors: furniture and precision instruments (Gemser 1997; Gemser and Leenders 2001). From this study, it emerged that investing in design may lead to better company performance, in particular when design is used in an innovative way and when the design-investing companies operate in an industry where design is a relatively under-utilised strategic tool. An interesting spin-off of this study was that 'design consciousness', the awareness of the important contribution of design to economic success, was increased in the sectors sampled, and moreover, more structural relationships were established between these sectors and BNO.
Premsela, the Dutch design foundation established in 2002 as a successor to the late Design Institute, and the BNO thought it was appropriate to try to emulate this kind of research in other sectors. It was considered to be of particular relevance to obtain insight into the value added of design in sectors that appear to have a relatively underdeveloped design-consciousness. The idea was supported by some people at the Ministry of Economic Affairs who also see the increasing relevance of non-technical innovation in the knowledge-based economy.
Premsela and the BNO proposed to us, researchers from the University of Groningen, to perform this research, focussing on the degree of 'design consciousness' in the Dutch 'Information and Communication Technology' (ICT) sector. As a research group with a specialisation in the field of non-technical innovation we were glad to accept this. In the last months of 2003 and the first of 2004 we completed a literature study and performed face-to-face interviews with experts and managers from the ICT industry. In this position paper we present the main findings of our *exploratory* research. These findings will set the stage for industry discussions the coming months.

1. The Added Value of Design

1.1. Design defined

The principal aim of this study is to examine the (possible) value added of design in a sector where design seems to be a relatively under-utilised strategic tool. The sector chosen as a research setting is the Dutch 'Information and Communication Technology' (ICT) sector. This sector can be described as mainly 'technology-driven' where the products' core benefit for

the customer is (still) the products' ability to accomplish specific technical tasks or functions. As noted by Ulrich and Eppinger (1995: 168-169), in such technology-driven sectors, the engineering or technical requirements will often dominate development efforts (instead of 'design-driven' dimensions such as usability and aesthetics).

As noted by Walsh (1996: 512), the discussion over the meaning of design is a confusing one, not in the least because the term 'design' is used in English to cover very different kinds of design activities, including disciplines such as architecture, fashion design, interior design, graphic design, industrial design, engineering design, and brand and corporate design (see also Roy and Potter, 1993). To complicate matters further, the term 'design' in the ICT sector – our empirical setting – is often used to indicate a broad set of activities in the product development process, namely those activities set in between the 'specification of requirements' and the actual programming and coding.

A clear definition of 'design' is thus necessary. However, both in literature and in practice a profusion of ideas exists about what design is. This apparent lack of uniformity in the definition of design, even among professional designers, reflects in part the different perspectives on the function of design, and, with it, the contribution of designers (Walsh, 1996; see also Gemser 1999; Walsh et al 1992). In this study, we propose that the main contributions of design, and thus designers, within the ICT sector can be found in two product areas: namely usability and aesthetics. Ideally, design also contributes to a third area, namely product functionality. However, as will also be shown in Section Four, within the ICT sector functionality is (still) to a large extent the domain of system analysts and software engineers. Because there is no uniform definition of design, we decided to adopt an *operational* definition in this research. This operational definition builds on the definition of Gemser (1999) and reads as follows:

Design (in ICT) is the result of the activities of designers; design (in ICT) defines the aesthetic and usability features of an ICT product.

The design contribution is thus assumed to determine the product aspects that relate directly to the user, that is, usability and aesthetics. We will elaborate on these terms in Section Two. The term 'designer' refers to the professional who undertakes the steps or activities resulting in 'design'. Within the ICT sector, 'designers' can carry such labels as 'information

designers', 'interaction designers', 'graphical user interface designers', 'human-computer interaction designers', 'web site designers', 'product designers' or 'industrial designers.' In the context of the present study, it should be emphasised that the term 'designer' does not refer to the work of the software engineer or system analyst.

The rest of the paper is structured as follows:

- In this first section we briefly enter into the value added of design in general and ICT in particular.
- In the second section, we discuss the possible design contribution in three major product areas: functionality, usability, aesthetics.
- In the third section we discuss how the study was organized, which kind of firms and industry representatives were interviewed, which kind of topics were raised in these interviews, and how our empirical findings were processed.
- In the fourth section we delve more deeply into the main findings of our field research. On the basis of this we come to conclusions and working hypotheses for discussion in possible future research.
- The fifth and final section provides a short summary of this paper and some concluding remarks.

1.2. The value added of design in general and in ICT in particular

The famous British designer Terence Conran (1996: 20-21) noted that: "Design is essential for economic success. There are many instances where design has played a key role in a company's profitability; few instances where a profitable company has succeeded by ignoring design. (...) By making technology accessible to ordinary human needs, the designer can play a crucial and enabling role. Without this essential interface, technology is a source of frustration and alienation that leaves us longing for the good old days." In a similar vein, Harkins (1990: 1994) argued that designers are "humanizing the (...) technology, bringing meaning to the objects of our age". An increasing number of companies indeed invest in design to gain a competitive edge in the market place (Walsh et al. 1992; Dutch Design Institute 1994). 'Design-intensive' firms – often operationally defined as firms with relatively large design budgets - are not only found in 'user-driven' sectors where design has traditionally played an important role, such as fashion and furniture, but also in more 'technology-driven' industries. An example of a technology-driven firm that nonetheless invests considerably in

design is Apple that had a huge commercial success with the stylishly designed iMac computer. Nokia is another example of a company that not only invests heavily in technology, but also in design and where this attention for design plays a key role in explaining the company's success (Ainamo and Pantzar, 2000).

How does design add value? Conran (1996: 18) argued that: "if something is well designed it can improve the quality of life of the user." He furthermore noted that: "something which is well designed should not necessarily cost more than the equivalent object which has been designed without care, thought or professionalism. To this end the designer must fully understand manufacturing, marketing and selling processes, and ensure that the product he or she designs can be economically and efficiently made, and competitively priced. (...) It is not about pushing up price or creating elite brands through the mystique of the label. (...) The identification of design with elite goods and snob value has helped to bring about its poor profile today, a misrepresentation of its true purpose to producers and consumers alike. (...) The remedy, I believe, is not to hive off design into ever-more esoteric areas, but to integrate it more fully in the entire process of product development, manufacturing and retail" (Conran 1996: 18).

Conran's claims are rather normative, since, from at least a manufacturer's point of view, design that entails the creation of exclusivity and mystique, may result in added value. However, we do sustain his main point: well-designed products can improve the quality of life of the user, and, in order to have well-designed products, it is often necessary that the designer is integrated in the entire process of product development, including manufacturing and retail.

From the perspective of the manufacturer (of ICT), adding value through design may manifest itself in such performance measures as:

- increased profitability
- increased turnover
- lower production costs
- higher productivity of users
- reduced support and service costs
- a higher degree of customer satisfaction; loyal customers

To what extent does design indeed result in better company performance? Empirical studies providing 'hard' financial data on the positive relationship

between design and company- or product performance are relatively limited in number. However, those studies that are available all point into the direction that investing (substantially) in design has a positive effect on company performance (see e.g. Black 1987; Walsh et al. 1992; Gemser, 1997; Gemser and Leenders, 2001; Groupe Bernard Juilhet 1995). Empirical research on the impact of design on ICT products/ companies seems to be completely lacking, though there are a few conceptual studies that acknowledge the benefits of investing in one of the component element of design, namely 'usability' (e.g. Hohmann, 2003). This exploratory study is a first attempt to fill this gap.

2. Different Design Dimensions

In this study, we are interested in the potential benefits of design for companies operating in the ICT sector. As noted in Section One, we argue that design plays an important role in determining the aesthetic and usability aspects of an ICT product. In this section, we will define and discuss the concepts aesthetics and usability. We will also briefly discuss functionality. While functionality is mainly the area of software engineers/ system analysts, this cannot be ignored since it is closely linked with usability and aesthetics, as will be elaborated on below. In our discussion, we mainly focus on design in an ICT context, but in order to clarify the issues, sometimes we have extended the discussion to design in other fields.

2.1. Functionality

Design may improve the way in which a product implements or performs its intended functions, i.e. its functionality. Functionality thus refers to the functions or tasks a product is able to perform. In the field of software, functions can be, for example, software that is able to perform complex calculations or is able to draw 3-dimensional figures.
In existing literature on product design, the contribution normally ascribed to an engineer is designing the aspects of a product that relate to technical and functional performance, while the contribution normally ascribed to a designer is designing the aspects that relate to the user, that is, aesthetic and ergonomic product features (e.g. Harkins, 1994a; Muller 1990; Potter et al, 1991; Ulrich and Eppinger, 1995). Pruys (1972: 24) for example argues that an engineer is mainly concerned with the relations which are internal to the product and a designer with the relations between the product and its user. The former Netherlands Foundation for Industrial Design (ioN), points out

that the design discipline distinguishes itself from 'purely' technical disciplines (e.g. mechanical or electric engineering) as it centres on 'use' and not on technology. Which, according to ioN, "may explain why in the case of industrial design a heavy emphasis is put on ergonomics and 'form giving'" (ioN, 1995: 109).
It should be pointed out however that the contributions ascribed to designers and engineers is analytical in nature and that in the practical world of product development there is often no clear borderline between the activities of engineers and designers, or this borderline may even be undesirable considering the interconnections between functionality, usability and aesthetics (see below).

2.2. Usability

One of the major contributions of design for the ICT sector seems to be to improve the usability of a product. 'Usability' can be defined as a measure of a product's potential to accomplish the goals of the user in an efficient, healthy, easy and pleasant way[1].
Usability thus not only includes efficiency in use (functionality and consistency), but also ergonomics ('healthy', 'easy'), and to some extent already incurring a positive experience ('aesthetic', 'pleasant' elements). The latter is related to the so-called 'aesthetic-usability effect' according to which aesthetic designs are perceived as easier to use than less aesthetic designs. As noted by Lidwel et all (2003: 18): "Aesthetic designs look easier to use and have a higher probability of being used, whether or not they actually are easier to use."
The relationship between usability and functionality on the one hand, and aesthetics on the other, is especially clear when we look at 'design consistency': "The usability of a system is improved when similar parts are expressed in similar ways" (Lidwell et al. 2003: 46). Lidwell, Holden and Butler (2003: 46) distinguish four kinds of consistency in design:

- functional consistency: consistency of meaning and action (e.g. traffic lights; the consistent use of well-known symbols): this enhances usability and learning.
- internal consistency: consistency with other elements in the system: this enhances trust in the system and its designers.

- external consistency: consistency with other elements in the environment (e.g. standards also adopted by designers of other products and systems).
- aesthetic consistency: consistency of style and appearance: this enhances recognition, communicates membership and sets emotional expectations.

Hohmann, talking about human-computer interaction, adds to this (2003: 73):

- platform consistency: an application should adhere to the platform standards on which it was developed.
- application consistency: all applications developed within a company should follow the same general model of interaction.
- task consistency: similar tasks should be performed through similar sequences of actions.

Moreover, consistency is only one of about ten 'design principles' that as a rule, improve usability of ICT. The other nine principles are: the use of concrete metaphors; providing feedback; preventing errors; providing corrective advice; putting the user in control; the use of a simple and natural dialogue; speaking the users' language; minimising user memory load; providing shortcuts for more experienced users (Hohmann 2003: 73).
In the field of ICT, usability has clear benefits, which leads to all kinds of economic added value, according to Hohmann (2003: 66):

- reduced training costs;
- reduced support and service costs;
- reduced error costs;
- increased productivity of users;
- increased customer satisfaction;
- increased maintainability.

The above listed advantages all relate to the users, but through customer satisfaction, of course, also the manufacturer gains. As Hohmann puts it quite succinctly: 'A single telephone call to customer support could destroy the profits associated with two dozen or more successful transactions' (Hohmann 2003: 66).
In order to increase usability, in general more 'user-producer' interaction

(Lundvall 1988: 352-359; Tidd et al. 1997: 252; Brown, Duguid 2000: 86-89), and related to ICT more elaborate testing (Ridaceela 2001; Hohmann 2003) have been advised. So, the bigger product software producers for example build prototypes which are released to gather information about how the applications are used and what possible problems related to these are. For graphical user interfaces (GUI's), also 'low-fidelity' paper prototypes are advised, to see whether the sequence of different screens is logical to user and really works. For a voice-based user interface (VUI), this may be a script that contains prompts and expected responses (Hohmann 2003: 69-72). These are, however, not the ways most software engineers appear to work: "The standard process involves drawing up a specification that details the functions a program should include and what the commands ought to be, then writing the program to the specs. Usability testing starts about three-quarters of the way through the design process, when the software has taken form. By then, it's often too late to incorporate the results into the current release" (Ricadela 2001: 54).

It appears that every generation of software development has to reinvent the usability wheel. In the late 1970s, Xerox' Palo Alto Research Centre (PARC) already incorporated usability concepts into the interface for its experimental Star computer. These principles were then borrowed by Apple for its different generations of Macintosh PC's. Microsoft followed with Windows about five years later. But, according to Donald Norman, a usability consultant and former executive at both Apple and Hewlett-Packard, "The Internet has taken usability and set it back 10 years" (cited in: Ricadela 2001: 52, 48).

Usability may however not be that easy to realise, as it is not always aimed at the original function of a product. Users may learn about possible use later on. Especially with respect to radical innovations, it is sometimes difficult to foresee for what a product will ultimately be used. On the basis of different cases, Ciborra illustrates how innovative, strategic applications of ICT are not fully designed top-down or introduced in one shot; rather they are tried out through prototyping and tinkering (Ciborra 2002: 42). Ciborra further noted that: "the early days of the Internet, and its predecessor ARPANET, are also full of *bricolage*, hacking, improvisations, and serendipity. ARPANET was not funded and built to be a medium for interpersonal communication; it was intended to allow scientists to share computing resources at a distance. It was about networked time-sharing systems; not about e-mail" (Ciborra 2002: 42-43). Thus, people may design systems and products with surprising

innovation opportunities hidden in them, and unknown to themselves. As a consequence, usability related to these unintended, later discovered functionalities will have to be improved later on.

2.3. Aesthetics

The last of the three main functions of design within an ICT context is related to aesthetics. Aesthetic features determine the appearance of a product, giving it a distinctive 'look' or image. The appearance of a product may be determined by, for example, the proportion, contours, colours, shape, materials, and/or texture of the product. A product's appearance may result in a positive experience and may increase the acceptance of the product by a targeted customer group, as will be explained below. In this paper, a product's appearance, and thus aesthetics, is not equated with 'beauty' as this is a highly subjective matter.

According to Conran (1996: 14): "design is 98 per cent common sense. What makes design so interesting and challenging is the other two per cent: what one might call 'aesthetics'. (....) Many products which achieve 98 per cent are demonstrably good: but those with the extra two per cent have a magic ingredient which places them in another category altogether. That two per cent makes the difference between something which is perfectly acceptable and something which is so special that everyone wants to possess it. When the magic ingredient is present, the quality of life is improved. (...) If something is aesthetically pleasing – if it strikes a chord, creates excitement or a surge of desire – people are often willing to overlook or overcome less-than-perfect performance in other areas." In a similar vein, Lidwell et al (2003: 18) noted that: "Aesthetic designs are more effective at fostering positive attitudes than unaesthetic designs, and make people more tolerant of design problems."

The physical appearance of a product is important, since visual images are remembered and recognized more directly than words and texts (Wheeler 2003: 7; Kazmierczak 2003: 52). Different appearances can have different meanings to all of us. Some forms and colour combinations have, for example, an exotic connotation, others may give a modern or, to the contrary, a more classic appearance. This can be summarized under the heading of 'design as sense making',[2] which is the object of visual semiotics, which tries to decode the sometimes hidden, possibly unintended, codes which connect signs and meanings (Van Leeuwen & Jewitt 2001). Especially when products have to been exported or adapted to other regions of the

world, it may be important to look at one's designs from a semiotic point of view, as more often than not, a certain design may have a totally different, even undesirable meaning in another culture. As a consequence, designers increasingly try to deal in a more intended way with this value connection of design - that is, the fact that some designs appeal to some values more than to others.
In a way, adding value has to be taken quite literally: in order to add economic value, cultural values have to be added to products (Jacobs 1999: 106). In this respect Edward de Bono talks about 'valufacture', the deliberate process of 'creating values' (de Bono 1993: 131).
Thus, designers may try to infuse their design with a certain meaning. But most important is, of course, the meaning which the customers, the 'receivers', give to a design. It has been suggested by Kazmierczak (2003) that a designer is successful when she is able to make the intended meaning 'cross' to the receiver. It may however be as much interesting to learn from unintended meanings which might provide unforeseen opportunities. As a consequence Press and Cooper (2003: 32) state that the "essential task for designers is to understand how people make sense and meaning of the things they design, and how they create new experiences with them."

2.4. Conclusion

To conclude, in this section we have presented the ICT product areas where the design contribution is assumed to be most prominent: usability, aesthetics and, to a lesser degree, functionality. These three product areas seem to interact with each other over time: when the functionality of a product becomes more established, competition may shift from functionality to the usability and/or aesthetic dimensions. Interaction also occurs between aesthetics and usability since good aesthetic designs can give at least the illusion of better usability, and in this way lead to customer satisfaction.
It was noted that it can be difficult to think about all relevant design aspects in a rational and consistent way beforehand. First, because users develop unintended uses for new products, and second because consumers do not always 'get the message'. This often results in adaptation, learning, and even 'bricolage', which rational designers possibly do not appreciate. However, far from being a failure of design, this brings with it opportunities for additional innovations. Whether one likes this or not, innovation will always remain a dynamic and unpredictable process.

3. Research method and research setting

In this section we clarify the methodology used in this exploratory study on the added value of design in the Dutch ICT sector.

3.1. The Dutch ICT sector

Our research site was the Dutch ICT sector. In the Dutch economy, the ICT sector is quite important. In 2001, it accounted for 5.44 % of the total Dutch economy in value added (CBS, 2003). In this research we focus solely on companies developing and selling (client-specific or mass produced) computer software. We thus exclude companies producing computer hardware, which is a relatively small group in the Netherlands (CBS 2003). In the rest of the paper, when we use the term 'ICT sector', we thus only refer to software producing organizations.

Particularly from 1995 to 2000 the ICT sector was 'booming'. From 2001 onwards, however, this growth decreased, and in 2002 the ICT sector even contributed negatively to the economic growth of the Netherlands (CBS, 2003). Thus, when interpreting the empirical results, it should be taken into account that the 'years of abundance' are over and that this could have had an effect on the extent to which ICT companies were prepared to invest in innovation and design.

3.2. Research Approach

In the first stage of the research, we discussed the role of design in the ICT sector in an 'open', unstructured, way with up to 25 experts from academia and industry. These experts were academics doing research in a relevant area or managers from ICT companies (these experts were excluded in our second stage). All of these experts agreed that the research topic was quite interesting and confirmed our premise that most ICT firms are not very design-conscious. Moreover, they provided us with suggestions of relevant people and companies to talk to in the second stage. In this first research stage, we also collected and studied relevant literature.

In the second stage we interviewed relevant senior managers from eight ICT companies. In an attempt to cover the Dutch ICT sector in its diversity as well as possible, our sample includes both relatively large and small-sized firms and includes firms that cover different sub sectors.[3]

Type of company	BIK Code[1]	Number of employees	Design consciousness
Company 1 Delivers ICT services; develops mainly client-specific software products, aims at B2B market	7200	500-1000	Low
Company 2 Delivers ICT services; develops mainly client-specific software products, aims at B2B market	7222	> 1000	Low
Company 3 Delivers ICT services, adopts existing software to client's wishes, aims at B2B market	74204	>1000	Low
Company 4 Delivers ICT services; and (to a limited extend) develops 'generic' software products, aims at B2B market	7200	250-500	Low
Company 5 Develops 'generic' software products, aims at B2B market	7222	100-250	Low-Medium
Company 6 Develops 'generic' software products, aims at B2B and B2C market	7222	1-50	Medium
Company 7 Develops websites, aims at B2B market	7222	1-50	High
Company 8 Develops computer games, aims at B2C market	7222	50-100	High

1. Only the first mentioned BIK code is given or the most relevant BIK code

Table 1: Profile of interviewed companies

To collect our empirical data, we sought responses from key informants who were knowledgeable about the issues being researched. These informants were in general senior managers and responsible for development and/or commercialisation of new products. We interviewed one to two informants per company (n=10 in total).

Next to interviews with managers from specific ICT companies, we had four additional interviews with experts having an overview of the industry. These four experts are working for an ICT branch organization, an organization stimulating research in ICT, a venture capital organization, and a ICT magazine.

3.3. Data collection and analysis

All the interviews were done by two researchers and were tape-recorded and written out so that they could be analysed extensively afterwards. The interviews took place in the period January– February 2004. Most interviews were held at the location of the respective firms. All the informants were

subjected to the same interview questions. With the informant's permission, the interview was tape-recorded and later transcribed. Although the interviews usually lasted on average 90 minutes, several person-days were required to arrange, conduct, and analyse each of these.
To gather the data needed from the companies and experts, a interview guideline was developed that contained open-ended questions. The interview guideline can be found in Appendix I. The questions included in the interview guideline resulted from earlier studies on the economic impact of design (Gemser 1997; Gemser and Leenders, 2001; Potter, et al. 1991a; Design Innovation Group, 1989), although they were adapted to the ICT context. The interview guideline is divided into three parts. Part One contains questions about general attributes of the firm and the interviewee. Part Two is the most important and contains questions about product development in general and design in specific. In Part Two, questions are included regarding, among other things, R&D investments, design investments, the product development process, the number and educational background of in-house ' designers', cooperation between (in-house or external) designers and other people involved in product development, and, of course, the perceived value added of design. Part Three contains questions aimed at exploring the informant's opinion on the role of design in a more macro-economic perspective.
The field research yielded mostly qualitative data, that is, data in the form of words. As noted by Dougherty and Hardy (1996: 1129): "[q]ualitative researchers generally use two approaches to data analysis: an in-depth analysis to uncover key themes and an analysis of how strongly the proposed themes feature the data." We used the first approach since we did not have much a priori knowledge about the role of design in the ICT branch and one of our main aims was to ' explore relevant issues'. As advised by Miles and Huberman (1994: 10-12), our data analysis process consisted of concurrent flows of activity: data reduction, data display, and conclusion drawing/verification. In order to condense the data, the most relevant facts and statements of the informants and their firms were grouped according to different topics. Examples of such topics are 'Definition of design', 'Changing role of design over time', 'Innovativeness of the firm in general', 'Design investments of the firm'. This clustering made it easier to note regularities and patterns in the data set. Also the creation of data displays such as graphs and charts helped to note patterns. To verify the first tentative conclusions emerging from the data, a feedback session was organized with

a small group of experts from the ICT and Design sector. Verification of the results will also take place on a larger scale, since in the near future, 'round-table discussions' will be organized with representatives of the ICT and Design industry. The conclusions drawn in this paper may thus best be considered as preliminary. The results and conclusions presented in Section Four are grounded by using verbatim examples of the interviews whenever possible.

4. Results

4.1. Design-consciousness within the ICT sector

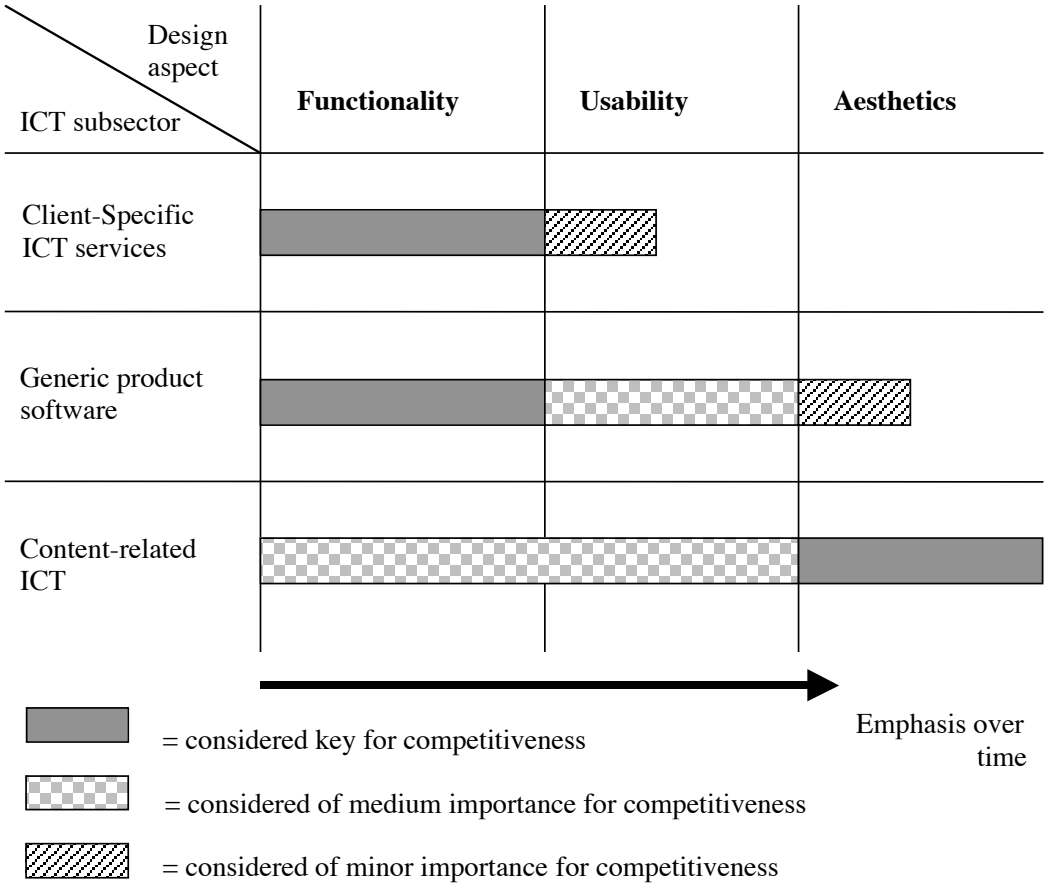
In order to assess the degree of 'design-consciousness' of the ICT companies sampled, we assessed whether specific attention was given to usability and aesthetics. All our interviewees supported the idea that design could add substantial value, but most of them equated 'design' with 'functionality'. This functionality was in general developed from a technological and cost-effective perspective, and not so much from the perspective of the user. Indeed, it was, as we expected (see Section Two), in general the domain of software engineers and system analysts, and not so much of designers. Improving 'usability' was also mentioned frequently as an area in which design could add substantial value, but it was also an area that often was put low on the priority list. Our sample is of course relatively small-sized. However, if we take into account the clear benefits of usability for ICT, as discussed in Section Two, it is quite disappointing to what extent this issue was *not* strongly emphasized.[4] An encouraging observation is, however, that most respondents slowly seem to change, embracing a more user-friendly approach in product development projects, as will be discussed below. Only for two ICT firms we sampled, the aesthetic or emotional side of design was really an issue. These two firms focussed on both usability and aesthetics during product development projects and used professional designers to realize these aspects. They even used these designers to improve the functionality of products. This makes them, in our terms, really design-conscious. Overall the degree of design-consciousness within the ICT sector seems indeed limited, as was also acknowledged by the four general experts we interviewed. As pointed out by one of those experts [RR], this seems not a result of lack of good professionals in design since "we [i.e the Dutch] have a very good reputation in the field of design, both in the field of furniture, utensils, architecture, stamps, graphic design and that [good name] for already a very long time."

When we examine the design-consciousness of the sampled firms more closely, we can classify the firms into three distinct categories, namely:

- Low design-consciousness: ICT firms delivering client-specific, tailor-made, applications;
- Medium design-consciousness: ICT firms developing ‘ generic’ product software;
- High design-consciousness: ICT firms developing ‘content-driven’ product software

Each of these categories emphasizes a different design dimension, as we visualize in Figure 1.

Figure 1: (Changing) Emphasis on Design Aspects in ICT sub sectors



When we analyse the design consciousness of the ICT firms in the sample, we see a development over time with regard to the emphasis management is giving to the three basic design elements:

1. Firms from the first group, consisting of ICT firms delivering client-specific applications, have until now been concentrating themselves mainly on functionality, although gradually they pay more attention to usability. However, even though these companies in general acknowledge the value added of design in the area of usability, they put 'usability' low on their priority list since other aspects are considered to lead to a higher pay-off. In the words of two different respondents:

"It would increase the quality perception [of our products] if we would tackle the issue of usability in a better fashion. (...) I do acknowledge the importance of design [in terms of usability] but it is not listed very high on my priority list. (...) Other aspects are more important in our market (...) the pay-off is higher if I spend my money on other areas." [do]

"It is certainly recognized, also by our management, that that aspect [i.e. the usability aspect] is something which should be taken into account. Only it is something that does not belong to the primary working area, it is more a fringe area." [PB]

As pointed out by all the four respondents in this group, most of their clients do not consider design an important ingredient in the success of ICT projects. These clients attach much more importance to the functionality and the costs of an ICT project at the short term. As noted by an expert [RR], clients have little affinity with aspects such as usability and aesthetics, and seem unwilling to pay for it. Partly this is a result of the fact that 'functionality' can be measured easily, while usability and aesthetics cannot, making that it is more easy to sell 'functionality' to the clients. To some extent, this is also a result of the fact that the clients, or at least those deciding which system to buy, have a technical background (are often engineers) themselves, or are managers which mainly look at the short-term costs aspects. As noted by a manager from a ICT firm with a low design consciousness:

"I think that our products are to a reasonable degree adapted to our users. Those users are in general of the ' thinking species'. Thus there is a good match. These users are engineers too." [DO]

According to some respondents, clients should be 'educated' about the economic pay-off of investing in usability and aesthetics [PB; MD]. This study might be a first step in this education process:

"In my opinion, clients need to be educated in what they really should be asking [from ICT services firms] and where they could benefit from. That is, I think, one of the points that is the most relevant when looking at your research (...) We can tell them, of course, but if clients for themselves have insufficient insight into it and are unable to see it beforehand and do not have a specific

case example or (…) do not have a feeling that it also counts for them, then they will not be asking for it." [PB]

Besides a traditional engineering culture in many ICT service firms (see also below), and the difficulty of quantifying design impact, explanations for the meagre attention for usability may also be found in the fact that clients mostly only get aware of their (usability) requirements later on in automation projects. In addition, forms of technical lock-in are an explanation: when a basic software architecture is in place, it may sometimes be difficult to change it.
ICT projects often fail because of a lack of attention for usability aspects:

"Two-thirds of the ICT projects fail. What is the cause? It all is related to people (…) The human factor, since an end user is involved." [MD]

"The costs of the implementation process of larger software applications is two to three times that of buying the licenses. (…) One out of four implementation processes goes well, one out of four fails, and two out of four are stuck in the middle. How many companies really do use [the software for] production planning and how many are still stuck in the phase of bringing everything to the fore? Most of them [do the latter]. Effectiveness [of the software implementation] is thus low. Because we are not able to complete the implementation phase in a good way. If you look at the interface side of the story, the aesthetics, there should be more attention for the look and feel and the 'eatability' of software. Thus not putting an emphasis on 'it is able to do that and that' [i.e. on functionality], but on 'how do I handle the software in a company situation'. How can you improve that acceptability process?"[WB]

In this context, one company strived to make its ICT systems less complex ('striving for simplicity') by deleting functions, which can be considered a first step towards better usability:

"We now make a plea for the ' deconstruction' of the software architecture. It has to be simplified (…) We all think that when it is able to perform a lot of functions, you have made something terrific, but that is not true." [MD]

Besides these factors, we also think that the pressure of competition plays a role. Similar to what happens in other sectors with overcapacity,

many competitors at some point mainly start to compete on the basis of price and cost, instead of thinking about adding value. This tendency may have been reinforced by dissatisfaction at the level of customers, related to a high degree of failed ICT projects. As a consequence many clients have started to look very critically at their ICT expenditures.

2. With regard to the design-consciousness of the second group, consisting of firms developing generic product software, similar issues emerged. Even when people in these firms more clearly see the relevance of usability, they still have relatively few specialists employed in this field. Usability gets a strong translation in the meaning of 'consistency', which in one firm is safeguarded on the basis of a 'corporate design style guide' [PBr], and in another on the basis of a 'design library' [CE]. Consistency and attractiveness of the programme make it more efficient and in this way less expensive for the customer, as noted by one respondent [CE]. Usability is an aspect not only taken care of in the product development phase but also in the 'implementation' and 'post-implementation' phase. As noted by one respondent [PBr], his company strives to sell software systems that are easy to install, and adheres a 'zero migration approach' that makes it much easier for a client to replace their 'old' software for a new release and thus reducing the 'total cost of ownership' for clients. In this second group, awareness of the value added of aesthetics is increasing, as an increasing number of clients prefer an attractive design of their programmes:

   "It [i.e. the software product] has to be quick and efficient, but we also take care that it looks good. That provides us with a competitive advantage."[CE]

   "In the past we won everything based on the functionality we could offer, and then the market changed and other things were also taken into account [by the client]. Total cost of ownership, but also this [user interface and aesthetics]. If functionality is not important anymore (…) then other aspects become important such as costs to acquire it, maintenance, and also user friendliness, how it feels, etcetera. Thus, users' experiences, yes. As a consequence we have been paying more attention to these aspects of late, making sure that client satisfaction is very high." And: *"It [aesthetics] became an issue since we were considered as the 'grey screen supplier'. [Specific software] systems, are systems with which one needs to works in a good and fast fashion. However,*

the eye wants something too, in particular when selling these systems. We started to loose more and more deals on that aspect [of being a grey screen deliverer]. And we have corrected this in the last one and a half year (…) a client can now [for example] change the look and feel of his screens as he pleases." [PBr]

Even though the company of the last-cited respondent is now consciously investing in design, it is apparently still surprised by its success:

"We even have a client (…) who is interested in switching [from an old software system to a new release] just because of the user-interface! Nothing more than the fact of a better user-interface (…) That is something we never have expected. That clients can even become enthusiastic about this kind of things." [PBr.]

The above-cited respondent also emphasised that, while recognizing the importance of aesthetics, this company only considers it necessary to spend specific attention to it when a totally new version of a programme is designed. Once this new version is released, the design is fixed for a few years and related to aesthetics no further development is considered necessary [PBr]. Thus, aesthetics would apparently not have to be looked after as continuously as in other industries, but mainly taken care of in steps. After catching up in this field, it would be possible to hold to the new standard for some time. This is a quite interesting remark, which in our opinion requires further investigation.
In our interviews one respondent came quite close to an awareness of the 'aesthetic-usability effect' mentioned in Section Two: the fact that programmes which people find aesthetically pleasing, have a higher probability of being used and profit from a higher level of customer satisfaction:

"Aesthetic design could also help to increase the acceptance of the software by the employees of an organisation, by adapting the software to the style of the organisation or the personal taste of the employee." [WB].

Usability does not only add value in the sense that it may result in higher turnover, it may also result in lower costs for the manufacturer

since the user friendliness of the software products may lead to spending less on problem-solving resources at the help desk department:

"If you look at the development process by itself, it may definitely cost less [if no attention is paid to design]. However, if you look at the products in their totality, thus not only what it costs to make them but also what it costs in terms of client service afterwards, then I do not think that it will be much cheaper. You need to look further than only looking at how much hours does it take to make it." [CE]

3. Finally, for the group of firms aimed at the more content-related fields of ICT like web design and videogames, aesthetics and usability are the means with which they differentiate themselves from others. In the area of gaming, it is mainly aesthetics since the user-interface and the technology within this industry are rather standard:

   "Where we distinguish ourselves in is that we are able to show more visually appealing things on screen [than competitors], that is the reason why consumers buy it" [MR].

   Even though the just cited respondent points out that his company now and in the future will be able to distinguish itself by means of aesthetics, he also noted that even the visual aspects of video games may become more and more standardized and that companies thus need to find other ways to distinguish themselves. The fact that even the use of (better) aesthetics per se may not prove sufficient for competitiveness over time, concurs with the findings of Gemser and Leenders (2001).
   Just as found in the second group of firms, there seem to be 'thresholds' and relative freezing of aesthetic designs for certain periods. For example, in the realm of web design probably the same rules apply as with the design of brands and related house styles – which only from time to time get a totally new design. And in the realm of gaming, we see that firms attempt to develop certain 'visual styles' for their games and hold on to these styles over time [MR].
   Typical for the high design awareness in this group is that, while aesthetics is often key to competitiveness, these firms do not only pay attention to aesthetics but also to functionality and usability: "I have to deliver a product that is good and I know that both design and

functionality are both essential."[RD]. Firms in this third group seem more design than software firms: "we present unique, new design, we are just like fashion designers" and "On the one hand it [i.e. developing a video game] is just like making a movie, very creative, but on the other hand it is a very complex software project" [MR] One respondent saw its role, in part, as raising the design consciousness of the customer, where the customer may for example be one of the firms from the first group. However, as pointed out by this respondent, it is hard to specify beforehand to a client what the added value is of integrating design in development projects while design is often associated with 'extra costs', with 'making things more expensive [RD]. Thus they also have to convince the customer that this investment finally will yield. Sometimes they do however succeed to convince clients: "Often it is quite a revelation when they see what the design firm can do for them." [RD]

4.2. Co-operation and educational background of the professionals, and the culture of the firm

The culture of the ICT firms is closely linked with their design-consciousness. The ICT firms focussing on client-specific services have a traditional technology-driven culture, even those companies that employ relatively many ICT-professionals with a non-technical educational background. In this context, it was noted that those employees with a non-technical background relatively soon conformed to the technology-driven culture of these firms. One manager noted that, since their corporate culture was technology-driven, the dominant view was: "as long as it works, it is fine":

"Our culture is more a culture of engineers than of designers. Our men are only interested in whether it works well. And when it works, then it is fine (…) Very technology-driven." [DO]

"Our company is erected by people with a technical background. The management of our company has a technical background. They have a specific view on their firm and market and that is in particular technology-driven." [PB]

The design-conscious firms belonging to the third group, on the other hand, have a more user-driven culture, where the dominant mind-set is to develop products in a user-centred way.
Often, the sampled ICT firms do not use their 'hard core' software engineers

to increase the usability and/or look and feel of a product, but use employees with educational backgrounds in such areas as cognitive psychology, anthropology, or even physiotherapy. With the exception of the content-related companies in the sample, the number of employees with an explicit design background such as graphic design or interaction design is in general very limited or even non-existent.

Cooperation among system analysts and software engineers and the more design-oriented staff (in-house or subcontracted) is not always a smooth process. Both groups have, in general, a very different perspective, a different 'thought world', and as such often are unable to effectively communicate with each other:

"Designers often have the tendency to say: 'it should be done in this way because then the message gets through in the best way, then the user is serviced in the best way'. It is a rather ' out-of-the box' way of looking at a problem. Then they deliver a description to the technicians. These subsequently say: 'but that is not possible in such a way, that is far too expensive to build or that will result in a system that is far too slow'. And then you get an endless quarrelling between those two parties." [PB]

"As designer you are occupying yourself much more with 'use 'and how would the user think about this. A software programmer is much less interested in this issue. The designer is the intermediary between the market and the software programmer."[CE]

"[ICT architects] all have 'beta' background; there are relatively few people who think about what happens with technology from a societal perspective (…) They are 'freaks', people with a problem-solving attitude." [RR]

As becomes clear from the above quotes, the tension is often one between 'creativity' and (presumed) technical limitations to realise this creativity in a cost-effective way. One of the ICT firms we sampled started out as a 'normal' design consultancy firm and thus software engineers were added only later on. The founding father of this company, having an art background himself, stated bluntly that whenever his software engineers claimed that something designed could not be done, he would through them out immediately. His 'antipathy' towards the 'cannot be done' attitude of engineers was that big,

that he sometimes demanded of client that there were no system engineers participating in the initial user-oriented phase of the design of the programmes. The other design-driven company in the sample, did have another approach however, noting that, whenever there was a conflict between the software engineer and the designer, the engineer often won, since this engineer could indicate whether it can be done, also in terms of costs, while the designer can often not ground his ideas in terms of 'hard' figures:

"The software programmer ultimately has the last word, for it has to be possible; he sees it in a very concrete fashion, these are the costs, these are the revenues, while the designer can only say "it would be nice if….". [MR]

As acknowledged by one of our respondents [PB], it seems thus to be an interesting research area to examine how the two thought worlds may come together, how the cooperation can be optimalized.
Interestingly, relatively few ICT companies subcontract to external design consultancies. One ICT firm delivering client-specific products did collaborate with a design-driven, small ICT 'new media institute', which is quite remarkable considering the low overall design-consciousness of this firm. On this relationship our respondent noted:

"We work together with [firm X]. That is interesting for both parties, since they work very differently than we do. They are more in the design area while we are more in the 'solid, hard' area. We are doing one project with them. (…) Such a co-project where they provide their creativity while we provide the more plan-based part of the job. I can image that we will do more with them in the future, I would like that. [MD]

4.3. Design: inside-out and outside-in

On the basis of the above observations, we hypothesize that, even though the role of design in the ICT sector is currently limited (with the exception of content-based ICT firms), this will change over time since the industry is slowly maturing and the underlying technology and the functions an ICT product is able to perform will become more and more standardized. As one of our respondents noted:

"One of the trends in ICT is that (…) all kinds of systems will become more standardized and will be made in such a way that it is relatively easy to replace them and relatively cheap to buy them from different suppliers because of which firms do not have to spend that much anymore on IT. (…) But if it becomes a commodity, and if it is cheaper and more easy to construct because of modules, then your competitive advantage will disappear. Because over time all firms in your market will have the same modules and technical possibilities, and you cannot compete on those aspects anymore. Differentiation can then only be obtained by the 'outer shell'. This will mean that more attention will have to be paid to image building, feelings, the experiences of a client."

This is not a very daring hypothesis, as this is a pattern we observe in more industries. As Yamamoto and Lambert (1994: 317) state: 'In a crowded marketplace faced with increasing standardization, attention paid to industrial design could be a key to enhanced sales performance'. Also Ulrich and Eppinger (1995) argued that technology development and design investments interact with each other over time: whenever the underlying technology of a product has 'leveled out', this gives room to, or rather necessitates, investments in design for the creation of differentiation. Gemser and Leenders (2001) provided empirical evidence that in the Dutch instruments industry, where product technology has began to level out, the use of professional design expertise to develop pleasing product appearances and increasing products' user-friendliness has indeed been a successful strategy to create differentiation in the market. In other words, these authors suggest that attention for design investments is dependent on technological development over time. We could call this development one **from the inside out**. The more developed an industry, the more it is necessary to pay attention to design for such aspects as usability and aesthetics.
There has also been a movement **from the outside in**, also called 'integrated design'. Related to this outside-in development Fairhead drew a stage model, which we reproduce in Figure 2 (on the basis of Von Stamm 2003: 15).

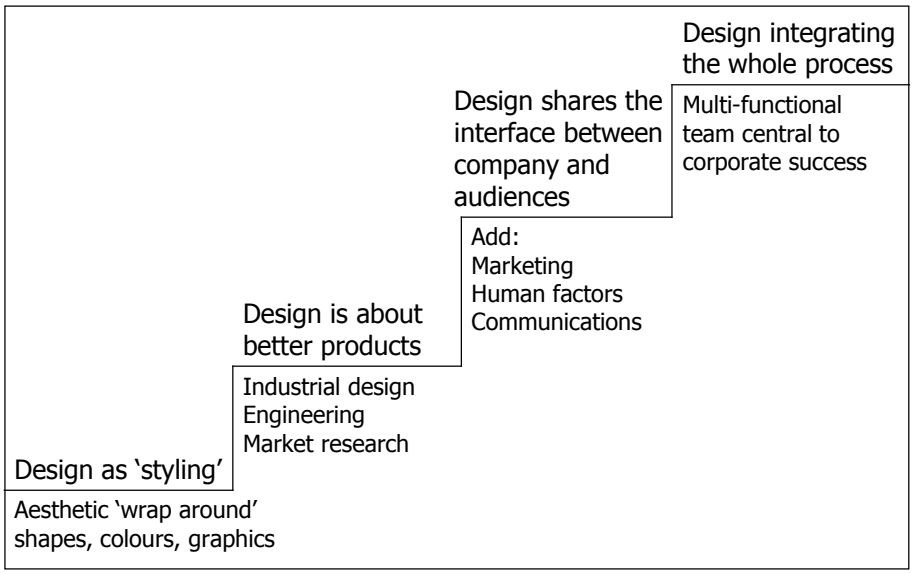


Figure 2: Design from the outside in (Fairhead 1988)

In Figure 3, we combine the two developments related to increasing design-consciousness which, in this study, we base on three basic design dimensions: functionality, usability, and aesthetics. With regard to the ICT firms sampled, functionality was often the responsibility of those trained in computer science or engineering, usability of those trained in interaction design or cognitive science, and aesthetics of those trained in 'traditional' design areas such as graphic design. As illustrated in Figure 3, increasing design-consciousness then combines an inside-out development – from paying predominantly attention to functionality in product development projects to explicitly including usability and aesthetic aspects too - and, on the other hand, an outside-in development –where professional designers are fully integrated in the product development process, and not only used for enhancing aesthetics but also for enhancing usability and functionality.

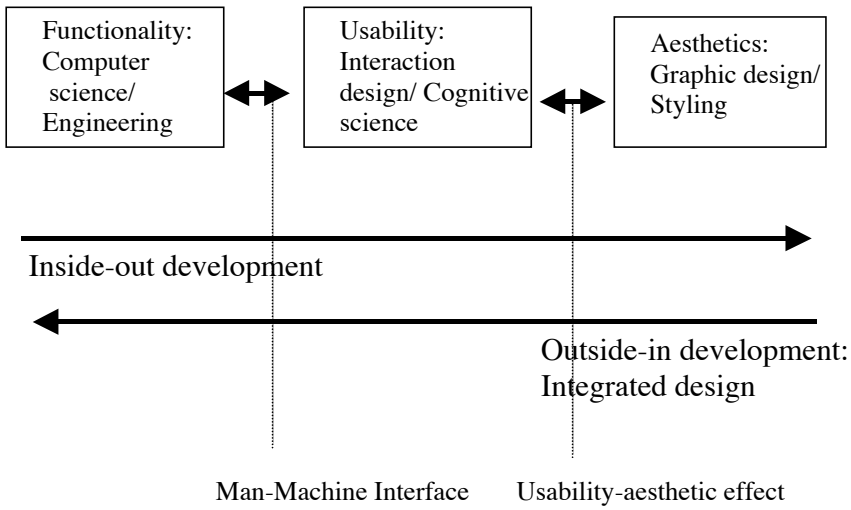


Figure 3: increasing design-consciousness in ICT as a combination *of inside-out and outside-in developments*

Thus, the basic hypothesis we propose on the basis of this study, is that the more ICT gets standardised, the more it will have to compete on the real integration of these three design dimensions and the integration of 'traditional' designers in more areas than 'plain' aesthetics. Our empirical findings indicate that this integration within the ICT sector may be a 'punctuated' kind of integration. This means that integration comes in relatively short 'stages', and between two stages may be halted for a specific period of time, which is related to the different thresholds in terms of software applications generations[5]. However, increasingly, this integration will have to become more continuous.

5. Conclusion

The principal aim of this study was to examine the (possible) value added of design in the Dutch ICT sector, a sector were design seems to be a relatively under-utilised strategic tool. To collect empirical data, we performed semi-structured, in-depth interviews with managers from ICT firms and representatives of the sector with more overview.
On the basis of our literature study, we considered the potential value added of design within the ICT sector to be in particular enhancing usability, aesthetics, and, to a lesser extent, functionality. In our empirical study, we

found that the role of design is still limited, in particular in the case of firms providing client-specific applications. For these firms, functionality – taken care of mainly by system analysts and software engineers – is still 'king', although usability slowly gets more attention in product development projects. This is expressed for example in more attention for 'total cost of ownership' of ICT systems. Within ICT firms designing 'generic' product software, usability has already gained more attention and slowly even aesthetics become an issue. Firms for which the content of ICT is predominant, such as video games producers and website builders, consider aesthetics to be their main competitive asset, and use designers not only for this product area but also for improving usability and functionality.

Apart from the clear design consciousness in the third category, these conclusions can be considered 'disappointing'. If we consider the crisis in the ICT sector of the past few years, to a large extent caused by customer dissatisfaction about failed ICT projects, the incorporation of more design dimensions (and professional designers), seem necessary and urgent: mostly to increase customer satisfaction and in this way added value. Moreover, we may observe that the more ICT technology and functionality is becoming standardized, ICT firms need to find other ways to distinguish themselves. Now there has been a tendency towards price competition as a consequence of both overcapacity in the sector and an increasingly critical attitude of the customers regarding ICT costs in relation to failed projects. The only way out of this cost trap is to really add value. For this it is also necessary to include the real end users at the client level - end users which as private ICT users are sophisticated enough to know what is really possible in this field.

A second conclusion is that where developments in the direction of the inclusion of design aspects (usability and aesthetics) happen, these proceed through thresholds, after which design appears to be 'frozen' for a certain period. As this is related to subsequent generations of programmes, there is an understandable logic behind this. Our hypothesis is, however, that attention for these design aspects is increasingly necessary, and therefore needs to be more continuous.

Taking into account our small sample-size, it may be obvious that our results and conclusions are preliminary and open for discussion and qualification. Indeed since our research was exploratory in nature, they are intended to be a stepping stone for further research. The next step is discussing these findings with representatives of the industry in a series of meetings.

End notes

1. With the help of www.whatis.com, 'definitions for thousands of the most current IT-related words
2. In Dutch: 'vormgeving als zingeving'.
3. Please note that we decided to exclude the relatively specialised area of telecommunications.
4. This finding is sustained by the observation that in the special end-of-the-year section 'Visie 2004' of the *Automatisering Gids* (19-12-03) in which 43 Dutch ICT firms presented their ideas for this year, no one even mentioned design!
5. Following Stephen Jay Gould, in modern evolutionary theory one talks about 'punctuated equilibrium' to emphasise that in most cases evolution happens in short spurts in which species adapt to sudden changes in the environment, followed by long periods of relative equilibrium.

Literature

Ainamo, A., Pantzar, M., "Design for the Information Society: What Can we Learn from the Nokia Experience?", *The Design Journal*, Vol. 3, No. 2, pp. 15-26.
Berkowitz, M. 1987, 'Product Shape as a Design Innovation Strategy', *Journal of Product Innovation Management* , 4, p. 274-283.
Black, C.D., Baker, M. 1987 Success through design. *Design Studies*, 8 (4), p. 207-216.
Bono, Edward de 1993, *Sur/petition. Creating Value Monopolies When Everyone Else is Merely Competing*, London, HarperCollins.
Brown, John Seely, Paul Duguid 2000, *The Social Life of Information*, Boston Mass., Harvard Business School Press.
Brown, Stephen 2003, *Free Gift Inside!! Forget the Customer. Develop Marketease*, Chichester, Capstone.
Brown, Stephen, Anthony Patterson (eds.) 2000, *Imagining Marketing. Art, aesthetics and the avantgarde,* London, Routledge.
CBS 2003, *De Digitale Economie 2003*, Voorburg/Heerlen, CBS.
Ciborra, Claudio 2002, *The Labyrinths of Information*, Oxford, Oxford University Press.
Conran, Terence 1996, *Terence Conran on Design,*, London, Conran Octopus.
Design Innovation Group, 1989, *Commercial Impacts of Design (CID) Project*, Questionnaire of the Design Innovation Group: The Open University/Umist, Milton Keynes.

Dougherty, D., and C. Hardy, 1996, "Sustained Product Innovation in Large, Mature Organizations: Overcoming Innovation-to-Organization Problems," *Academy of Management Journal*, Vol. 39, pp. 1120-1153.
Dutch Design Institute (Vormgevingsinstituut) 1994, *Design across Europe. Patterns of Supply and Demand in the European Design Market.* Research by AEA London.
Gemser, Gerda, in cooperation with Mark Leenders, Felix Janszen 1997, *Concurreren door investeren in industrieel ontwerpen*, Amsterdam, BNO.
Gemser, Gerda 1999, *Design Innovation and Value Appropriation*, Rotterdam, Ph.D. Thesis Erasmus University.
Gemser, Gerda, Mark Leenders, 2001, 'How integrating industrial design impacts on corporate performance', *Journal of Product Innovation Management*, Vol. 18, No. 1, pp. 28-38.
Groupe Bernard Juilhet, 1995, *French SMEs and Design. Research by order of the French Ministery of Industry* (in French), Paris.
Harkins, 1994a, "Is Design Doing its Job?", *Machine Design*, February 7th, pp. 53-58.
Harkins, J.K., 1994b, "A Means to Our Ends: 3D CAD Tools Help to Accomplish Design Goals the the '90s", *Design Management Journal*, Spring, pp. 79-82.
Heller, Eva 1989, *Wie Farben wirken*, Reinbek, Rowohlt.
Hohmann, Luke 2003, 'Usability: Happier Users Mean Greater Profits', *Information Systems Management*, Fall 2003, p. 66-76.
Industrieel Ontwerpen Nederland, *Produkt '95 Jaarboek voor Industriële Produktontwikkeling*, Rotterdam: WYT Uitgeefgroep.
Jacobs, Dany 1999, *Het Kennisoffensief. Slim concurreren in de kenniseconomie* (2de editie), Alphen a/d Rijn, Samsom.
Kazmierczak, Elzbieta 2003, 'Design as Meaning Making: From Making Things to the Design of Thinking', *Design Issues,* 2003 no. 2, p. 45—59.
Leeuwen, Theo van, Carey Jewitt (eds.) 2001, *Handbook of Visual Analysis*, London, Sage.
Lidwell, William, Kritina Holden, Jill Butler 2003, *Universal Principles of Design,* Gloucester Mass., Rockport.
Lundvall, Bengt-Åke Lundvall 1988, 'Innovation as an interactive process: from user-producer interaction to the national system of innovation' in Giovanni Dosi et al., *Technical Change and Economic Theory*, 1988, London, Pinter, p. 349-369.
Michels, Wil, Patrick van Thiel 2002, *Corporate Design Management*, Groningen, Wolters-Noordhoff.

Miles, M.B., and A.M. Huberman, 1994, *Qualitative Data Analysis: an Expanded Sourcebook*, Thousand Oaks: Sage Publications.
Muller, W., 1990, *Vormgeven. Ordening en Betekenisgeving*, Utrecht: Lemma.
Olins, Wolff 1995, *the new guide to identitity,* London, Gower & Design Councel.
Packard, Vance 1957, *The Hidden Persuaders,* New York, McKay.
Potter, S., Roy, R., Capon, C.H., Bruce, M., Walsh, V., Lewis, J. 1991, *The benefits and costs of investment in design: using professional design expertise in product, engineering and graphics projects*. Report of the Design Innovation Group: The Open University/Umist.
Press, Mike, Rachel Cooper 2003, *The Design Experience,* Aldershot, Ashgate.
Pruys, S.M., 1972, *Dingen vormen Mensen: een Studie over Produktie, Consumptie, en Cultuur*, research commissioned by Stichting Industriële Vormgeving, Bilthoven: Ambo.
Ridaceela, Aaron 2001, 'Remember The User's Point of View', *Informationweek.com,* 02-04-01, p. 48-56.
Roerdinkholder, F.A. 1995, *The Economic Value of 'Good Industrial Design'*. (in Dutch), Amsterdam, Dutch Design Institute.
Roothart, Hilde, Wim van der Pol 2001, *Van trends naar brands*, Deventer, Kluwer.
Roy, R, and S. Potter, 1993, " The Commercial Impacts of Investments in Design," *Design Studies*, Vol. 14, no. 2, pp. 171-193.
Stamm, Bettina von 2003, *Managing Innovation, Design and Creativity*, Chichester, Wiley.
Tidd Joe, John Bessant, Keith Pavitt 1997, *Managing Innovation,* Chichester, Wiley.
Ulrich, K.T., Eppinger, S.D. 1995, *Product Design and Development.* MIT (USA): McGraw-Hill.
Walsh, V., 1996, " Design, Innovation, and the Boundaries of the Firm," *Research Policy*, Vol. 25, pp. 509-529.
Walsh, V., Roy, R., Bruce, M., Potter, S. 1992, *Winning by Design. Technology, Product Design and International Competitiveness*, Oxford, Blackwell.
Wheeler, Alina 2003, *Designing Brand Identity,* Hoboken N.J., Wiley.
Yamamoto, M. Lambert, D. R. 1994, 'The impact of product aesthetics on the evaluation of industrial products', *Journal of Product Innovation Management*, 11, p. 309-324.