Customization and personalization in the Internet economy

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“The discovery which has been pointed to by theory is always one of profound interest and importance, but it is usually the close and crown of a long and fruitful period, whereas the discovery which comes as a puzzle and surprise usually marks a fresh epoch and opens a new chapter in science.”

Sir Oliver J. Lodge (1851-1940)

Abstract

In this thesis I deal with the question how to support customization and personalization for pure digital products in the Internet economy to dramatically decrease search costs for consumers, so variety can be maximized. This thesis builds upon theories about digital products, mass customization and variety. These three themes have some relations that uncover a gap in literature. In this thesis I developed hypotheses based on these relations, and tested them empirically. The hypotheses are: larger variety enables higher levels of customization, higher levels of customization leads to larger possible variety, larger variety leads to more complexity and more complexity leads to higher search costs for consumers, and higher levels of customization leads to lower search costs for consumers.

The main motivations for this thesis are the specific characteristics of digital products and the Internet economy. The characteristics of digital products enable the customization of digital products, and in combination with the Internet, these characteristics make it possible to for consumers to have virtually unlimited choice. This thesis uncovers a gap in literature. Where the majority of research on mass customization addresses the customization of physical products, this thesis addresses the customization of digital products on the Internet.

To accomplish the goal of this research, I conducted a case study at two companies that supply digital products on the Internet in the form of music. These companies, Last.fm and Pandora Media, allow consumers to customize and

personalize radio stations. The main data sources of the case study are three interviews, which are analyzed by applying the technique of pattern matching.

The results show that some hypotheses are supported by the empirical data, and some are not. The case studies show that companies should follow a mass customization strategy where consumers are involved early in the design and fabrication process, and employ modularity at the assembly and use stages. These companies can be classified as involvers (Duray et al., 2000). The main differences between the proposed hypotheses and the empirical data can be found in complexity and search costs. The case studies show that variety does not necessarily leads to more complexity and higher search costs, because it is not the intention of the supplier to lower the average interaction length of time and in turn to lower search costs for consumers, but to increase interaction to allow the consumer to discover new digital products.

The conclusions lead to the revision of the proposed hypotheses, and have implications for theory on digital products and mass customization. Digital products are experience goods, which leads to two important implications. First, instead of lowering the average interaction length of time (Blecker et al., 2006), it is desired to increase the average interaction length of time between the supplier and the consumer. Second, instead of lowering search costs for consumers, it is desired for them to discover as much as new products as possible. This thesis contributed to the existing knowledge of mass customization by determining the strategy to choose when offering customizable digital products, which should be the involver. This thesis contributed to the work of Brynjolfsson et al. (2003), who question whether it is lowering search costs that improves consumer surplus, or discovering obscure products. Where literature suggests that lowering search costs increases consumer surplus, this thesis shows that discovering new digital products outweighs minimization of search costs.

Keywords: digital products, mass customization, product variety, consumer surplus, complexity, search costs, interaction systems, Internet economy.

Acknowledgements

At this stage in writing my thesis I can look back to the last nine months. During these months, this thesis was one of the highest priorities of my life, which caused other important things sometimes had to wait. But it was worth it.

This thesis is my final work of the master's education Information Studies program Business Information Systems at the University of Amsterdam. The master's education was the most inspiring and instructive period of my study. This thesis fits into this because I learned so much during this period and my interest for the subjects that came by during the last year of my study increased significantly.

Writing this thesis was not an easy task, and I could not have done it without the help of some people. First of all, I would like to thank my supervisor, dr. Onno Truijens. From the beginning of my master's thesis trajectory he was enthusiastic about the subject of the thesis, and kept the same enthusiasm throughout the end. I remember the first time we talked about the Internet economy, digital products and so on. We discussed about what I first intended to do could contribute, and made me several useful suggestions to read on and to revise my first intentions. These suggestions gave me new insights about literature and pointed me in some directions on what was missing in literature, which resulted in preliminary hypotheses that were the first foundations of this thesis. Onno, thank you very much for your support during this trajectory.

Many thanks go out to the companies that agreed on being a part of this research, Last.fm and Pandora Media. In particular, I would like to thank the interviewees Martin Stiksel of Last.fm, and Matt Nichols and Tim Westergren of Pandora Media. Your input was the most important for the case studies, and led to some insights that would not have been realized without it. Thank you all very much for being so open about your companies and providing me with useful answers on my questions. I would also like to thank dr. Frank Piller of the Technische Universitaet Muenchen for giving me some directions for reading literature and for preparing my empirical research.

During the master's thesis trajectory I did not work just on my own. For me it was important to have formed a peer review group with Michael Meinders and Stefan Krauth. With the help of my peers, I could let them review parts of my thesis and get objective and valuable feedback on these parts. Working together with my peer review group not only gave me feedback on my work, but also motivated me during times I needed it. In particular during the last two months I benefited from working together every week, and it motivated me to finish this thesis. Guys, thank you for your support.

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Table of contents

Chapter 1

Introduction

The central theme of this thesis is the customization of digital products in the Internet economy. As a global network, the Internet can be used to take advantage of the typical characteristics of digital products such as reproducibility (Choi et al., 1997) and versioning (Shapiro and Varian, 1999). These characteristics facilitate the customization of digital products and can thus lead to an enormous variety. In turn, this enormous variety can facilitate customization, which in theory can provide all consumers with customized and personalized products they need or desire. However, this abundance of choice can make the Internet a rather complex environment for consumers. The purpose of this thesis is to find out how suppliers of digital products over the Internet can reduce this variety-induced complexity for consumers by customizing their digital products in a way that it reduces this complexity. To accomplish this aim, I conducted a case study at two companies (Last.fm and Pandora Media). Both companies enable consumers to customize digital products on the Internet, in the form of online personalized radio stations, but they use different strategies. The perspective which is chosen for this thesis is the consumer. The case studies at the two companies are conducted at the supplier, however, the aim is to increase consumer surplus.

1.1 Background to the research

The power of the Internet lies in its ubiquitous presence and ability to provide low cost and universally standard means for content exchange, coordination and collaboration (Barua et al., 1999). The Internet economy is an example of the new economy. In this thesis I follow the explanation of Arthur (1996) who describes the new economy as an economy of increasing returns opposed to the economy of diminishing returns, seen from the information supplier perspective. The difference between the 'old' economy and the 'new' Internet economy can be found in two areas. The first is the networked economy with phenomena like positive feedback and network externalities (Arthur, 1996; Katz and Shapiro, 1985), the second can be found in the characteristics of digital products, which are fundamentally different from traditional tangible products. This section outlines the broad field of study and then leads into the focus of the research problem. The thesis is based on three main themes which are interrelated: digital products, mass customization and variety.

The first main theme is digital products. Digital products have some characteristics that distinguish them from physical products (Choi et al., 1997; Shapiro and Varian, 1999; Evans and Wurster, 2000). Physical products take physical space, and it takes time to physically transport them. Digital products do not take physical space, and they can be transported over networks such as the Internet, which reduces transportation time to almost zero. Other differences can be found in the physical characteristics of digital products. These characteristics are indestructibility, transmutability and reproducibility (Choi et al., 1997; Werbach, 2000). Indestructibility means that the number of uses does not reduce the quality of the product in any way. Transmutability means that digital products are easily perceptible to change, which allows for customized and personalized products to be delivered. Reproducibility refers to the ease with which copies of digital products may be produced at low and constant costs. This last characteristic has major implications for the cost structures of digital products (Shapiro and Varian, 1999; Evans and Wurster, 2000). Digital products are costly to produce but cheap to reproduce, which means that the cost of production is dominated by the first-copy costs. This is also different from physical products, which have to be priced according to the production costs.

The second main theme is customization. Needs and desires of consumers are changing, which leads to high market turbulence (Pine, 1993). Mass customization is a term which is often used in literature, basically referred to as mass production of customized goods. Many researchers addressed mass customization for physical goods (Pine, 1993; Gilmore and Pine, 1997; Lampel and Mintzberg, 1996; Duray et al, 2000; Tseng and Piller, 2003; MacCarthy et al., 2003). Because digital products are transmutable, they are extremely customizable. The Internet economy enables strategies of customization and personalization for suppliers of digital products, much more than the economy of tangible products. These enablers are the characteristics of digital products. Take for example the Amazon.com website. Jeff Bezos of Amazon: *"If I have 10 million visitors to my Web site, I should have 10 million Web sites for my visitors!"* (Riedl, 2001). Santonen (2003) suggests basically the same, but instead bases it on demand-side economies of scale (Shapiro and Varian, 1999). Demand turbulence is increasing the level of customization in the case of digital information products (Santonen, 2003).

The third main theme is variety. Variety, or increased choice, is positively related to consumer surplus (Brynjolfsson et al., 2003). Variety is a term that sometimes is mixed up with customization. Customization and variety are strongly related to each other, but variety is not the same as customization. Variety provides choice for consumers, but not the ability to specify the product as is the case with customization. Variety is the tool for mass customization, because it can create the link between the consumer and the product (Svensson and Jensen, 2001). Customization can lead to many variations of products. In addition, the reproducibility of digital products can lead to an enormous variety. The Internet makes it possible to reproduce digital products for virtually anyone, which can lead to an enormous choice of digital products.

The three themes described have some relations. First, the characteristics of digital products enable the customization of these products, and second, in combination with the Internet, the characteristics make it possible for consumers to have virtually unlimited choice. These relations uncover a gap in literature. The majority of research addressed the mass customization of physical products, however almost no research addresses the customization of digital products. The following section elaborates on this gap in more detail.

1.2 Problem statement

The goal of this research is to make an addition to existing theory about consumer surplus in the Internet economy, and in particular the contribution of customization of digital products. According to Brynjolfsson et al. (2003), increased online availability of previously hard-to-find products represents a positive impact on consumer surplus. Product customization is one way to create consumer value, by closely matching a product to a consumer's needs (Squire et al., 2004). Not much research has been conducted on the customization of pure digital products in the Internet economy. The majority of the available research on the Internet economy is about e-commerce where tangible products are being sold or delivered through intangible services (Choi and Whinston, 1999; Dewan et al., 2003), while other research focuses on the mass customization of physical products. Also existing literature on mass customization mainly focuses on supplier surplus. This research will address pure digital products: on-line delivered customized products where both product and channel are digital, and instead of the supplier surplus, this research focuses more on consumer surplus. Product customization, enabled by the Internet could allow sellers to exploit buyers, but it also would benefit buyers (Grover and Ramanlal, 1999; Barua et al., 2004).

To accomplish the goal of this research, characteristics of customization have to be identified to support a customization strategy for suppliers in such a way that it can decrease search costs for consumers dramatically, so variety of digital products can be maximized. Variety is positively related to consumer surplus (Brynjolfsson et al., 2003). I make an addition to their findings by relating increased variety with customization and personalization, which could be mutually reinforcing in the Internet economy. The consumer should benefit from this increase in variety and customization, while variety induced complexity and search costs are being lowered dramatically.

The overall research question takes the main themes of customization and personalization in the Internet economy into account, in particular for pure digital products. These themes outline the context of the research. The overall research question is the following:

How to support customization and personalization for pure digital products in the Internet economy to dramatically decrease complexity and search costs for consumers, so variety can be maximized?

To gain answers to the overall research question, I constructed hypotheses which are the result of a review of literature in Chapter 2 on digital products, mass customization, and the benefits and drawbacks of variety. The hypotheses are the following, and visualized in Figure 1.1:

H1: The larger the product variety, the higher the level of customization.

H2: The higher the level of customization, the larger the possible variety.

H3.1: The larger the variety, the larger the complexity.
H3.2: The larger the complexity, the higher the search costs.

H4: The higher the level of customization, the lower the search costs.

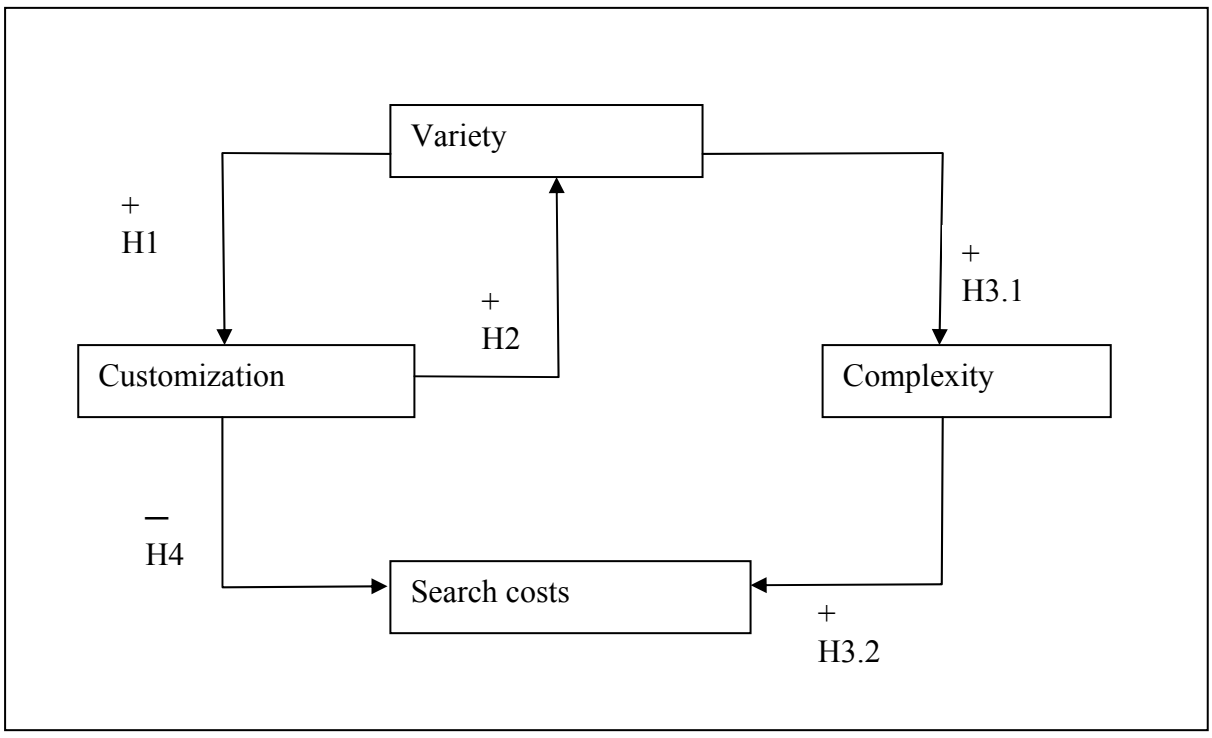

Figure 1.1: Research framework.

1.3 Justification for the research

This thesis has a practical and a scientific relevance. The most important is the scientific relevance. In this research I would like to make an addition to the work of Brynjolfsson et al. (2003), who argue that increased online availability of previously hard-to-find products represents a positive impact on consumer surplus. This addition can be found in the use of customization of digital products on the Internet. Scientific literature is scarce on the customization of digital products; this thesis tries to fill that gap.

The practical relevance can be found in the fact that the consumer plays a significant role in the Internet economy. These consumers can benefit from increased variety as was argued by Brynjolfsson et al. (2003). If the hypotheses can be supported, the practical relevance would be the answer to the overall research question, because suppliers would have more knowledge on how to customize digital products and can serve the consumer better. In addition, suppliers of digital content on the Internet should benefit of this research, because if they can find more consumers for their digital products, they might benefit from positive feedback resulting in network externalities (Arthur, 1996; Witt, 1997; Kline, 2001; Katz and Shapiro, 1985; Liebowitz and Margolis, 1994; 1995).

1.4 Methodology

The research methodology is presented in Chapter 3. This section introduces the research methodology. The overall research question is a ‘how’ question and it is needed to focus on contemporary events, which leaves the case study as the strategy to use (Yin, 2003). This research can be seen as a combination of exploratory and explanatory. The units of analysis are online digital products in the form of music, more specific in the form of personalized radio stations at two companies: Last.fm and Pandora Media. They are both online services that offer digital products to be consumed over the Internet, and offer the possibility to customize and personalize radio stations to listen to. The primary data source which is used is the interview. For the case study on Last.fm I had an interview with one of the founders. For the case

study on Pandora Media I had two interviews, one with the founder and one with the marketing manager. Other data sources I used are documentation found on the websites of the companies and other websites.

1.5 Outline of the thesis

The complete thesis consists of a literature review on the relevant themes of this thesis and two case studies. The structure of the thesis is the following. The first chapter after this introductory chapter is the literature review, Chapter 2. It describes literature on digital products, mass customization and variety. Chapter 2 ends with a confrontation of the literature and the overall research question, and poses four hypotheses which are the foundation for the case studies. Chapter 3 contains the research methodology. In this chapter I discuss the research strategy, the research design with the unit of analysis, site selection criteria, I describe the data sources that where used, how the data was collected, how the data was analyzed and the instrumentation. Chapter 4 contains the case studies on Last.fm and Pandora Media, where the collected case study data is analyzed and reported. Last.fm and Pandora Media are both Internet based companies that offer the listener to customize and personalize their listening experience, and discover new music. They both follow different strategies to accomplish this. Both case studies are analyzed and reported in the same manner and in the same structure. The main data sources are three interviews. The thesis ends with Chapter 5, where the results are discussed and conclusions in perspective to the overall research question are drawn. Also further research is suggested in Chapter 5.

Chapter 2

Literature review

This chapter presents a literature review on the relevant themes of this thesis, which are digital products, mass customization and variety. The reviewed literature is used to analyze these themes and works towards the hypotheses on the relationships between customization, variety, complexity and search costs. Each theme is first clearly defined, followed by an overview of existing literature and is then narrowed down towards the research hypotheses. Also the characteristics of the main themes are identified in order to operationalize them for the empirical research.

Section 2.1 starts with a review of the existing literature on digital products and their characteristic features, which distinguish them from physical products. That theme is followed by section 2.2 on customization. The chapter continues with a literature review on variety in section 2.3, which is strongly related to mass customization. The chapter ends with the research hypotheses.

2.1 Digital products

In the literature multiple terms are used for the term digital product. Examples of the term are information products, information goods, information services or

intangible goods. In this thesis I will stick to the term digital product, because the used definition of customization in subsection 2.2.1 refers to products. In this paragraph I will explain what digital products are, and what their basic characteristics are.

The first subsection describes the characteristics of digital products, in particular their physical nature. The section continues with a subsection about the costs structures of digital products, followed by a section on versioning. These themes are very specific for digital products when compared to physical products, and are therefore relevant for this thesis.

2.1.1 Characteristics of digital products

Digital products do not have a physical form or structure that can be physically consumed (Choi et al., 1997). Digital products are always experience goods, because they have to be used first before its value can be determined (Nezlek and Hidding, 2001). Suppliers of digital products need to rely more on signals that consumers send in, and therefore product customization and discriminatory pricing based on consumer types become essential for digital products (Choi et al., 1997). Examples of digital products are on-line newspapers, magazines, music, education, and searchable databases (Loebbecke, 1999). Digital products are fundamentally different from physical products in three basic characteristics (Nezlek and Hidding, 2001). These characteristics are indestructibility, transmutability and reproducibility (Choi et al., 1997). Some non-digital products share these characteristics, but only to a limited degree. A digital product is the first product that incorporates all these three characteristics.

The first physical characteristic is indestructibility. Indestructibility indicates that there is no wear and tear associated with the use of digital products. The number of uses does not reduce the quality of the product in any way (Choi et al., 1997). A product sold by a producer is equivalent to one offered in the second-hand market, sellers of digital products therefore use strategies to be able to continue selling their first-hand products. Licensing for example is a strategy they use, so the digital product has no value anymore after a period of time. Another strategy that can be used is updating the product, so the value of an earlier version is reduced.

Transmutability is the second physical characteristic of digital products. Transmutability means that digital products are easily perceptible to change, which is paradoxical to the first characteristic (Choi et al., 1997). This allows for customized and personalized products to be created and delivered to the consumer. Product differentiation is therefore a strategy that producers follow (Choi et al., 1997). This can be achieved by customizing and updating the product, and selling the product as interactive services, not just stand-alone products. The Internet makes it easy for digital products to be sold as interactive services. The transmutability raises the whole issue of customized products, individualized pricing, and the proper use of consumer-revealed information (Choi et al., 1997).

The third and most noteworthy physical characteristic of digital products is their reproducibility. It refers to the ease with which copies of digital products may be reproduced, stored, and transferred at low and constant costs (Choi et al., 1997). This characteristic is the most noteworthy because it has consequences for pricing digital products, which is very different from physical products. It means that after the initial investment costs, the marginal costs of production approaches zero.

Seen from an economic perspective, transmutability of digital products appears to work in the producers' favour, while indestructibility and reproducibility appear to work in the consumers' favour. The following subsection describes the costs structures that are specific for digital products, including price discrimination.

2.1.2 Costs structures

Digital products are costly to produce but cheap to reproduce, which means that the costs of production are dominated by the first-copy costs (Shapiro and Varian, 1999). The costs of producing the first copy are the fixed costs, and the costs of reproducing are the variable costs. This costs structure leads to substantial economies of scale, the more you produce, the lower your average costs of production. However, fixed costs are also determined by sunk costs. These are costs that are not recoverable if production is halted. Once the first copy of a digital product or information good has been produced, most costs are sunk and can not be recovered (Shapiro and Varian, 1999). Not only the costs are low, but also the time required for producing a copy is

marginally low, making it completely unnecessary to store multiple copies of the same product (Luxem, 2000).

For a producer of digital products it is important to keep the fixed, sunk and marginal costs as low as possible. To accomplish this, and actually realize economies of scale, digital products have to be sold to many sellers. For this, there are several strategies to follow. For example, the producer of digital products has to prevent the commoditization of the product (Shapiro and Varian, 1999). When a digital product is produced with high fixed costs, the producer needs to sell the same product multiple times to be able to make a profit. If the digital product becomes a commodity, the producer can not make a profit from it anymore because the price reaches zero. To prevent commoditization of the digital product, the producer can try to protect the product with technical or juridical means.

Because of the costs structure, digital products do not have to be priced according to the production costs. Most physical products have costs almost equal to the marginal costs because these marginal costs are high. Digital products can be priced according to their value for the consumer. The value of a digital product for the consumer increases when the product can be personalized or customized (Shapiro and Varian, 1999). Detailed data on consumer preferences are more abundant for digital products which are used on the Internet, and as a result, consumers obtain a higher degree of satisfaction from customized products (Choi et al., 1997). With the costs structure of digital products, it is even possible to personalize prices as well. If the information products are highly tuned to the consumers' interests, there is more flexibility in pricing (Shapiro and Varian, 1999).

Information technology allows for fine-grained observation and analysis of consumer behaviour (Varian et al., 2004). This allows for various kinds of marketing strategies that were previously extremely difficult to carry out. For example, a seller can offer prices and goods that are differentiated by individual behaviour and characteristics. Price discrimination is a strategy that can be applied to digital products. It may be an especially attractive strategy for digital products because of high fixed or first-copy costs, and low marginal costs. There are three forms of price discrimination. First-degree price discrimination can be applied when digital products are highly personalized. This is the case for mass customization and personalization (Varian et al., 2004). In the extreme case, with first-degree price discrimination,

companies will charge the highest price they can to each consumer for the same product. This is only possible when the seller has collected information of the consumer that their competitors do not have (Varian et al., 2004). Also, because digital products can be customized without much added costs and consumers can be charged independently, first-degree price discrimination can be applied easily for digital products sold over the Internet (Choi et al., 1997). The Internet makes it possible to directly interact with a seller, and as a result consumers can buy products for a personalized price. Second-degree price discrimination is pricing products according to different market segments. Different versions of digital products can be sold at different prices. Third-degree price discrimination refers to selling at different prices to different groups.

2.1.3 Versioning

Second-degree price discrimination can be achieved by selling digital products in different versions. Versioning refers to offering digital products in different versions for different market segments (Shapiro and Varian, 1999). Versioning is a strategy to achieve economies of scale, which is very suitable for products with low variable costs, such as digital products. Because digital products are transmutable, versioning is an even more attractive strategy. Digital products can be versioned in different ways. One of them is delay. Some digital products are worth more when they are new, so by selling these digital products to different market segments at different times, the product can be sold to more consumers. Another product dimension where versioning can be applied is the user interface, such as versions for advanced users and beginning users. An example is an advanced search interface (Shapiro and Varian, 1999). Other product dimensions where versioning can be applied are on-line and off-line versions, or quality of the product. Different versions can be applied by producing a high-quality version first, and then subtract value from it by removing features or degrading the product (Shapiro and Varian, 1999).

It is not always needed or desired to version along all possible product dimensions. One version does not suffice, because too few market segments can be served. From the consumer perspective, too much versions or too much variety can lead to complexity (Schwartz, 2000; Shapiro and Varian, 1999; Piller et al., 2005).

Digital products such as DVDs can be sold as a standard version, and an enhanced collectors' edition (Varian et al., 2004). If the digital product is subject to network externalities, you may want to restrict the number of versions you offer. Because many digital products are subject to network externalities, they only become valuable once a large number of people are using them. Free versions can therefore be a good way to bring a product's use up to a critical mass (Shapiro and Varian, 1998; Gallaugher et al., 2001).

Versioning is one way to achieve economies of scale, bundling is another, and can be seen as a special form of versioning (Shapiro and Varian, 1999). Bundling refers to selling two or more distinct goods together at a single price (Adams and Yellen, 1976, in Varian et al., 2004; Choi et al., 1997; Bakos, 1998). This is particularly attractive for digital products since the marginal costs of adding an extra good is negligible. Bundling can improve consumer value, because a bundle of two distinct digital products can be sold for less than the two products sold separately. Consumers that are only interested in one of the products can choose the single product. Bundling digital products is comparable with mass customization. There are companies on the Internet that allow consumers to customize a CD, by letting them choose which songs they would like on it.

2.2 Customization

Customization is the most prominent theme in this thesis. As stated in the main research question, it should be investigated how customization of digital products over the Internet can be supported in order to maximize variety while minimizing complexity and search costs. Mass customization is a popular subject in research (Pine, 1993; Gilmore and Pine, 1997), and is getting more attention in literature the last decade because the needs and desires of the consumers are changing, which leads to high market turbulence (Pine, 1993). However, in literature little attention is paid to the customization of digital products.

Because there is no uniform definition of mass customization, I will start this section first by defining customization, followed by a review of the relevant literature on mass customization. This literature can be classified according to the point of consumer involvement and the type of modularity employed (Duray et al., 2000). The

reason for this positioning is that mass customizers can be identified and classified based on two characteristics: the point in the production cycle of consumer involvement in specifying the product and the type of modularity employed (Duray et al., 2000).

2.2.1 Definition

Mass customization is a term often used in literature, generally referred to as the mass production of customized goods. The term mass customization was introduced by Davis (1987) as a strategy for the future where technology should enable mass customized goods. It seems there is no commonly accepted definition for the term. Some definitions of mass customization used in the literature are 'providing products that are created to the consumer's specifications' (Ettlie and Ward, 1997), or 'offering unique products in a mass-produced, low-cost, high volume production environment' (Duray, 2002). This absence of a definition was also identified by Kaplan and Haenlein (2006). They presented a definition of traditional mass customization, and use that definition to define electronic mass customization. The definition of electronic mass customization addresses digital products as one of three dimensions. This research intends to grasp the concept of customization for digital products in the Internet economy. Therefore, I will use the definition of electronic mass customization to come to a definition of customization of digital products over the Internet.

Traditional mass customization can be defined based on three findings (Kaplan and Haenlein, 2006). First, mass customization should be applied to products only. Second, mass customization should only be used to describe consumer–producer interaction at the operations level of the value chain. Thirdly, mass-customized products should have production costs and monetary prices similar or only slightly higher than those of mass-produced goods. Earlier, Tseng and Piller (2003) used a comparable definition of mass customization by defining a differentiation level for customized products or services, a cost level like mass production efficiency and a relationship level to increase consumer loyalty. Kaplan and Haenlein (2006) argue that customization can only be practiced on products and not on services. Their definition is as follows:

> *"Mass customization is a strategy that creates value by some form of consumer–producer interaction at the fabrication/assembly stage of the operations level to create customized products with production costs and monetary price similar to those of mass-produced products."*

Kaplan and Haenlein (2006) use the definition stated above to define electronic mass customization. For that, they use the dimensions product, player and process which can all be physical or digital (Choi et al., 1997). These dimensions determine the degree of electronic commerce, and are adopted to define pure electronic mass customization. If all dimensions are digital, it can be called the core of electronic commerce (Choi et al., 1997).

Loebbecke (1999) argued however that the dimensions of Choi et al. (1997) cannot be used for on-line delivered content or purely intangible products. Since this research focuses on intangible products only, this definition is not applicable. Loebbecke (1999) proposes a distinction similar to Choi et al. (1997) that a product can be either physical or digital, but the player or the consumer is always physical. In addition, Loebbecke (1999) adds the characteristic of bundled or unbundled value. Traditionally, intangible products were always embodied in some physical means. Now, the link between content and support has been loosened (Goedvolk et al., 2004). As a result, identical content can appear in different forms and packages. The content is what is valuable, bundled or unbundled. For a digital product to be delivered over the Internet, it should be unbundled from a physical carrier. The importance of bundling content with a physical carrier has decreased significantly with the emergence of the Internet. The process dimension is kept, but is reformulated as off-line and on-line. Furthermore, a high degree of customization can be achieved when consumers are involved at the design stage of the production cycle (Lampel and Mintzberg, 1996; Duray et al., 2000; Da Silveira et al., 2001; MacCarthy et al., 2003). Pure customization can therefore not only occur at the fabrication/assembly stage, but also at the design stage.

The definition of customization for this thesis is based on the definition of Kaplan and Haenlein (2006) and uses the dimensions of Loebbecke (1999). This results in the following definition, which is visualized in Figure 2.1. This definition

draws on mass customization addressed in existing literature, which is reviewed in the next section. The definition incorporates the type of product to be customized, the process and the value.

> *"Pure customization is a strategy that creates value by some form of consumer– supplier interaction at the design stage of the operations level to create customized products with production costs and monetary price similar to those of mass-produced products, where the product is digital, the process is online and the content is unbundled from its physical carrier."*

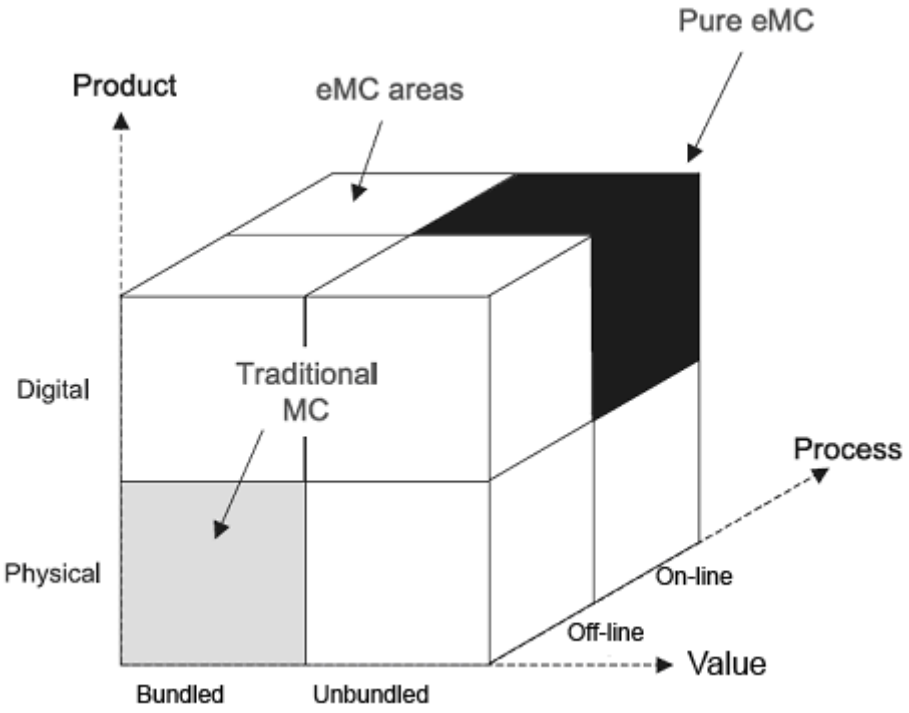

Figure 2.1: Dimensions of Electronic Mass Customization (Kaplan and Haenlein, 2006) adapted from Choi et al. (1997) and adjusted according to Loebbecke (1999).

Figure 2.1 shows the difference between pure electronic mass customization and traditional mass customization. A mass customization market can differ in three components when traditional mass customization and pure electronic mass customization are compared: the product, the process and the value. To illustrate these dimensions, the figure has orthogonal axes.

2.2.2 Point of consumer involvement

The definition used in this thesis holds a high degree of customization when consumers are involved at the design stage. According to Duray et al. (2000), mass customizers can be identified and classified based on two characteristics. One of them is the point of consumer involvement in the design process; the second is the type of modularity employed. The point of consumer involvement in the production cycle is a key indicator of the degree of customization provided. It is used to operationalize the degree of customization. If consumers are involved in the early design stages of the production cycle, a product is highly customized. This paragraph reviews existing literature on the point of consumer involvement that can be the case for mass customization.

Lampel and Mintzberg (1996) differentiate between five mass customization strategies, which are pure customization, tailored customization, customized standardization, segmented standardization and pure standardization. These strategies vary in consumer involvement in the value chain, from where consumers are not involved at all, which is the case for pure standardization, to where consumers are involved in distribution, assembly, fabrication and design. This is the case for pure customization, where the product is truly individually customized.

The work of Gilmore and Pine (1997) is very influential in the literature on mass customization. They mention four approaches of mass customization, which vary in change or no change for both product and representation (Gilmore and Pine, 1997). The first customization approach that the supplier can adopt is collaborative customization, which is appropriate for businesses whose consumers cannot easily articulate their needs. This approach inhibits both a change in product and representation. An advantage of this approach is that consumers can be assisted in discovering products that they otherwise would not have identified or found (Gilmore and Pine, 1997). The second approach is the adaptive approach, where the product and the representation do not change. This approach is appropriate for businesses whose consumers want the product to perform in different ways on different occasions. In this approach it is technology that plays an important and active role, because direct interaction is not needed. Permutations, one of the characteristics of information products (Choi et al., 1997) are possible in standard offerings. The third approach is

the cosmetic approach, which is appropriate when consumers use a product in the same way and differ only in how they want it presented. Personalized offerings and advertisements are suitable possibilities for products over the Internet. The final approach is the transparent approach, which is appropriate when consumers' specific needs are predictable or can easily be deduced. In this approach only the product changes, not the representation.

All of the above approaches have advantages over the others, and at the same time suffer from some limitations. This was also acknowledged by Gilmore and Pine (1997), and they propose to combine two or more approaches. They argue that it is the key to draw on whatever means of customization prove necessary to create consumer-unique value (Gilmore and Pine, 1997; Pine, 1993).

Da Silveira et al. (2001) also reviewed literature on mass customization, and classified that literature in generic levels of mass customization. They also reviewed Pine (1993), who suggests four stages of customization. These stages range from modular production where standard components can be configured in a high variety of products which is the highest customization stage, followed by point of delivery customization where additional custom work can be done at the point of sale. The next stage is customized services where standard products are tailored by people in marketing and delivery before they reach consumers, and providing quick response meaning short time delivery of products, and the stage which Pine (1993) calls embedded customization where standard products can be altered by consumers during use. Da Silveira et al. (2001) also reviewed Spira (1996) who develops a similar framework with four types of customization. According to Spira (1996, in Da Silveira et al., 2001) customized packaging is the lowest level of customization, followed by providing additional services, then by performing additional custom work, and by assembling standard components into unique configurations which is the highest level of customization.

Da Silveira et al. (2001) conducted a literature review on the work of Gilmore and Pine (1997), Lampel and Mintzberg (1996), Pine (1993) and Spira (1996). They combined all their work on mass customization, which led to eight generic levels of mass customization ranging from design to standardization. Their eight levels are design, fabrication, assembly, additional custom work, additional services, package and distribution, usage, and standardization.

MacCarthy et al. (2003) conducted a similar study. They also identified a chain perspective of mass customization (Ross, 1996, in MacCarthy et al., 2003), using five approaches. These approaches vary from core mass customization which is an approach where the consumer can modify core elements, post-product customization where a customized service converts a standard product into a customized one, mass retail customization where customization takes place at the retailer, self-customizing products, and the last approach is high variety push. MacCarthy et al. (2003) also addresses mass customization strategies identified by Alford et al. (2000). The first is core customization where the consumer is involved in the design process, optional customization where the consumer is able to choose from a very large number of options, and form customization where consumers are limited in changes or enhancements. MacCarthy et al. (2003) criticize the classification schemes they reviewed, because they under-emphasize the temporal relationships between activities and whether the resources used in order fulfilment are fixed or modifiable. According to MacCarthy et al. (2003), the classification schemes they reviewed omit whether a company customizes a product on a once-only or on a call-off basis. With these considerations, they identified five fundamental modes of mass customization. The first is catalogue mass customization, where a consumer order is fulfilled from a pre-engineered catalogue of variants, produced using standard order fulfilment processes. The second is called fixed resource design-per-order mass customization. A consumer order is fulfilled by engineering a consumer specific product, produced through standard order fulfilment processes. The third mode is flexible resource design-per-order mass customization, where a consumer order is fulfilled by engineering a consumer specific product, and produced through modified order fulfilment processes. The fourth mode is fixed resource call-off mass customization, where a customized product is designed for a consumer, to be manufactured via standard order fulfilment processes in anticipation of repeat orders. The fifth mode they identified is flexible resource call-off mass customization. This is the same as the fourth, but the order fulfilment activities are modifiable.

All off the above reviewed literature are about the point of consumer involvement in the production cycle. The earlier the consumer is involved in this process, the higher the degree of customization is. According to Duray et al. (2000), consumer involvement can be scaled into two factors. The first factor is consumer

involvement in the design and fabrication stages, and is considered as a high degree of customization. Consumers can change the actual design of the product or introduce new features rather than selecting features from a listing. This involvement requires the design or fabrication of a unique component for such consumers, and consumers are seen as partners (Piller et al., 2004). In summary, the specific items that support this factor are the following:

- consumers' requests are uniquely designed into the finished product;
- each consumer order requires a unique design;
- consumers can specify new product features;
- each consumer order requires the fabrication of unique components prior to assembly;
- consumers can specify the size of components.

The second factor is consumer involvement in the assembly and use stages, and is considered as a low degree of customization. All items relate to the involvement of the consumer through the selection of standard components or products from a prescribed listing of features. It does not allow for new designs or features to be produced. The specific items that support this factor are the following:

- each consumer order is assembled from components in stock;
- consumers can select features from listings;
- consumer orders are filled from stock;
- consumers can assemble a product from components.

The above consumer involvement factors accurately depict the role of the consumer in the design process (Duray et al., 2000). The next subsection reviews the literature on modularity, which is the second characteristic to classify a mass customizer.

2.2.3 Modularity

The second characteristic to identify and classify a mass customizer is the type of modularity employed (Duray et al., 2000). The best method to implement mass customization is to develop products around modular architectures, thereby achieving economies of scale and scope (Blecker et al., 2006). The definition of customization used in this thesis states that production costs and monetary price of customized products should be similar to those of mass-produced products. Duray et al. (2000) addresses this issue by suggesting that modularity can facilitate an increase in the number of product features available, while simultaneously decreasing costs. Creating modular components that can be configured into a wide variety of end products and services is the best method for achieving mass customization (Pine, 1993). Modularity can be defined as follows:

> "*A system is modular when it consists of distinct (autonomous) components, which are loosely coupled with each other, with a clear relationship between each component and its function(s) and well-defined, standardized interfaces connecting the components, which require low levels of coordination (Wolters, 2002)".*

This definition followed from a literature review where some features where distinguished that are of importance to determine the degree of modularity. These features are: distinctiveness or autonomy of components, loose coupling between modules and tight coupling within modules, clarity of mapping between functions and components, standardization of interfaces, and low levels of coordination. The modularity of a system decreases when one or more of these conditions fail to hold (Wolters, 2002).

There are six types of modularity for the mass customization of products and services (Ulrich and Tung, 1991, in Pine, 1993; Duray et al., 2000). These six types are component-sharing modularity, component-swapping modularity, cut-to-fit modularity, mix modularity, bus modularity and sectional modularity, see Figure 2.2.

In component-sharing modularity, the same component is used across multiple products to provide economies of scope. These products are uniquely designed around

a base unit of common components, for example elevators. This kind of modularity never results in true individual customization, but allows the low costs production of products and more variety of products. It is best used to reduce the number of parts and thereby the costs of an existing product line that already has high variety (Wolters, 2002).

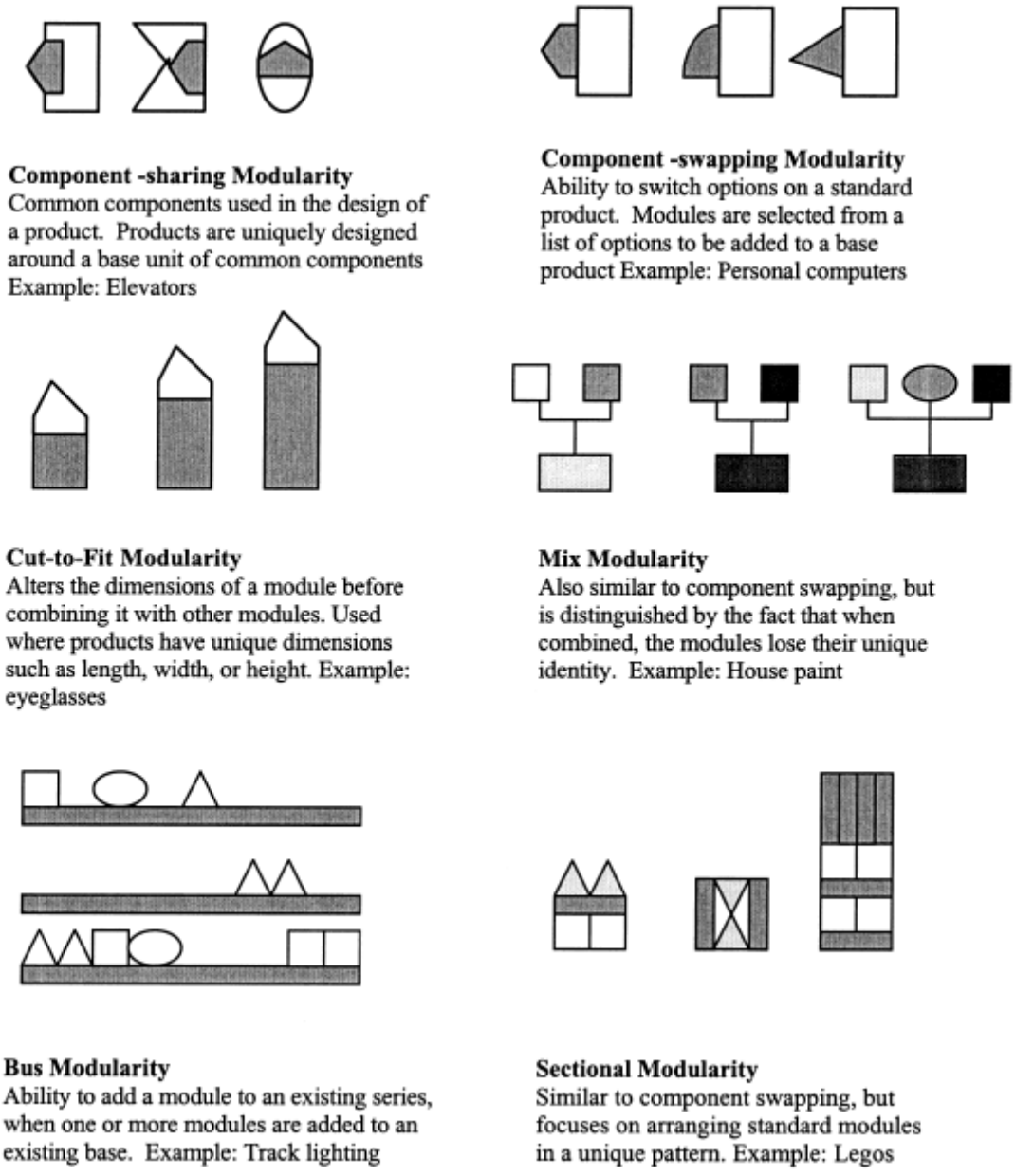

Figure 2.2: Modularity types (Ulrich and Tsung, 1991, in Pine, 1993).

In component-swapping modularity it is possible to switch options on a standard product. Modules are selected from a list of options to be added to a base product, for example personal computers. The key to taking advantage of component-

swapping modularity is to find the most customizable part of the product and separate it into a component that can easily be reintegrated. The separated component should have three characteristics. First, it should provide high value to the consumer, second, it should be easily and seamlessly reintegrated once separated, and third, it should have great variety to meet differing consumer needs and wants. An infinite number of components to be swapped, or variety so great that consumers are unlikely to run across anyone with exactly the same product can lead to true individual customization.

Cut-to-fit modularity is similar to component-sharing and component-swapping modularity, except that one or more of the components is variable. The dimensions of a module can be altered before it is combined with other modules. This type of modularity is used where products have unique dimensions such as length, width or height. Examples are eyeglasses, or clothing. This type of modularity is most useful for products whose consumer value rests greatly on a component that can be continually varied to match individual needs.

Mix-modularity is also similar to component-sharing and component-swapping modularity, but is distinguished by the fact that when combined, the modules lose their unique identity, and as a result they become something different. An example is house paint. When particular colours of paint are mixed together, those components are no longer visible in the end product.

Bus modularity uses a standard structure that can attach a number of different kinds of components. One or more modules are added to an existing base, for example track lighting or the universal serial bus (USB). The bus can be seen as the infrastructure, and is usually hidden. The key of this type of modularity is the existence of a bus, the infrastructure that is really required for each consumer, and modularizing everything else into components that can be plugged into that standard structure.

Sectional modularity is the type of modularity that provides the greatest degree of variety and customization. It is similar to component swapping, but focuses on arranging standard modules in a unique pattern. As long as each component is connected to another at standard interfaces, it allows the configuration of any number of different types of components. An example is Lego, where the number of objects that can be built is not limited by anything. This type of modularity allows the structure or the architecture of the product itself to change and to reuse, which

provides tremendous possibilities for variety and customization. The key to be able to use this type of modularity is to develop an interface that allows sections or objects of different types to interlock.

Modularity also has its drawbacks. Products, which are based on the same encompassing system (often called platforms) may only differ one or a few modules from each other. In this case, customers may indeed have difficulties in distinguishing them (Wolters, 2002).

To measure the type of modularity employed, Duray et al. (2000) also identified two factors. The first factor is modularity through fabrication, and can be considered a measure of modularity in the design or fabrication of a product. Components are original designs, or alterations to standard designs. The modularity types that fit in this classification are component sharing modularity and cut-to-fit modularity (Ulrich and Tung, 1991, in Pine, 1993; Duray et al., 2000). The specific items that support this factor are the following:

- components are designed to consumer specifications;
- components are sized for each application;
- components are altered to consumer specifications;
- component dimensions are changed for each consumer.

The second factor is modularity through standardization. It contains items that address modularity in the form of options to standard products or interchangeability of components. This type of modularity is most likely to be utilized in the assembly stages of a manufacturing process. The modularity types that fit in this classification are component swapping modularity, mix modularity, bus modularity and sectional modularity (Ulrich and Tung, 1991, in Pine, 1993; Duray et al., 2000). The specific items that support this factor are the following:

- products have interchangeable features and options;
- options can be added to a standard product;
- components are shared across products;
- new product features are designed around a standard base unit;
- products are designed around common core technology.

The factors of both point of consumer involvement summarized in section 2.2.2 and type of modularity employed in this section can be combined and classified into four mass customization configurations, see Figure 2.3.

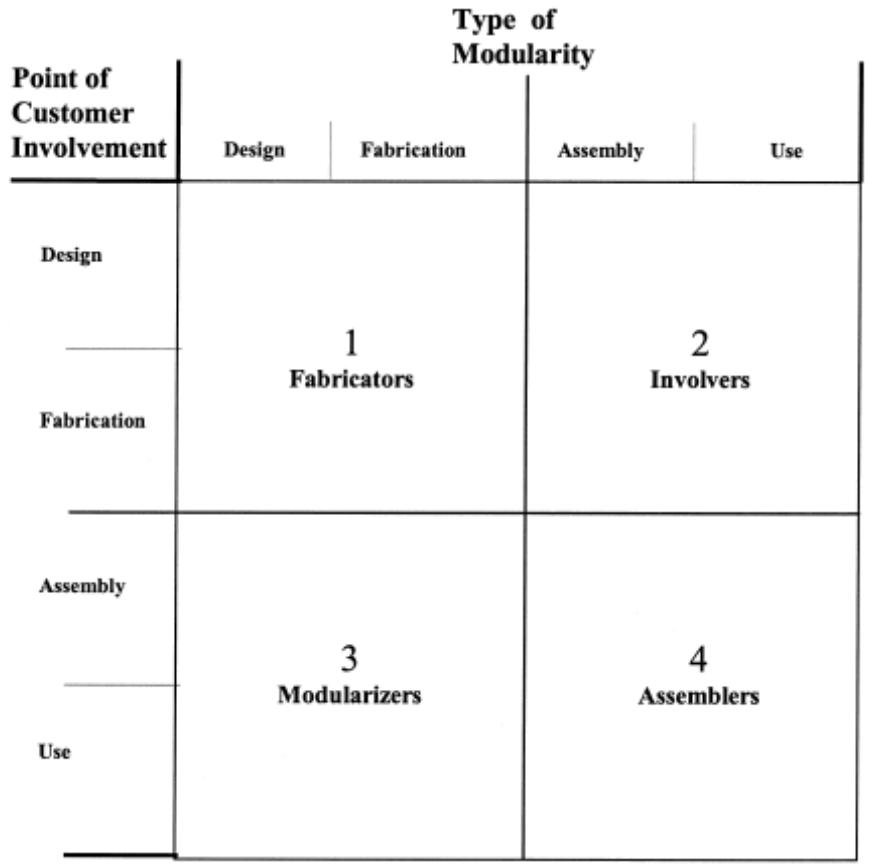

Figure 2.3: Matrix grouping of mass customization configurations (Duray et al., 2000).

When both the point of consumer involvement and the type of modularity occur during the design and fabrication stages in the production cycle, the mass customizer can be classified as a fabricator. Consumers are involved early in the process. They closely resemble a pure customization strategy, but employ modularity to gain commonality of components (Duray et al., 2000). When the point of consumer involvement occurs during the design and fabrication stages, but modularity is used during the assembly and use stages, the mass customizer can be classified as an involver. Consumers are involved early in the process, although no new modules are fabricated for this consumer. Customization is achieved by combining standard modules to meet the specification of the consumer (Duray et al., 2000). When the point of consumer involvement occurs during the assembly and use stages, but

modularity at the design and fabrication stages, the mass customizer can be classified as a modularizer. They use modularity earlier in the process than when the consumer is involved (Duray et al., 2000). When both the point of consumer involvement and modularity occur at the assembly and use stages, the mass customizer can be classified as an assembler. They provide mass customization by using modular components to present a wide range of choices to the consumer. To employ modularity, a varied assortment of products is needed.

2.3 Variety

Consumers rank variety of assortment straight after location and price when naming reasons why they shop at their favourite stores. Consumers care about variety because they are more likely to find what they want when going to a store that offers more varied assortments (Hoch et al., 1999; Helander and Khalid, 2000). Even more important than variety is perceived variety. Optimal consumer assistance during the interaction process considerably decreases the perceived variety, while the actual variety can be very high (Blecker et al., 2006).

Variety is a term that sometimes is confused with customization. Customization and variety are strongly related, but are not the same. Variety provides choice for consumers, but not the ability to specify the product as is the case with customization. When variety is high, it can be a substitute or enabler for customization, but customization and variety are distinct (Duray et al., 2000; Pine et al., 1993). Variety is the tool for mass customization, because it can create the link between the consumer and the product (Svensson and Jensen, 2001).

Digital products were described in paragraph 2.1. The characteristics of digital products, such as versioning and transmutability, can result in an increase in product variations. The fact that digital products take no stocking space, place no limits on a variety maximum. This paragraph addresses variety, first by addressing the value of variety from the perspective of the consumer. Variety also leads to complexity, which is addressed in section 2.3.2.

2.3.1 The value of choice

Variety simply involves more choices from which the consumer is able to choose. Not always does a consumer know with certainty whether he or she will obtain what he or she wants when looking for a product, but the greater the number of items carried by the place the consumer is looking for the product, the greater the expectation that the consumer finds what he needs (Baumol and Ide, 1956; Desmeules, 2002).

A mass customizer should be able to offer a wide range of useful external variety, while maintaining low internal variety (Blecker et al., 2006). External variety refers to the product variations that are perceived by the consumers. The perspective which is chosen for this thesis focuses on the consumer, thus the external variety. Since mass customization aims at fulfilling individual consumer needs, it involves an extensive external variety.

Consumers do not want more choices, they want exactly what they want – when, where and how they want it (Pine et al., 1995). Important drivers that lead to more variety and more mass customization are globalization and market turbulence (Svensson and Jensen, 2001; Santonen, 2003). Markets are becoming increasingly global, and competition from low costs manufacturing countries is getting larger. Products are no longer targeted at one geographic market only, but moreover towards a global market. Product variations therefore must be made possible in order to adapt to different needs and tastes. Through the use of modularization in mass customization, the risk in product development can be reduced as a large number of variants can be launched (Pine, 1993).

Other drivers for more variety are demand, deregulation and the experience economy. Consumers demand and get more variety and options in all kinds of products, which lead to more diversity and niche markets or “long tail” markets (Anderson, 2006). Deregulation has also increased the number of choices; more competition has lead to more variety (Kezunovic et al., 1998). Another driver is the so called experience economy (Pine and Gilmore, 1998). The social experience a consumer gets when buying products leads to more variety, because every experience is experienced in a unique way.

When firms adopt high variety strategies, they fulfil two distinct goals (Kahn, 1998 in Desmeules, 2002). First, more variety makes it more likely for consumers to find exactly the option they were looking for, such as customized products. Second, it allows consumers to enjoy variety over time, so they can discover new products. These strategies enable long-term relationships with consumers and learning consumers' preferences over time (Desmeules, 2002). The process of learning preferences can be influenced by the way product information is presented (Huffman and Kahn, 1998).

Information products, or digital products, are experience goods (Nelson, 1970; Shapiro and Varian, 1999). This means that consumers do not know what it is worth to them until they experience it. There is a relationship between variety and the positiveness of a consumption experience, when the evaluative task is performed by cognition (Desmeules, 2002). This relationship is shown in Figure 2.4.

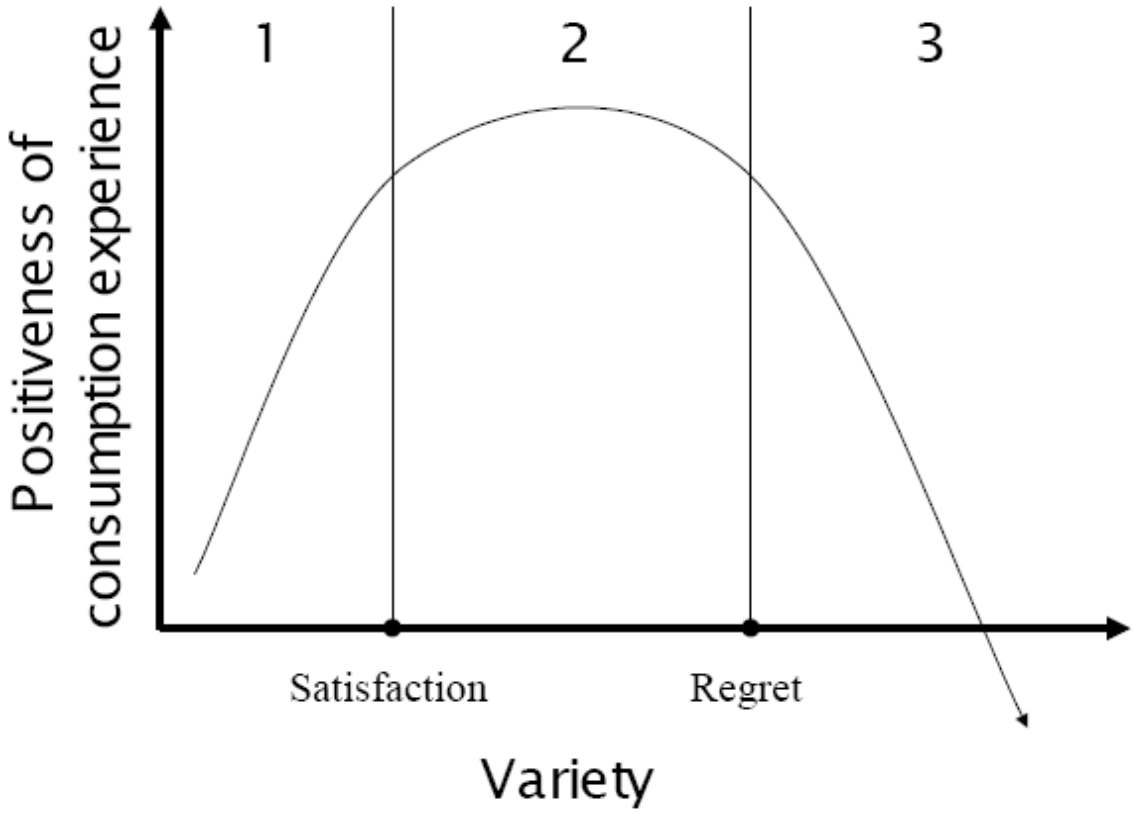

Figure 2.4: Relationship between (perceived) variety and positiveness of consumption experiences when the evaluative task is performed by cognition (Desmeules, 2002).

There are three sections to the curve on the graph. The first, section 1, is an upward sloping portion, followed by a relatively flat line, section 2. Consumer satisfaction increases with increased variety. Adding more options increases the positiveness of the experience because the chances that the consumers find what they want increase. There is a point where the consumer experience is satisfied, called point of satisfaction. This point can be reached with a single option to choose from, or in other cases with multiple options to choose from. As satisfaction is reached, at section 2 in the figure, adding more variety does not influence the positiveness of the consumer experience much. According to Desmeules (2002), this is the optimal amount of perceived variety.

To measure variety, I follow Blecker et al. (2006). Blecker et al. (2006) introduce a key metrics system to control variety induced complexity in mass customization, which is based on three assumptions. The key metrics system is first based on the assumption that the product family is built around platforms and modules. The second assumption is that the interaction process is carried out over the Internet, so that the consumer is involved in the production process. Both assumptions are in line with the mass customization classification of Duray et al. (2000). Third, they assume that the mass customizer has not implemented a cost calculation system that enables one to accurately evaluate the costs triggered by variety induced complexity.

Blecker et al. (2006) revealed that multiple use, interface complexity and platform efficiency are key metrics that directly influence the extent of product variations that can be offered by the mass customizer. In mass customization, products have to be developed around common parts without restricting the range of end product variants required by consumers. Commonality of components or modules can considerably reduce overhead, because it reduces internal variety and thereby variety induced complexity (Blecker et al., 2006). However, the fulfilment of individual needs of the consumer, which requires external variety, is the most important objective of mass customization. To achieve this objective, the supplier has to strive for individualizing products while using only a few modules. The multiple use metric provides a measurement of the number of product variants required by consumers as compared to the total number of modules. The higher the value of this metric, the better since it indicates a higher flexibility of the product assortment (Blecker et al.,

2006). The second metric that directly influences the possible variety, is the complexity of the interface. In order to generate a wide range of product variants by only mixing and matching a few modules, an optimal design of module interfaces is necessary. Interface complexity reduces the extent of product variations, and should in turn be reduced by standardization of interfaces (Blecker et al, 2006). The third factor that directly influences the possible variety is the product platform. A platform is the core module of a product family. Because of this, several product variants based upon a particular platform will be introduced or eliminated during the product lifecycle (Blecker et al., 2006). The complexity of deriving new products on the basis of one platform should be kept as low as possible. Blecker et al. (2006) introduce the average platform cycle time efficiency as a key metric that directly influences the possible variety, which measures the average elapsed time to develop a derivative product in comparison to the elapsed time for the development of a product platform.

2.3.2 Variety and complexity

One limit of mass customization often quoted is that excess variety may result in an external complexity. The burden of choice can lead to an information overload, resulting from a limited capacity of humans to process information (Choo, 1998). As a result, the configuration process may last quite a while, and consumers may experience an increase in uncertainty during the transaction (Piller et al., 2005).

Too much variety can lead to complexity. As shown in Figure 2.4, there is a point where the positiveness of the consumption experience decreases when variety increases (Desmeules, 2002). This point on the inverted U-shaped figure is called the point of regret. This is the point in the amount of variety where variety alone brings about doubt and regret avoidance mechanisms (Desmeules, 2002; Schwartz, 2000). After the point of regret, the positiveness of the consumption experience goes down because of stress and frustration caused by heightened expectations and the inability to make a choice.

There are possibilities to move the point of regret to the right. This does not indicate what the optimal amount of variety should be, but there are techniques to increase the amount of variety before the point of regret is reached. Presenting information by attributes rather than by alternative increases consumer satisfaction,

and also enables the consumer to be more ready to make a choice (Huffman and Kahn, 1998). As variety is high, consumers should be explicitly asked about their preferences rather then just listing all available options (Huffman and Kahn, 1998). Variety alone is not enough when the amount of variety exceeds a point where the positiveness of the consumption experience decreases. Since the positiveness of the consumer experience depends on the perceived variety, it remains possible for the consumer to experience the consumption in a positive way. This consumption experience can be influenced by how the information about the product class is presented (Huffman and Kahn, 1998). When variety is low, the positiveness of the consumers' experience can be maximized just by offering the products by alternative. Presentation by alternative is preferred when assortments are small. However, in complex situations, the consumer can benefit from learning his or preferences first (Huffman and Kahn, 1998; Louviere et al., 1999, Kurniawan, 2006). Huffman and Kahn (1998) also found that satisfaction levels for consumers can be higher when they are asked to explicitly state their within-attribute preferences. In order for consumers to process a complex, high variety choice set, the consumption experience should not be frustrating.

Kurniawan et al. (2006) conducted a study on differences between product configuration and product selection, in terms of consumers' decision quality. Their results show that product configuration offers consumers greater satisfaction during the process and in the products of their choices than product selection does. These results are comparable with the results of Huffman and Kahn (1998). One aspect on decision quality with product selection is product accuracy. Product accuracy is the closeness between preferred product and the product that is actually bought or selected.

Dellaert and Stremersch (2004) addressed consumer preferences for mass customization. They mention ways in how mass customization configurations may differ, which have influence on the perceived complexity of mass customization configurations. One of them is about the company presenting a default version which consumers may then customize, or the firm may not show a default version and let consumers start from scratch in composing the product. Their results show that firms should offer a default version that consumers can use as a starting point for mass customization, which minimizes the complexity for consumers. This default version

should not be too advanced, because consumers are more willing to switch up than they are willing to switch down.

Consumer expertise also influences the perceived complexity (Dellaert and Stremersch, 2004; Franke and Piller, 2003; Huffman and Kahn, 1998; Piller et al., 2005). Consumers with high product expertise experience lower complexity when participating in mass customization than consumers with low product expertise. They are also more able to analyze information and to select that information which is most important and task relevant.

When consumers are involved early in the mass customization process, the consumer interacts with the mass customizer. The interaction process, or interaction sub-process (Blecker et al., 2006), can be supported by interaction systems to guide the consumer through the interaction process. It is difficult or even impossible to know what consumers want at the beginning of the interaction process (Franke and Piller, 2003). Therefore it is strongly recommended to implement immediate feedback tools for mass customization toolkits (Von Hippel, 2001; Franke and Piller, 2003). The main problem with these interaction systems is that configuring a product can become quite difficult, frustrating, and time consuming for the customer (Stegmann et al., 2006). To overcome these difficulties, Stegmann et al. (2006) propose two methods of consumer support. The first is automatically generated product and component recommendations, which depends directly on the quality of available customer information (Balabanovic and Shoham, 1997; Resnick and Varian, 1997). The second is direct recommendations among consumers.

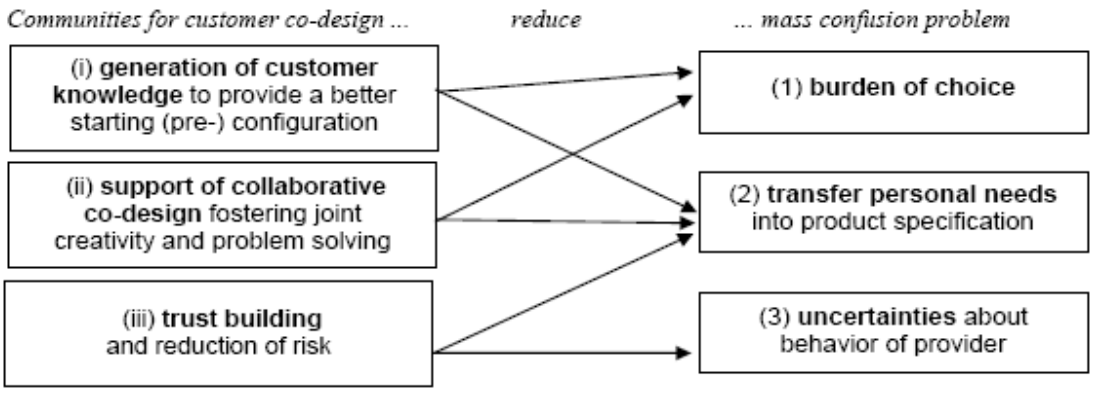

Figure 2.5: Contributions of communities for co-design to reduce mass confusion problems (Piller et al., 2005).

Offering customized products requires an individual, or one-to-one, relationship between the consumer and the supplier. Besides the external complexity and the lack of consumer knowledge, Piller et al. (2005) identified another problem category. This third limit of mass customization is the information gap regarding the behaviour of the supplier. For many consumers, customizing a product is still an unfamiliar process, and can be compared with the principal-agent problem. Asymmetric information distribution as well as deviations between the goals of the principal, or the consumer, and the agent, or the supplier, which cause the latter to behave in an opportunistic manner (Wigand et al., 1997). This behaviour incurs costs for the consumer. For digital products this is a serious problem, because these products are experience goods.

The above uncertainties can be dealt with by collaborative consumer co-design in online communities (Piller et al., 2005). Communities for consumer co-design offer three contributions to reduce mass confusion problems (Piller et al., 2005). The first is the generation of consumer knowledge. Consumer knowledge reduces the burden of choice and transfers personal needs into product specification, as is visualized in Figure 2.5. Offering users a starting solution based on the profile of the consumer increases the personalization of the co-design process, and increases the customization possibilities. Lacking a proper consumer profile leads to ineffectiveness of the co-design process (de Vries, 2003). The second is the provision of support for interactive, collaborative filtering where consumers directly interact on the co-design platform. Consumers may mutually support each other in finding a solution which best fits their needs (Piller et al., 2005). This second contribution reduces mass confusion in the same way as the first. The third contribution is trust building and the reduction of risk. It reduces mass confusion by transferring personal needs into product specification and reduces uncertainty about the behaviour of the provider.

Blecker et al. (2006) identified key metrics that can be used during the interaction process to measure the average interaction length of time, and the abortion rate, which could give some answers on the questions raised by Franke and Piller (2003). The interaction system is the primary instrument for reducing the consumer's costs arising from a principal-agent constellation that is inevitable in mass customization (Franke and Piller, 2003). Because of extensive product assortments in mass customization, consumers may experience high complexity during the web-

based configuration process. A high range of product variety is relevant for the fulfilment of different consumer needs, but the experienced complexity that comes with it is something that has to be reduced. To determine the optimal level of variety from the consumers' perspective, the key metric 'used variety' was introduced (Piller, 2002, in Blecker et al., 2006), see Figure 2.6. The used variety metric compares the variety that is actually perceived by consumers to the theoretically possible product variants. Low values of this metric indicate that a large number of product variants are unperceived or uninteresting for consumers. To measure the perceived complexity due to variety, Blecker et al. (2006) proposes two key metrics. The first is the average interaction length of time, which measures how much time consumers need on average to completely configure a product variant. The second key metric is the abortion rate. If consumers are uncertain about their choices or are overwhelmed by the interaction process, it is more likely that the consumer will abort from the interaction process.

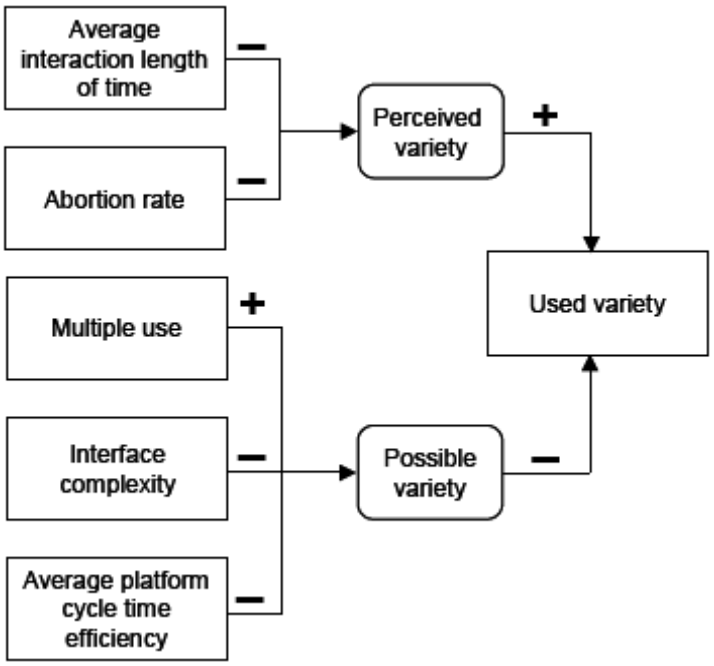

Figure 2.6: First part of the key metrics system (Blecker et al., 2006).

This section addressed some methods to overcome variety induced complexity from the consumers' perspective. These methods should be used in a way to move the point of regret of the inverted U-curve (Desmeules, 2002) to the right.

2.4 Hypotheses

This paragraph presents the hypotheses of this thesis. If these hypotheses can be supported with the empirical research, they can be used to answer the overall research question.

Overall research question: How to support customization and personalization for pure digital products in the Internet economy to dramatically decrease complexity and search costs for consumers, so variety can be maximized?

The literature review revealed that digital products are very well suited to be customized (Choi et al., 1997; Shapiro and Varian, 1999). The literature review also showed that digital products as well as consumer demand leads to more variety when compared to physical products (Choi et al., 1997; Shapiro and Varian, 1999; Evans and Wurster, 2000). The Internet makes versioning, personalization and bundling even easier. Various digital products can be personalized by versioning and bundling, and can be delivered on demand by direct interaction of the consumer with the supplier. Digital products allows for some interesting twist on bundling, which is called customized bundling (Shapiro and Varian, 1999). This bundling can be compared with modularization to some extent. Different products, or modules, can be bundled together while interacting with the supplier. Because consumer preferences differ, an increase in variety would make more variations in bundling possible.

Variety is a tool for customization, because it can create a link between the consumer and the product (Svensson and Jensen, 2001). Also, demand turbulence is increasing the level of customization in the case of digital information products (Santonen, 2003). Because of these arguments, I assume that that an increase in product variety would make more combinations of bundles possible, which leads to the following hypothesis:

H1: The larger the product variety, the higher the level of customization.

Thus, more variety should make it easier for the supplier to enable the consumer to customize digital products. Following the definition of customization for

this research, it means that an increase in variety should increase supplier-consumer interaction at the design stage of the operations level to create customized digital products delivered over the Internet.

As the arguments above lead to H1, these arguments also mention that an increase in customized versions leads to more personalized products. As more customized or personalized digital products are created by the consumers, it is possible to make more different bundles which can in turn increase variety. Consumers generally prefer more variety when given a choice (Kahn and Lehmann, 1991), and they tend to use the supplier with the largest variety (Loebbecke, 1999) Permutations of choice options quickly reach an immense number of possible products (Franke and Piller, 2003; Choi et al., 1997). If digital products have standardized interfaces, which are loosely coupled and have a clear relationship, they can form a modular system (Wolters, 2002). As the type of modularity employed is a characteristic of the customization classification, it can lead to more variety. This leads to the following hypothesis:

H2: The higher the level of customization, the larger the possible variety.

The two hypotheses above are mutually reinforcing. If the above hypotheses can be proven valid, pure customization will be reached when variety can be maximized. When the possible variety is high, it is possible for more consumers to find what they are looking for, which is positively associated with consumer surplus (Brynjolfsson, 2003; Hoch et al., 1999; Baumol and Ide, 1956; Desmeules, 2002). However, an increase in variety does not necessarily mean an achievement of more consumer surplus. It is the goal of this research to make an addition to existing theory about consumer surplus in the Internet economy, and in particular the contribution of customization of digital products.

The literature on variety induced complexity unveiled the drawbacks of variety. Abundance in variety can result in doubt and regret avoidance mechanisms (Desmeules, 2002). In going to some particular store the consumer incurs some costs (Baumol and Ide, 1956; Helander and Khalid, 2000). The difficulty of shopping increases with the number of items that are offered. Prices change with varying

frequency in all markets, and no one will know all the prices which various sellers quote at any given time (Stigler, 1961).

Abundance in variety can result in supply overload, and in combination with low transaction costs can lead to excessive volumes of information generating complexity (Schwartz, 2000; 2004; Desmeules, 2002, Piller et al., 2005, Huffman and Kahn, 1998). This abundance makes it harder for consumers to find or discover the right digital products, which increases search costs. Search costs are accepted by the consumer if they lead to savings greater than the search costs (Baumol and Ide, 1956; Stigler, 1961). These costs need not to be equal for all consumers because of differences in tastes and costs of time can differ (Stigler, 1961). Like transaction costs, search costs in the Internet economy are lower than they are in physical economies, but an excessive increase in variety in general, and an increase in complexity in particular makes it more difficult for consumers to find all relevant information or, as Shapiro and Varian (1998) put it, the best information. The drawbacks of variety from the perspective of the consumer can be summarized as complexity for the consumer, and also as extra costs for the consumer. The reasoning above leads to the following composite hypotheses:

H3.1: The larger the variety, the larger the complexity.
H3.2: The larger the complexity, the higher the search costs.

The above hypotheses show that digital products and the Internet economy lead to customization and variety, and also that variety in the form of complexity can lead to more costs for the consumer, while minimization of search costs positively influences consumer surplus (Choi et al., 1997; Shapiro and Varian, 1999). If the hypotheses H3.1 and H3.2 can be supported, increase in variety will lead to higher search costs. At the same time, the Internet economy has already led to lower search costs compared to the physical economy. This implies that the advantages of the Internet economy must outweigh the disadvantages of the increase in variety to obtain consumer surplus.

In most literature search costs are being defined as costs to get the best deal possible to obtain a specific product (Choi et al., 1997; Shapiro and Varian, 1999; Keeney, 1999). Information filtering becomes increasingly critical as consumers are

faced with an overload of information (Choi et al., 1997; Blecker et al., 2006; Loebbecke, 1999). When variety is maximized, search costs also play a role in locating or discovering unknown products within a single supplier. Finding products where consumers are unaware of, improves consumer surplus, and also the perception of variety is important (Brynjolfsson, 2003; Blecker et al., 2006; Desmeules, 2002). Product awareness thus lowers search costs. Because in general, firms know more about their products than the consumers do (Choi et al., 1997; Wigand et al., 1997), making consumers aware of products can be part of the customization strategy of a digital content supplier.

Consumers experience difficulties during the product selection process because of the perceived complexity, but not necessarily because of the actual complexity or variety. Optimal consumer assistance during the interaction process considerably decreases the perceived complexity, while the actual variety can be very high and is therefore independent from the perceived variety (Huffman and Kahn, 1998). The literature review on variety and complexity uncovered some strategies or methods the supplier can use to reduce the variety induced complexity from the perspective of the consumer (Kurniawan et al., 2006; Piller et al., 2005; Dellaert and Stremersch, 2004; Blecker et al., 2006; Huffman and Kahn, 1998). For this research, these strategies or methods should be applied during the supplier-consumer interaction, or during customer involvement which is one method to classify a mass customizer (Duray et al., 2000). This leads to the final and probably most important hypothesis of this research:

H4: The higher the level of customization, the lower the search costs.

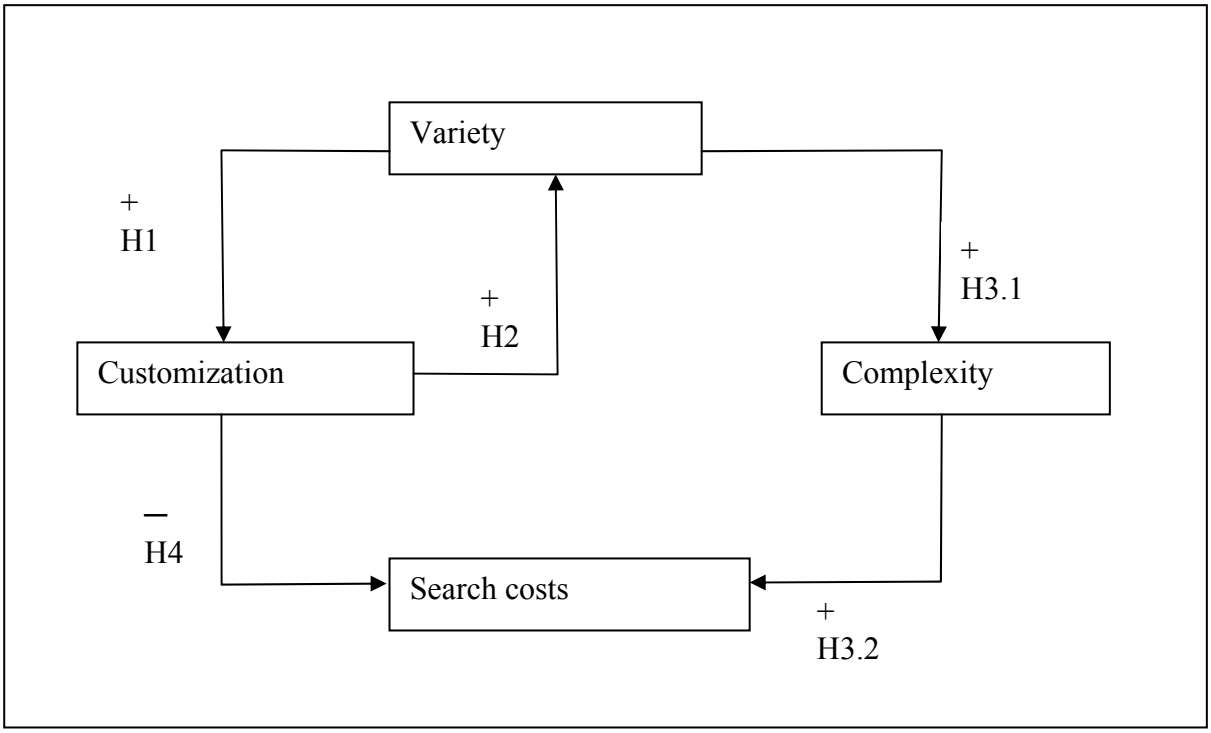

Figure 2.7: Research framework.

From the above hypotheses and the research framework visualized in Figure 2.7, it can be concluded that variety influences search costs both positively and negatively, that is, if the hypotheses can be supported. Therefore the importance of customization becomes extremely important. To allow for variety to be maximized, it is important to arrange customization in such a way that it first will abolish the negative influence of variety induced complexity, and second, supports consumer surplus by making use of the maximum increase in variety. Consumer surplus due to increased product availability is seven to ten times larger compared to lower prices due to increased market efficiency (Brynjolfsson et al., 2003).

Chapter 3

Research methodology

Chapter 2 identified four hypotheses based on the literature review. In this chapter I outline the research methodology. An introduction to the methodology was provided in section 1.4 of Chapter 1; this chapter aims to build on that introduction and to provide assurance that appropriate procedures were followed. I followed Yin (2003) and Myers (1997) to come to a strategy for conducting this research. This part of the research influences how to collect relevant material and how to process this material in order to answer the main research question. The chapter defines the scope and limitations of the research design, and situates the research amongst existing research traditions in information systems.

This chapter is divided into five sections. In the first, the epistemological stance in the field of information systems is examined and justified. The second section is about the research strategy. It describes why the followed research approach is the case study research. Section three deals with the research design, it presents the unit of analysis, it covers the site selection criteria, it describes the data sources that where used, how the data was collected and how the data was analyzed. It is presented in such a way that other researchers can replicate this research (Yin, 2003). Section three ends with the instrumentation for the research analysis and an overview of the research protocol and case study database. Then in section 3.4, the research design is

evaluated. To end this chapter, I will give a brief summary of the choices made for this research in section 3.5.

3.1 Epistemological orientation

Qualitative research can be classified in terms of three underlying assumptions about what constitutes 'valid' research and which research methods are appropriate (Orlikowski and Baroudi, 1991; Myers, 1997): positivist, interpretive and critical. The epistemological orientation of the study should be made explicit to inform the reader about how to review the paper (Gummesson, 1991; Walsham, 1995).

Positivist studies generally attempt to test theory, in an attempt to increase the predictive understanding of phenomena (Myers, 1997). An information system research project can be considered positivist if there is evidence of formal propositions, quantifiable measures of variables, hypothesis testing, and deducing the inferences concerning the phenomena from the representative sample to a stated population (Orlikowski and Baroudi, 1991). Positivists belief that the world conforms to laws of causation, which could be objectively tested (de Vries, 2004).

Interpretive studies generally attempt to understand phenomena through the meanings that people assign to them (Myers, 1997). The epistemological stance on interpretive approaches is that knowledge of reality is gained only through social construction such as language, shared meanings, tools, documents etc. (Walsham, 1993). In an interpretive research project there are no predefined dependent and independent variables, but a focus on the complexity of human sense-making as the situation emerges (Kaplan and Maxwell, 1994). The interpretive approach is inductive and concerned with discovering and interpreting social patterns (Orlikowski and Baroudi, 1991).

Critical research focuses on the oppositions, conflicts and contradictions in contemporary society (Myers, 1997). Information Systems (IS) research may be categorised as critical if its main task is seen as being one of social critique, whereby the restrictive and alienating conditions of the status quo are brought to light (Klein and Myers, 1999). Critical theorists assume that people can consciously act to change their social and economic conditions. They also assume that social reality is historically constituted and that it is produced and reproduced by people.

My orientation of this research will be positivistic, because I will test theory by testing the formulated hypotheses. Important criteria in qualitative case study research are to describe whether the research is exploratory or explanatory, or a hybrid of the two. The number of cases has to be clear, the site selection criteria has to be articulated, the unit of analysis has to be stated, the data sources has to be made clear, and finally it has to be clear whether triangulation is used or not and what type of triangulation (Klein and Myers, 1999). De Vries (2004) added two criteria, which are to be explicit about the data analysis techniques and about the epistemological orientation.

3.2 Research strategy

Taking the main research question into account, I have to answer a 'how' question and I have to provide insight into a decision-making process. This implies to conduct deep research instead of broad. It also implies qualitative research, because I think it is not possible to do calculations with gathered data, but it would be possible to compare results with theory. Qualitative data sources include observation and participant observation (fieldwork), interviews and questionnaires, documents and texts, and the researcher's impressions and reactions (Myers, 1997). Quantitative methods include survey methods, laboratory experiments, formal methods (e.g. econometrics) and numerical methods such as mathematical modelling (Myers, 1997). The third decision is more difficult to make. I would like to make an addition to existing theory of Brynjolfsson et al. (2003), so that means existing literature is an important foundation. However, to answer the 'how' question, I have to evaluate practice situations, or maybe followed strategies. As a result, this research is a combination of empirical and desktop research.

In this thesis I already started with a desktop research in Chapter 2, which resulted in the overall research question and four hypotheses. The overall research question is a 'how' question. This means the strategy I have to choose is an experiment, history or a case study (Yin, 2003, p. 5). The next criteria to test are if it is needed to control behavioural events and if it is needed to focus on contemporary events. The first criteria cannot be confirmed, and the second can, which leaves the case study as the strategy to use. A case study examines a phenomenon in its natural

setting, employing multiple methods of data collection to gather information from one or a few entities (Benbasat et al., 1987).

Yin (2003) identified three types of case studies, exploratory, explanatory, and descriptive. An exploratory research design tries to precisely define the research question and form hypotheses. In an exploratory case study, the collection of data occurs before theories or specific research questions are formulated. Descriptive research design goes a bit further and tries to describe different characteristics of a phenomenon. The descriptive case study will require a theory to guide the collection of data. The explanatory research design can be used when the research field has matured. This design tries to explain course of events and relate how things happened. This thesis can be seen as a combination of exploratory and explanatory. According to Yin (2003), this is an explanatory research because it tries to answer a 'how' question. However, because existing literature about customization of digital products is scarce, this research can be classified as exploratory.

3.3 Research design

In the most elementary sense, the research design is the logical sequence that connects the empirical data to a study's initial research questions and, ultimately, to its conclusions (Yin, 2003). It can also be seen as a blueprint, chain of evidence, or logical model of proof. It needs to maximize construct validity, internal validity, external validity and reliability.

In this research design, I present the methodological issues of the thesis. It presents the unit of analysis, it covers the reasons for selecting organizations, it describes the data sources that where used, how the data was collected and how the data was analyzed. It is presented in such a way that other researchers can replicate this research (Yin, 2003).

3.3.1 Unit of analysis

For a case study it is important to define the case, in terms of what the case is, and where the case leaves off (Miles and Huberman, 1994; Yin, 2003). This is a

problem for many researchers in case studies. The more a study contains specific propositions, the more it will stay within feasible limits, and also the context has to be clear (Yin, 2003).

This case study is multiple and holistic (Yin, 2003). I have conducted interviews within two different organisations. Case studies can be single or multiple-case designs, where a multiple design must follow a replication rather than sampling logic. When no other cases are available for replication, the researcher is limited to single-case designs. One of the rationales to justify a single case study is if theory has specified a clear set of testable propositions (Yin, 2003), which is the case in this research. To test the propositions I made use of the customization characteristics identified in the literature study. Also theory has to specify the circumstances within which the propositions are believed to be true (Yin, 2003). This is also the case in this research, because it focuses on online delivered content as the unit of analysis. During this research, I had the opportunity to conduct multiple case studies. Multiple case studies are preferred, because they can be more robust than a single case study and, depending on the results, can strengthen the external validity (Yin, 2003).

Single case- and multiple case studies can further be classified as holistic or embedded. In an embedded case study, the case is split in multiple units of analysis, while a holistic case study has one unit of analysis for each case. The unit of analysis of each case is that part of the company that is relevant to answer the main research question, also called logical subunits (Yin, 2003). When no logical subunits can be identified, the holistic design is advantageous. When this unit of analysis changes during the study, the researcher can be forced to start over. When conducting an embedded case study, the researcher has the pitfall to focus too much on a single unit, and fails to return to the larger unit of analysis.

3.3.2 Site selection criteria

During this thesis it was not possible to collect data from many sources. The sites to study should be appropriate and accessible. There are simply not many sources available where digital products are being customized over the Internet, which is a requisite to answer the main research question and the hypotheses that where identified during the literature review. The site to study should also be a location

where entry or access to the sources should be available, and the appropriate people should likely be available (Berg, 2004). The logic of using samples is to make inferences about some larger population from a smaller one, which is the sample (Berg, 2004).

There are various sampling principles to select the sites to study, such as maximum variation sampling, critical case sampling, snowball sampling, purposive sampling or convenience sampling (Miles and Huberman, 1994; Berg, 2004). Sampling involves decisions about which people to observe or interview. Maximum variation sampling, for example, involves looking for outliers to see whether main patterns still hold. Qualitative samples tend to be purposive rather than random, which is very important with small numbers of cases (Miles and Huberman, 1994). Two actions are involved when sampling in qualitative research. First, the boundaries have to be set to define aspects of the cases that can be studied within the limits of the available time and means, that connects directly to the research questions and that probably will include samples of what needs to be studied. Second, a sampling frame needs to be created to help to uncover, confirm or qualify the basic processes or constructs of the study (Miles and Huberman, 1994).

During this research I made use of the principle of multiple-case sampling. Multiple case sampling adds confidence to findings. This approach connects directly to the overall research question, adding confidence on the 'how' research question. The overall research question:

> *How to support customization and personalization for pure digital products in the Internet economy to dramatically decrease complexity and search costs for consumers, so variety can be maximized?*

When using this kind of sampling, an explicit sampling frame is needed (Miles and Huberman, 1994). The sampling frame was created by identifying suppliers that offer online digital products on the Internet, that can be customized, preferably have a large variety, and it should be easy for consumers to find the digital products they would like. Organizations that offer digital products where variety is high, and offer these products online are scarce; in particular companies that offer possibilities to customize their products. Nowadays, digital products in the form of

music seem to qualify for these criteria. The two most popular organizations that offer customized music are Last.fm and Pandora Media. Both organizations agreed to be part of this research. These two sites offer digital products in the form of streaming music on the Internet. Another company who offers digital products in the form of music is Mercora, but they did not agree to participate.

3.3.3 Data collection

Yin (2003) identifies six sources of evidence that can be collected during case studies, each having their strengths and weaknesses. The first is documentation, which is stable because it can be reviewed repeatedly, it is unobtrusive, it is exact and it has a broad coverage. However, it can also be difficult to retrieve, the selection and reporting can be biased, and the access can deliberately be blocked. The second is archival records, which is the same as documentation, but in addition it also has the advantage of being precise and quantitative, and the disadvantage of being difficult to access due to privacy reasons. The third is interviews. Interviews are targeted and insightful, but also have disadvantages because they can be biased due to poorly constructed questions or poor responses, and they can be inaccurate due to poor recall. The fourth are direct observations which have the advantage of being real-time and contextual, but they can be time consuming, selective, the observed event may react different due to the observation, and is time consuming. The fifth is participant-observation which has the same characteristics as direct observations. They have an extra advantage as being insightful into interpersonal behaviour and an extra disadvantage of the possibility being biased due to manipulation. The sixth and last source of evidence is physical artefacts. They are insightful into cultural features and technical operations; however, selectivity and availability are disadvantages.

When conducting a case study, three principles of data collection can maximize the benefits of the above six sources of evidence (Yin, 2003). The first is to use multiple sources of evidence, which, if done properly, enables data triangulation. It also helps to avoid tunnel vision (Verschuren, 2003). The second principle is to create a case study database. Yin (2003) recommends keeping the data or evidence and reports separated. The last principle is to maintain a chain of evidence, which increases the reliability of the information.

There are many possible sources of evidence to identify, for example documentation and archival records in the form of existing reports. Another source of evidence that was used was by means of interviews. The semi structured interview was used, because the topics are clear and some questions can be predetermined, but it leaves space for probing beyond given answers (Berg, 2004). The interviews were recorded, transcribed and reviewed by the interviewees. The remaining sources of evidence, which are direct observations, participant-observation, and physical artefacts, were not used.

3.3.4 Data analysis

Data analysis in qualitative research can be defined as consisting of three concurrent flows of action: data reduction, data display, and conclusions and verification. These flows are present in parallel during and after the collection of data (Miles and Huberman, 1994). Data reduction refers to the process of selecting, focusing, simplifying, abstracting and transforming the collected data. It needs to be reduced in order to make the data more readily accessible and understandable (Berg, 2004; Kvale, 1996). Data display is intended to organize the collected data in such a way that it permits conclusion drawing (Miles and Huberman, 1994; Berg, 2004). The third component of the data analysis process is conclusion drawing and verification. During the collection of data, there should not be made any definitive conclusions, and these preliminary conclusions should be verified during the process (Miles and Huberman, 1994).

Linking data to propositions can be done in a number of ways, for example the technique of pattern matching, whereby several pieces of the same case may be related to some theoretical proposition (Yin, 2003). Other strategies are explanation building, time-series analysis, logic models, and cross-case synthesis. Every case study should strive to have a general analytic strategy, defining priorities for what to analyze and why. Examples of such general strategies are relying on theoretical propositions, thinking about rival explanations, and developing a case description (Yin, 2003).

The general analytic strategy that I used for data analysis is the technique of relying on theoretical propositions. The four hypotheses that followed from reviewed literature and the overall research question, led to this case study. To develop internal

validity and external validity, I followed the specific analytical technique of pattern matching (Yin, 2003). When all collected data is available in textual format, data can be methodologically analyzed (Miles and Huberman, 1994). In pattern matching, or pattern coding, an empirically based pattern is compared with a predicted or proposed one. Pattern coding has four important functions (Miles and Huberman, 1994). First, it reduces large amounts of data into a smaller number of analytical units. Second, it gets the researcher into analysis during data collection, so that later fieldwork can be more focused. Third, it helps the researcher elaborate a cognitive map for understanding interactions. Fourth, it lays the groundwork for cross-case analysis by surfacing common themes.

The above strategy was used as a strategy during the case study. One of the data sources, and also the most dominant, existed of transcribed interviews, as I conducted three interviews within the two companies during this research. Kvale (1996) differentiates between five main approaches to analyze interviews. These are meaning condensation, meaning categorization, meaning structuring through narratives, meaning interpretation, and ad hoc meaning generation. During this research I used a combination of the meaning condensation approach and the meaning categorization approach. Meaning condensation entails an abridgement of the meaning expressed by the interviewees into shorter formulations. Long statements are compressed into briefer statements in which the main sense of what is being said is rephrased in a few words. Meaning condensation thus involves a reduction of large interview texts into briefer more succinct formulations (Kvale, 1996). Meaning categorization implies that the interview is coded into categories. Long statements are reduced to predefined categories, and can reduce and structure a large text into a few tables and figures (Kvale, 1996).

3.3.5 Instrumentation

This paragraph summarizes the instrumentation which is used for this research. All measures are based on the review of the literature in Chapter 2.

Mass customization classification

To classify the mass customizer in terms of consumer involvement in the design process and product modularity, I follow Duray et al. (2000). They developed an instrument to classify mass customizers, with established scales to enhance validity, reliability and generalizability of measures.

According to Duray et al. (2000), consumer involvement can be scaled into two factors. The first factor is consumer involvement in the design and fabrication stages, and is considered as a high degree of customization. The second factor is consumer involvement in the assembly and use stages, and is considered as a low degree of customization. To measure the type of modularity employed, Duray et al. (2000) also identified two factors. The first factor is modularity through fabrication, and can be considered a measure of modularity in the design or fabrication of a product. The second factor is modularity through standardization. It contains items that address modularity in the form of options to standard products or interchangeability of components.

To operationalize the concept of point of customer involvement, the earliest point of involvement classifies the company. Once a customer is involved in the process, involvement carries throughout the whole production cycle. If a customer's initial point of involvement is in the design stage of the production cycle, the customer's preferences would be incorporated throughout the remaining stages of fabrication, assembly and use (Duray et al., 2000). The same is the case for the type of modularity employed. Once each company has been assigned one value for each of the variables, customer involvement and modularity, the classification process is simplified. Table 3.1 shows the identification of mass customizers.

Group	Modularity		Customer involvement	
	Design / fabrication	Assembly / use	Design / fabrication	Assembly / use
1. Fabricators	+	±	+	±
2. Involvers	-	+	+	±
3. Modularizers	+	±	-	+
4. Assemblers	-	+	-	+

Table 3.1: Classification of the mass customization configuration.

Possible variety

To measure variety, I follow Blecker et al. (2006) who propose a key metrics based approach to control variety induced complexity in mass customization. Blecker et al. (2006) revealed that multiple use, interface complexity and platform efficiency are key metrics that directly influence the extent of product variations that can be offered by the mass customizer. The multiple use metric provides a measurement of the number of product variant required by consumers as compared to the total number of modules (Ericsson and Erixon, 1999 in Blecker et al., 2006).

Possible variety	*Authors*
Multiple use	Blecker et al., 2006
Interface complexity	Blecker et al., 2006
Platform efficiency	Blecker et al., 2006

Table 3.2: Possible variety metrics.

Complexity and search costs

The literature review revealed that measuring complexity is not easy, because it is very subjective, and depends on how the consumption experience is experienced (Desmeules, 2002). To evaluate the extent of perceived complexity, I follow Blecker et al. (2006), who proposes two metrics. The first metric measures the average interaction length of time, in other words, how much time consumers need to on average to completely configure a product variant. The second key metric refers to the abortion rate. If consumers are uncertain about their choices or overwhelmed by the interaction process, it is more likely that they give up configuration and leave the website of the mass customizer.

Perceived complexity	*Authors*
Average interaction length of time	Blecker et al., 2006; Kurniawan et al., 2006
Abortion rate	Blecker et al., 2006

Table 3.3: Perceived complexity metrics.

To answer the main research question, I will have to be able to identify if search costs are dramatically reduced for consumers. These identified measures are primarily taken from Kurniawan et al. (2006), who did a study about decision quality with product selection.

Search costs	*Authors*
Number of alternatives searched	Kurniawan et al., 2006
Product accuracy	Kurniawan et al., 2006
Search agents	Helander and Khalid, 2000

Table 3.4: Search costs metrics.

To identify methods or strategies that the mass customizer uses to reduce the perceived complexity and search costs, I will use the following metrics:

Reduce perceived complexity (customization)	*Authors*
Attribute vs. alternative	Huffman and Kahn, 1998
Default version	Dellaert and Stremersch, 2004
Consumer expertise	Dellaert and Stremersch, 2004; Piller et al., 2005; Huffman and Kahn, 1998
Automatic recommendation	Stegmann et al., 2006
Direct recommendation	Stegmann et al., 2006
Trust building	Piller et al., 2005
Collaborative co-design	Piller et al., 2005

Table 3.5: Reduce perceived complexity, or customization metrics.

3.3.6 Case study protocol and case study database

The case studies are conducted following a protocol containing the following.

- Procedures to introduce the case to the interviewees;
- Procedures to start and finish a case study;
- Procedures for conducting interviews including initial questions;
- Procedures for data recording in the case study database.

For every case, a case study database is constructed with the following structure.

- Introducing e-mails to the interviewees;
- Recorded interviews;
- Literal transcription of the interviews;
- Downloaded documents from the companies' websites;
- Earlier interviews found on the Internet.

3.4 Evaluation of the research design

Four tests have been commonly used to assess the quality of any empirical social research such as case studies (Yin, 2003). Table 3.6 lists the four widely used tests and the recommended case study tactics, as well as the cross-reference to the phase of research when the tactic occurs.

Tests	*Case study tactic*	*Phase of research in which tactic occurs*
Construct validity	- Use multiple sources of evidence; - Establish chain of evidence; - Have key informants review draft case study report.	- Interviews, documentation; - Case study protocol (3.3.5); - Case study protocol (3.3.5).
Internal validity	- Do pattern matching; - Do explanation building; - Address rival explanations; - Use logic models.	- Applied; - Not applied; - Not applied; - Not applied.
External validity	- Use replication logic in multiple case-studies.	- Both case studies were conducted in the same manner.
Reliability	- Use case study protocol; - Develop case study database.	- Case study protocol (3.3.5); - Case study database (3.3.5);

Table 3.6: Case study tactics for Four Design Tests (Yin, 2003).

3.5 Summary

This chapter outlined the research methodology. Table 3.7 summarizes the most important decisions made for this research.

Level of decision	*Choice*
Epistemological orientation	Positivist
Type of research	Hybrid of exploratory and explanatory
Research strategy	Multiple case studies
Data collection	Documentation, archival records, interviews
Data analysis	Pattern matching
Selected sites	Last.fm, Pandora Media
Unit of analysis	Online digital content (music)

Table 3.7: Summary of the research methodology.

Chapter 4

Analysis of data

Chapter 3 outlined the research methodology, and described the choices that were made for this thesis. In this chapter the analysis of the collected case study data is analyzed and reported with respect to the main research question and the constructed hypotheses as well as the instrumentation which was developed in Chapter 3. Therefore I present the case studies conducted at Last.fm and Pandora Media. Both Last.fm and Pandora Media are online personalized radio stations, both offering a large variety of digital products in the form of music, but use different customization strategies. The primary sources of data which are analyzed are three interviews. One interview with one of the co-founders of Last.fm, one with the marketing manager of Pandora Media, and one with the founder and now Chief Strategy Officer of Pandora Media.

The first section of this chapter explains how the two case studies are presented. This introduction to the case studies is then followed by the case studies, first the case study on Last.fm, second the case study on Pandora Media. After that, the hypotheses which were constructed in chapter two are tested. The chapter ends with some preliminary conclusions based on the results, and with respect to the main research question. This conclusion forms the basis for the final chapter, in which the main research question is answered, and further research is addressed.

4.1 Introduction

The two case studies are analyzed and presented in a similar structure as much as possible, and no comparisons between the two are made at that stage. This approach is chosen so the two case studies are reported within their own context and can be compared easier afterwards. Both case studies start with an introduction of the company. In the next sections, the constructed instruments are applied on the cases. First according to the mass customization configuration, second on the possible amount of variety factors, third on the variety induced complexity factors and fourth on the search costs factors. At the end of the case studies I describe the lessons learned.

Analysis of the material is mixed with the material itself. If larger parts of an interview tell its own story, I put these interview parts in the text. Interview quotes are included in the text in italics and between quotation marks. Sometimes interview parts are condensed, visualized with brackets ([…]), or are clarified which is done as follows: (BR: …). Besides the interview quotes, there are some references in the text to material which is used as data source for the case studies, which is recognizable by the acronyms like (Source: FAQ) or (Source: DM).

4.2 Case study Last.fm

Last.fm is an Internet radio station and music recommendation system that records what you listen to, and then presents you with an array of suggestions based upon your taste — artists you might like, users with similar taste, personalised radio streams, charts, and much more (Source: FAQ). Last.fm is a company that employs 16 people, and started from the beginning as two different projects, Last.fm and AudioScrobbler. Last.fm merged with sister site AudioScrobbler in August 2005. The system builds a personalized detailed profile of each user's musical taste, showing their favourite artists and songs on a customizable profile on the website, comprising the songs played on its stations selected by means of a collaborative filter, or optionally, recorded by a Last.fm plug-in installed into its users' music player.

Last.fm started in late 2002, and it developed out of a platform for artists and bands. It consisted of a platform where people could upload their own compositions, and of a radio stream on these compositions. The problem Last.fm faced was that nobody knew any of the artists, so the challenge was to present the music in such a way that the right music would be connected to the right listeners, by presenting it in genres or playlists. They realized that the more music they would get, it would be more difficult to fit it in genres, also because putting music into genres is somewhat subjective. The challenge Last.fm was facing was how to find an audience for the music, without having to go to the music press. They thought there was an easier way to connect people with the right music.

AudioScrobbler started as a final year project at the Southampton University. The project consisted of some plug-ins that could be installed on media players like Winamp, iTunes and Windows Media Player. These plug-ins submitted every song that was listened to on these players to a central database, to a personal online music profile. This online music profile consisted of favourite artists, favourite songs, and weekly charts.

In August 2005, Last.fm and AudioScrobbler joined into one site. The basis of the site is the personal music profile. Once a music profile is available, the system starts comparing it with other profiles to find musical neighbours with similar music taste, so new music can be recommended. All other listeners determine the recommendations by the music they listen to, therefore it is a social recommendation service. It is not based on editorial input, or algorithms extracting some properties out of sound files. Each music profile belongs to one person, and describes their taste in music. Last.fm uses these music profiles to make personalized recommendations, match consumers up with people who like similar music, and generate custom radio stations for each person.

Last.fm is included in this research because it matches the site selection criteria of Chapter 3. One of its objectives is to promote music and find the right audience for it, and another is to have as much digital products available to offer. Last.fm is completely community driven (Source: OB). With this community driven approach Last.fm tries to let consumers discover new music from its broad catalogue.

4.2.1 Data sources

The primary data source of the Last.fm case study is an interview I conducted with one of the co-founders of Last.fm, Martin Stiksel. The duration of the interview was just over an hour, and was held during a Skype session which was recorded with permission. The recorded conversation was literally transcribed afterwards, and sent back to the interviewee to review it. Other data sources are documentation in the form of the extensive website of Last.fm, and archival records in the form of some published interviews on the Internet. A complete list with references can be found at the end of the chapter.

4.2.2 Mass customization classification

Last.fm can be classified as an involver in terms of the mass customization configuration, see Table 4.1. The earliest point of consumer involvement is in the design and fabrication stages, while the type of modularity employed is present in the assembly and use stages. The point of consumer involvement is primarily determined by the fact that consumers can specify new product features, consumers' requests are uniquely designed into the finished product, and each consumer order is a unique design. The type of modularity employed is primarily determined by the fact that options can be added to a standard product, components are shared across products, and products are designed around a common core technology.

Group	Modularity		Consumer involvement	
	Design / fabrication	Assembly / use	Design / fabrication	Assembly / use
1. Fabricators	+	±	+	±
2. Involvers	-	+	+	±
3. Modularizers	+	±	-	+
4. Assemblers	-	+	-	+

Table 4.1: Classification of the mass customization configuration.

Consumer involvement

The earliest point that consumers of Last.fm are involved is during the design and fabrication stages. Consumers can specify new product features, consumer's requests are uniquely designed into the finished product, and each consumer order requires a unique design. In the remaining stages of the production cycle, the consumers are still involved, because it is possible for consumers to select features from listings. This section gives proof of the consumers' involvement for these factors.

The AudioScrobbler plug-in that Last.fm users can use on their favourite music player automatically submits the song information from the song that they are listening to Last.fm, and this song gets its own page on the Last.fm website if it does not exist yet. The submitted metadata of new music is immediately available for everyone. Another consumer group is the record label industry, which can also specify new product features by uploading new music.

> *"There is a section at the bottom of the Last.fm website where you click on a link which is called 'Labels & Artists'. As a record label you can sign up to Last.fm and upload your music into the radio and if your music is totally unknown, nobody has heard it before, you can give it starting points in the Last.fm system, so for example you can tag it (BR: tags are keywords or labels (Source: FAQ)), you can say that this is like rock and roll, or this is hip-hop or something like this so it has a starting point. Then you can also type in similar artists, so you can say like my band sounds like Legoweld and Kraftwerk and other punk records from Holland. […] When a user is listening to this for the first time, then we already have some information to start recommending it to other people."*

Both listeners and producers are involved early in the design and fabrication stages, by specifying new product features. About 8,000 producers and record companies, small to medium large, work together with Last.fm, and they are uploading music regularly. The music appears on the radio straight away, and it can be accompanied with a cover image and a link to their favourite online store. On the Last.fm website they can have an artist page, an album page and a label page to customize as well and write about the artist or the track.

At some level it is possible for consumers to uniquely design their requests into the finished product. On the Last.fm website there is the possibility to customize the radio with a popularity filter. This filter is a slider that can be set from obscure to popular, which directly influences the recommendation radio station of the listener. Recommended music that can be listened to comes from musical suggestions from users, groups and from the Last.fm platform (Source: DM). Users are other listeners that can directly recommend music to other listeners. Listeners can also join groups which are created by other listeners, and can recommend music to all members of that group. A group can be based on similarities between users, such as their country or a favourite artist, or something else users have in common. Every Last.fm consumer is free to start a group about anything.

Every product, or radio station, is different from every other available product. When a new person starts using the Last.fm radio player, his or her musical profile immediately starts to personalize.

> *"You have to pick a station to start with, so when you install the player for example it pops up with a window which tells you to type in a similar artist so you can start of a similar artist station which is one way of starting to fill up your profile. So you just start off a radio, there is tag radio stations as well that you can start, but obviously if we don't know anything about you at the very beginning, we can't really make you any personalized suggestions yet. Once that we know stuff about you it gets better and better. The longer you use it, the more we know about you the better we can recommend you new things. At the beginning you have to give it a kick, you have to sort of kick it off yourself by typing in either an artist or a tag and pressing play."*

As mentioned, when consumers are involved early in the design and fabrication stages, they are also involved in the assembly and use stages. It is possible for consumers to select features from listings, as is the case when consumers are involved in the assembly and use stages.

> *"If you click on music (BR: on the Last.fm website) and then on tags, popular tags in the middle, like 'electronic', then you see all this things tagged with*

electronic. And on the right hand side there is a playlist with songs which are all full length tracks, so these are all coming from labels so there is a special playlist for the electronic tag that you can listen to straight away and all these songs are available for free."

Table 4.2 gives an overview of all the consumer involvement factors of Duray et al. (2000) that were encountered at Last.fm.

Consumer involvement factor	*Stage in production cycle*
Consumers can specify new product features	Design / fabrication
Consumer's request are uniquely designed into the finished product	Design / fabrication
Each consumer order requires a unique design	Design / fabrication
Consumers can select features from listings	Assembly / use

Table 4.2: Overview consumer involvement factors Last.fm.

Type of modularity employed

The type of modularity that is employed is through standardization, in the form of adding options to standard products or interchangeability of components. The modularity factors that apply to Last.fm are that options can be added to a standard product, components are shared across products, and products are designed around a common core technology. This section gives examples of these factors. This section also explains which modularity type of Ulrich and Tsung (1991, in Pine, 1993) can be applied to Last.fm.

Options can be added to a standard product. When a consumer listens to music through Last.fm, tracks are automatically being added to the radio station, the standard product. It depends on the availability of tracks for the radio station how many different tracks will be added. The consumer is not able to manually add particular tracks to the radio station that he or she is listening to, but can influence the selection mechanism by giving feedback about the track that is being listened, or by specifying tags or artists to be added to the customized radio station. Feedback can be given in the form of just listening the complete track, skipping a track, tagging a track, recommending a track to another listener, banning or loving a track. Banned tracks

would never be added to any radio station that the consumer listens to, while loved tracks are more likely to be added again.

Components are shared across products. Every track has the possibility to be found on radio stations that are musically different from each other, because listeners can classify each track with tags. When tagging, they do not choose from categories, but they tag the tracks as they like.

> *"In tag radio stations sometimes people mix very interesting things. Because of our similar artists they are more based on, like as I said, on peoples listening history. Sometimes as well it could sound different, but it has a similar feeling, maybe it has a similar mood to it."*

Products are designed around a common core technology. The common core technology of Last.fm is the Internet, the installed radio player and the available plug-ins for some music players. While the Internet is a common network for all consumers, the radio player and the plug-ins come in versions for Microsoft Windows, Linux and Apple MAC OS X. On this technology or platform, it is possible to add every available track, the digital product, to the platform.

All the above factors point to bus modularity, see Figure 2.2. It is the ability to add a module to existing series, when one or more modules are added to an existing base (Ulrich and Tsung, 1991, in Pine, 1993). It can be compared to track lightning or the Universal Serial Bus (USB). Table 4.3 gives an overview of all the modularity factors of Duray et al. (2000) that are the case at Last.fm.

Modularity factor	*Stage in production cycle*
Options can be added to a standard product	Assembly / use
Components are shared across products	Assembly / use
Products are designed around a common core technology	Assembly / use

Table 4.3: Overview modularity factors Last.fm.

Last.fm can be classified as an involver in terms of the mass customization classification of Duray et al. (2000). Consumers are involved in the design and

fabrication stages of the production cycle, and the modularity type they employ is during the assembly and use stages. Listeners, or consumers, make use of unique products that consists of components that are shared around other unique products.

4.2.3 Possible variety

The possible external variety that Last.fm offers can be considered as very high. The possible variety is positively influenced by the multiple usages of modules, an interface that is not perceived as complex for the consumers and a platform that is efficient. At Last.fm, all three factors that influence the possible variety, influences the possible variety in a positive manner. Table 4.4 summarizes these influences. The minus sign at the second column indicates that the interface is not perceived as complex based on the constructed instrument.

Possible variety factor	*Influences Last.fm*
Multiple use	+
Interface complexity	-
Platform efficiency	+

Table 4.4: Overview of possible variety influences at Last.fm.

The variety of Last.fm comes in two different ways. The first is the total number of tracks which have been collected by the AudioScrobbler plug-in. This adds up to more than 40 million different tracks. These tracks consist of metadata about the artist, the track and the album. The second number is the total number of tracks that can actually be listened to. This number is a lot lower, but still almost one million different tracks that can be streamed on the radio stations.

To measure variety according to the metrics used in this research, some assumptions should be met first (Blecker et al., 2006). The first assumption is that the product family is built around platforms and modules. This assumption is met by the identified modularity factors. The second assumption is that the interaction process is carried out over the Internet, so that the consumer is involved in the production process. This assumption is also met. The third assumption is that the mass customizer has not implemented a cost calculation system that enables one to accurately evaluate

the costs triggered by variety induced complexity. The implementation of a cost calculation system could not be identified, resulting in meeting all assumptions.

At Last.fm, the tracks are the modules, or the used components of the digital product. All components can be part of any digital product, which are the customized and personalized radio stations, because components are shared across products. The quote in Framework 4.1 shows the enormous potential of variety in radio stations that can be listened to on Last.fm.

"You can listen to your personal radio that is everything that you previously listened to. […] Then there is neighbourhood radio, which plays you things from your neighbours that you haven't heard yet, which is like some sort of recommendation radio. Then, we have the direct recommendation radio, which takes your top artists and your neighbours' and tries to find the best recommendations from both of them, so it takes a similar artist of your top artists and takes some artists from your neighbours and takes them together and this is the recommendation radio. […] Then there are similar artist radio stations, so where you can go to an artist page and listen to songs which are similar to Brian Eno, to say. And the way we calculate this similar artists is also based on our profiling data. Basically similar artists are calculated from people that listen to this artist also listen to that artist. That's the way we come up with our similar artists, again from this data that we are getting from the AudioScrobbler plug-ins. […] And then we have artist fan radio, which plays you songs out of the profiles of fans of this artist, and then there is group radio, which plays you songs from the profiles of all group members, and there is tag radio, which plays you all the songs tagged with a certain tag by our users, and there's a few other ones that I can't even remember anymore. The most popular ones out of these are neighbourhood radio, and similar artist radio. […] And there are custom radio stations as well. If you click on the radio tab in the middle you can type in like three similar artists and it builds you a radio station based on these three artists."

Framework 4.1: Quote explaining the possible variants of radio stations.

All possible variants of radio stations, or digital products, are a modular system where all tracks, or modules, can be present on every radio station. This indicates that the multiple use metric is very high, which enables high levels of possible external variety. The system also makes use of the submitted metadata from the AudioScrobbler plug-ins to add tracks to the radio stations, which positively influences the multiple use metric.

The interface of the Last.fm player is not too complex. When the player is installed, and the listener starts using it, the listener has to type in a similar artist or tag to start listening to the radio. All the options present on the installed player are straightforward. The radio station which is being listened to is being displayed, as well as the current artist, track and album. The artist, track and album are clickable and take the listener to the Last.fm website to the artist, track or album page, respectively. Other possibilities for the listener to interact with the player is to skip a song that is being listened to, to ban a song to never listen to it again, and to love a song to increase the chance of hearing that song or similar songs again. The listener can also tag a song on the player, or click on a link to go to the Last.fm website to write a journal posting about the song or artist.

While the features on the player are easy to use and are used frequently, there are some other possibilities on the website which are not used very frequently.

> *"If you look at your recommended music there is a slider. […] If you click on the top right where is your picture there is the recommended. Click there. So you get to the recommendation overview, and if you click on recommended music, you get on the right a list of recommendations that you can filter by popularity by dragging the slider at the top. […] This is a very good feature that nobody finds. So at the moment by default it is on weakly recommendations, which you can switch over to show overall recommendations then you get recommendations based on everything that you previously have listened to. You can fade away from the more popular stuff and drill down to the more obscure stuff. So if people want to find out about the more obscure stuff they can use this tool to get recommendations basically which is going to the more obscure section. Or they can turn it up the left hand side. […] A lot of people don't know about this. […] It is one of the best things*

and we're hiding it. […] It's been around for a while but nobody finds it because it is very hidden."

The last factor that influences the possible variety is platform efficiency. The product platform is made up of the radio player, which plays songs in a sequence defined by the interaction between the listener and the platform. This design suits every possible radio station variant, because every radio station just plays songs in a particular sequence. Changing consumer tastes and preferences do not have influence on this platform concept, which is making the platform very efficient. The only problem with this design is the lack of available songs that can occur for a particular radio station, which results in the player to stop playing.

The possible variety is positively influenced by all three factors. Modules can be used on every product, the interface is not too complex, and the platform is efficient.

4.2.4 Complexity and search costs

The analysis of complexity and search costs is divided in three parts. First, the perceived complexity will be analyzed, followed by the search costs and how perceived complexity is being reduced in the case of Last.fm in terms of customization.

Perceived complexity

The perceived complexity can be considered as high and low at the same time. The time that a listener takes to completely configure a product variant can be high, while this does not have to be a problem in the case of Last.fm. The abortion rate at Last.fm is also high and low at the same time, because there are reasons that consumers abort from using the radio player. Table 4.5 gives an overview of the perceived complexity factors at Last.fm.

For a listener to start getting musical neighbours, it takes about 100 songs in their musical profile. From that point, personalization can start to happen, musical neighbours are getting calculated and recommendations are given. During that first

process, interaction with the player is happening, just by listening complete songs without giving any other feedback, or by giving feedback in terms of skipping a song for example or tagging a song or artist. It is not known if the listener is then satisfied, but basically they can influence the stations they are listening to all the time. After listening to about 100 songs, the radio player is getting better in terms of personalizing the station and giving recommendations. The more that is known of the listener, the better it gets in the long run, but the interaction process is a continuous and fluid process.

Perceived complexity factor	*Influences Last.fm*
Average interaction length of time	+/-
Abortion rate	+/-

Table 4.5: Overview of perceived complexity factor influences at Last.fm.

There are reasons for listeners to leave the interaction process or even to prevent from starting to use the player. The first entry barrier is that it is needed to download and install the radio player, which can be complicated for some people. The same is the case for the AudioScrobbler plug-ins. A reason to leave the interaction process is because personalization does not start right away. It can depend on whether listeners like the first few songs or not to decide carrying on listening. It is needed to invest some time to take advantage of the personalized radio stations.

Search costs

The search costs for consumers at Last.fm can be considered as acceptable. Since the data about consumers is not extensive and empirical data from consumers or users of Last.fm is not available, it is not easy to measure search costs very thoroughly. Last.fm is a social recommending system, where the listeners decide how to classify songs and artists by tagging them, and where discovering a product is more important than finding the right product. The number of alternatives searched can be considered as high, which negatively influences search costs for consumers. The product accuracy is good, and search agents are available but are not the primary way to find desired products. An overview is given in Table 4.6.

Search costs factor	*Influences Last.fm*
Number of alternatives searched	-
Product accuracy	+
Search agents	+/-

Table 4.6: Overview of search costs factors influences at Last.fm.

The number of alternatives searched at Last.fm is not entirely known. The product is the radio station, and the music played changes all the time. Therefore, the preferred product is not fixed, it is experienced while consumed. The radio stations can be influenced all the time, and other radio stations can be started at any time as well. It is not the purpose of Last.fm to reduce the time that consumers are interacting with the platform, quite the contrary. It is the purpose to let the consumer interact as much as possible and to discover new tracks and artists.

"Every tag is different, I don't know how many tags, last time we looked there were 70,000 different ones but that was a long time ago so I don't really know the current number but it is really interesting to scan through the tags because it's really classified like… people listening to music is basically based on the music listeners rather than on editors or like some magazine journalists that are… which is very good, you can really see how music is listened to rather than how it is perceived from a commercial point of view when you're talking about genres, because genres are essentially invented to present things better in the record store. You have to have something like this otherwise you can't find anything. […] And it's maybe much closer on how music is actually listened to rather than you know genrefication that comes from a point of view how music is sold or how music is best sold. […] There are endless discussions on how to write hiphop the right way, they all have their reasons why to write hiphop like this and to write hiphop like that, I tell you a 100 percent. […] If you combine this, there will be uproar in the community. They all have their reasons for writing hiphop like this or hiphop like that. Most of the people will say there is a specific reason why they call it something."

Framework 4.2: Quote explaining the accuracy of product selection.

The accuracy of the product can be considered as good. The easiest way to start using the radio player is by typing in a tag or an artist. When typing in an artist or tags, similar music is being played based on tags that are given to songs. Framework 4.2 explains how the accuracy of the product is kept high in terms of the tags that are used. Another way to keep the accuracy of the product high is by providing good recommendations, which is addressed later in this section.

The Last.fm website enables consumers to search for artists, albums, tracks, tags and labels on the music exploration page (Source: EM). This search mechanism searches in all submitted data from the AudioScrobbler plug-ins and the radio player. However, the Last.fm platform uses different strategies for consumers to enable them to find music or artists by their social recommendation system. It is not about searching, but about discovering new music.

Reduce perceived complexity

Last.fm offers various strategies to reduce the perceived complexity for consumers. The selection mechanism makes use of selecting by attribute rather than by alternative, default collections of music are offered, and consumer expertise is increased. Automatic as well as direct recommendations are made, and trust building and collaborative co-design is supported, see Table 4.7.

Reduce perceived complexity factor	*Influences Last.fm*
Attribute vs. alternative	+
Default version	+
Consumer expertise	+
Automatic recommendation	+
Direct recommendation	+
Trust building	+
Collaborative co-design	+

Table 4.7: Reduce perceived complexity, or customization metrics.

Last.fm presents their products by attribute, not by alternative. In reality, Last.fm presents the choice sets first in the form of popular tags, which then can be

refined with related tags. This way of presenting choices also stimulates to learn preferences, by discovering music related to the choice that was made at first.

Last.fm makes use of defaults, for example by the recommendation system which can be customized by the consumer. By default the recommendations are set on weekly recommendations. This setting can be changed by the consumer to show overall recommendations, which will allow the consumer to get recommendations based on everything that previously was being listened to. This setting can also be customized by moving a slider on the Last.fm website between popular music and more obscure music. If consumers would like to find out about the more obscure music, they can use this tool to get recommendations which are more from the obscure section.

Last.fm offers possibilities to increase consumer expertise in various ways, and all these possibilities are available on the website. First, there are groups. Joining a group is a way for users who have a common interest to get together. Music statistics are generated for groups just like individual users, so listeners can see what musical taste certain groups of people have. Anyone can create a new group and encourage people to join the group (Source: FAQ). In these groups, people can communicate with each other about an artist or subject that the group is about. Listeners can learn from other listeners and increase their expertise this way. Second there are forums, where certain topics can be discussed, for example how to use the player. Third, there is the wiki on every artist and label page to write collaboratively about the artist. The purpose of the wiki is to provide a brief, concise, and unbiased description about the artist or label. This can include basic information about the person or group, the type of music they play, what they are most known for, and such (Source: FAQ). Fourth, there is a frequently asked question area on the website to increase consumer expertise.

Recommendation methods on Last.fm are presented both automatic and direct. Automatic recommendations are generated once a week. These recommendations are presented on the website, first on the personal page of the listener as a top ten of recommended artists. Methods for generating automatic recommendations are history-based filtering, rule-based filtering and collaborative filtering. History-based filtering, because the listening history of the consumer is being analyzed. Rule-based filtering, because the listener can apply settings such as weekly recommendations.

Collaborative filtering because musical neighbours are included in the recommendation method. The user can listen to the personal recommendation radio immediately from the website. In the recommended music section the listener can customize how the recommendations are handled by a number of ways. First, the user can customize the recommendation radio by sliding a slider from obscure to popular songs, second by only recommendations from the last week or overall and third by dismissing recommendations.

> *"So in this recommendation section we also display things that are not necessarily on our radio, but you still find out about the artist, you still get artist recommendation. […] So the recommendations are also based on the metadata, instead of only the streams."*

Direct recommendations come from friends or groups. Listeners can recommend a particular track, album or artist directly to another listener, and to groups of listeners. Recommendations from a particular group that a listener is part of, can be enabled or disabled.

Trust or reducing risk is achieved by making use of a community. For the music this is achieved by tagging tracks or artists, automatic recommendations, and groups. It is the wisdom of the crowd that is important. Trust in recommendations is usually higher when the recommendations stem from peers (Piller et al, 2005).

> *"Our idea is that obviously the things that are most often used rise to the top of our charts. Usually the tags are quite good for a particular artist because most people use sensible tags. I mean with this knowledge of the crowd, the more people use a specific tag then obviously it has more relevance, so we usually weigh things, so it might be that one tag that one person has used for a particular artist is maybe not likely to be prominently displayed, but that's the thing. The more people use a certain tag, the more prominently it gets displayed."*

Collaborative co-design is done by a continuous interaction between the listener and the Last.fm platform. The listener can start building a personal profile by

listening to some predefined stations, such as global tag radio, or by submitting tracks by using the AudioScrobbler plug-ins. After about 100 submitted tracks, the Last.fm platform has enough information to start generating musical neighbours which enables the listener to discover new music that is probably something that the listener likes.

For consumers, the perceived complexity can be high and low at the same time. At Last.fm, much is possible for consumers to reduce the perceived complexity. Instead of decreasing search costs for consumers, Last.fm stimulates to use the platform as much as possible to discover new music.

4.2.5 Lessons learned

Last.fm can be classified as an involver in terms of the mass customization classification of Duray et al. (2000). The earliest point of consumer involvement is in the design and fabrication stages, while the type of modularity employed is present in the assembly and use stages. Variety at Last.fm is high for consumers. All three factors which positively influence perceived variety are supported, while at the same time all assumptions (Blecker et al., 2006) to measure variety according to these factors are met. The perceived complexity at Last.fm can be considered as high and low at the same time, the search costs for consumers at Last.fm are acceptable and Last.fm offers various strategies to reduce the perceived complexity for consumers.

Last.fm tries to let the consumers interact as much as possible with the interaction system and the product accuracy is good. This also has implications for the number of alternatives searched by consumers. According to theory, a high value of this metric has a negative influence on search costs. At Last.fm the products change all the time, which makes it necessary to keep searching for alternatives. Search agents are not the primary way to search for products. The whole system is about discovering new products by listening to recommended music. The social driven community of Last.fm plays an important role here. All factors that lower the perceived complexity could be identified, which can be seen as ways to support customization.

4.3 Case study Pandora Media

Pandora is an online music streaming service designed to help find and enjoy music that one will love. It is powered by the Music Genome Project, which is a comprehensive analysis of music (Source: FAQ). The inspiration for the company came from the experiences of the founder as being a musician. The company was founded to help musicians find their audiences and to make a living out of their craft.

The Music Genome Project started in January 2000 by a group of 35 trained musicians with the idea to create the most comprehensive analysis of music ever (Source: ZDNET). They set out to capture the essence of music at the most fundamental level. They ended up assembling literally hundreds of musical attributes or 'genes' into a very large Music Genome. Taken together, these genes capture the unique and magical musical identity of a song, which can be compared to DNA. That includes everything from melody, harmony and rhythm, to instrumentation, orchestration, arrangement, lyrics, and the rich world of singing and vocal harmony. It is not about what a band looks like, or what genre they supposedly belong to, or about who buys their records; it is about what each individual song sounds like. Over the past six years, they have carefully listened to the songs of over 20,000 different artists, ranging from popular to obscure, and analyzed the musical qualities of each song one attribute at a time (Source: MGP).

Since November 2005, Pandora started with the service they now provide to everybody. More than three million people have signed up since (Source: NYT). On Pandora, all is based on the actual quality of the song. That does not take into account whether a group of people think of one particular band fitting into one genre, or if a radio station plays one particular song because the record label wants them to play it, it is all about what the actual musical qualities are. It is really unique in that respect.

Pandora is included in this research because one of their objectives is to find an audience for their large catalogue of music, whether it is obscure or popular. Their approach of music discovery is interesting for this research, because it is different from Last.fm. Where Last.fm is socially driven, Pandora is driven by trained musical analysts, who classify music first before it can be listened to on the radio.

4.3.1 Data sources

The primary data sources for the Pandora case study are two interviews with Pandora employees. The first interviewee was Matt Nichols, marketing manager of Pandora. The second was Tim Westergren, founder of the Music Genome Project and Pandora. Both interviews were held during a Skype session and recorded with permission. Afterwards the recorded interviews were transcribed literally and sent to the interviewees for a review. Other data sources are documentation and archived records from the Pandora website and from previous interviews found on the Internet. A list of specific reference material can be found at paragraph 4.4.

4.3.2 Mass customization classification

Pandora can be classified as an involver in terms of the mass customization configuration, see Table 4.8. The earliest point of consumer involvement is during the design and fabrication stages, while the type of modularity employed is present in the assembly and use stages. The point of consumer involvement is primarily determined by the fact that consumers' requests are uniquely designed into the finished product, and each consumer order is a unique design. The type of modularity employed is primarily determined by the fact that options can be added to a standard product, components are shared across products, products are designed around a common core technology, and products have interchangeable features and options.

Group	Modularity		Consumer involvement	
	Design / fabrication	Assembly / use	Design / fabrication	Assembly / use
1. Fabricators	+	±	+	±
2. Involvers	-	+	+	±
3. Modularizers	+	±	-	+
4. Assemblers	-	+	-	+

Table 4.8: Classification of the mass customization configuration.

Consumer involvement

The earliest point that consumers of Pandora are involved is during the design and fabrication stages. Consumers' requests are uniquely designed into the finished product, and each consumer order requires a unique design. In the remaining stages of the production cycle, the consumers are still involved, because each consumer order is assembled from components in stock. This section provides proof for the consumers' involvement for these factors.

Consumers' requests are uniquely designed into the finished product. When a consumer gives feedback to the system, the number of songs that can be played on the radio station can be increased.

> *"When you create a station and you give it feedback, it opens up a whole new number of songs you can play on that station. It makes stations fluid, and truly listeners based. Every time a listener says I like this song, increases the number of songs, I don't know the exact number, but it increases the number of songs by at least dozens. So by making the stations truly customizable and by providing an interface that works easy for a user to add new music and say 'I like it', that increases the amount of music that will play on that station."*

If two different songs from a particular artist will be marked as 'thumbs down', it will ban the artist from the station. However, if at any time you gave this artist a 'thumbs up', that artist will not be banned (Source: FAQ).

Each consumer order requires a unique design. Every product, or radio station, is different from every other available product. All radio stations are dynamic; a particular radio station based on just a single artist contains a different playlist every time the station is launched. No two stations are the same.

Each consumer order is assembled from components in stock. Pandora adds about 8,000 songs each month, and has about 400,000 songs stocked from 20,000 different artists. Each radio station created and influenced by the consumers is assembled from that stock. Consumers are not able to specify new product features.

Table 4.9 gives an overview of all the consumer involvement factors of Duray et al. (2000) that are the case at Pandora.

Consumer involvement factor	*Stage in production cycle*
Consumer's request are uniquely designed into the finished product	Design / fabrication
Each consumer order requires a unique design	Design / fabrication
Each consumer order is assembled from components in stock	Assembly / use

Table 4.9: Overview consumer involvement factors Pandora.

Type of modularity employed

The type of modularity that is employed is through standardization, in the form of adding options to standard products or interchangeability of components. The modularity factors that apply to Pandora are that options can be added to a standard product, components are shared across products, products are designed around a common core technology, and products have interchangeable features and options. This section gives examples of these factors. This section also explains which modularity type of Ulrich and Tsung (1991, in Pine, 1993) can be applied to Pandora.

Options can be added to a standard product. When a consumer listens to music at Pandora, tracks are automatically being added to the radio station, the standard product. It depends partly on the availability of tracks for the radio station how many different tracks that will be, and partly on the feedback that the consumer gives to Pandora. The consumer is not able to manually add particular tracks to the radio station that he or she is listening to, but can influence the selection mechanism by giving feedback about the track that is being listened, or by specifying artists or tracks to be added to the customized radio station. The musical genome of these specified artists or tracks is used to add more music to the station. Feedback can be given in the form of just listening through the complete track, skipping a track, banning a track for a month, and liking or disliking a song by giving it 'thumbs up' or 'thumbs down'.

Components are shared across products, but not across all products. Because tracks are based on genomes, it is not possible for a particular track to be found in the same station with another track that is totally different in terms of the genome. Tracks should be musical neighbours in terms of the musical genome.

Products are designed around a common core technology. The common core technology that Pandora uses is the Internet and a browser that is capable of playing

Flash movies. The Internet is a common network for all consumers and the Flash player is a common technology for browsers. On this technology or platform, it is possible to add every available track, the digital product, to the platform.

Products have interchangeable features and options. Modules or tracks that were added to a radio station by the system can be moved to another station that a consumer has created earlier.

Modularity factor	*Stage in production cycle*
Options can be added to a standard product	Assembly / use
Components are shared across products	Assembly / use
Products are designed around a common core technology	Assembly / use
Products have interchangeable features and options	Assembly / use

Table 4.10: Overview modularity factors Pandora.

All the above factors point to bus modularity, see Figure 2.2 in Chapter 2. It is the ability to add a module to existing series, when one or more modules are added to an existing base (Ulrich and Tsung, 1991, in Pine, 1993). It can be compared to track lightning or the Universal Serial Bus (USB). Table 4.10 gives an overview of all the modularity factors of Duray et al. (2000) that are the case at Pandora.

Pandora can be classified as an involver in terms of the mass customization classification of Duray et al. (2000). Consumers are involved in the design and fabrication stages of the production cycle, and the modularity type they employ is during the assembly and use stages. Listeners, or consumers, make use of unique products that consists of components that are shared around other unique products.

4.3.3 Possible variety

The possible external variety that Pandora offers can be considered as high. The possible variety is positively influenced by the multiple usages of modules, an interface that is not complex for the consumers and a platform that is efficient. At Pandora, all three factors that influence the possible variety, influences the possible

variety in a positive manner. Table 4.11 summarizes these influences. The minus sign at the second column indicates that the interface is not complex.

To measure variety according to the metrics used in this research, some assumptions should be met first (Blecker et al., 2006). The first assumption is that the product family is built around platforms and modules. This assumption is met by the identified modularity factors. The second assumption is that the interaction process is carried out over the Internet, so that the consumer is involved in the production process. This assumption is also met. The third assumption is that the mass customizer has not implemented a cost calculation system that enables one to accurately evaluate the costs triggered by variety induced complexity. The implementation of a cost calculation system could not be identified, resulting in meeting all assumptions.

Possible variety factor	*Influences Pandora*
Multiple use	+
Interface complexity	-
Platform efficiency	+

Table 4.11: Overview of possible variety influences at Pandora.

At Pandora, the tracks are the modules, or the used components of the digital product. The tracks are shared across different radio stations. It is not exactly known how many songs are being listened to each day, but according to Pandora it is are many songs. It is known that over 90 percent of the music that has been analyzed is being listened to. In May 2006 there were sixteen million different stations created out of the 400,000 available tracks since launch in August 2005.

> *"We're adding about 8,000 songs a month that's the first thing so we're constantly adding new music. And the second thing is, when you create a station on Pandora, we essentially take that song that you've started with or an artist, and create a station that is almost infinitely long, and over time, and this is a work in progress, we will do things to shuffle and change that playlist so you're getting a steady supply of new music and fewer repeats unless you really want that. So you're going to be introduced to a lot of new music. […] You never hear the same playlist twice on Pandora."*

Not all tracks are shared. Some tracks cannot be played on a particular radio station because of the musical genome, which can be too different. Each track has been analyzed by professional musicians, and they analyze according to a specific genome that they choose that matches the musical qualities of the track.

> *"Every song is analyzed on every gene in that genome. We have a couple of different genomes though, so there's a little bit of variation between like jazz and electronical for example and rap, so rap has a few extra genes in lyrics which jazz doesn't have, so there is some variation. But they all get analyzed on the whole gene. […] Well, those are pretty set, so when an analyst picks… the system picks which genome it should be in and then all the genes are already laid out there. So once you pick the genome, the analyst analyzes every gene."*

Tracks have to be musical neighbours to be present on the same station. Providing feedback however, increases the amount of tracks that can be played on a radio station. Consumers can put as many songs or artists as the seed for a station as they like. That will create variety. The 400,000 tracks that are offered on Pandora do not include all genres yet. For now, only music with English lyrics is available, but Pandora is working on adding Latin and Spanish music for example.

> *"We are pushing out Latin music soon. So that's a big thing coming out you know. A big challenge for us is making this service available internationally and include international music, because right now it's English only. I think a service like this is reaching potential when we're international, when we're doing music from all over the world, connecting people across continents."*

The interface of the Pandora player is not complex. To start using Pandora, it is only needed to enter the name of an artist or song as a seed and a radio station is created based on the musical genome of that artist or song. For every station it is possible to see what the station is based upon and why it is playing, since it is possible to add artists and tracks to a station. Every track that has been marked as liked or disliked by clicking on 'thumbs up' or 'thumbs down' on the player can be reviewed.

For every track that is playing or has been listened to during the listening session, it is possible to go to a specific page for the artist, album or track on the Pandora website. It is possible to create a new station from a track or artist that has been listened to instantly, to bookmark the track or artist, or to buy it from Amazon or iTunes. Other possibilities on the player are to add stations to a mixed station that plays tracks from different stations after each other.

> *"So, there are a handful of things that we present right now in terms of information, so you've seen the little window that'll come up that is saying this song is matching because of this and we give a little bit of musical detail. So that's one thing. You can also link on your personal favourite's page to the all music guide, that gives background information of the artist, and we're going to add more of that in over time. Those are the two primary things."*

Pandora tries to provide its service on other devices as well. It is possible to use the service on stand-alone devices with a remote control to listen to the stations or create new stations, which makes the service more accessible for some people. This is made possible because Pandora allied with a third party, called Slim Devices.

The platform that Pandora uses can be considered as efficient. The mentioned common core technology makes it very efficient; no installation of a client program is needed, an Internet browser is sufficient. The available tracks are ready to be added when they are being analyzed by the musicians. Within a week after analysis, a track can be listened to on the radio stations. It is easy to derive new products of the platform, just by creating a new station from a track or artists that has come by.

> *"The amazing thing that the Internet does, you can do different things for individual persons you know. And it's just using computer power. That's all, and that is very cheap."*

4.3.4 Complexity and search costs

The analysis of complexity and search costs is divided in three parts. First, the perceived complexity will be analyzed, followed by the search costs and how

perceived complexity is being reduced in the case of Pandora in terms of customization.

Perceived complexity

The perceived complexity can be considered as high and low at the same time. The time that a listener takes to completely configure a product variant can vary from consumer to consumer. Pandora tries to support all consumers. The abortion rate at Pandora is high and low at the same time, because there are reasons why consumers abort. Table 4.12 gives an overview of the perceived complexity factors at Pandora.

Perceived complexity factor	*Influences Pandora*
Average interaction length of time	+/-
Abortion rate	+/-

Table 4.12: Overview of perceived complexity factor influences at Pandora.

Pandora tries to make the service as simple as possible, but at the same time tries to interact as much as possible with their consumers. One of the company's goals is to increase the amount of time that consumers interact with the platform, and to let them come back over and over again. They encourage repeat listeners.

> *"In terms of making it easy, that was our number one tenet of this project. I think what is being unique about Pandora is that you can enter one song, or one artist, that's all you need to give it. So it's very easy, so that is an unusual easy way to craft a station of music. It's really focused around music that you like."*

On average, every sixth or seventh track that a consumer listens to is getting feedback from the consumer. That feedback can be in the forms mentioned such as 'thumbs up' or 'thumbs down', which is the most given feedback, to new stations. The average listening session for a new listener lasts for about two hours; it grows a little bit longer to three to four hours for a repeat listener. A lot of visitors do not give feedback at all, they just type in a song and let the station run, other listeners give a lot of feedback and like to create stations that are very diverse and are based on different

artists, so it really depends on the listener. This kind of flexibility is what Pandora is after.

> *"There are some people who don't quite get it, but we think that it's a pretty simple interface, most of our listeners find it easy to use, honestly one of the bigger problems is our repeat users who don't have broadband, who don't have high-speed Internet connections, so I think that's one of the main reasons why people come to the site and just leave immediately. Two of our biggest complaints are people who are looking for a song on demand, so people who come to the site and type in a song and expect to hear that song, or type in an artist and expect to hear just that artist, so we try to explain that's not what Pandora is, that is not how we work, but that's one of the complaints we get. The other things we get are people who type in a specific song, and want to hear just that song, which isn't what we do. There's a whole different set of licensing costs, of regulations around how many songs we can play by a specific artist in a specific time period and if we can play a song on demand. So the main reasons for consumers to leave are the lack of broadband speed and the song on demand issue of hearing just that artist. Some of the issues that we try to communicate with the customer are what we're doing, what Pandora is, and what it isn't."*

Framework 4.3: Quote explaining abortion rate of the Pandora service.

Data on consumers that leave the service during interaction is not available. The sample size or study group that Pandora has is a little bit biased, because they generally only hear from consumers that are using the service. Not every consumer becomes a long-term consumer, but the company has been praised for the simplicity of their service. Pandora does not know about the people who are quitting their service because they find it too difficult to use.

> *"We have done a fair number of studies as watching people use it, seeing who they interact with it, it seems like it is fairly easy to use, that's not the biggest hurdle."*

A reason why some people leave is because Pandora does not have classical music yet. Framework 4.3 explains the vision of one of the interviewees on the abortion rate, and how Pandora deals with it.

Search costs

The search costs for consumers at Pandora can be considered as acceptable. Given that the data about consumers is not extensive and empirical data from consumers or users of Pandora is not available, it is not easy to measure search costs very thoroughly. It is more important for Pandora to let consumers discover music that they will like, but is unknown to them. The number of alternatives searched can be considered as high, which negatively influences search costs for consumers. The product accuracy is good, and search agents are available but not the primary way to find desired products. An overview is given in Table 4.13.

The number of alternatives searched is difficult to measure. Consumers can influence radio stations all the time, depending on what they would like to listen to at that moment. Because digital products have to be experienced in order to determine its value, it is difficult to measure. Pandora does not try to decrease the number of alternatives searched. It is quite the contrary, they would like consumers to keep searching or to discover new music.

Search costs factor	*Influences Pandora*
Number of alternatives searched	-
Product accuracy	+
Search agents	-

Table 4.13: Overview of search costs factors influences at Pandora.

The accuracy of the product can be considered as good. The music that is being served is always based on the musical qualities of the tracks, based on the musical genome. The musical qualities are defined by trained musicians, but Pandora admits that it can be wrong on these definitions.

"And then in terms of discovering new music, when we make a playlist for you, there is no bias in the playlist towards more or less popular music, so you're

just as likely to hit something that is well known or not well known there's no kind of bias towards popularity. So that means that if you enter a well known artist, you're increasingly likely that with every passing day, because we're doing more and more independent music compared to major label music, to hear something that you haven't heard before. So the new music that we're analyzing, the majority of it is lesser known music."

"I think that Pandora is kind of emblematic of how the Internet has allowed people to really get information and indulge in a lot of advertorial things. If you take the example of eBay, I think Pandora is kind of analogous to that. In the past if a consumer in the eBay example wanted to buy obscure nineteen century porcelain dolls or something, somebody would have to go out and find one store in the country or overseas that may be specialized in these things. Now with the Internet it brought that marketplace to everybody. I think the same thing is the case for Pandora. In the past if somebody was into an obscure punk rock band from Washington DC that played in the 1970's, to find their records they would have to go either on some kind of fan mailing list or they'll have to go to some place which is specialized in that, only present in major media places like Los Angeles or Chicago or San Francisco, but now with Pandora it has really allowed people have a central place where they can indulge in music that they enjoy easily. As obscure as it is, Pandora will let you home in on a particular song that you like without a lot of effort. I think that that is kind of… you know if you talk about search costs the amount of time it takes to go to a record store and research which record store carries this particular obscure artists, is significant compared to on Pandora typing in the name of a song or an artist. I think that we're analogous to an eBay in that respect, Pandora provides a great dis-aggregation of a huge musical catalogue."

Framework 4.4: Quote explaining why search costs are reduced for consumers using Pandora.

It is possible to present the consumer with unknown music because of a broad music catalogue. By playing music that is similar to very obscure songs it is possible to discover new music while the accuracy of the searched product stays good. To let

the consumer discover new music is why the company exists, and it does it by presenting music, known or unknown, that matches the musical genome of the radio station.

> *"I believe personally that that's what makes people fall in love with music and stay in love with music. I think the reason most people loose their affection for music is because they get tired of hearing the same stuff over and over again. And that's sucks the light out of people"*

The website of Pandora lets consumers search for artists and songs. The search results consist of a biography of the artist, some selected albums of the artist and a list of similar artists. Framework 4.4 explains how the search costs for consumers on Pandora are being minimized.

Reduce perceived complexity

Pandora offers various strategies to reduce the perceived complexity for consumers. The selection mechanism makes use of selecting by attribute rather than by alternative, and consumer expertise is increased. In addition automatic as well as direct recommendations are made, and trust building and collaborative co-design is supported, see Table 4.14.

Reduce perceived complexity factor	*Influences Pandora*
Attribute vs. alternative	+
Default version	-
Consumer expertise	+
Automatic recommendation	+
Direct recommendation	+
Trust building	+
Collaborative co-design	+

Table 4.14: Reduce perceived complexity, or customization metrics.

Pandora presents their products by attribute instead of by alternative. Tracks are being presented by their musical qualities, based on their genome.

"Every song gets analyzed along every gene in the genome. Essentially those are 400 genes. Every gene that has a score, and those genes essentially cover all of the details of the song, so it's melody and harmony and rhythm and instrumentation and compositional form and vocal performance and lyrics, it's all of the individual segments, and with anyone of those segments like instrumentation will capture every instrument that is playing and what that instrument is doing, and so when you essentially have the musical equivalent of a DNA, and then each one of those genes has a weight, like an importance level. And then you essentially calculate distance, then it becomes a big mathematical equation. It's really about musical information and what the software does, it looks at that songs' DNA and calculates how close everything else is to it by looking at the score and the weight."

The product is based on the musical genomes, which consists of specific genomes that can be compared to attributes. However, it is not possible to create the product based on these attributes directly. Indirectly they are, because the product is based on tracks and artists that have similar musical genomes.

Pandora does not make use of default versions of radio stations. The process of listening to music is dynamic for every consumer. Radio stations that are based on the same track or artist have different playlists for every consumer and are different every time the radio station is started. There are popular radio stations based on top artists, but there are no default versions available.

Pandora offers possibilities to increase consumer expertise. The most important is the feedback that the radio player provides on why a particular track is being played.

"Well, I think that when a user says 'Why is the song playing', the information that we give them is an abridge summary of why the song is playing, it'll list four-five reasons of why, where in reality there are hundreds of musical genes that go in to it, so what we'll display to the user is kind of an abridge summary of why the song is playing. […] We're going to get much more detail around that eventually so… we're allowing someone a lot more kind of look into the

genome. Right now it's pretty surface you know, it's a very cursory look at the details."

Pandora makes use of automatic as well as direct recommendations. Automatic recommendations are being made by email. New tracks are constantly being added to Pandora, and when more variety is added to a particular station that is created and is being listened to recently, Pandora sends out an e-mail that lists some new tracks that are added to that station.

"I think that listeners always want more variety and basically are continuing analyzing music and we're continually adding new music to the project so for instance if you have a given station, we're constantly are adding new music to that station and one of the things that I do with the email marketing stuff, the personalized emails is that we send out an email once or twice a month to listeners that lets them know that there is new music that we've added to their stations. So lets say that someone comes in and they start a station, over the next few months we're constantly analyzing new music, some of which will play on that station, we'll email that listener and say 'hey we've added new music to your station, here are the songs, come and listen and eventually you'll hear the new songs', and listeners really reacted strongly to that, it is a nice reminder for them to back and check out Pandora and it lets them know that we're constantly adding music"

Direct recommendations can be made by consumers themselves. On the player there is the possibility to share a particular station with someone else, by sending an e-mail out to a friend and recommend a particular station that way.

Trust or reducing risk is achieved by various strategies. Pandora sometimes uses surveys to ask people what they like and what they do not like about the service. New consumers are getting an email to welcome them and to encourage them to make use of the service, and Pandora actively tries to answer all incoming e-mail containing questions or suggestions. Tim Westergren, the founder of Pandora, is actively meeting new listeners and looking for new music by trips around the United States. Pandora reports on these trips by the weblog they have, and by email newsletters they send out.

"And we've also done, not for a little while, but we've done these studies where you actually put someone in front of the computer and you watch them trough a mirror, sort of like a typical user test."

Collaborative co-design is not something that Pandora stands for, because they analyze and classify every track based on a musical genome by trained musical analysts. However, they implemented a new feature that allows for collaborative co-design. A recent method to allow for collaborative co-design is a feature which is called community feedback. When consumers overwhelmingly give negative feedback to a particular track on some similar radio stations with the 'thumbs down' feedback, the track will be played less on such a radio station. This community feedback is immediately going into work, without the intervention of the musical analysts. Pandora acknowledges this way that it is wrong about the genome, and will immediately play the track less on such a station.

"We've also recently added a feature just this week that allows for community feedback to influence playlists on a particular station. For instance, on a given station to say Coldplay radio which is a very popular station, if an overwhelming number of listeners react negatively to a certain song, that song has become less likely to play on that station for any user. So it's kind of a community based feedback system that mainly applies to some of our more popular stations, but the concept behind it is if the Pandora community, if an overwhelming number of listeners say that 'hey this song doesn't fit into the station', we're going to use that feedback to adjust that playlist accordingly and make it less likely for that song to play on that station and only for that station."

Other collaborative co-design methods are the continuous interaction that takes place between the player and the consumers. Each radio station is unique for every consumer. Pandora does not know what to do with all of the feedback that is being given, because consumers have different habits when giving feedback to the player. However, many new features are based on consumer feedback.

4.3.5 Lessons learned

Pandora Media can be classified as an involver in terms of the mass customization classification of Duray et al. (2000). The earliest point of consumer involvement is during the design and fabrication stages, while the type of modularity employed is present in the assembly and use stages. Variety at Pandora is high for consumers. All three factors which positively influence perceived variety are supported, while at the same time all assumptions (Blecker et al., 2006) to measure variety according to these factors are met. The perceived complexity at Pandora can be considered as high and low at the same time, the search costs for consumers at Pandora are acceptable and Pandora offers various strategies to reduce the perceived complexity for consumers.

It is not the intention to lower the average interaction length of time for consumers that are configuring a product. It could not be recognized that this has a negative influence on the perceived complexity, instead Pandora tries to let the consumers interact as much as possible with the interaction system while the product accuracy is good. This has implications for the number of alternatives searched by consumers. According to theory, a high value of this metric has a negative influence on search costs. At Pandora the products change all the time, which makes it necessary to keep searching for alternatives. Search agents are not the primary approach to search for products. The whole system is about discovering new products by listening to recommended music. The only factor that lowers the perceived complexity and could not be identified is the default version. All other factors can be seen as ways to support customization.

4.4 Specific reference material

The websites where these specific reference materials were found were last accessed on November 6th, 2006, both for Last.fm and Pandora Media.

Reference code	*Document*
FAQ	Frequently asked questions (http://www.last.fm/help/faq/)
DM	Dashboard - Music (http://www.last.fm/dashboard/music)
EM	Explore music (http://www.last.fm/explore/)
OB	Open Business (http://www.openbusiness.cc/2006/10/04/interview-with-lastfm/)

Table 4.15: Last.fm specific reference material.

Reference code	*Document*
FAQ	Frequently asked questions (http://blog.pandora.com/faq/)
MGP	Music Genome Project (http://www.pandora.com/mgp.shtml)
ZDNET	ZDNet.fr (http://www.zdnet.fr/actualites/internet/0,39020774,39314240,00.htm)
NYT	New York Times, Sunday 3 September 2006 (http://blog.pandora.com/press/images/nytimesal.pdf)

Table 4.16: Pandora Media specific reference material.

Chapter 5

Discussion and conclusions

In this chapter, the pieces of the thesis come together, and the overall research question is being answered which has implications for theory. In this chapter I confront the hypotheses with the patterns recognized in the case studies. Some parts of the hypotheses can be explained by literature, some parts have to be explored in further research. I will start this chapter with an introduction where I relate the preceding chapters to this final chapter. That paragraph is followed by a confrontation of the hypotheses with the empirical data from the case studies, which leads to conclusions about the research problem. The last paragraphs of this chapter are reserved for the implications for theory that follow from the conclusions, the limitations of the study and ideas for further research.

5.1 Introduction

The introductory chapter of this thesis identified a gap in literature on the customization of digital products on the Internet. This gap was elaborated on in Chapter 2. The literature review showed that literature was pointing in some

directions, but how to support the customization of digital products according to the customization definition presented in section 2.2.1 was not clear. Some pieces of that puzzle were still missing, resulting in the overall research question and the hypotheses. In Chapter 3, the research methodology chapter, I presented the instrument based on the literature review, and served as the base for Chapter 4. The analysis of the case studies resulted in information to close the gap that was identified. In this final chapter I aim to close that gap. The case studies unveil some proof that has implications for the hypotheses. This leads to confirmations and revisions of the hypotheses proposed in Chapter 2.

Besides confronting the case studies with the hypotheses which are presented, I also compare the case studies between themselves in the subsections of paragraph 5.2. This confrontation shows that there is overlap between the cases, but also that the cases show some differences between each other. This is interesting, because both case studies offer digital products in the form of music, and have a varied assortment of digital products which can be customized by the consumer.

The conclusions about the hypotheses and the confrontation of the case studies lead in the conclusions about the research problem in paragraph 5.3. These conclusions in turn have implications for existing theory on digital products and mass customization which are presented in paragraph 5.4, and unveil some limitations of this research. The limitations of this research are presented in paragraph 5.5. Based on the conclusions, the implications for theory and the limitations of this research, some topics are identified for further research in paragraph 5.6.

5.2 Conclusions about the hypotheses

In this paragraph I draw conclusions upon the hypotheses. For each hypothesis, I will summarize findings from Chapter 4, and explain these findings within the context of this and prior research which is examined in Chapter 2.

Before I start with the pattern matching, I would like to reflect on the term customization. The term is dominant in this thesis; it is the most important term in the overall research question and in the posed hypotheses as well. In this thesis, the term is used within two different contexts. In the first context, it is used as a strategy for

suppliers, which is based on two characteristics. The first characteristic is the point in the production cycle of consumer involvement in specifying the product; the second is the type of modularity employed (Duray et al., 2000). In the second context it is used as the possibilities for consumers to interact with suppliers to create or specify a product. When these two contexts are combined, it fits the customization definition which is used for this thesis formulated in section 2.2.1. Customization as a strategy is commonly known as mass customization and is more generic of nature, while customization by consumers when interacting with the supplier is more specific.

5.2.1 H1: Larger variety enables higher levels of customization

The first hypothesis states that a large product variety enables more possibilities for customizing products. Based on the literature review I assume that the characteristics of digital products in combination with consumer-supplier interaction over the Internet make it possible to apply versioning, personalization and bundling of digital products. An increase in variety should increase consumer-supplier interaction at the design stage of the operations level to create customized digital products delivered over the Internet. The first hypothesis which resulted from the literature review was the following:

H1: The larger the product variety, the higher the level of customization.

I start with a discussion of the proposed pattern for the first hypothesis versus the analyzed pattern in the cases. I finish this section with a discussion on the relation between a large product variety and the degrees and possibilities of customization based on the data analysis in Chapter 4, and discuss the differences between the cases.

Both cases support hypothesis H1 on customization on the general or strategic level. Both cases have a large product catalogue, and that large catalogue supports a high level of customization. A high level of customization is the case when consumers are involved early in the production cycle (Duray et al., 2000). Last.fm as well as Pandora Media can be classified as the involver mass customization classification because consumers are involved early in the production cycle, and the type of

modularity employed is during the assembly and use stages. The modules are not manufactured or changed by consumers, but arranged or combined according to consumer specification. When variety is high, modularity is an enabler for mass customization. Modularity at the assembly and use stages seems to be a suitable strategy for suppliers of digital products.

The cases confirm that a large variety of digital products leads to a high level of customization in terms of interaction possibilities for consumers with the supplier, only the factor trust was not influenced by any of the variety factors. An overview of the influence of product variety on customization that can be identified based on the case studies is summarized in Table 5.1. When both cases have similar results on the influence of variety on customization, it can be recognized in the second column of the table. The specific factors of consumer involvement and the type of modularity employed are summarized between the brackets in behind the factors in the last column.

To proof the influence of increased product variety on customization, I will use the data analysis of Chapter 4 on product variety. For each variety factor that influences customization, I will start with the influence on consumer involvement and modularity. This is followed by the influence on the interaction possibilities for the consumer.

Both cases have a high value of the *multiple use* metric, marked with the plus (+) sign at Table 4.4 and Table 4.11. Because this metric is high, components are shared across products, which enable modularity at the assembly and use stages in the production cycle. Besides using the same modules on multiple products, Last.fm makes use of the submitted metadata from modules that are not available at the supplier, which makes it easier to make better automatic recommendations.

The *interface complexity* is low for both cases. This makes it easy for the consumer to start interacting with the system, and to be involved early in the design process. Both cases illustrate that it leads to consumer's requests to be uniquely designed into the finished product. The Last.fm case study shows that the low interface complexity has a positive influence on customization because it enables consumer involvement by means of the ability to specify new product features, and to select features from listings. Both cases explain that the interface enables various customization possibilities in terms of interaction. The Last.fm case study shows that

the interface can support the use of defaults, by offering default versions that can be customized. Both cases show that it can increase consumer expertise, Last.fm by having a community whose members can interact with each other on the Last.fm website and Pandora by providing feedback on why a particular track is playing or has been played. Both case studies also show that the interface can provide the possibility to make direct recommendations. At Last.fm it is possible to recommend a particular track, album or artist; at Pandora it is possible to recommend a product by sharing it with other consumers.

Product variety	*Case*	*Influence on customization*
Multiple use	Both	Type of modularity employed (components are shared around products)
	Last.fm	Automatic recommendation
	Pandora	-
Interface complexity	Both	Consumer involvement (consumer's requests are uniquely designed into the finished product), direct recommendation, consumer expertise
	Last.fm	Consumer involvement (consumers can specify new product features, consumers can select features from listings) defaults
	Pandora	-
Platform efficiency	Both	Type of modularity employed (options can be added to a standard product, components are shared across products, products are designed around a common core technology), automatic recommendation, collaborative co-design
	Last.fm	-
	Pandora	Type of modularity employed (products have interchangeable features and options)

Table 5.1: Influences product variety on customization, matched from cases.

The companies from both case studies have an *efficient platform*. An efficient platform has a positive influence on customization by means of the type of modularity employed during the assembly and use stages because products are designed around a common core technology. Both case studies also illustrate that an efficient platform makes it easy to add a module to an existing product, as in bus modularity (Ulrich and Tung, 1991, in Pine, 1993), and makes it easy to share components across products. The case study at Pandora shows that an efficient platform leads to products that have interchangeable features and options by moving modules to other products. In terms of specific customization possibilities, both cases show that an efficient platform leads to automatic recommendation and collaborative co-design. Automatic recommendations play an important role in both case studies, because it helps discovering new music, which is one of the reasons the companies exist.

It can be concluded that larger product variety leads to higher levels of customization, because larger product variety enables modular products and consumer interaction. Variety is a tool for customization, because it can create a link between the consumer and the product (Svensson and Jensen, 2001). The data analysis proves that the product variety for both cases is high. The factors that determine product variety have a positive influence on almost all of the customization factors, for both customization as a strategy and customization as interaction possibilities for consumers with the supplier. The Last.fm case study shows that the large perceived variety enables more customization possibilities than the Pandora case study. This difference can be explained by the more varied assortment of Last.fm.

5.2.2 H2: Higher levels of customization enables larger variety

The second hypothesis also supposes a relationship between variety and customization, but where customization was the dependent variable for the first hypothesis, it is variety that is the dependent variable for hypothesis H2. Again, this relationship is a positive one. The second hypothesis is the following:

H2: The higher the level of customization, the larger the variety.

Customization	*Case*	*Influence on variety*
Consumer involvement	Both	-
	Last.fm	-
	Pandora	-
Type of modularity employed	Both	Multiple use (components are shared across products)
	Last.fm	-
	Pandora	Multiple use (products have interchangeable features and options)
Attribute vs. alternative	Both	Interface complexity
	Last.fm	-
	Pandora	-
Default version	Both	-
	Last.fm	Interface complexity
	Pandora	-
Consumer expertise	Both	-
	Last.fm	-
	Pandora	-
Automatic recommendation	Both	Multiple use, interface complexity
	Last.fm	-
	Pandora	-
Direct recommendation	Both	Multiple use, interface complexity
	Last.fm	-
	Pandora	-
Trust building	Both	-
	Last.fm	-
	Pandora	-
Collaborative co-design	Both	-
	Last.fm	Multiple use
	Pandora	-

Table 5.2: Influences customization on increased product variety, matched from cases.

Like the previous hypothesis, I start with a discussion of the proposed pattern for the second hypothesis versus the analyzed pattern in the cases. I finish this section with a discussion on the relation between customization and the influence on variety based on the data analysis in Chapter 4 and then I discuss the differences between the cases.

Both cases partly support hypothesis H2. The case studies illustrate that six of the nine identified customization factors increase variety on two out of the three variety factors. The multiple use and interface complexity factors are influenced in a positive manner, which are similar with the proposed pattern of hypothesis H2. However, the case studies can not show that any of the customization factors can increase variety on the platform efficiency factor. Modularity increases variety on the multiple usages of modules. All specific customization factors except for consumer expertise and trust building increase variety on the multiple use factor or the interface complexity factor, some specific customization factors influence variety even on both factors. Table 5.2 summarizes the influence of customization on an increase in variety. The specific factors belonging to the type of modularity employed are placed between brackets after the influenced variety factor.

Consumer involvement, as one of the characteristics to classify a mass customizer, does not have any influence on variety. The second characteristic to classify a mass customizer, *the type of modularity employed*, does have an influence on variety. Both cases show that the sharing of components across products during the assembly and use phases lead to an increase in product variety. It increases variety on the multiple use factor. The Pandora case study shows that the interchangeability of features and options also increases product variety. When modules are moved to or shared over a range of different products, they are used more often.

The second group of customization factors are the interaction possibilities for the consumer with the supplier. The cases show that not all these factors increase variety, and that these factors do not increase variety on all variety factors. One of the customization factors that do increase variety is *presenting choice sets by attribute rather than by alternative*. Both cases present their choice sets by attribute instead of by alternative when the choice set is large, which makes the interface less complex. *Automatic and direct recommendations* increase variety by increasing the multiple usages of modules. Both case studies also illustrate that these recommendations make

the interface less complex, because new digital products and modules can be discovered more easily, which again can increase variety. The case study at Last.fm shows that the usage of a *default version* makes the interface less complex. The last customization factor that increases variety is *collaborative co-design*. The case study at Last.fm shows that collaborative co-design leads to musical neighbours, which enables the consumer to discover new music. Collaborative co-design increases variety by increasing the multiple usages of modules.

Based on the data analysis in Chapter 4, it can be concluded that the type of modularity employed, presenting large choice set by attribute instead of by alternative, default versions, automatic as well as direct recommendations, and collaborative co-design increase variety on two out of the three factors: multiple use and complexity. Consumer expertise and trust do not have any influence on an increase in variety, and platform efficiency is not influenced by any of the customization factors. Hypothesis H2 is supported by the cases, but not by all the customization factors on all of the variety factors. The Pandora case demonstrates more influence of the type of modularity employed, while the Last.fm case study explains more influence of default versions and collaborative co-design.

5.2.3 H3.1: Larger variety increases complexity

The third hypothesis is split up in two. The first part of hypothesis H3 suggests a positive relationship between an increase in variety and complexity. The literature on variety induced complexity unveiled the drawbacks of variety. The first part of the third hypothesis is the following:

H3.1: The larger the variety, the larger the complexity.

The cases can neither prove nor reject the proposed hypothesis H3.1. Two out of the three variety factors have an influence on the perceived complexity. According to theory, a complex interface leads to longer interaction with the supplier. However, both cases explain that the interface is not complex, and it is desired to increase the interaction with the supplier. The only factor that increases complexity based on the

cases is the platform efficiency. An inefficient platform leads to more consumers leaving the platform. It is interesting to notice that according to theory, consumers leave because of a complex interface. The cases demonstrate, however, that consumers leave because of an inefficient platform, but they also leave because there is not enough variety. Table 5.3 summarizes the influence of product variety on complexity, based on the data analysis in Chapter 4.

Product variety	*Case*	*Influence on complexity*
Multiple use	Both	-
	Last.fm	-
	Pandora	-
Interface complexity	Both	-
	Last.fm	Average interaction length of time
	Pandora	-
Platform efficiency	Both	Abortion rate
	Last.fm	-
	Pandora	-

Table 5.3: Influence of an increased product variety on complexity, matched from cases.

Both cases confirm that an *ineffective platform* can lead to the abortion from the service. The case study at Last.fm shows that the usage of client software makes the platform less efficient, and the case study at Pandora illustrates that slow Internet connections leads to consumers leaving the service. The case study at Last.fm explains that some features are complex because they are hard to find. This increases the complexity because it increases the average interaction length of time.

Two out of the three variety factors have influence on complexity. The most interesting is the *interface complexity*. The Last.fm case study shows that a complex interface leads to an increase in complexity by increasing the average interaction length of time, while at the same time both case studies show that it is the purpose to increase the average interaction length of time. This interesting result can be explained by the purpose of both companies. They try to let the consumer discover new digital

products, instead of letting them find their digital product they are searching as fast and easy as possible. According to theory, an interface that is not complex reduces complexity because it decreases the average interaction length of time. However, the cases show that an interface that is not complex, is not decreasing the interaction length of time, but is encouraging consumers to interact more with the system. However, an unnecessary increase of the interaction length of time is not desired.

5.2.4 H3.2: Larger complexity increases search costs

The second part of the third hypothesis extends the influence of variety. Hypothesis H3.1 proposes the relationship between increased variety and complexity, hypothesis H3.2 suggests a positive relationship between larger complexity and higher search costs. The second part of the third hypothesis is the following:

H3.2: The larger the complexity, the higher the search costs.

The cases support hypothesis H3.2 to some extent. It is true that the average interaction length of time is related to the number of alternatives searched. According to theory, the average interaction length of time should be minimized to reduce complexity (Blecker et al., 2006), and the number of alternatives searched should be minimized to reduce search costs (Blecker et al., 2006; Kurniawan et al., 2006). The cases demonstrate however that it is not the purpose to decrease the interaction length of time, but to increase interaction with the consumer. Table 5.4 summarizes the influence of complexity on search costs, based on the data analysis in Chapter 4.

The cases show that only one of the complexity factors has an influence on search costs. Both cases show that an increase in the *average interaction length of time* leads to an increase in the number of alternatives searched. According to theory, this leads to higher search costs. The case study at Last.fm explains that the average interaction length of time has a negative influence on the product accuracy. The hard to find features on the Last.fm website make it more difficult to find products more accurately. The cases do not indicate that the *abortion rate* leads to an increase in complexity, which therefore shows no relation with search costs. Both case studies

can not confirm a relationship between any of the complexity factors and search agents.

Complexity	*Case*	*Influence on search costs*
Average interaction length of time	Both	Number of alternatives searched
	Last.fm	Product accuracy
	Pandora	-
Abortion rate	Both	-
	Last.fm	-
	Pandora	-

Table 5.4: Influence of complexity on search costs, matched from cases.

5.2.5 H4: Higher levels of customization decrease search costs

The last hypothesis of the research framework suggests a relationship between customization and search costs. This hypothesis is the only hypothesis that suggests a negative relationship between two themes of the framework. The literature review suggests that high levels of customization should lower the search costs for consumers. The fourth and last hypothesis is the following:

H4: The higher the level of customization, the lower the search costs.

The cases support hypothesis H4, albeit not completely. Except for two customization factors, the data analysis of Chapter 4 confirms that customization decreases search costs on all three search costs factors. Both case studies show results that are similar for most customization factors. There are some differences on the factors attribute vs. alternative and default versions. A summary of the influence of customization on the lowering of search costs is given in Table 5.5.

The case studies illustrate that *consumer involvement*, as being one of the characteristics to classify a mass customizer, decreases search costs for the consumer. Because consumer's requests are uniquely designed into the finished product, the

product accuracy is improved, and the number of alternatives searched is decreased. The Last.fm case study shows that this can be achieved because consumers can customize the way recommendations are being made. Both case studies explain that when consumers are providing feedback, it results in presenting more accurate products to consumers. By providing feedback, the supplier learns about consumer preferences, which results in more accurate products, while the number of alternatives searched is being decreased.

Both case studies confirm that *presenting large choice sets by attribute instead of by alternative* decreases search costs for consumers. However, the case studies show deviations in the way it affects search costs. The Last.fm case study illustrates that it leads to a decrease of the number of alternatives searched by consumers in order to accurately find products of their choice. Last.fm does it by using tags and related tags, which is a very accurate way to find or discover new products. The Pandora case study explains that presenting attribute information to consumers about why a particular track is playing decreases search costs, because consumers learn their musical preferences that way, which is a possible substitute for search agents.

The Last.fm case study proofs that *default versions* decrease the number of alternatives searched. Last.fm offers a default version for recommendations, which can be customized. This is in accordance with Dellaert and Stremersch (2004) who argue that companies should offer a default version that consumers can use as a starting point for mass customization to minimize complexity.

Both case studies confirm that *consumer expertise* leads to better product accuracy. Pandora uses attributes to explain why tracks are being played. This consumer expertise lets consumers find or discover new products more accurately. The Last.fm case study shows that consumer groups make it easier for members of these groups to find products, or more precisely modules of products, more accurately. At the same time it decreases the number of alternatives searched.

Both case studies confirm that recommendations decrease search costs. *Direct and automatic recommendations* decrease the number of alternatives searched, and both types of recommendations lead to a better product accuracy. There is a difference at the case studies in how automatic and direct recommendations are presented. At Last.fm, recommendations are available on the personal page of the consumer, while Pandora sends e-mail messages to recommend new or changed digital products.

Customization	*Case*	*Influence on search costs*
Consumer involvement	Both	Number of alternatives searched, product accuracy
	Last.fm	-
	Pandora	-
Type of modularity employed	Both	-
	Last.fm	-
	Pandora	-
Attribute vs. alternative	Both	-
	Last.fm	Product accuracy, number of alternatives searched
	Pandora	Search agents
Default version	Both	-
	Last.fm	Number of alternatives searched
	Pandora	-
Consumer expertise	Both	Number of alternatives searched, product accuracy
	Last.fm	-
	Pandora	-
Automatic recommendation	Both	Number of alternatives searched, product accuracy
	Last.fm	-
	Pandora	-
Direct recommendation	Both	Number of alternatives searched, product accuracy
	Last.fm	-
	Pandora	-
Trust building	Both	-
	Last.fm	-
	Pandora	-
Collaborative co-design	Both	Product accuracy
	Last.fm	-
	Pandora	-

Table 5.5: Influence of customization on decreasing search costs, matched from cases.

Both cases proof that *collaborative co-design* reduces search costs. At Last.fm it reduces search costs because it leads to consumers having a personal profile. Once consumers do have a personal profile, it becomes possible to make better recommendations based on musical neighbours. The Pandora case study confirms that collaborative co-design is improving product accuracy due to consumers who are collaboratively giving feedback to the system, which leads to changes in the products. It has some similarities with the consumer involvement factor, because consumers' requests are designed into the finished product. The difference is that it is not done uniquely, but collaboratively.

The case studies can not proof that *trust* and the *type of modularity employed* have influence on search costs. It can be argued that trust decreases search costs, by reducing uncertainties about the behaviour of the provider. The Last.fm case study shows however that it does not reduce uncertainties about the behaviour of the provider, but it results in which products are more popular compared to other products.

5.3 Conclusions about the research problem

In this paragraph the conclusions about the initial research problem are drawn. Paragraph 5.2 already drew some conclusions on the hypotheses based on the data analysis of Chapter 4. These conclusions are taken together here, and are used to answer the overall research question and to draw conclusions on this research. The hypotheses are supported by the data analysis of Chapter 4, but there are some interesting results that have influence on the supposed hypotheses and research framework. The overall research question where the hypotheses are extracted from is the following:

> *How to support customization and personalization for pure digital products in the Internet economy to dramatically decrease complexity and search costs for consumers, so variety can be maximized?*

This overall research question followed from the research problem which was identified in Chapter 1. The goal of this research is to make an addition to the work of Brynjolfsson et al. (2003), who argue that increased online availability of previously hard-to-find products represents a positive impact on consumer surplus. This addition can be found in the use of customization of digital products on the Internet.

This research is both explanatory and exploratory. It is explanatory because it explains where the hypotheses can be supported and where they can not. It is exploratory because the hypotheses are based on literature on the customization of physical products, where this research addresses customization of digital products. Through the research presented in this thesis, I came to a better understanding on how to support customization according to the overall research question. The data analysis in Chapter 4 has lead to insights that were discovered during the interviews, and that were not assumed and explained from literature. The hypotheses still hold after the data analysis, but some are revised.

The most important conclusion from the data analysis is that the lowering of search costs for consumers is not the most important goal of the customization of digital products in the Internet economy. The average interaction length of time increases the number of alternatives searched, but that does not mean an increase in search costs for consumers. More important is that discovering new digital products should be made easier for consumers. This and other insights have direct implications for the research framework presented in Chapter 1 and elaborated on in Chapter 2. Before the research framework is revised, I reflect on the conclusions of the hypotheses in paragraph 5.2

The conclusion on H1 was that the larger the product variety, the higher the level of customization. However, the increase in variety has the most influence on the type of modularity employed. Customization can be seen as a strategy for the supplier and as interaction possibilities for the consumer. This way of treating customization is in line with the definition that was proposed in this thesis (section 2.2.1), which in short states that customization is a strategy that creates value by some form of consumer–supplier interaction. This conclusion results in the revision of the hypothesis from H1 to H1':

H1': The larger the product variety, the higher the level of customization in terms of modularity at the assembly and use stages.

The conclusion on H2 was that the higher the level of customization, the larger the variety, but not on all variety factors and also not all customization factors increase variety. The type of modularity employed is the most important customization factor that increases variety, because modularity as one of the characteristics of the mass customization classification increases variety on the multiple usages of modules. The most important specific customization factors that increase variety are automatic and direct recommendations and presenting large choice sets by attribute instead of by alternative. They are the most important because they are supportive to the type of modularity employed. Consumer expertise and trust building do not increase variety, but they can not be seen as consumer-supplier interaction. This conclusion results in the revision of the hypothesis from H2 to H2':

H2': Mass customizers that can be classified as involvers, increase the variety or choice.

The cases can neither prove nor reject the proposed hypothesis H3.1. The cases show deviations with theory, because the increase in variety illustrated by the cases does not increase complexity for the consumers. It seems that it is desired to increase the average interaction length of time when customizing digital products. The increased average interaction length of time has influence on the second part of the third hypothesis. The cases support hypothesis H3.2 to some extent. It is true that the average interaction length of time is related to the number of alternatives searched. According to theory, the average interaction length of time should be minimized to reduce complexity (Blecker et al., 2006), and the number of alternatives searched should be minimized to reduce search costs (Blecker et al., 2006; Kurniawan et al., 2006). The cases show however that it is not the purpose to decrease the interaction length of time, but to increase interaction with the consumer. The above results in the revision of the hypotheses H3.1 and H3.2 to H3.1' and H3.2':

H3.1': The larger the product variety, the higher the average interaction length of time.
H3.2': The higher the average interaction length of time, the better it is for consumers to discover new digital products.

The cases support hypothesis H4, albeit not completely. Except for two customization factors, the data analysis of Chapter 4 shows that customization decreases search costs on two of the three search costs factors. Both case studies show results that are similar for most customization factors. Because it does not seems to be the goal to lower search costs for consumers, but to increase the discovery of new digital products, customization by means of consumer-supplier interaction should increase the average interaction length of time. This increase in turn should result in the discovery of more new digital products for consumers. The above results in the revision of the hypothesis H4 to H4':

H4': The higher the level of customization, the better it is for consumers to discover new digital products.

It can be concluded that customization and personalization should be supported by employing modularity at the assembly and use stages, and consumer involvement at the design and fabrication stages. Employing modularity at the assembly and use stages increases variety, and consumer involvement at the design and fabrication stages supports customization that lowers search costs. Taken together, mass customizers who can be classified as involvers in terms of the mass customization classification of Duray et al. (2000), make it easier for consumers to find previously hard-to-find digital products on the Internet, while variety induced complexity is controlled and variety is high. According to theory, lower the average interaction length of time is a factor that decreases variety induced complexity for the consumer, which in turn should decrease search costs. The cases demonstrate however that it is not the purpose to lower, but to increase the average interaction length of time. This increase in interaction should make it easier for consumers to discover new digital products. The conclusions on the hypotheses in paragraph 5.2 and the revision of them

in this paragraph leads to the revision of the research framework, which is visualized in Figure 5.1.

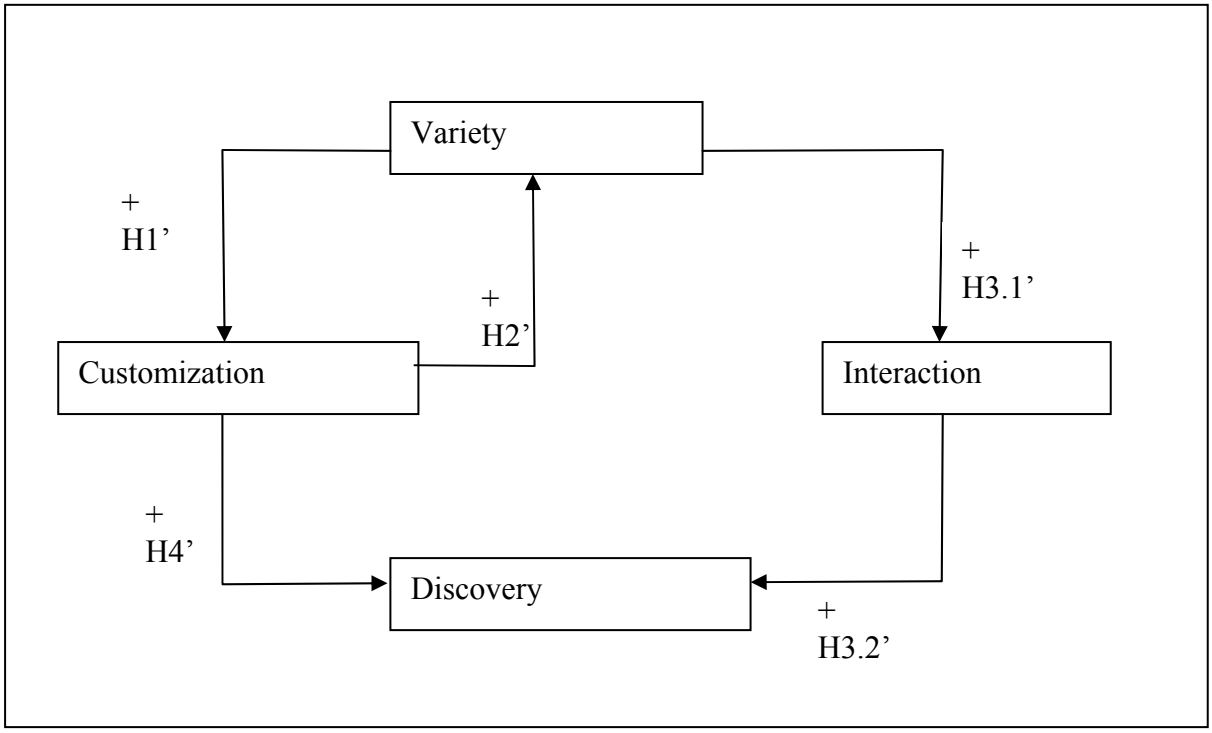

Figure 5.1: Revised research framework and hypotheses.

In summary, the most important findings and conclusions are:

- customization of digital products can be split in generic and specific customization;
- an increased variety of digital products does not lead to more complexity;
- the average interaction length of time should not be decreased but increased;
- discovering new digital products or modules is more important than minimizing search costs.

Generic customization can be seen as a strategy to follow for suppliers. The optimal customization strategy in terms of the mass customization classification is offering consumer-supplier interaction at the design and fabrication stages, and to employ modularity at the assembly and use stages. Customizers that follow this strategy can be classified as involvers (Duray et al., 2000). An increase in external variety of digital products does not increase complexity. It does increase the average

interaction length of time, but that is desired when customizing digital products. The cases show that an increase of variety is something that is something to strive for because more consumers can be reached, and these consumers can customize more by interacting more, and can discover more digital products.

5.4 Implications for theory

This paragraph also serves as the conclusion of this research. Where paragraph 5.3 addressed conclusions about the research problem and the hypotheses, this paragraph addresses issues that are not directly related to the research problem, but are implications for theory that became apparent during the data analysis in Chapter 4. In this paragraph I would like to reflect on paragraph 1.3 where I justified this research based on my initial assumptions. This section is a statement of the completed research's usefulness. Through the explanatory and exploratory research I presented in this thesis, I came to a more comprehensive understanding of mass customization, consumer-supplier interaction, perceived variety and the typical characteristics of digital products.

5.4.1 Mass customization and consumer co-design

The results of this research point to the revision of the customization definition for digital products. This thesis contributed to the current knowledge of mass customization by determining the strategy to choose when offering customizable digital products. The involver mass customization classification configuration is the strategy to choose.

Modularity at the assembly and use stages is not considered the highest level of customization (Duray et al., 2000). The highest level is during the design and fabrication stages. Based on the type of modularity employed, I conclude that a strategy of co-design should be followed, not a strategy of co-creation.

5.4.2 Digital products

This thesis shows that physical products and digital products have significant differences. Current literature is extensive about customization or mass customization of physical products. The literature is scarce on customization of digital products that are offered and customized on the Internet. A difference between customization of physical products became apparent during this research, a difference which can be found in the average interaction length of time to customize a product. This difference can be explained by the costs structures of physical and digital products. The value of a physical product is clearer than the value of a digital product before it is used. Because the value of a physical product can be determined before using it, it is desired for the consumer to obtain the desired customized product as quick as possible by interacting with the supplier. Because digital products are by definition experience goods (Pine and Gilmore, 1998), it is difficult to value the product before it has been used. This difference has two implications. First, instead of lowering the average interaction length of time (Blecker et al., 2006), it is desired to increase the interaction length of time between the supplier and the consumer. Second, instead of lowering search costs for consumers, it is desired for them to discover as much new products as possible.

5.5 Limitations

Every research has its limitations, as is the case with the research presented in this thesis. I discuss limitations on generalization, limitations due to perspectives taken in the initial research design and limitations due to the scope of the study.

The advantage of case study research is the level of detail that can be reached and its suitability to develop hypotheses. The disadvantage of case studies is that generalization is difficult (Yin, 2003). Generalization of case studies should be done analytically. Multiple case studies, conducted under the same circumstances can enhance generalization. This research is a multiple case study, but only included two cases. More comparable case studies conducted under the same circumstances and with comparable results can improve generalization.

For this thesis, I only did research on digital products in the form of music. The research goal and the resulting research framework and hypotheses did not address only digital products in the form of music, but digital products in general. This is a limitation of this thesis, because different digital products have different characteristics. For example, music can be experienced while doing something else, because music can be experienced by sound only. Digital music in the form of movies for example requires one to watch it, which is different compared to music. The site selection criteria and availability of cases resulted in two cases that offer digital products in the form of music. Case studies that will be conducted under the same circumstances with different types of digital products and with comparable results can further improve generalization.

Another limitation of this thesis is that only empirical data from suppliers was collected. The research objective targets consumers, but due existing literature which primarily addresses customization from the perspective of the supplier, I had to stick with the suppliers of digital products.

5.6 Further research

Throughout this thesis and especially in this chapter, I have provided several topics for further research. This final section is written to help researchers in their selection and design of future research. Further research can refer to either topics or methodologies, or to both. A case study methodology thesis should mention the need for positivist research to generalize the findings of this hybrid of explanatory and exploratory research. Removing some limitations mentioned in paragraph 5.5 can provide opportunities for further research. Other opportunities for further research are mentioned in the following four sections.

5.6.1 Co-creation of digital products

Digital products have some characteristics that can be compared to services. The conclusions of this research pointed to the characteristic of digital products that

stresses its nature as being experience goods. Like services, digital products have to be experienced first in order to determine its value. Other similarities are that services cannot be stocked and that the consumer participates in the delivery process. An important difference is that services are always produced and consumed simultaneously (Grönroos, 1990, Berry and Parasuraman, 1991, in de Vries, 2003), while customizing digital products does not have to be, and that reliability is more important than customization for services as opposed to products (Johnson and Nilsson, 2003; Johnson and Ettlie, 2001). However, when the type of modularity is employed during the design and fabrication stages, digital products are designed and consumed simultaneously. When digital products are designed and consumed simultaneously, they are co-created instead of co-designed. Further research can address the co-creation of digital products, which is a higher level of customization according to Duray et al. (2000).

5.6.2 Variety and the long tail

This thesis proves that increased variety does not necessarily means an increase in complexity for consumers. An increase in variety means more possibilities for consumers to discover new digital products that they will like. Brynjolfsson et al. (2003) suggested that the value of discovery may significantly outweigh the value of lower transaction costs. Anderson (2006) took this suggestion and addressed the economic consequences of an abundance of variety, which he calls the long tail. Anderson (2006) argues that companies should make everything available and that these companies should help consumers find what they need. I recommend further research on the economics of an abundance of variety.

5.6.3 Toolkits of mass customization co-design

The cases in this thesis explain that interaction possibilities for consumers increase the discovery of unknown digital products. Interaction possibilities for this thesis were taken from literature on mass customization. Because consumer demands are changing constantly, Von Hippel (2001) addresses user toolkits for innovation.

These toolkits allow suppliers to give freedom to consumers to customize their products. I recommend further research on consumer toolkits, to extract the most valuable interaction possibilities for consumers that should be offered. Consumers' subjective preference for features that should be customized should also be quantified (Jiao and Tseng, 2004).

5.6.4 Customization and sharing of digital products

The Pandora case shows that sharing modules with other products increases the multiple usages of modules. Sharing modules is useful for products that should match the needs of various consumers, not just that of a single person (Piller et al., 2005). Piller et al. (2005) suggest that communities can foster the sharing of products. Sharing thus plays a role in modularity and in communities as well. I suggest further research on customization and sharing of digital products within communities.

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Appendix A

Transcript interview Martin Stiksel, Last.fm

Interview Date: May 4th, 2006 Interviewee: Martin Stiksel of Last.fm Location: Amsterdam and London Time: 12:00 (11:00 AM London time) Duration: 63 minutes (I) = Interviewer (Bas Reus) (S) = Subject / interviewee (Martin Stiksel)			
Time		Transcript	Notes

Transcript not included in public version.

Appendix B

Transcript interview Matt Nichols, Pandora Media

Interview Date: May 4th, 2006 Interviewee: Matt Nichols of Pandora Media Location: Amsterdam and Oakland Time: 19:00 (10:00 AM PT) Duration: 43 minutes (I) = Interviewer (Bas Reus) (S) = Subject / interviewee (Matt Nichols)			
Time		Transcript	Notes

Transcript not included in public version.

Appendix C

Transcript interview Tim Westergren, Pandora Media

Interview Date: May 8th, 2006 Interviewee: Tim Westergren of Pandora Media Location: Amsterdam and Oakland Time: 19:00 (10:00 AM PT) Duration: 41 minutes (I) = Interviewer (Bas Reus) (S) = Subject / interviewee (Tim Westergren)			
Time		Transcript	Notes

Transcript not included in public version.