

Propositions

accompanying the dissertation “Customization Choices: Consumers’ product choices in mass customization environments” of Niels Y. Vink.

1. Companies should concentrate on the design of product configurators, because a product configurator affects the satisfaction with the customization process.

2. Consumers are more satisfied with products they have customized themselves compared with products they have not customized.

3. Mass customization allows consumers to customize both the functionality and the experience of the product.

4. Mass customization does not necessarily make the world more beautiful, but it does make it more satisfied.

5. Product configurators fulfill a need for freedom of choice.

6. Mass customization demands the design of sets of products instead of singular products.

7. The chance to encounter a vacuum cleaner of James Dyson within the faculty of industrial design engineering is smaller than the chance to encounter a book about James Dyson. This demonstrates that within the faculty of industrial design engineering, product designers receive more attention than the product design.

8. An excellent lecture rather leads to more than to less questions.

9. The safety of small cars should receive more attention, because the number of passengers is often reversely proportional to the size of the car.

10. The law of physics “mass is inert” also applies to social decision processes; the bigger the group of decision makers, the slower the decision process.

These propositions are considered defendable and as such have been approved by the supervisors,

Prof. dr. J.P.L. Schoormans
Prof. dr. W.M. Oppedijk van Veen
Stellingen
behorende bij het proefschrift “Customization Choices: Consumers’ product choices in mass customization environments” van Niels Y. Vink.

1. Bedrijven dienen veel aandacht te geven aan het ontwerp van productconfiguratoren, aangezien een productconfigurator de tevredenheid over het customization proces beïnvloedt. Dit proefschrift

2. Consumenten zijn meer tevreden over producten die ze zelf samengesteld hebben dan over producten waarbij ze dat niet gedaan hebben. Mede dit proefschrift

3. Mass customization stelt consumenten in staat zowel de functionaliteit als de beleving van het product samen te stellen. Mede dit proefschrift

4. Mass customization maakt de wereld niet persé mooier maar wel meer tevreden. Mede dit proefschrift

5. Productconfiguratoren vervullen bij consumenten een behoefte aan keuzevrijheid.

6. Mass customization vereist het ontwerpen van verzamelingen van producten in plaats van afzonderlijke producten.

7. De kans om binnen de faculteit industrieel ontwerpen een stofzuiger van James Dyson aan te treffen is kleiner dan de kans om een boek over James Dyson aan te treffen. Hiermee wordt aangetoond dat productontwerpers bij de faculteit industrieel ontwerpen meer aandacht krijgen dan het productontwerp.

8. Een goed college zou eerder tot meer dan minder vragen moeten leiden.

9. De veiligheid van kleine auto’s zou meer aandacht moeten krijgen, omdat het aantal inzittenden vaak omgekeerd evenredig is met de grootte van de auto.

10. De wet van traagheid uit de natuurkunde “massa is traag,” is ook toepasbaar op sociale beslissingsprocessen, hoe groter de groep beslissers, hoe trager het beslissingsproces.

Deze stellingen worden verdedigbaar geacht en zijn als zodanig goedgekeurd door de promotoren,

Prof. dr. J.P.L. Schoormans
Prof. dr. W.M. Oppedijk van Veen
CUSTOMIZATION CHOICES

Consumer Product Decisions in Mass Customization Environments

Niels Y. Vink
CUSTOMIZATION CHOICES

Consumer Product Decisions in Mass Customization Environments

Proefschrift

ter verkrijging van de graad van doctor
aan de Technische Universiteit Delft,
op gezag van de Rector Magnificus prof. dr. ir. J.T. Fokkema,
voorzitter van het College voor Promoties,
in het openbaar te verdedigen op dinsdag 24 juni 2003 om 13:30 uur
door Niels Yuri VINK
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ingenieur industrieel ontwerpen
egenomen te Hoorn.
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Includes biographical references and indexes.
ISBN 90-9016751-X
NUR: 775, 802, 988

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CONTENTS IN BRIEF

CUSTOMIZATION CHOICES.
The problem of consumer product decisions in mass customization environments ______ 1

Chapter 1. Designing mass customization environments _____________________________ 3
Chapter 2. Customization choices _____________________________________________ 17
Chapter 3. Researching customization choices ____________________________________ 39

RESEARCH PART I.
Product information in mass customization environments ________________________ 43

Chapter 4. Variance and type of pictorial information ______________________________ 45
Chapter 5. Assortment size and type of information ________________________________ 61
Chapter 6. Number of product characteristics ____________________________________ 75
Chapter 7. Detecting decision strategies __________________________________________ 83

RESEARCH PART II.
Presenting product information product configurators ___________________________ 95

Chapter 8. Presentation format and product newness ________________________________ 97
Chapter 9. Presentation format and customization processes _________________________ 113
Chapter 10. Presentation order and customization strategies ________________________ 125
Chapter 11. Presentation order and conflicting strategies ____________________________ 137

CONCLUSIONS ______________________________________________________________ 153

Chapter 12. Conclusions for customization choices _________________________________ 155
Chapter 13. Guidelines for designing product configurators _________________________ 171

Summary _________________________________________________________________ 187
Samenvatting ______________________________________________________________ 191

Appendices ________________________ 195
References ______________________________________ 201
Index ________________________________________ 211
Glossary __________________________ 215
Curriculum vitae ____________________ 221
CONTENTS

Acknowledgements

CUSTOMIZATION CHOICES.
The problem of consumer product decisions in mass customization environments 1

CHAPTER 1
Designing mass customization environments 3
  1.1 The shift to mass customization 3
  1.2 Product configurators 4
  1.3 Implementing mass customization 6
  1.4 Products suitable for product configurators 10
  1.5 Usage situations of product configurators 11
  1.6 Challenges in designing product configurators 14

CHAPTER 2
Customization choices 17
  2.1 Stages in the decision process 17
  2.2 Integrated stages in the decision process 18
  2.3 Consumer motives to search 20
    2.3.1 Active search 21
    2.3.2 Consumer knowledge 22
    2.3.3 Active search in mass customization environments 24
  2.4 Making a product decision 25
    2.4.1 Reducing product uncertainty 26
    2.4.2 The decision process in mass customization environments 28
    2.4.3 Decision value of customization choices 28
  2.5 Customization challenges 30
    2.5.1 Characteristics of the decision problem 31
    2.5.2 Characteristics of the decision environment 35
    2.5.3 Characteristics of the decision maker 36
  2.6 Conclusion 37

CHAPTER 3
Researching customization choices 39
  3.1 Product information in mass customization environments 39
  3.2 Presenting product information in product configurators 40
  3.3 Method 42
RESEARCH PART I.
Product information in mass customization environments

CHAPTER 4
Variance and type of pictorial information
4.1 Variance within attribute levels
4.2 Type of pictorial information
4.3 Study 1
   4.3.1 Stimuli
   4.3.2 Design
   4.3.3 Procedure
   4.3.4 Measures
   4.3.5 Respondents
4.4 Results of study 1
   4.4.1 Control measures
   4.4.2 Dependent measures
4.5 Conclusions for amount and type of information
   4.5.1 Variance within attribute levels
   4.5.2 Type of pictorial information
   4.5.3 Characteristics’ importance

CHAPTER 5
Assortment size and type of information
5.1 Assortment size
5.2 Type of product information
5.3 Study 2
   5.3.1. Stimuli
   5.3.2 Design
   5.3.3 Procedure
   5.3.4 Measures
   5.3.5 Respondents
5.4 Results of study 2
   5.4.1 Control measures
   5.4.2 Dependent measures
5.5 Conclusions for type of information and assortment size
   5.5.1 Type of product information
   5.5.2 Assortment size

CHAPTER 6
Number of product characteristics
6.1 Number of product characteristics
6.2 Study 3
   6.2.1 Stimuli
   6.2.2 Procedure
   6.2.3 Measures
   6.2.4 Respondents
6.3 Results of study 3
   6.3.1 Control measures
   6.3.2 Dependent measures
6.4 Conclusions for number of product characteristics
9.3.3 Measures .......................................................... 117
9.3.4 Respondents .................................................... 118
9.4 Results from study 6 .............................................. 119
  9.4.1 Outlier analysis ............................................. 119
  9.4.2 Esthetic evaluation of the overall product .......... 119
  9.4.3 Customization process .................................... 119
9.5 Conclusions for presentation format and customization processes ........................................ 122
  9.5.1 Presentation format ........................................ 122
  9.5.2 Customization process .................................... 123

CHAPTER 10
Presentation order and customization strategies ................................................................. 125
  10.1 Configurality ................................................... 125
    10.1.1 Unity ...................................................... 125
    10.1.2 Utility .................................................... 126
    10.1.3 Customization strategies .............................. 127
  10.2 Presentation order ........................................... 128
  10.3 Study 7 ......................................................... 129
    10.3.1 Respondents ............................................. 129
    10.3.2 Part 1: configurality .................................... 129
    10.3.3 Part 2: presentation order ......................... 130
  10.4 Results of study 7 ........................................... 133
    10.4.1 Configurality ............................................ 133
    10.4.2 Presentation order ..................................... 133
  10.5 Conclusions for presentation order and customization strategy ................................... 135
    10.5.1 Presentation format and configurality ............ 135
    10.5.2 System evaluation ....................................... 135
    10.5.3 Reversibility ............................................. 135
    10.5.4 Customization strategy ............................... 135

CHAPTER 11
Presentation order and conflicting strategies ................................................................. 137
  11.1 Conflicting strategies ....................................... 137
  11.2 Presentation order .......................................... 138
  11.3 Study 8 .......................................................... 138
    11.3.1 Stimuli ................................................... 138
    11.3.3 Procedure ............................................... 141
    11.3.4 Measures ................................................ 142
    11.3.5 Respondents ............................................ 144
  11.4 Results of study 8 .......................................... 144
    11.4.1 Control measures ....................................... 144
    11.4.2 Conflicting strategies .................................. 144
    11.4.3 Presentation order ..................................... 147
    11.4.5 Additional analyses .................................... 148
  11.5 Conclusions for conflicting strategies and presentation order ................................ 149
    11.5.1 Configurality and conflicting strategies .......... 149
    11.5.2 Presentation order ..................................... 150
    11.5.3 Reversibility of the decision ........................ 150
    11.5.4 Customization strategies ............................ 150
If the rule of thumb in science "a solution for a problem raises more questions than it answers" is correct, than this dissertation raises many questions. However, I also hope that it answers some. I believe that investigating customization choices has provided me with answers, such as insights into consumers' customization process. These insights could not have come without the help of others.

I am immensely grateful to my promoters Jan Schoormans and Walle Oppedijk van Veen. I like to thank both of you for persuading me to do a PhD. I have enjoyed working with you. Jan, thank you for inspiring me when it was difficult. I know you have learned me far more than only doing consumer research. I think you can improve anyone's intelligence. Walle, thank you for your critical reviews of my writings and the inspiring ideas that always followed the critique. Your input lead to optimization of this dissertation.

I also appreciate the support of all my colleagues. I very much liked all the lunches we have done together and all the joint effort you put in making this a success. I also enjoyed our daily walk around the cemetery. We started as colleagues and you have become my friends. During my time with the department of Product, Innovation and Management, I've had many roommates and I always enjoyed their company. Sylvia Mooij you were my first roommate. Thanks for showing me through the initial steps at the department. Erik Veldhuizen and Serge Rijsdijk, you were my roommates for a short while. Erik, it was fun working on the list of recommended books for the library and on the Promood website together. Serge, thanks for valuable feedback on my papers. I was also fun constructing the innovating software "Vragenlijst." Pascale Govers, sharing a room and our opinions about a wide range of subjects always lead to interesting discussions. After sharing the room with you for almost 2 years you knew me too well, and I had to move in with Maaike Kleinmann. Maaike, thanks for the valuable input about the design challenges that I encountered when finishing my dissertation. Amina, you provided me with many insights in Muslim culture. Ruth, I know June 20th will be a beautiful day and I hope you will be very happy with your husband Wilfred. Thank you all for the discussion we had about research methodology and the nice dinners we had.

Kaj, I have learned much from doing research together and writing a book chapter together. Dirk, thank you for our discussions about alternative paradigms in decision-making, methodological perspectives and contrast studies. Erik Jan, you helped me in writing my papers. You provided basic guidelines as well as specific comments on one of my first papers. Marielle, your input and discussions at the start of my project has helped me greatly. I also like to thank Karin Langelaan and Sandra Snoek for their help in handling everyday things. Karin, thanks to you especially for your help with the lunches, and for all the other times you helped me.
I was fun working on research together with many students, which I have done often. I like to thank all of them for assisting me in my research: Olivier Lauteslager, Ralf Becks, Nicole Jasperse, Rozemarijn Plante, Agnes van Manen, Helleke Hendriks, Barbara de Nooijer, Wouter Dorsser, Mathijs de Wit, Erik van der Linden, Eline van Maanen, Gert Degen, Tomas Pasma, Marlous van der Elst and Willem Jacobs. I'm grateful for the work you have done. I also want to express my gratitude towards Robert Veryzer and John Godek for the valuable discussions we had. Peter Lloyd, thanks for reading through one of my chapters and checking my English.

I am glad that my paranymphs, Mark Stuivenvolt and Klaas Vink, will stand beside me when I defend my dissertation (in case it comes to a scuffle). Thank you, Elly, for always asking about my dissertation. I always had to explain my work plain and simple, which has greatly helped me. Frieda, you always kept me with both feet on the ground by telling me to finally get the story on paper and preferably in English understandable by you. Thank you for listening to me talking about my research and being there for me.

April 2003
Customization choices deal with the decision processes of consumers when they customize products in mass customization environments. Increased use of both computers by consumers and technology by manufacturers allows for individually customized products. An increasing number of consumers wants to distinguish themselves from other consumers (Jensen, 1999, p. 87-97) and demand unique and personalized products. Because consumers demand more variety, a shift to mass customization is necessary. Mass customization provides manufacturers with the flexibility needed to deal with this. There are different strategies for mass customization, both from a production and a marketing perspective. Some products are better suited for mass customization than others and mass customization can be implemented in various ways.

This dissertation will focus on the design of mass customization environments and how the design of these environments influences consumer decision-making. Although the computing speed of computers increases at large speed as postulated by Moore’s law (1965), the capacity of human decision makers to process information has remained more or less the same (West et al., 1999). How do these new environments affect consumer decisions? Designers should consider how consumers are making customization choices, when designing mass customization environments. Customization choices are jointly determined by the way consumers make choices and the characteristics of the customization task (Bettman, Luce, and Payne, 1998; Payne, Bettman, and Johnson, 1993). There are three types of questions that need to be answered before manufacturers offer the possibility of customizing products:

1. How much product information should be offered in mass customization environments?
2. What type of product information should be offered in mass customization environments?
3. How should product information be presented in product configurators?

In Chapter 1 the manufacturers view on mass customization is reviewed. There is not much knowledge on how consumers make decisions in these environments. In Chapter 2 the decision process of making customization choices is discussed. The research issues that follow from this discussion are summarized in Chapter 3. These research issues form the basis of the research in this dissertation.
Mass customization is the mass production of individually customized products and services (Pine, 1993, p. xiii). Manufacturers implementing mass customization strategies will produce products after they are ordered. Consumers provide their individual preferences and the product is manufactured according to these specifications. This allows consumers to create their own, unique product that expresses their personal tastes and preferences. Cars, for example, are increasingly mass customized. Consumers can visit showrooms and inquire about different car models and take a test drive, but provide their own specifications when actually buying the car. The car’s color, upholstery, engine, and wheel rims are chosen by these consumers and the individually customized cars are produced. Does this increasing interest for individually customized products make mass customization viable for manufacturers?

1.1 The Shift to Mass Customization

Until recently, products were either custom made or mass-produced. For centuries, craftsmen designed and created all products. In craft production all products are custom made by someone who possessed the appropriate materials, tools, and skills. However, at the end of the 18th century, manufacturers discovered that costs could be greatly reduced if human skills were substituted by machinery. In 1759, Matthew Boulton produced metalwork in large quantities against low prices to stand up against the competitors (Heskett, 1994, p. 14). A friend of his, Josiah Wedgwood, used mechanical turning tables, to produce large quantities of tableware as early as 1763 (Heskett, 1994, p. 16-17). These developments lead to the production of standardized products on a mass basis. In mass production all products are produced in large quantities to gain low unit costs (Pine, 1993). These two different manufacturing strategies still coexist today. Consider the following products that are examples of craft production and mass production respectively: a Rolls Royce and a Ford; an Armani custom made suit and an off-the-rack suit from Macy’s; and a five course meal at a four star restaurant and a cheeseburger and fries at McDonald’s (Pine, 1993, p. 9-10).

Pine (1993) describes how these two seemingly opposite manufacturing strategies can be integrated and explains the inevitable shift from mass production to mass customization. The system of mass production is based on efficiency through stability and control: the efficiency of the production process must be maintained through stability and control of the manufacturer’s labor, production process, production technologies, and product markets (Pine, 1993, p. 28). However, since the mass production of Henry Ford’s model T in 1913, labor costs have increased, production processes and technologies change at an increasing rate. Markets become saturated and increasingly heterogeneous. Pine (1993) shows how these factors lead to the loss of efficiency, stability and control. This indicates that a shift from mass production to mass customization is imperative. Mass customization is creating variety
and customization through flexibility and quick responsiveness (Pine, 1993, p. 44). Labor, production processes and technology must be flexible and responsive in order to provide variety for the market. Skilled personnel can provide such flexibility and responsiveness. Thus, mass customization allows manufacturers to take advantage of high labor costs of skilled personnel, changes in production and technology, and heterogeneity of markets.

1.2 PRODUCT CONFIGURATORS

Traditionally, retailers interact with consumers personally. Consumers come to the store and talk with the retailer about a certain product. There is person-interactivity, which is interactivity between people that occurs through a medium or is unmediated, as in the case of face-to-face communication (Hoffman and Novak, 1996). This works well when products are mass-produced, because the interactivity remains limited to the provision of information, such as an overview of the product benefits. If the product does not have the desired benefits, consumers search for another product that does possess the desired benefits. In case of customized products, consumers can influence the specifications of the product, and these specifications are sent to the manufacturer. The specifications for each individual consumer are collected and sent to the manufacturers for production.

These processes are often too complex to be handled by sales personnel force and would be prone to errors. No sales person can help in choosing a product out of one million possibilities. In order to manage such complex processes, manufacturers that pursue mass customization use product configurators to interact with consumers. These product configurators allow consumers to influence the product design in an interactive manner. This influence on the product design relates to consumers' influence on the functionality and appearance of the product. These product configurators capture the specifications of these products, so manufacturers know what products to produce. Consumers participate in modifying the appearance and functionality of products in real time. Product configurators possess machine-interactivity (Hoffman and Novak, 1996, p. 53; Steuer, 1992, p. 84), because consumers are interacting with the product configurator instead of with a person. Product configurators allow consumers to optimize products in an interactive manner by choosing product characteristics and receiving direct feedback on these choices. Manufacturers such as Smart (www.smart.com) offer such a product configurator (see figure 1.1). Also Mattel provides a product configurator, which allows young consumers to customize their Barbie (see figure 1.2).

Consumers using the Smart configurator can evaluate the specifications of the Smart. Information is presented about both the colors of the Smart and about characteristics related to performance, such as engine power. Consumers are allowed to customize these characteristics. Direct feedback shows how changes in the characteristics affect the design of the car. Another example of a product configurator, which has a high degree of machine interactivity, is the Giant Bike Lab (www.giant-bicycles.nl/us). The product configurator offers a variety of consumer actions to which it is able to respond. Consumers can choose various characteristics of the bicycle and the product configurator provides feedback about
the resulting design of the bicycle. Giant allows for all combinations of parts, which offers consumers the possibility of creating unique designs.

Product configurators should be interactive, so consumers can evaluate the consequences of their choices. However, product configurators should also be vivid, so consumers are able to make evaluations of the different aspects of the product, as if they were in the store, holding the product. *Vividness* is the richness of information in product configurators (Hoffman and Novak, 1995; Steuer, 1992). Other authors refer to this characteristic as realness (Naimark, 1990). The two determinants of vividness are *sensory breadth*, which refers to the number of sensory dimensions simultaneously presented (such as the basic orienting product configurator, the auditory product configurator, the haptic product configurator, taste-smell product configurator, and the visual product configurator), and *sensory depth*, which refers to the quality of the information (Steuer, 1992, p 83). Products displayed in stores have high vividness: all possible sensory dimensions are addressed and the quality of the information is high. For product configurators this is not always the case. The Smart product configurator in figure 1.1 has only limited sensory breadth, because it only presents information to the visual product configurator. No sound or force-feedback is used. This sensory breadth is typical for product configurators in the early 21st century.

![Figure 1.1 Customizing a car at Smart (www.smart.com)](image)

All sensory dimensions are important in the evaluation of the product, with no dimension necessarily more important than the other. Consumers use the sound of products in their evaluations, for example (Snelders, Mooy and Hekkert, 2000). However, the visual dimension is an important one. The appearance of a product plays an important role in product choices (Bloch, 1995; Creusen, 1998). Because of this increased importance designers should strive for high sensory depth on the visual dimension. The sensory depth
differs between different product configurators. The quality of the images and descriptions of products may vary widely. The sensory depth of Smart’s product configurator is limited; the images are small and only a few functions of the car are described. An example of high sensory depth is the 3D details of the Sony digital video cameras\(^1\), although it is not a product configurator. The quality of the images is high and consumers can investigate the functions from all sides of the camera. The vividness of product configurators should always be measured against other existing product configurators. As technology advances, the requirements for creating high vividness will advance as well. At the moment, the 3D details of the Sony digital video cameras provide an example of high vividness. In a few years, this may be cumbersome compared to new developed product configurators, because designers have added other sensory dimensions of high quality to product configurators. These product configurators are able to offer consumers a large number of products to choose from. Manufacturers may produce such variation by implementing different mass customization strategies.

![Figure 12: Customizing a Barbie at Mattel (www.barbie.com)](image)

1.3 IMPLEMENTING MASS CUSTOMIZATION

Manufacturers can differ in the degree to which they customize the production process. Before consumers acquire the product, the product has to be designed (design stage), fabricated (fabrication stage), assembled (assembly stage), and distributed (distribution stage). Customization of each of these stages of the production process leads to five different strategies that manufacturers may use (Lampel and Mintzberg, 1996). Manufacturers use

\(^1\) (http://195.2.39.25/minisites/nl/megahandycam/)
**pure standardization**, when none of these stages are customized. Ford Motor Company used this strategy in 1913 when producing the Ford-T model. Initially, this car was only available in one model and in one color, thus demonstrating pure standardization. **Segmented standardization** is used when the distribution stage is customized. Manufacturers make different products for different segments of the market. Different products are designed for each market segment. Thus, manufacturers customize a product for each market segment, but not at the request of individual consumers. A segmented standardization strategy therefore increases the choices available to consumers, without increasing their influence over design or production decisions. Philips (www.philips.com), for example, uses a segmented standardization strategy when making various coffeemakers, targeted at different segments in the market. Most mass customization manufacturers use a **customized standardization** strategy, which also customizes the assembly stage. This allows consumers to select their own set of components. Mattel uses such a customized standardization strategy on their website (see figure 1.2), where young consumers can customize a Barbie (www.barbie.com).

When the fabrication stage is customized as well, Lampel and Mintzberg (1996) speak of **tailored customization**. The manufacturer presents a product prototype to consumers and then tailors it to the consumers’ individual preferences. Manufacturers of clothing may use tailored customization. On the website of Nike (nikeid.nike.com) or Customatix (www.customatix.com) consumers can design their own shoes. The product configurator allows consumers to specify different colors for the shoe (see figure 1.3).

![Figure 1.3 Customizing a shoe at Nike (nikeid.nike.com)](image)

To make the shoe truly unique, a consumer can create identification (ID) on the back of the shoe. So my shoes could say "Niels" on the left shoe and "Vink" on the right. Finally, in **pure customization** the design process is customized and the product is especially designed for individual consumers. Examples are jewelers, who design customized jewelry, or residential
architects who design customized houses. This type of customization has been employed by craft production for centuries.

Within these strategies, manufacturers may not only vary the degree to which the production process is customized, but also in the way they interact with consumers. Many manufacturers build databases with extensive information about their customers. This allows them to provide specific offers that are relevant for certain consumers. If someone buys an electric shaver, for example, a manufacturer may offer replacement blades after two years. In the case of mass customization of products, four different approaches to consumer interaction can be distinguished (Gilmore and Pine, 1997).

First of all, manufacturers can use an adaptive approach when the production process is not customized, and there is minimal interaction with consumers. This is an appropriate approach when consumers want the product to perform in different ways and technology makes this possible. Honeywell sells thermostats that are all identical when sold. However, the thermostat learns about the users’ behavior patterns and adapts accordingly. Consumers can also customize their thermostat themselves by entering various programs in the memory of the product. Each consumer thus owns a thermostat that is customized to their individual preferences, although the production process and the interaction with are identical for each thermostat. Manufacturers can also use a cosmetic approach, where there is some consumer interaction, but no customization of the production process. The production process is essentially the same, but companies communicate to consumers that they create a unique product for each individual. A manufacturer of credit cards, for example, may manufacture a unique credit card for each consumer. At the website of Advanta (www.advanta.com), for example, consumers can customize the way their credit card looks (see figure 1.4) by choosing the business name that is printed on the card. Thus, the customization of the business name on the credit card makes the credit card unique, but does not really change the actual product.

![Figure 1.4 Customizing a credit card at Advanta (www.advanta.com)](image)

When the product is customized to some degree (i.e. not pure standardization), manufacturers may use a transparent approach. The production process is customized, but this is not
explicitly communicated to the consumer. The manufacturer customizes the product so it
suits the individual preferences of consumers, without letting them know explicitly that the
product is being customized for them. This is often the case with car or household insurances.
The insurance fee is customized depending on the neighborhood of the insurant, without
letting the insurant explicitly know that the contribution is customized.

Finally, manufacturers may use a collaborative approach, which is based on customizing the
production process and communicating this to consumers. At Shirt Custom (www.shirts-
custom.com) or Bivolino (www.bivolino.com) consumers can customize their own dress shirt
(see figure 1.5). The product configurator also explicitly states that the dress shirts are
customized for the visitors, which also becomes clear from the name of the website: shirts-
custom. In this case the production process of the dress shirt is customized and this is
communicated to consumers as well.

![Figure 1.5 Customizing a dress shirt at Shirt Custom (www.shirts-custom.com)](image)

The collaborative approach has the greatest impact on the production process of
manufacturers. This approach leads to an enormous variety of products, which are produced
after consumers choose their products. Consumers thus have to choose collaborative
customized products before they are produced. In the adaptive and cosmetic approaches the
product is not customized, and in the transparent approach consumers often do not know
about the customization. The collaborative approach signals the ultimate form of mass
customization, where every product is build only after it is ordered. Not every product is
therefore suited for mass customization. There are many ways of implementing mass
customization. Currently, manufacturers usually offer product customization through product
configurators. This is certainly not the only way to implement mass customization, but this dissertation will explicitly investigate product configurators. This means that mass customization is implemented either as customized standardization or tailored customization and that this is communicated to consumers as well (a collaborative approach to consumer interaction).

1.4 Products suitable for product configurators

Product configurators allow consumers to specify their preferred characteristics of the product before it is produced. In order to choose the preferred overall product, consumers should be able to evaluate these products before purchase. Interactivity and vividness allow evaluations of both the functionality and appearance of the product. In product configurators consumers should be able to evaluate all the product variants that result from changing characteristics. The extent to which the effect of changes can be evaluated depends on the type of characteristic. Some characteristics can be more easily evaluated than others. These characteristics can be distinguished using a categorization into search attributes, experience attributes, and credence attributes (Darby and Karni, 1973; Nelson, 1970; Wilkie, 1994, p. 490). Search attributes allow consumers to evaluate the benefits prior to purchase. The fact that these attributes are easy to evaluate in a product configurator makes them searchable. It is easy for consumers to search many products (or alternatives) based on one or more search attributes. A search attribute for digital cameras, for example, may be the number of mega pixels. It is easy for consumers to search for a digital camera with the most mega pixels. Products, of which the most important attributes are search attributes, are suited for product configurators, because consumers are able to evaluate these characteristics on the spot.

Experience attributes can only be evaluated after purchase and repeated use. Products, of which the most important attributes are experience attributes, have to be experienced before the benefits can be evaluated. Therefore, products with many experience attributes are less suitable for product configurators. Two different types of products with experience attributes can be distinguished (Klein, 1998; Norton en Norton, 1988; Wilkie, 1994, p. 495): nondurables and durables.

Nondurables are products that are consumed quickly and are often repurchased on a frequent basis, such as ice cream. Consumers who buy a new kind of Italian ice-cream will only be able to evaluate the ice-cream after consumption; in other words, after a taste-experience. Consumers will always sample nondurables, because the costs of searching for product information do not outweigh the costs of the product. The costs of buying an ice cream do not outweigh the costs of evaluating the ice cream without purchasing it. Non-durables are not suited for product configurators. Consumers will rather try these products than search for them.

Durables are products that are used multiple times and are infrequently purchased, as for example a vacuum cleaner. As with ice cream, consumers will only be able to evaluate the vacuum cleaner after repeated use. Using the product allows consumers to compare their expectations with the actual performance. Contrary to nondurables, consumers will be
encouraged to search information, because the product is used multiple times, is infrequently purchased, and often expensive. Therefore, consumers want to make a well-founded decision and search information. Consumers will search for a vacuum cleaner before they purchase one. In most stores such search is relatively easy. However, durables are not suited for product configurators, unless manufacturers are able to communicate (some of the) experience of the experience attributes of the products. This may be achieved by adding product demonstrations or information clearinghouses to the product configurator (Van Driel, et al., 2003). Product demonstrations allow consumers to experience certain product characteristics through virtual demonstrations of the product (Dahan and Srinivasan, 2000; Mooy, 1998). Adding product demonstrations to product configurators that offer products with experience attributes provide consumers with virtual experience. Manufacturers could add movies demonstrating the cleanliness of a house after using a certain type of vacuum cleaner or add a virtual model of a digital camera which consumers can operate (see www.sony.com for example). Information clearinghouses allow consumers to communicate with manufacturers by means of two-way interaction. Product configurators that offer products with experience attributes could offer consumers the possibility of asking the manufacturer questions. Asking questions this way does not take consumers a lot of effort. The answer is customized for each consumer and therefore very relevant. However, consumers have to accept that the reply may take some time (Van Driel, et al., 2003).

Credence attributes cannot be accurately evaluated even after purchase and repeated use. Consumers have to believe that the product characteristics provide the promised benefits. Skin care products, for example, have credence attributes. How can consumers really know whether these products reduce wrinkles? Products with credence attributes are thus very hard to evaluate, even in stores. This makes products with many credence attributes unsuitable for product configurators, unless manufacturers are able to communicate some of the credence attributes to consumers. Product demonstrations and information clearinghouses can be used to achieve this, although this may be even harder than for products with experience attributes.

Search attributes are most suited for product configurators. This does not mean that experience and credence attributes cannot be offered through these product configurators. Product presentations and information clearinghouses provide ways of communicating these attributes.

1.5 Usage situations of product configurators

Manufacturers may offer product configurators in various situations. Usage situations vary in their suitability for offering different types of attributes. Manufacturers can provide product configurators in three situations. First, product configurators can be used on mobile laptop computers. Sales personnel visit consumers at their home for personalized advice, where consumers use the product configurators together with the sales representative. It is believed that this works best for products with many credence attributes. Many insurance-companies already offer insurances this way. Sales personnel visit consumers at their home and aid consumers in the customization of an insurance. Sales personnel are experts on specific insurances and their advice can provide the information necessary to evaluate these products,
even though insurances have many credence attributes. When the consumer has made a selection for all options, the insurance contract is produced.

Second, consumers can use the product configurators on in-store computers. Sales personnel can assist consumers with the customization process. These in-store product configurators may carry products with many experience attributes. Consumers may be unfamiliar with these experience attributes and appreciate assistance from sales personnel. Bicycles may be suited to sell by these in-store product configurators. Sales personnel can help a beginning cyclist in the selection of the many characteristics. Airborne (www.airborne.net) is a product configurator for bicycles which may be used as in-store product configurator. Aided by a sales assistant, the cyclist can choose from a wide variety of options for each characteristic (see figure 1.6). Price and weight of the bicycle adapt to any changes made and are displayed just below the bicycle (see figure 1.6). A small image in the upper left corner shows the appearance of the bicycle.

Mass customization of computer systems can be applied in-store as well. Consumers are often uncertain about the specifications of their computer and characteristics of computer product configurators change rapidly. Sales personnel could aid consumers in the selection of a computer, using product configurators such as Dell (www.dell.com). Dell’s product configurator shows the appearance of the computer and several specifications (see figure 1.7). Several alternatives are presented next to each other. Selecting a specific computer allows customization of the specifications. Experienced computer users and seasoned cyclists can operate product configurators, such as Airborne and Dell, themselves. They use the product
configurators in the store and at the manufacturer’s website without assistance from sales personnel. This constitutes the third usage situation of product configurators: on the Internet. Products most suited offered for web-based product configurators are products with a considerable number of searchable attributes, such as watches. Ewatchfactory (www.ewatchfactory.com) and Esprit (www.swissesprit.com) offer such product configurators.

Figure 1.7 Customizing a computer at Dell (www.dell.com)

**CHOSE A DESKTOP**

<table>
<thead>
<tr>
<th>LATEST PENTIUM 4 with 533MHz Bus Speed</th>
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<tbody>
<tr>
<td>Cutting Edge Technology</td>
</tr>
<tr>
<td>Dimension 8200</td>
</tr>
<tr>
<td>Pentium® 4 processor at 1.0GHz</td>
</tr>
<tr>
<td>128MB 100Mhz DRAM Memory</td>
</tr>
<tr>
<td>Claydon budget higher performance</td>
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<tr>
<td>Includes 6.3GB hard drive</td>
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<tr>
<td>Integrated video &amp; graphics (compatible to 100Mhz)</td>
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<tr>
<td>Networking, networking</td>
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<tr>
<td>Advanced DDR SDRAM</td>
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</table>

Figure 1.8 shows the product configurator of Esprit that allows consumers to customize a watch. Consumers can choose from different styles, case, dials and straps. The consumer is guided through the different steps of creating a watch, choosing one characteristic at a time. The watch is built in front of the consumer’s eyes and is complete once a choice for each characteristic has been made.

Thus, in general, advisors with mobile laptop computers product configurators are most suited to offer products with many credence attributes. When products have many experience attributes, consumers may require assistance and in-store product configurators may be most suitable. Finally, web-based product configurators are suitable for products with many search attributes.
1.6 Challenges in Designing Product Configurators

Mass customization is increasingly viable for manufacturers. However, offering customization choices to consumers poses many challenges. One of the main challenges of mass customization for consumers is the possible danger of information overload (Pine, 1993, p. 246-249). Manufacturers using mass customization production processes are able to provide a large variety of products that consumers can choose from. Consumers could be overwhelmed by the amount of information presented in product configurators, which keeps them from making any customization choices at all. When designing product configurators, manufacturers have to decide how much product information should be presented, what information should be presented, and how it is presented to avoid this information overload.

How much product information should be presented to consumers? In the product configurator of Airborne (see figure 1.6) all product information is presented at once. Consumers may be overwhelmed by the quantity of information offered in this product configurator. On the other hand, other product configurators offer limited product information. Only a limited number of characteristics can be customized in the product configurators of Esprit (see figure 1.8). The product configurator of Dell (see figure 1.7) initially provides limited information about the computers, although other characteristics of Dell’s computer can be customized. Also, the product configurator of Smart (see figure 1.1), provides limited information about the car; what about the type of stereo, type of upholstery, safety, warranty etc.? Are consumers willing to buy a car based on such limited information? These limitations could be the result of production limits. Perhaps the production lines of Smart do not allow for so much variety. On the other hand, Smart may have reduced the variety on purpose, so the number of choices that consumers have to make remains limited. Smart may believe that consumers do not want to make endless number of choices for all possible characteristics, although this is feasible in their production facility. It is not clear how much product information should be presented in product configurators in order to satisfy consumers’ information need.
A second question is what type of product information should be presented to consumers? Some types of product information are better suited for product configurators. As discussed, search attributes seem most suited for product configurators, whereas credence attributes seem most difficult to communicate. Experience attributes are moderately appropriate. Manufacturers have to invest effort in order to communicate these different attributes to consumers effectively, such that the expectations evoked by product configurators correspond to actual performance. Many of the product characteristics in the product configurators, which served as examples in this chapter, are experience attributes. The product characteristics in the product configurators of Dell and Airborne are mainly related to functionality. Airborne allows consumers to customize the functional characteristics of the bicycle, but does not show how they affect the product appearance. As for the appearances of Dell’s computers: they cannot be customized. In the product configurators of Esprit, Barbie, and Nike, on the other hand, the product characteristics are mainly related to appearance. In the product configurator of Esprit (see figure 1.8), for example, only characteristics related to the appearance of the watch can be customized. Characteristics such as an indication of the date, alarm, or water resistance cannot be selected. Consumers using the product configurator of Nike (see figure 1.3) can only customize the colors of the shoe and the ID. Information about the quality of the materials used is not provided. What type of characteristics do consumers want to customize and for what type of products?

A third question relates to how the product information should be presented to consumers. Feedback about the current selection of product characteristics can be provided in different ways. Most of the product configurators present the products in assembled form. For the Barbie product configurator, for example, Mattel had to design and visually create 864 images of the assembled Barbies. Mattel had to invest much time and effort to create all these visual materials. Does assembled presentation improve the design of the product configurator? In what order should the product information be presented? The product configurators of Nike, Dell, Airborne, Esprit, Advantage, and Shirt Custom provide several steps that the consumers has to take, before the overall product can be evaluated. The product configurators of Smart and Barbie show all product characteristics that can be customized on one screen. This allows consumers to get overview over the different alternatives that can be created. Do consumer prefer to different phases in the customization process, because they are overwhelmed by the amount of product information otherwise? Furthermore, it is not clear how product information should be presented in product configurators. The product configurator of Mattel provides an initial Barbie as a starting point, whereas in the product configurator of Esprit (see figure 1.8) the watch is constructed during the choices for each characteristic. Only then the total appearance can be evaluated. Could the product configurator offer an initial configuration that can be customized by the consumer?

Mass customization refers to the development, production, marketing, and distribution of customized products and services on a mass basis (Pine, 1993). However, the production of products starts only after a consumer makes customization choices. Therefore, also knowledge about the way consumers choose products in these environments is needed. How does the decision-making process evolve when consumers are making customization choices? In the next chapter the challenges for manufacturers are discussed in more depth in the
context of consumer decision-making. The focus will be on the customization choices that consumers have to make in these environments.
CHAPTER 2
CUSTOMIZATION CHOICES

Consumers use product configurators to make customization choices. Customization choices are the decision processes of consumers when they customize products in mass customization environments. In the process of making these choices, they have to search for information, evaluate the product characteristics and make choices. Such decision processes in mass customization environments are different from decision processes in traditional environments. In this chapter, the decision processes in traditional environments are described first. These decision processes are different in mass customization environments. Such decision processes will be referred to as customization processes. Consumers engaged in these processes customize the characteristics of the product; hence these are called customizable characteristics. More specifically, consumers customize characteristics by changing the levels of these characteristics. Finally, the various characteristics of customization tasks and their influence on customization choices are discussed.

2.1 STAGES IN THE DECISION PROCESS

There are many models of consumer decision processes (for an overview of alternative paradigms in decision-making, see Decrop, 1999 and Svenson, 1996). Most of them were developed from Simon's original idea of describing the decision process as a series of stages (Pederson, 2000). The number of stages in these models ranges from two (Haubl and Trifts, 2000; Lussier and Olshavsky, 1979; Wright and Barbour, 1977) to six (Beach and Mitchell, 1978; Guttman, Moukas and Maes, 1998). An overview of the stages in the decision process is provided in table 2.1. These models of the decision process have in common that they usually distinguish three types of processes: pre-decision processes, decision processes, and post-decision processes. The pre-decision process often includes a problem recognition stage, where consumers become aware of an unmet need (Beach and Mitchell, 1978; Guttman, et al., 1998; Pederson, 2000) or a stage were consumers determine which store to buy the product and when to buy it (Guttman et al., 1998; Wilkie, 1994, p.475). Also ongoing search, where consumers collect information without actually considering a purchase (Bloch, Sherrell and Ridgeway, 1986), can be viewed as a stage in pre-decision processes. Consumers collect product information, which they may use later when they do intent to make a purchase.

Pre-decision processes in mass customization environments may concern searching for product configurators in the store or on the Internet. Post decision processes include stages, such as a delivery stage, where consumers actually acquire the product (Guttman et al., 1998). A product evaluation stage is sometimes included (Guttman et al., 1998; Wilkie, 1994, p. 542), where consumers compare the actual performance of products to their expectations.

2 Such levels or values of product characteristics will be referred to as 'attribute levels.'
Finally, a disposal stage may also be included in post-purchase processes (Wilkie, 1994, p. 534).

<table>
<thead>
<tr>
<th>Table 2.1. Stages in the decision process</th>
<th>Number of stages</th>
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<tbody>
<tr>
<td>Pre-decision stage</td>
<td>2</td>
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<td>4</td>
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<td>6</td>
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<td></td>
<td>6</td>
</tr>
<tr>
<td>problem recognition</td>
<td>problem recognition</td>
</tr>
<tr>
<td>evaluation of the decision task</td>
<td></td>
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<tr>
<td>Decision Stage</td>
<td></td>
</tr>
<tr>
<td>recommendation (elimination)</td>
<td></td>
</tr>
<tr>
<td>search</td>
<td>strategy selection</td>
</tr>
<tr>
<td>comparison (selection)</td>
<td>information</td>
</tr>
<tr>
<td>evaluation</td>
<td>processing</td>
</tr>
<tr>
<td>strategy</td>
<td>implementation</td>
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<td>choice</td>
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<td>choice</td>
<td>choice</td>
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<tr>
<td>purchase and delivery</td>
<td></td>
</tr>
<tr>
<td>consumption and evaluation</td>
<td></td>
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<tr>
<td>Post-decision stage</td>
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</table>

Both pre- and post-decision processes in mass customization environments are not expected to be very different from these processes in traditional environments. Therefore, pre-decision processes (searching for product configurators in the store or on the Internet) and post decision processes (the processes of evaluating the decision after a product has been chosen) are not considered. How consumers find a product configurator on the Internet is important, but does not receive attention in this dissertation. Research in this dissertation will focus on customization challenges that are encountered during the decision process. Three stages are distinguished in this process of customization choices: a search stage, an evaluation stage, and a choice stage. In the search stage, consumers deliberately attempt to gain knowledge about a product. In the evaluation stage, consumers evaluate a product or compare them to other products. In the choice stage, consumers make a choice between the available alternatives. The three stages of the decision process in mass customization environments are different from decision processes in traditional environments: the stages in the decision process are integrated. This means these stages are interwoven with each other and cannot be distinguished independently.

2.2 INTEGRATED STAGES IN THE DECISION PROCESS

When making customization choices, consumers usually go through a customization process that consists of three stages. In the search stage, consumers search for product information. This information is used in consecutive stages of evaluation and choice. Thus consumers search for product information, evaluate the product characteristics and the configured
products and choose an alternative. However, consumers may return to the search stage to acquire more information, when the product characteristics or the configured products receive negative evaluations. Even after consumers choose a configured product, they may return to the search stage to verify their choice. Sometimes, consumers start searching again after a choice has been made, because they expect to find a better product. Consumers use these stages in an iterative way. Mass customization environments seem to encourage such iterative decision processes. This means that consumers go through the stages of search, evaluation and choice, more than once. Iterative decision behavior is likely to occur in mass customization environments, because of various reasons. First, iterative behavior is inherent to mass customization environments. Products are constructed in front of consumers’ eyes, unlike traditional ways of choosing products. This means that when consumers are searching for product information in product configurators, consumers have to evaluate the offered product characteristics and customize these characteristics at the same time. Consumers are customizing a shoe for example; say the shoe will have two colors: a major color and a minor color. They may search for the possible color combinations of the shoe. In this search process, they have to make an initial choice for the major and minor color before they can evaluate the various combinations of these colors. The evaluation of these initial choices may lead to additional search, choice, and evaluation of colors, until a satisfying combination of colors is found.

Second, in mass customization environments it may cost consumers less effort to go through the customization process. It is easy to collect information for various products. Consumers do not have to visit different stores, but can search large amounts of product information from one place. Also comparing products takes less effort because computers allow easy comparisons and evaluations. Such comparison makes it easier for consumers to take a quick look at additional information but also influences the search process. Starting to search takes less effort in mass customization environments and therefore makes iterative behavior more likely. Fanatic cyclists may have heard of Giant’s product configurator (see chapter 1). They may try this product configurator. These cyclists casually choose some product characteristics and evaluate the resulting bicycle. The new features that they have casually chosen may interest them; they want to know more about the other possibilities of the product configurator and start a more extensive search.

Third, mass customization environments allow consumers to switch between the stages of the decision process more easily. Consumers can compare and evaluate products before they have searched all products. Many consumers may therefore compare and evaluate alternatives quickly to investigate what product information is needed to make a decision. A more extensive search is initiated when the information need is identified. This procedure may repeat itself several times, leading to iterations in the decision process. For example, consumers may be looking for a digital camera, but do not know anything about these products. They may evaluate several cameras to see the differences in price. Next, they start searching for products in the appropriate price range.

Fourth, when a choice has been determined consumers do not have to purchase the configured product right away. Choice is not equal to purchase in mass customization environments. In a store there is some social pressure to buy the product directly, because the
sales clerk invested effort to help consumers. On the Internet consumers can use product configurators multiple times, without the social pressure to buy the chosen product. They may want to repeat the entire decision process to check if they have chosen the appropriate product. Furthermore, consumers often consult with their partners about purchases (Wilkie, 1994, p. 399-401). They may repeat the decision process together with their partner, as a way to deliberate upon the decision. All these consumer actions may lead to more iterations of the decision process.

Fifth, consumers may also use product configurators for entertainment purposes. They may try to make awkward combinations of characteristics. The configurations they have arbitrarily customized may pleasantly surprise them and evoke their curiosity. As a result they may go through the decision process multiple times. Trying the product configurator for entertainment purposes will lead to more iteration cycles of the decision process. Thus, the decision process in customization environments is different from decision process in other environments.

### 2.3 Consumer Motives to Search

Searching for product information can be motivated by two objectives, which manifest themselves by two types of search: ongoing and pre-purchase search (Bloch, Sherrell and Ridgeway, 1986). Consumers engage in *ongoing search* when they gather information without actually considering a specific purchase. Consumers have various motives to engage in ongoing search. First, consumers may engage in ongoing search to gain knowledge that can be used for future purchase decisions. Consumers may follow developments in audio technology, for example, so they know what product characteristics should be considered when the old stereo set breaks down. Second, consumers may search out of interest and fun. Many consumers read magazines about products out of interest and fun, for example computer magazines and consumer reports, without the intention to purchase products from this category. Third, consumers engage in ongoing search after a purchase to justify their decision to family, friends, colleagues, or to themselves. People frequently visit stores after purchase to check whether they indeed bought the product at the lowest prices available. As mentioned before, ongoing search can be viewed as a stage in the pre-purchase process and will not be considered in the discussion of mass customization environments.

Consumers usually start searching for product information when they consider the purchase of a product, which is called *pre-purchase search*. In this case they consciously search for information with the intention to make a particular purchase. Consumers may have various motives when engaged in pre-purchase search. First, consumers are motivated to make accurate decisions. When consumers consider a new car for example, they may desire the fastest car available. The speed of the car can be determined accurately, but depends on various characteristics, such as weight, engine power, and aerodynamics. The consumer that really wants the fastest car will be motivated to search for these characteristics of each car in order to make an accurate decision; that is, to choose the fastest car. Second, when it is not possible to make accurate decisions, consumers desire to minimize product uncertainty before making a purchase. The safest car, for example, cannot be determined unambiguously and
consumers are motivated to reduce the product uncertainty to an acceptable level. They collect product information until they have a certain level of confidence in the safety of a particular car. A third motive to engage in pre-purchase search may be to avoid negative emotions by avoiding conflict in decision (Bettman, Luce, and Payne, 1998). When buying a new car, for example, consumers may have to trade off the safety of a car against environmental concerns. The degree of emotion often depends on the degree of conflict between the alternatives and the specific characteristics involved in the conflict. Consumers may avoid conflict by suspending the purchase decision. When the decision is postponed, negative emotions will be postponed as well. Fourth, consumers are motivated to search in order to maximize the ease with which a decision can be justified afterwards, because they are individually accountable (Tetlock, 1983) or personally responsible (Petty, Harkins, Williams, 1980). As described, justification of the decision may also be a motive to engage in ongoing search. Consumers may choose a car, for example, that sells for the lowest price. Price is easier to justify than safety, because a difference in price can be measured more easily than a difference in safety. Fifth, sometimes consumers are not motivated to search for product information. They just want to minimize the effort required for decisions (Bettman, et al., 1998), which relates to the time, money, physical and cognitive effort they have to invest. When consumers are buying a new car, for example, they take the first car that meets certain characteristics (for example, price, engine power and size), to minimize the time (visiting retailers), and physical effort (walking from car to car), and cognitive effort (deciding which of all these cars to choose). Finally, personal characteristics may lead to active search of product information in the external environment. Some consumers are more motivated to search for product information than others. Some consumers, for example, enjoy thinking; they have a need for cognition (Cacioppo, Petty, and Morris, 1983), which motivates them to search for product information.

Consumers may use product configurators, because the large amount of information in these product configurators allows them to reduce uncertainty or because they try to make accurate decisions. Other consumers will use these product configurators because of the minimal effort it takes to use them in terms of time and physical effort. Some consumers will look at product configurators to gain knowledge about new technological advancements, whereas others just visit these product configurators to be entertained by their interactivity and vividness. In order to make decisions, consumers often acquire product information through active search.

2.3.1 Active search
Consumers who actively search for product information use various sources of information (Punj and Staelin, 1983; Schmidt and Spreng, 1996; Srinivasan and Ratchford, 1991). These sources can be classified into four types (Beatty and Smith, 1987): retailers, media, interpersonal relations, and neutral sources. Consumers can obtain product information by visiting retailers. At the store or showroom they may visually inspect the product, but they may also be able to try it. They can talk to salespersons and ask them questions. Consumers who consider buying a car, for example, visit a showroom and make a test-drive. Another source of product information is the media. Consumers may acquire product information by inspecting and investigating advertisements in brochures, magazines, newspapers and billboards, but may also pay attention to commercials and demonstrations of products on
television, radio, Internet and in the cinema. Consumers who are looking for a new car may by chance see a television commercial about a car that they are considering or may deliberately buy a car magazine. Consumers may also use interpersonal relations as a source of product information. They may ask friends and family for advice and their personal experiences. Consumers considering a Volkswagen Beetle may ask friends that own a Beetle about their experiences with that car. Some consumers use neutral sources of product information. They may be reading consumer reports, news articles, and product tests by independent organizations.

Most consumers value some sources of information more than other sources. Westbrook and Fornell (1979) used consumer information sources to make a distinction between four types of consumers (see also Wilkie, 1994, p. 495). About 20 percent of all consumers are personal advice seekers. They use predominantly interpersonal relations as source of information and do not use many other sources. Store intense shoppers make up 30 percent of the consumers. This group of consumers uses retailers as their principal source of information. Objective shoppers rely heavily on neutral sources of product information. They represent about 20 percent of consumers. Finally, moderate shoppers make up 30 percent of all consumers. These consumers tend not to use retailers and interpersonal relations as sources of information and only moderately search the media and objective sources. These classifications were deducted from researching decision process in traditional environment, but can be extended to the decision process in product configurators.

Consumers will use product configurators in different situations, although some consumers may not use product configurators at all. Personal advice seekers are most likely to use these product configurators together with salesmen visiting their home, regardless of the type of characteristics (search, experience, or credence attributes). Because personal advice seekers prefer personal advice, they are not likely to encounter product configurators otherwise. Store intense shoppers are most likely to encounter product configurators in the store. Sales personnel can help them while making customization choices. Objective shoppers may not use product configurators at all, if they do not consider these product configurators to be objective. Finally, moderate shoppers are most likely to use product configurators on the Internet, because they tend not to use retailers and interpersonal advice. The amount of search depends on the type of consumer and on the motivation to search. However, consumers’ knowledge about products also influences decisions.

2.3.2 Consumer knowledge
Consumer knowledge may be acquired actively, by previous active search or prior personal experience with the product. Active search using different sources of information results in knowledge. Prior personal experience results from personal use of a product, previous choice and previous decisions. Information acquired actively is stored in memory and may be used later when considering a purchase. Consumers may also notice an advertisement on a billboard, incidentally watch a commercial on television or hear about a product from a friend. In this way they acquire knowledge about products passively (Beales et al., 1981).

Three different types of consumer knowledge can be distinguished: subjective knowledge, objective knowledge, and familiarity (Brucks, 1985). Subjective knowledge is what
consumers think they know. It is the consumer’s perception of the amount of product information they have stored in memory, which does not necessarily correlate with the objective amount of product information stored in memory. Consumers high in subjective knowledge appear to be efficient searchers, because they eliminate a subset of alternatives early in the process. Furthermore, these consumers are often confident in their ability to make decisions (Park and Lessing, 1981). Objective knowledge is the amount, type, and organization of product information that consumers actually have stored in memory. Consumers high in objective knowledge are likely to search more characteristics than consumers with less objective knowledge and seek less information about inappropriate alternatives (Brucks, 1985). Familiarity is the amount of purchasing or usage experience with a product (Alba and Hutchinson, 1987). Consumers consider more product characteristics of familiar products and consider fewer alternatives. Overall, the amount of search shows an inverted-U-shaped relationship with familiarity. When consumers get more familiar with products, they require more product information; this is not only because they consider more product characteristics, but also because they search information related to the stores where the product is available and experiences of other users of the product. However, when consumers get more familiar with products, they also have greater knowledge about these products and their need for information decreases.

Alba and Hutchinson (1987) also distinguish expertise as a component of consumer knowledge. Expertise is the ability to use product information to make optimal decisions. Expertise positively correlates with familiarity. Alba and Hutchinson (1987) distinguish between five ways in which familiarity may improve expertise: (1) cognitive structures become more refined and complete as familiarity increases, (2) the ability to analyze information improves as familiarity increases, (3) the ability to elaborate on information improves as familiarity increases, (4) the ability to remember information improves as familiarity increases, and (5) cognitive effort to perform product related tasks is reduced as familiarity increases. The first component relates to the number of characteristics that consumers consider (Moorthy, Ratchford, and Talukdar, 1997). An expert is likely to consider more characteristics than a novice. Therefore the amount of search will increase when consumers are becoming more familiar with products. However, consumers consider fewer alternatives when they get more familiar with products. This leads to the inverted-U-shaped relationship between familiarity and amount of search indicated above. Thus, the amount of search will increase initially and decrease when consumers get more familiar with products. The other components relate to the cost of search (Moorthy, Ratchford, and Talukdar, 1997). The cost of search for experts is likely to be lower than the cost of search for novices, because their ability to analyze, elaborate, remember, and cognitively process information is higher.

The different types of consumer knowledge influence the effort that consumers are willing to invest in searching product information and the uncertainty about whether they have made the appropriate decision. Consumers high in subjective knowledge invest less effort than consumers low in subjective knowledge and are often more certain about their decisions. Consumers with much objective knowledge invest more effort than consumers with little objective knowledge. The relation between familiarity and effort can be described by an inverted-U-shape; effort increases initially, but decreases when consumers become really
familiar with products. Expertise is correlated to familiarity and shows a similar inverted-U-shape relationship with effort.

2.3.3 Active search in mass customization environments
When engaged in the search stage, consumers prefer to use their knowledge rather than search actively for product information (Alba and Hutchinson, 2000, p.134; Beales et al., 1981). First, visiting retailers takes more effort than searching memory. Consumers have to invest effort to visit retailers, but also have to take opening hours of these retailers into account. Second, media sources often do not deliver the information in the form that maximizes its usefulness and minimizes the difficulty of processing it (Beales et al., 1981). Most products in brochures can be easily compared on price. However, product information in these media often does not allow for easy comparison of other product characteristics. Some retailers only present the number of mega pixels of their digital cameras in their brochures. This does not make the brochure very useful for comparing and selecting the camera with the best battery. Third, interpersonal relations as sources of information are most useful when consumers place the same importance on the product characteristics as their friends do. One consumer may, for example, consider the number of mega pixels of digital cameras the most important, whereas a friend may find the battery and the size of the camera more important. The advice of this friend may not be very useful for this consumer, because they consider other product characteristics to be important and therefore would choose different cameras. Fourth, the sources of information, such as media, friends, or neutral sources, are not always available when consumers make a decision. When deciding about a digital camera, no commercials may appear on television, friends may be on holiday and computer magazines do not have reviews about digital cameras in the current issue. Thus, consumers may therefore heavily rely on their knowledge in their decision processes. However, information stored in memory is often biased and incomplete.

Active search using mass customization environments can be a useful addition to knowledge stored in memory. Mass customization environments do not have the disadvantages of other sources of search. Information from various retailers is easily accessed. Furthermore, mass customization environments allow consumers to search the information in a way that they find useful. These product configurators can be designed in such a way that consumers themselves can structure the information. This makes it easier to compare product characteristics that are important to each specific consumer. In this way, mass customization environments are also able to place the same importance on product characteristics as the consumer that uses the product configurator. These mass customization environments can provide product suggestions and include individual preferences. Finally, for product configurators on the Internet, product information is available 24 hours a day and can be consulted whenever it is needed. Product configurators as a source of information have their own disadvantages. The products offered through product configurators, for example, are most often of one brand.

How do consumers use product information to make decisions about the product? Consumers may have different motives that guide these product decisions. They often try to satisfy multiple motives at the same time. Therefore the decision process in mass customization environments may depend on the trade-offs between different motives.
2.4 Making a Product Decision

Consumer decision processes involve both the retrieval of product information from memory and the acquisition of additional product information from the external environment (Simonson, Huber, and Payne, 1988). Consumers use this information to make decisions. For some product categories, consumers may simply retrieve these previously formed evaluations from memory and select their preferred product (Hauser and Wernerfelt, 1990; Roberts and Latin, 1991). Such processes often occur when consumers are making recurring purchases, such as the daily groceries. However, consumer evaluations are often constructed when needed (Bettman, Luce, and Payne, 1998; Dhar, Nowlis, and Sherman, 2000; Payne, 1982; Payne, Bettman and Johnson, 1992; 1993). One reason why evaluations are constructed is that consumers lack the cognitive resources to generate well-defined evaluations for many situations (Bettman, Luce, and Payne, 1998). Especially when consumers are making choices in mass customization environments, they are unlikely to construct evaluations for all variations of products they encounter (i.e., 864 evaluations for the possible Barbies). Furthermore, due to the iterative nature of the decision process, evaluations may be constructed along with the product. In mass customization environments consumers are unlikely to use a predefined decision process and hence are unlikely to use predefined evaluations. They have to be constructed on the spot. Second, consumers often bring multiple motives to a given decision problem (Bettman, Luce, and Payne, 1998). To determine their evaluations, consumers trade off these different motives. The way consumers trade off their motives when engaged in active search can be understood in terms of different frameworks.

According to the accuracy-effort framework (Payne, 1976) consumers make a decision by trading off the desire to make accurate decisions and the desire to minimize effort. An accurate decision may be the selection of the optimal bet (see for example, Payne, Bettman, and Johnson, 1988) or optimal product (see for example, Bettman, Luce, and Payne, 1998). Products in the latter case are presented by characteristics, of which the optimal attribute levels can be easily determined. These characteristics may be warranty and price, for example, where a lengthier warranty period and a lower price are considered to be better decisions (Tversky and Simonson, 1993).

However, according to the perceptual framework (Kahneman and Tversky, 1979; Tversky and Kahneman, 1981), consumers focus on certain aspects of alternatives that are particularly salient in the decision task. Specifically, consumers seem to focus on the value of a product in relation to the other products in the choice set. An assumption of this framework is that participants focus on the relational characteristics of the alternatives at the expense of absolute characteristics of the alternatives (Dhar, Nowlis, and Sherman, 2000). Consider the choice between 3 cars, for example: one Japanese sedan, one Japanese sports car, and an American sports car. The country of origin is more salient, when the cars are grouped by country of origin, whereas the body style is more salient when the cars are grouped by body style (Brenner, Rottenstreich, and Sood, 1999).

Bettman, Payne and their colleagues (Bettman, Luce, and Payne, 1998; Payne, Bettman, and Johnson, 1992; 1993) propose to integrate these two frameworks, because they clearly
complement each other. The perceptual view of the decision process is suitable for predicting which product characteristics are noticed and how the decision process is affected by the presentation of the decision problem. The accuracy-effort framework is suitable for considering how consumers use the information they notice in order to satisfy their motives. During the decision process, consumers may cycle between noticing product characteristics and deciding how to use these characteristics. Thus, in mass customization environments, consumers may notice certain product characteristics because of the way they are presented. This process can be explained by a perceptual framework. Next, consumers use these characteristics to make a decision by trading off the effort of comparing the prices of all products against the desire to choose the product with the lowest price. These processes can be explained by the accuracy-effort framework. Thus, the two frameworks complement each other by providing insights into different aspects of the decision process. However, consumers cannot always determine the accuracy of a decision and will reduce their uncertainty about a product decision instead.

2.4.1 Reducing product uncertainty

Products are often presented by characteristics, of which the optimal attribute level can be determined, such as the length of a warranty. However, for many characteristics, such as safety, the optimal attribute level cannot be determined. In this case, consumers cannot determine the optimal product. When the accuracy cannot be determined or takes much effort, consumers use an uncertainty-effort framework; consumers make a decision by trading off the desire to reduce uncertainty and the desire to minimize effort. Rather than increasing accuracy of the decision, consumers search for product information to decrease the uncertainty about the decision. For example, consumers may search for information about car safety and compare cars until they are reasonable certain that they have found the safest car available.

Moorthy, Ratchford, and Talukdar (1997) propose that consumers try to reduce both the individual and the relative product uncertainty. Relative product uncertainty is consumers subjective uncertainty about which product is the best. Individual product uncertainty is consumers’ subjective uncertainty about what each product offers. Consumers may be certain about which supermarket offers the lowest priced products (relative product uncertainty), for example, but they may be uncertain about what these products actually cost (individual product uncertainty). Consumers are expected to search for product information while there is significant relative or individual product uncertainty. When making decisions about the safety of cars (relative product uncertainty), consumers try to reduce uncertainty about which car is safest, but also how safe the safest car actually is (individual product uncertainty). When consumers have certainty about which car is the safest and how safe this car is, they will stop searching. However, searching all these products takes effort. Searching all products in the mass customization environment would also maximize effort. How do consumers decide whether to continue searching or to stop searching and choose the product they consider best?

In order to determine whether to continue searching or choose the current product, consumers use the confidence that is already available from previous search. Following Alba and Hutchinson (2000, p. 126), confidence is conceptualized as degree of certainty. Previous search for product information has already reduced (relative and individual product)
uncertainty. Further search will reduce (relative and individual product) uncertainty even more. Consumers stop searching for more product information, when they expect that the reduction of uncertainty by search is equal or less than the effort this would take. At this point they will choose the product if they are confident about the decision, i.e. the relative and individual product uncertainty have reached acceptable levels; they will not choose the product otherwise. When searching for an apartment, for example, consumers may have uncertainty about hidden deficiencies of the apartment (individual product uncertainty). Consumers can invest effort in inspecting the apartment to reduce uncertainty about the quality of the apartment. Further effort in terms of time, physical and cognitive effort, could be invested to reduce uncertainty about any hidden deficiencies by asking a knowledgeable friend to take a look at the apartment. Money can be spent to hire an expert that thoroughly inspects the apartment, which will reduce uncertainty about any hidden deficiencies even further. However, at a certain point, the amount of effort that consumers have to invest in inspecting the apartment will not outweigh the reduction in uncertainty and consumers will stop reducing individual uncertainty about the apartment. At this point they choose the apartment if they feel confident that this is the best apartment so far and that it does not have any hidden deficiencies; they will not choose the apartment otherwise.

Relative and individual product uncertainty depends on familiarity (Moorthy, Ratchford, and Talukdar, 1997). The more familiar products are, the less individual product uncertainty is experienced: greater familiarity with products, leads to less uncertainty about what each product offers. However, relative product uncertainty shows an inverted-U-shape relationship with familiarity: greater familiarity with products initially leads consumers to take more information into account. They cannot use this information to reduce uncertainty, because they lack familiarity with the information. As a result consumers become more uncertain about which product is the best. However, consumers who are very familiar with products, know which products are best and thus relative product uncertainty decreases when consumers are really familiar with products. Also the effort that consumers have to invest is related to familiarity (Moorthy, Ratchford, and Talukdar, 1997). The effort that consumers invest in searching for product information shows an inverted-U-shape relationship. Initially consumers need much additional information and invest much effort. When they become familiar with a product this need for additional information decreases and they invest less effort.

Consumers often have multiple motives when making product decisions (Bettman, et al., 1998). The perceptual framework explains which product characteristics consumers will use. Motives such as avoiding negative emotions and maximization the ease with which a decision can be justified, can be better explained by the perceptual framework. These motives can be used to explain which characteristics are searched for. When consumers want to justify their choice of a car, for example, price becomes a very salient characteristic. The perceptual framework explains this increased search for price information. The accuracy-effort framework and the uncertainty-effort framework explain how product information is used to make decisions. The accuracy-effort framework explains how decisions are made when an accurate decision can be determined (i.e. most revolutions for the drum of a washing machine). The uncertainty-effort framework explains how consumers make decision when they cannot determine the accuracy of a decision.
In mass customization environments - like in other buying environments - consumers often cannot search all product information available, which is needed to make accurate decisions. Rather, they reduce their uncertainty about the correctness of decision. Making customization choices implies trading off the desire to reduce uncertainty and the desire to minimize effort. Consumers will search the customizable characteristics until they have chosen the appropriate attribute levels or until they are unwilling to invest additional effort.

2.4.2 The decision process in mass customization environments
Consumers use various strategies in their decision process to satisfy their motives. Beach and Mitchell (1978) divided decision strategies into three categories: non-analytic, unaided-analytic, and aided-analytic. Non-analytic decision strategies consist of simple, pre-formulated rules. Little information is processed. These strategies include procedures such as flipping a coin or just repeating the previous response. These rules are sometimes used to rationalize decisions based on other strategies, when the decision maker does not wish to justify the actual strategy. Unaided-analytic decision strategies explore the decision in more depth, but no tools (e.g. pen and pencil, mathematics, computer, calculator) are used. Research concerning unaided-analytic decision strategies is most frequently studied. Respondents are usually instructed to use unaided-analytic decision strategies.

Aided-analytic decision strategies allow consumers to use tools. These are often called decision aids and help consumers in choosing or customizing a product (Widing and Talarzyk, 1993). Product configurators could be designed in such a way that they help consumers in their decision process. This should be done with great care, otherwise the help that the product configurator offers will lead to decreased decision value and even annoyance. Take Clippie for example, the Microsoft Word assistant in the shape of a paperclip. The word processing software tracks the behavior of users and attempts to help them by guessing what they are trying to accomplish. It offers help for example, when it suspects that consumers are typing a letter. However, often Clippie does not make the correct predictions and users have to invest effort correcting the suggestions that Clippie has provided. This example shows that aided-analytic strategies employed by a product configurator should be carefully designed and they should be (almost) always correct. Assumptions of the product configurator that are incorrect may annoy consumers. Such incorrect assumptions can be even more harmful when consumers do not know that the assumptions of the decision aids are incorrect. Consumers will then choose products that do not increase decision value. Widing and Talarzyk (1993) found that some decision aids lead to great confidence, but resulted in many errors and much time to make decisions. In order to design decision aids that really help consumers in their decision process, knowledge is needed about how consumers process product information in mass customization environments. Only then product configurators will be able to provide suggestions that are customized to individual preferences.

2.4.3 Decision value of customization choices
When making customization choices, consumers try to increase the decision value. This decision value is a concept that is used to determine the value that consumers derive from the customization process and the resulting customized product. The value that consumers derive from making customization choices is important, because consumers will use traditional
environments to acquire their products if these environments provide more value. However, there are two requirements for achieving high decision value. First, consumers should have an appreciation for customization. Second, product configurators should be designed to support customization choices.

When consumers do not appreciate customization of products, then they will not attach any value on customized products. These consumers will not use product configurators. Customization has a number of advantages (Godek, Yates, and Auh, 2000). First, customization allows for unique products, which allows their owners to differentiate themselves from other consumers. Uniqueness relates to the newness of products. When consumers configure unique products, these products are also likely to be new. Second, customization allows for personalization. Consumers get products they want. They can select the type of characteristics they prefer, while leaving out characteristics they do not like. Third, consumers gain control over the characteristics that are incorporated into the product. They decide which characteristics are included in the final product and which are not. This perception of control may lead consumers to use product configurators. The consumers’ perception of control over product configurators may therefore be more important than the actual control (Hoffman and Novak, 1996). However, some consumers may not appreciate product customization, because they believe the customization process is too complex, the decision process is too difficult, or the price too high.

Designers should create product configurators that support consumers in their customization choices. Consumers may want to choose the best characteristics, but product configurators should also enable consumers to make such choices. First, designers should pay attention to the navigation and operation of product configurators. Consumers are unlikely to use product configurators they cannot operate or navigate. Second, consumers make an evaluation of the product configurator (or system evaluation). Designers of such product configurators should strive for high system evaluations by optimizing operation and navigation. Furthermore, the system evaluation can be enhanced by attractive design that provides overview over the assortment of products as well as detailed information about specific products. Consumers are unlikely to use product configurators they do not like. When consumers both appreciate customization and value the product configurator, high decision value may be achieved.

The decision value of customization choices consists of three components: effort put into the customization process, uncertainty about customization choices, and evaluation of the customized product. The effort put into the customization process relates to the time, money, and physical and cognitive effort that consumers have to invest. The effort that consumers invest in searching for information in mass customization environments often consists of two phases. In the first phase, consumers have to invest effort in finding, starting and learning the system. In the second phase, consumers search and interpret actual product information. Although the first phase is important, this dissertation concentrates on the second phase of this search process. One of the motives that consumers have, is the minimization of effort. Given identical levels of uncertainty and product evaluation, consumers will prefer decision processes that require the least effort. In this case, less effort signals more decision value.
The uncertainty about customization choices relates to relative and individual product uncertainty and system uncertainty. The product uncertainties are very subjective. Consumers may believe, for example, that a certain product is the best product available, when objectively this is not the case. As discussed, (relative and individual) product uncertainty determines whether consumers continue to search and evaluate product alternatives. As long as they expect to decrease either relative or individual product uncertainty, they keep on searching as long as the investment in effort is acceptable. In mass customization environments, consumers may also exhibit uncertainty about the operation of product configurator. Consumers may be uncertain about the possibilities of the product configurator or may not know how to customize a product. Also, many consumers have trouble finding certain product characteristics and doubt the possibility of combining characteristics. These processes increase uncertainty about the product configurators. Consumers try to reduce the uncertainty about both the products and the product configurator. Less uncertainty about customization choices indicates higher decision value.

The last component of decision value is product evaluation. When consumers provide higher evaluations of the product, this will contribute to the value of their decision. It is assumed that product evaluations will be rather high when consumers can customize these products themselves. Consumers will choose those characteristics they like and hence the resulting product evaluations are likely to be high.

The decision value in mass customization environments is highly subjective, and may be different for each consumer. Every consumer is willing to invest a different amount of effort, make decisions under different degrees of uncertainty and will provide different product evaluations. No optimal levels for the decision value can be determined, that are valid for all consumers. Rather, research will focus on differences in the characteristics of the customization task on decision value. In order to design mass customization environments that increase decision value, an understanding is needed of how consumer decisions are influenced by the characteristics of the customization task. This need is demonstrated by the notion that evaluations in making customization choices are often constructed on the spot. People often do not have well-defined evaluations, but construct them when customizing products. Because the evaluations are constructed when needed, characteristics of the decision task may greatly influence decision processes in mass customization environments.

2.5 Customization Challenges

Beach and Mitchell (1978) distinguish decision characteristics that describe (1) the decision problem: the characteristics that are inherent to the decision problem itself and (2) the decision environment: the characteristics that describe the decision environment. The characteristics that describe the decision problem can be categorized in task effects and context effects (Payne, 1982). Task effects describe those factors associated with the structure of the decision problem, such as the amount of information, type of product information, presentation format, and type of task, whereas context effects describe those factors associated with the particular value of alternatives in the decision problem, such as similarity of products and the attractiveness of the assortment. Characteristics of the decision
environment are reversibility, significance, accountability, and time and money constraints. The research issues that we investigate are highlighted in the text.

2.5.1 Characteristics of the decision problem

Amount of information
The amount of information greatly influences the way consumer's process product information (Payne, 1982; Payne, Bettman, and Johnson, 1993). The use of simple decision rules increases with the amount of information (Bettman, et al., 1998). There are at least two factors that contribute to the amount of information: the number of alternatives, and the number of characteristics (Payne, 1982). When the number of alternatives was increased consumers searched less information about the alternatives (Payne, 1976; Moorthy, Ratchford and Talukdar, 1997). When the number of characteristics was increased, consumers showed more variability in their choices and consumers relative product uncertainty decreased. Furthermore, an increase in the number of characteristics leads consumers to choose less accurate bets (i.e., lower expected utility). Chernev (1997) investigated the addition of characteristics to a choice set and how these additions affected choice. Adding a characteristic with similar importance, that is shared with all alternatives, does not affect choice. Conversely, adding a characteristic with primary importance that is shared with all alternatives, leads to polarization of choices. This means that the addition of a characteristic that has a different weight compared to the other characteristics, is more likely to lead to choice of extreme alternatives, whereas adding a characteristic with equal weight does not. Kim and Chhajeed (2001) investigated the effect of addition of alternatives that share some but not all characteristics. They added both alternatives and characteristics to the choice set. Kim and Chhajeed (2001) found that such a manipulation improves the value of the minor alternative, and decreases the value of the superior alternative.

Most research into the amount of information investigates the choice between bets (c.f. Johnson, Payne, and Bettman, 1988; Payne, 1976; Payne, Bettman and Johnson, 1988; Tversky, 1969; Tversky, 1972). One of the reasons to do so is that the accuracy of a decision can be objectively determined. Research should address how the amount of information influences the decision value. The number of alternatives that are offered in mass customization environments is called the product assortment. It is generally found that assortment positively influences the amount of search, although the set sizes were limited in range (Schmidt and Spreng, 1996; Srinivasan and Ratchford, 1991). Mass customization environments are able to offer large assortments of products (Degeratu, Rangaswamy, and Wu, 2000). No researchers to the author's knowledge have investigated the effect of assortment size on relative product uncertainty. Consumers may experience less uncertainty in choices made from effortful decisions (Alba et al., 1997, p. 50). Research should identify the relation between assortment size and uncertainty and other aspects of decision value. One of the first questions related to the amount of product information that should be answered is: how much product information should be offered in mass customization environments.

Type of product information
Traditionally, research presents characteristics related to product functionality and characteristics related to product appearance are more or less ignored. However, consumers
attach increasing value to the appearance of products. Should product information relate to product functionality or to product appearance? This raises the question of how the type of product characteristics in mass customization environments affects decision value. The type of characteristics that consumers consider important for their decision may depend on the type of product that is customized. Jarvenpaa (1990) found that consumers use pictorial forms because they are more salient and not because they are more important. Does this salience affect decision value? In other words, how does the type of pictorial information affect decision value? Is mere presentation of visual materials enough to increase decision value, or does the pictorial information have to be meaningful as well?

The correlation between characteristics may affect the decision process. Consumers often believe, for example, that price and quality are correlated (Baumgartner, 1995, p. 634). Consumers have to trade off the price for quality, because higher product quality usually means higher prices. Correlation between characteristics is thus related to the concept of conflict between characteristics (Bettman, Luce and Payne, 1998, p. 200-201) and is also called configurality when this correlation between characteristics affects product appearance (Hollbrook and Moore, 1981a; 1981b; Slovic and Lichtenstein, 1971). Consumers have to give up something on one characteristic in order to get more of another characteristic. When the correlation between characteristics concerns configurality, consumers have to give up some value of one or more characteristics in order to improve the overall product appearance. Consumers can follow two customization strategies. They can ignore the configurality and evaluate characteristics separately. They select the attribute levels that add most value. Consumers can also try to take the configurality into account and select those attribute levels that go well together, i.e., contribute most to the overall appearance. In most situations, consumers will try to follow both strategies, but these strategies will often be in conflict with each other. Conflict between customization strategies may have a negative influence on the decision value. Consumers may derive less value from such decisions. How does conflict between these customization strategies affect the decision value of customization choices?

Presentation format
How should these different types of product information be presented? When customizing functional product characteristics, consumers often choose from lists of characteristics, while the product appearance remains unchanged. Imagine consumers choosing a computer, for example. They can change the hard drive, memory, processor, and software without any change to the exterior of the computer. Feedback about these functional characteristics is provided in numerical or verbal form. With this feedback, consumers can evaluate the product. When consumers also choose characteristics related to product appearance consumers should be able to evaluate this appearance. This appearance of the product can be presented in various ways, such as a disassembled or assembled presentation format. What is the influence of presentation format of product characteristics on decision value of customization choices? Will feedback about the disassembled characteristics allow consumers to make reliable product evaluations?

The way in which product information is presented has a great influence on the consumers’ decision process. The presentation format may differ in the order in which information is
presented, the form in which information is presented, or the mode in which information is presented. Payne (1982) argued that more research on the effects of presentation format is needed, because the underlying principles that lead to the choice of a product are not clearly understood. Most of the research on presentation format concentrates on the eventual choice that consumers make, while disregarding the decision value (Payne, 1982; Payne, Bettman, and Johnson, 1993). Also, most research into presentation format investigates the choice between bets (Payne, 1982; Payne, Bettman, and Johnson, 1993). The accuracy of a bet can be objectively determined by calculating the expected utility. However, for many consumer products, the accuracy of a decision cannot be determined. For those decisions, consumers reduce the relative product uncertainty about the decisions until they expect that it takes them too much effort to reduce uncertainty even more.

Product information can be presented in different presentation forms; sometimes product information is communicated in numerical form, sometimes in verbal form, and in pictorial form at other times. Several researchers (Budescu, Weinberg, and Wallsten, 1988; Erev and Cohen, 1990) investigate the preferred presentation form of probabilities. People prefer to convey probabilities of future events in verbal terms, but prefer to receive such probabilities in numerical form. Erev and Cohen (1990) found that no information form is more efficient per se. However, more people considered the numerical mode to be the best, although both were as likely to deliver good decisions. Research that compares numerical and verbal forms for product information is limited. Huber (in: Payne, 1982) demonstrated that information presented in numerical form can be more easily compared between products than information in verbal form. Jarvenpaa (1989; 1990) compares the presentation of product characteristics in numerical, verbal and pictorial form, where information about characteristics is presented in bar charts. Consumers using a numerical format initially pay attention to those characteristics that they find most important, whereas consumers using a pictorial format initially pay attention to the most salient characteristics. No differences in the processing of information presented in the verbal and pictorial form are mentioned.

De Bont (1992) investigated the use of verbal and pictorial presentation forms for the testing of early product concepts. An early product concept is a promising idea about a new product presented in numerical, verbal and pictorial forms. Adding sketches of product appearance in pictorial forms does not lead to overall processing of the product. The product characteristics are evaluated separately. Furthermore, presenting information about product appearance in pictorial mode versus verbal mode leads to different evaluations. Presenting product appearance in pictorial form leads to more reliable evaluations of the appearance compared to presenting product appearance in verbal forms. In general, product information about characteristics may be provided in numerical, verbal as well as pictorial presentation modes. However, numbers and text seem to communicate functionality easiest, whereas images seem to communicate appearance easiest.

Product information can be presented in two different presentation modes, either sequentially or simultaneously (Tversky, 1969). Russo (1977) found that use of price information increased when all prices were presented in an organized list compared with the usual situation in a store, where all prices were presented individually on each product. What is the influence of the presentation mode of the product information on the decision value of
customization choices? Different characteristics could be presented simultaneously, to provide overview of the possible combinations, but this may also lead to information overload. Therefore, product information could also be displayed sequentially, so that consumers do not have to process all product information simultaneously. A sequential presentation mode may be suited when consumers can choose many product characteristics.

However, the presentation order may also influence the decision process. Tversky and Sattath (1979: in Payne, 1982) showed that the order in which alternatives are presented influences the choices that consumers made. What is the influence of presentation order of the product characteristics on the decision value of customization choices? Consumers may prefer to choose the most important characteristics first. On the other hand, they may prefer to postpone such decisions. How does this affect the decision value?

Type of task
The type of task influences the decision process. This factor relates to the type of task that respondents perform in experiments. In some experiments respondents evaluate products, whereas in other experiments respondents choose products. When consumers are evaluating products, they process products by alternative: they evaluate a product and then move on to the next product. In a choice task, processing may be primarily by characteristic, because respondents compare the different characteristics of the products to determine which product to select. An evaluation task is more likely to lead to anchoring and adjustment. This means that one alternative is used as a starting point for evaluation and then the other evaluations are adjusted relative to this alternative. Furthermore, Tversky (1977) suggests that in an evaluation task, alternatives are evaluated on similarities, whereas in a choice task, alternatives are compared on dissimilarities. Studies investigating decision processes in mass customization environments should take these effects of type of task into account. Next the context effects of the decision problem are discussed: the similarity of products and the attractiveness of the assortment.

Similarity of products
Context variables have not often been studied, but the similarity of alternatives in a set is the context variable that has been studied most (Payne, 1982). Adding a product to the assortment leads to a decrease in the choice of the most similar product (Tversky and Sattath, 1979: in: Payne, 1982). However, Huber, Payne, and Puto (1983) showed that adding a product that is better than all other products in the assortment, increased the choice of the most similar product. Thus, the choices consumers make depend on the other products in the assortment. Comparing various alternatives is easier when alternatives are similar (Shugan, 1980). Tversky and Simonson (1993) show how similarity of products in an assortment may affect the choices that consumers make. Sometimes, consumers choose products with extreme attribute levels, whereas at other times consumers choose products with moderate attribute levels. Consumers sometimes choose products with extreme attribute levels, because one characteristic is of paramount importance. Consumers may choose a television, for example, with the highest quality and the highest price, because they value quality much more than the other characteristics. However, consumers will often find products with extreme attribute levels less attractive than products with intermediate attribute levels. This will lead to the preference for the middle option. This is more likely when all characteristics
are important. In an experiment of Tversky and Simonson (1993) respondents chose between an Emerson microwave oven priced at $110 and a Panasonic microwave oven priced at $180. When faced with these two choices, 43% chose the Panasonic. When a third alternative was added, a Panasonic priced at $200, 60% chose the Panasonic priced at $180. When consumers value all characteristics, they are more likely to make a trade-off between the various characteristics and an intermediate product that performs well on all characteristics. When consumers consider one characteristic to be very important in mass customization environments, they will try to choose the best attribute level. Other characteristics will be more or less disregarded. Consumers will only take characteristics into consideration, when these characteristics are at least moderately important.

Attractiveness of the assortment
Assortment in mass customization environments should be attractive to consumers; otherwise they will not be satisfied with the resulting product. The attractiveness of the assortment is influenced by reference products (Hsee and Leclerc, 1998). A product recently encountered serves as a reference product. Presenting two products together, next to the reference product, will enhance evaluation of the two products when the two products are less attractive than the reference. Consumers will compare these two products and not to the reference product. In this case, the differences between the two products are smaller than the differences between each of the two products and the reference product. Conversely, presenting products separately will enhance evaluation when the two products are more attractive than the reference product. Consumers will compare each of the two products to the reference product. Differences between each of the (two) other products and the reference are larger. The other (two) product will be evaluated higher when they are more attractive than the reference and presented separately. Research into mass customization environments should take these effects of attractiveness into account.

2.5.2 Characteristics of the decision environment
There are four characteristics of the decision environments that may influence consumer decisions (Beach and Mitchell, 1978). Reversibility of the decision is the degree to which a decision can be reversed. To what extent can decisions be reversed? In traditional environments, consumers are sometimes able to reverse their decisions after purchasing a product, whereas at other times they cannot. Earrings, for example, cannot be exchanged for other ones for reasons of hygiene. The decision is irreversible once a pair of earrings has been purchased. Decisions about other products, such as television sets, can only be reversed if the product has a defect. These decisions are moderately reversible. Decisions about gifts, such as books, are often completely reversible. When the recipient of a gift already owns the book, it can be easily exchanged for another. In mass customization environments it should be easier to reverse decisions, because choosing a product is less likely to lead to purchasing the product. Decisions about the characteristics are made first, after which consumers decide whether to purchase the product. Reversibility is easier, because decisions about customized characteristics can be reversed before the product is purchased. What is the influence of the degree of reversibility on the decision value of customization choices? Consumers may experience less individual and relative product uncertainty, when the decision is reversible, because if it turns out that another option is superior they can still reverse the decision. Making decisions that are reversible should take less effort, because there is less pressure to
make the correct decision or having to live with the negative consequences (Beach and Mitchell, 1978).

**Significance** of the decision is the impact of the consequences of this decision. Some decisions are more significant then others, because consequences of the decision last longer. When consumers buy an ice cream flavor they dislike, for example, the consequences are less significant than when they buy a television they dislike. The significance of a decision may differ for each consumer. This depends on the individual preferences and the circumstances when making a decision. When decisions are more significant to consumers, they are likely to invest more effort. They will also desire to reduce more uncertainty when decisions are more significant to them.

**Accountability** is the degree to which the decision maker is responsible for the consequences of the decision (Beach and Mitchell, 1978). The accountability may influence the decision process. When the accountability of consumers increases, consumers are more likely to invest effort. They will also want to be more certain of their decision. Also the motives of consumers may be influenced by accountability. When consumers are accountable for their decisions, they will be more likely to make a decision that can be most easily justified.

Finally, **time and money constraints** may influence decisions. This characteristic of the decision environments thus influences the effort that consumers invest in the decision process. Some consumers take less time to make decisions and are not prepared to spend much money on the product. When consumers have time and money constraints, the effort of making decision is decreased, which may lead to an increase in the uncertainty with the decision. When consumers invest less effort searching the product information, they are likely to be less certain about whether they have chosen the best alternative (relative product uncertainty) and about what each product offers (individual product uncertainty).

These characteristics related to the decision environment cannot be controlled in a mass customization environment, except the reversibility of the decision. The time and money constraints, significance, and accountability differ per person and per situation. How can a product configurator influence how significant the consequences of a decision are for a particular consumer or whether one is accountable for this decision? The significance, accountability, and time and money constraints will therefore not be considered any further in this dissertation, although these characteristics may have important consequences for product decisions.

### 2.5.3 Characteristics of the decision maker

There are several characteristics of the decision maker that are likely to influence the decisions in mass customization environments. A first characteristic is consumer **knowledge**. As discussed, different types of knowledge can be distinguished, which all have different effects on decision value. The effort that consumers are willing to invest is influenced by subjective knowledge, objective knowledge, familiarity and expertise. Consumers high in subjective knowledge invest less effort than consumers low in subjective knowledge, whereas consumers with much objective knowledge invest more effort than consumers with little objective knowledge. The relation between familiarity and effort can be described by an
inverted-U-shape; effort increases initially, but decreases when consumers become really familiar with products. Expertise is correlated to familiarity and shows a similar inverted-U-shape relationship with effort.

The uncertainty about whether they have made the appropriate decision is influenced by subjective knowledge and familiarity. The influence of objective knowledge and expertise on uncertainty has not received attention in the literature. More subjective knowledge leads to more certainty about decisions. The effects of knowledge on individual and relative product uncertainty are only investigated for familiarity. When familiarity increases, individual product uncertainty decreases. Familiarity shows an inverted-U-shape relationship with relative product uncertainty; uncertainty increases initially, but decreases when consumers become more familiar with products. Increased objective knowledge is expected to lead to more certainty about decisions. Because familiarity and expertise are correlated, the effect of expertise on uncertainty is expected to be similar to the effect of familiarity on uncertainty. In general, the effects of consumers’ knowledge on both individual and relative product uncertainty have received little attention. It may be assumed that when the differences in the amount of knowledge are large, this may have profound effects on the decision value of customization choices.

A second characteristic that may influence the decision process is the computer skills of consumers. When they are using product configurators on their own, they need some computer skills (Boekhorst, Koers, and Kwast, 1999). Consumers who do not possess such skills should not be included in experiments concerning the decision value of product configurators, because the lack in skills will affect the validity of the results. The current research focuses on the effects of the characteristics of the decision problem on decision value. Computer skills mediate the relation between characteristics of the decision problem and the decision value.

To prevent an influence of individual differences in knowledge and skills on decision value, experiments should use homogeneous groups of respondents in terms of such knowledge and skills. Students in Industrial Design Engineering are such a homogeneous group in terms of knowledge and computer skills.

2.6 CONCLUSION

Product configurators allow consumers to configure their own products. Even though product configurators may one day be able to design the larger part of products offered in mass customization environments (Wallace and Jakiela, 1993), designers will always need to design the product configurator itself. When designing such product configurators, designers put high value on the freedom in expressing themselves in their design. Ideally, designers prefer designing without any restrictions, because this allows them to express themselves most fully. However, designers are always restricted by the wishes of the manufacturer that produces the product or the consumers who use the product. Both these restrictions are important, but the current research focuses on those constraints imposed by consumers. These constraints relate to the influence that the characteristics of the decision problem have on
customization choices. These characteristics relate to the customization task, the customization environment, and the decision maker. Designers can influence the characteristics of the customization task related to the structure of the product information most easily.

When designers try to determine how they should structure the product information in product configurators, three questions need an answer. First, how much information should be provided? Designers should know how much information can be provided in mass customization environments. Second, what type of product information should be offered? Designers should know how much information should be provided about product functionality and how much about product appearance. Third, how should product information be presented in product configurators? Designers should know how different presentation formats affect decision value. Answers to these questions will improve the design of product configurators. The next chapter will summarize the research issues and provide an overview of the studies that investigate them. The research in the following chapters will investigate these questions.
CHAPTER 3
RESEARCHING CUSTOMIZATION CHOICES

The previous chapter showed a clear need for researching customization choices. When designing product configurators, designers should take various characteristics of the customization task into account. These characteristics influence customization choices. In this chapter the various research issues raised in Chapter 2 are summarized. Three main research questions regarding these characteristics are investigated. The first research question refers to how much product information can be offered in mass customization environments. The second research question is what type of product information should be offered in mass customization environments. Research part I will investigate these two research questions.

The third research question addresses the question how this product information should be presented in product configurators. This latter question is related to the processing of the information that is offered, or in terms of the literature: the stimulus. Alba et al. (1997) signal a need for research into stimulus-based processing instead of memory-based processing. Interactive product design systems will reduce memory constraints significantly, leaving questions about how product information should be presented to consumers. Research part II will focus on this research question. Both research parts will investigate the effects of the characteristics of the customization task on decision value (see 2.4.3 decision value of customization choices, p. 29).

3.1 PRODUCT INFORMATION IN MASS CUSTOMIZATION ENVIRONMENTS

Both the amount of product information and the type of product information that are offered through mass customization environments are investigated. The research issues of research part I, the studies, and the products used in these studies, are shown in table 3.1. This table also shows the chapter that describes each study and the product category that was used in the study.

The research issues concerning the amount of information are discussed first. The first research issue investigates how the within-attribute variance influences decision value. Product information increases when the within-attribute variance increases (see amount of information, p. 31). When a characteristic has multiple levels compared to a single level the amount of information increases. There is, for example, more information when consumers can choose out of 2, 3, 4, or 5 doors for a car compared to 2 doors for a car. The relationship between within-attribute variance will be discussed more thoroughly when the study is described. The second research issue is: how does the assortment of products in mass customization environments affect decision value (see amount of information, p. 31)? The third research issue that will be addressed is how the number of product characteristics affects decision value (see amount of information, p. 31).
When functionality of products is considered important, consumers may consult other characteristics than when appearance of products is important. Therefore, the fourth research issue investigates how the type of product characteristics in mass customization environments affects decision value (see type of product information, p. 31). Depending on the type of product, consumers' decisions may be based on different characteristics. However, consumers may use some characteristics because they are more salient and not because they are more important (Jarvenpaa, 1990). To investigate whether salience has an effect on decision value, the fifth research issue addresses how the type of pictorial information affects decision value (see type of product information, p. 31).

**Table 3.1. Research issues of research part I.**

<table>
<thead>
<tr>
<th>Research issue</th>
<th>Study</th>
<th>Chapter</th>
<th>Product(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. How does the within-attribute variance of characteristics affect the decision value</td>
<td>1</td>
<td>4</td>
<td>Coffeemakers</td>
</tr>
<tr>
<td>2. How does the assortment of products affect the decision value</td>
<td>2</td>
<td>5</td>
<td>Telephones</td>
</tr>
<tr>
<td>3. How does the number of product characteristics affect decision value?</td>
<td>3</td>
<td>6</td>
<td>MP3-players</td>
</tr>
<tr>
<td>4. How does the type of pictorial information affect decision value?</td>
<td>1</td>
<td>4</td>
<td>Coffeemakers</td>
</tr>
<tr>
<td>5. How does the type of product characteristics affect decision value?</td>
<td>2</td>
<td>5</td>
<td>Telephones</td>
</tr>
<tr>
<td>6. How can decision strategies detected?</td>
<td>3</td>
<td>6</td>
<td>MP3-players</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>7</td>
<td>Coffeemakers</td>
</tr>
</tbody>
</table>

When designers of interactive product design systems desire to support consumers' customization choices, accurate knowledge about the decision process is necessary. Consumers may have various strategies to make customization choices. This leads to the sixth research issue: how can decision strategies be detected (see 2.4.2 decision processes in mass customization environments, p. 28)? When designers know which strategies consumers apply, they are able to design decision aids that help consumers in their decision processes and increase consumers' decision value.

### 3.2 Presenting Product Information in Product Configurators

In research part II, two product configurators are designed and programmed. These product configurators are used to investigate the way information about product appearance should be presented in product configurators. Table 3.2 provides an overview of all research issues in this part and the studies conducted. This table also shows the chapter that describes the study and the product category that was used in the studies. Product information can be presented in two presentation modes: simultaneous or sequential presentation modes (see presentation format, p. 33). What is the influence of presentation mode on the decision value of customization choices (research issue 6)? To investigate this research issue, two studies use a
simultaneous presentation format, and two studies use a sequential presentation format. Feedback about the customizable characteristics related to product appearance could be presented separately, as disassembled characteristics. On the other hand, these characteristics could be presented as a whole by assembled characteristics. Thus, the eighth research issue reads: What is the influence of presentation of product characteristics on decision value of customization choices (see presentation format, p. 32)? We will see that respondents find it hard to base their decisions on disassembled presentation of product characteristics. New products are inherent to mass customization environments. When assortments are large, consumers are likely to encounter new combinations of product characteristics. The ninth research issue therefore relates to the influence of product newness on the decision value of customization choices (see appreciation for customization, p. 29).

Table 3.2. Research issues of research part II.

<table>
<thead>
<tr>
<th>Research issue</th>
<th>Study</th>
<th>Chapter</th>
<th>Product(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7. What is the influence of the presentation mode on the decision value of customization choices?</td>
<td>5</td>
<td>8</td>
<td>Bicycles</td>
</tr>
<tr>
<td>8. What is the influence of presentation of product characteristics on decision value of customization choices?</td>
<td>5</td>
<td>8</td>
<td>Bicycles</td>
</tr>
<tr>
<td>9. What is the influence of product newness on decision value of customization choices?</td>
<td>5</td>
<td>8</td>
<td>Bicycles</td>
</tr>
<tr>
<td>10. What is the influence of presentation order of the product characteristics on decision value of customization choices?</td>
<td>5</td>
<td>8</td>
<td>Bicycles</td>
</tr>
<tr>
<td>11. What is the influence of the degree of reversibility on decision value of customization choices?</td>
<td>5</td>
<td>8</td>
<td>Bicycles</td>
</tr>
<tr>
<td>12. What type of customization strategies do consumers use when making customization choices?</td>
<td>5</td>
<td>8</td>
<td>Bicycles</td>
</tr>
<tr>
<td>13. Does conflict between these strategies affect decision value of customization choices?</td>
<td>5</td>
<td>8</td>
<td>Bicycles</td>
</tr>
</tbody>
</table>

In the studies investigating the disassembled and assembled presentation format, the product information is presented simultaneously. However, when product information is presented sequentially, what should be the presentation order (see presentation format, p. 33)? Thus, what is the influence of the presentation order of the product characteristics on decision value of customization choices? This constitutes the tenth research issue. Product configurators allow reversibility of customization choices. How is the decision value affected when consumers get the chance to reverse their decisions? In other words, how does the degree of reversibility influence the decision value of customization choices (research issue 11; see 2.5.2 characteristics of the decision environment, p. 35)? When designers of product configurators desire to support consumers’ customization choices, accurate knowledge about
the customization process is necessary. Consumers may have various customization strategies to make customization choices. Therefore, two research issues investigate what customization strategies consumers use to make customization choices (research issue 12; see 2.4.2 decision processes in mass customization environments, p. 28) and whether conflict between these strategies affects the decision value (research issue 13; see type of product information, p. 32). When designers know how consumers make customization choices, they are able to design decision aids that increase consumers’ decision value.

3.3 METHOD

Since the research concerns computerized product configurators it seems appropriate to conduct all experiments on a computer. All experiments are especially developed and designed for each study using Macromedia Director. Compared to methods studying consumer decision-making, computers offer at least five advantages (Brucks, 1988). First, respondents’ activities can be monitored more precise than in other methods studying consumer decision-making. Second, researchers have more control over variables, for example, the amount of information that respondents are allowed to search. Third, researchers can build contingencies into their designs. This enables them to make complex designs and to provide information depending on previous actions (see study 5 or 6 for example). Fourth, a rich and complex information environment can be created, because many factors can easily be incorporated and controlled. Fifth, many experiments can be run simultaneously, depending on the availability of computers. Designing and programming the experiment for the first computer, takes lot of effort, but can easily copied onto other computers.

Furthermore, respondents require some level of knowledge and skills about computers to be able to use computerized systems. Computer skills could mediate the relation between characteristics of the decision problem and the decision value. Students in Industrial Design Engineering were used in most studies to prevent an influence of individual differences in knowledge and skills on decision value.
Current technologies make the production of personalized products technically feasible (c.f. Lampel and Mintzberg, 1996; Swaminathan, 2001). Technically, it is not difficult to produce products with different functionality or appearance. Consumers also show an increased interest in customizing the functionality and appearance of the products they purchase. Therefore, manufacturers increasingly offer products through product configurators on the Internet or at in-store computer systems. These systems allow consumers to configure products in an interactive manner by choosing preferred product attributes and receiving direct feedback on these choices.

The number of product variants that can be offered is enormous. Car dealers offer choices between different colors, type of engines, types of upholstery (for the seats and the interior), the types of wheel rims and a huge variety of other options. Consumers can choose all these options for the Volkswagen New Beetle, for example; potentially offering 10,000 different car models. Consumers may be overwhelmed by the large assortment of products that are offered through customization systems. Retailers cannot carry all these products in their assortment, because stores have limited space for showing products. In a retailer’s store, there is always limited shelf-space and the amount of different products that can be displayed is also limited. Mass customization environments are able to offer large assortments of products (Degeratu, Rangaswamy, and Wu, 2000). A manufacturer can always add more products to the mass customization environment with minimal costs.

In four studies, the effects of increasing the amount of information in mass customization environments are investigated. The amount of information increases with variance within attribute levels, assortment size, and number of product characteristics; they are investigated in studies 1, 2, and 3 respectively. Study 4 is an exploratory study, which investigates the decision processes when searching information. The amount of product information can be adapted to the way consumers process such product information. Also, the effects of the type of information are studied. The mere presence of pictorial information may affect customization choices, even though the pictorial information may be meaningless for the evaluation of the product appearance. Study 1 investigates this possible effect. In study 2 and 3, the effects of offering characteristics related to functionality and appearance are investigated.
CHAPTER 4

VARIANCE AND TYPE OF PICTORIAL INFORMATION

How much information can be presented in mass customization environments? The amount of information that consumers have to search is affected by the variance within attribute levels. This study investigates whether the variance within attribute levels has consequences for the decision value of customization choices. Consumers can search some characteristics with little variance within attribute levels more easily than characteristics with much variance within attribute levels, because in this latter situation require consumers to investigate many attribute levels. What type of product information should be offered in mass customization environments? In general, two types of product information can be distinguished: product information about the appearance and product information about the functionality and economic information (such as price and warranty)\(^3\). This information can be presented either verbally or pictorially. Pictorial representation of product information can be a useful addition to verbal information. Such pictorial information may either provide information about the product appearance or it may enhance the understanding of the product functionality. This study investigates these two characteristics of a customization task: variance within attribute levels (small versus large) and type of pictorial information (relevant for appearance versus irrelevant for appearance).

4.1 VARIANCE WITHIN ATTRIBUTE LEVELS

To determine the amount of product information traditional approaches use simple counts of the number of alternatives and characteristics to which consumers are exposed (Lurie, 2001; Payne, 1976; Wright, 1975). Recent work (Lurie, 2001; Van Herpen and Pieters, 2001) suggests that not only the number of products and characteristics may increase the amount of product information, but also the variance within characteristics. More variance means that consumers have to process more within-attribute information.

Table 4.1 shows three characteristics of six alternatives; a consumer presumably has to process 18 attribute levels (3 characteristics times 6 alternatives). However, consumers will not blindly process all attribute levels. They will orient themselves on the different options and try to think what characteristics they want in their product. In this case, consumers will consider the color of the product and the price they are willing to pay. The warranty does not have to be considered, because it is the same for all alternatives. The warranty can be viewed as one attribute level, because there is no variance in the attribute levels. Lurie (2001) and Van Herpen and Pieters (2001) argued that the amount of information decreases when the variance within an attribute level decreases. There is more information about color than about price. Price has two levels (either €80 or €100) and consumers have to process two attribute levels, whereas for color a choice between 3 colors has to be made. Thus, consumers only

\(^3\) Because the emphasis does not lie on the difference between functional and economic information, these product characteristics will be called “functional.”
have to process warranty (1 attribute level), price (2 attribute levels), and color (3 attribute levels) = 6 attribute levels instead of 18 to make a choice. If all attribute levels of all characteristics are different, then consumers have to process 18 attribute levels. This example shows that the amount of information can vary even when the number of alternatives and characteristics remains the same.

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Color</th>
<th>Price</th>
<th>Warranty</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Red</td>
<td>80</td>
<td>1 year</td>
</tr>
<tr>
<td>2</td>
<td>Red</td>
<td>100</td>
<td>1 year</td>
</tr>
<tr>
<td>3</td>
<td>Yellow</td>
<td>100</td>
<td>1 year</td>
</tr>
<tr>
<td>4</td>
<td>Yellow</td>
<td>80</td>
<td>1 year</td>
</tr>
<tr>
<td>5</td>
<td>Blue</td>
<td>100</td>
<td>1 year</td>
</tr>
<tr>
<td>6</td>
<td>Blue</td>
<td>100</td>
<td>1 year</td>
</tr>
</tbody>
</table>

The variance within an attribute level may impact the relative attention that consumers invest in the decision process. When product characteristics receive relatively much attention these characteristics are more likely to be configured and hence have a profound influence on the customization choices. Some characteristics may have dichotomous attribute levels, such as two cord lengths for a coffeemaker: half a meter and one-and-a-half meters. Other characteristics have multiple attribute levels. An extreme example is price. The price for a coffeemaker may range from €10.00 for a cheap coffeemaker to €300.00 for a design coffeemaker with every possible price in between. In terms of eurocents, price has 29,000 attribute levels. Even though price has more levels than cord length, both characteristics can be selected without a lot of effort by using cutoff values. Consumers could instruct product configurators to present alternatives that have cord lengths of one-half-a-meter and cost less than €100. However, when such tools are not available, the amount of information that has to be investigated by consumers depends on the variance within attribute levels. This leads to hypothesis 4.1.

H4.1 In mass customization environments without search tools, consumers will invest more effort searching characteristics with multiple attribute levels compared to characteristics with dichotomous attribute levels.

Using cutoff values product configurators can be easily selected, mainly because these attribute levels have interval scales. However, other attribute levels have nominal scales. A coffeemaker, for example, either has a timer or it does not. Still, consumers could instruct product configurators to present coffeemakers that have timers. Even when multiple nominal attribute levels are involved such procedures are possible. Thus, consumers may instruct product configurators to present coffeemakers only if they are black. However, for many characteristics related to product appearance, consumers cannot specify cutoff levels. A coffeemaker, for example, may be available with thermos flasks of various appearances. Consumers cannot tell the product configurator to ignore all ugly thermos flasks. They have to investigate all thermos flasks themselves. Even when consumers may be able to evaluate product appearances in a glance, they have to evaluate each one. Thus,
H4.2 In mass customization environments, consumers will invest more effort searching characteristics related to product appearance compared to characteristics related to product functionality.

When the variation in the attribute levels decreases, products become more similar. Researchers have investigated whether the characteristics’ weights depend on this variation of the characteristics. The results are mixed (Payne, et al., 1993, p.59). Some researchers report that characteristics with greater variance, received more weight. In contrast, other studies have found that characteristics’ weights are not dependent on the variation of the characteristics. This study will investigate the effect of variance on the importance of the characteristic.

4.2 TYPE OF PICTORIAL INFORMATION

Consumers searching for products, are often interested in both functionality and appearance related characteristics of the product. Thus, product configurators should both provide information about the functionality of the products as well as the appearance of these products. Every product configurator will to some extent offer product information about functionality and appearance, either by numerical, verbal, or pictorial representation. There is evidence that numerical and verbal representations are more appropriate to communicate product functionality, whereas pictorial representations are more appropriate to communicate product appearance (Loosveldt, 1998). The cord length of a coffeemaker, for example, is more appropriately communicated by numerical representations, whereas the product appearance of a coffeemaker is more appropriately communicated by pictorial representation. Functions will be represented numerically or verbally, whereas appearance will be represented pictorially. Furthermore, we will assume that numerical, verbal and pictorial representation will be used simultaneously in mass customization environments.

What type of pictorial information should be offered in a mass customization environment? Pictorial information can be used to provide information about the product appearance, but also to clarify the functionalities of the product, without providing explicit information about the product appearance. Characteristics relevant for the appearance can be accompanied by images that are relevant for the product appearance, whereas some characteristics relevant for the functionality can also be accompanied by images, but are irrelevant for the product appearance. However, the latter images may make the functional characteristics more salient.

Can pictorial information reduce product uncertainty? The type of pictorial information may affect the individual product uncertainty, which is consumers’ subjective uncertainty about what each product offers, and the relative product uncertainty, which consumers’ subjective uncertainty about which product is the best. Adding pictorial representations of product appearance is likely to reduce individual product uncertainty, because these representations provide information about the product appearance. Information about the product appearance is much harder to communicate using verbal representations. Pictorial information about the product appearance thus reduces individual product uncertainty about product appearance.
However, product functionality is easier communicated using verbal representations. In many cases, pictorial information about product functionality does not add relevant information about the functionality and is therefore unlikely to reduce individual product uncertainty. Thus, when relevant pictorial representations about appearance are provided, individual product uncertainty about product appearance is reduced, but not necessarily about the product functionality.

Furthermore, when information about the product appearance is available, then consumers are better able to determine which product is the best. Thus, adding pictorial information about product appearance reduces relative product uncertainty. Providing pictorial information about product functionality does reduce relative product uncertainty to the same extent as pictorial information about product appearance. Consumers will have less product information available to determine which product is the best. In sum, more product uncertainty is reduced when pictorial representation provides information about product appearance. Thus,

H4.3 When consumers in a mass customization environment are provided with pictorial information relevant for the product appearance versus pictorial information irrelevant for the product appearance, they are less likely to experience

a. individual product uncertainty
b. relative product uncertainty

The mere presentation of images could enhance the product evaluation and system evaluation. These measures were included in the study to investigate the effects of variance and type of pictorial information on these measures.

4.3 STUDY 1

To investigate hypotheses 4.1 4.2 and 4.3 a 2 x 2 empirical experiment was conducted with variance (no variance versus variance) and type of pictorial information (relevant for appearance versus irrelevant for appearance).

4.3.1 Stimuli

To investigate the effects of type of pictorial information, some product characteristics were accompanied by relevant pictorial information about product appearance whereas other characteristics were accompanied by irrelevant pictorial information about the product appearance. There are two possible problems with such stimuli. First, characteristics of the product have to be relevant for the decision process. The relevance of the functional characteristics has to be similar to the relevance of the appearance related characteristics. When the functional characteristics are considered more important than the appearance related characteristics, this would confound the effects of type of pictorial information as well. To control for this confound a preliminary study was performed.

Second, respondents may pay more attention to functional characteristics than to appearance characteristics (or the other way around), regardless of the type of pictorial information. Such
an effect would confound with the effects of type of pictorial information. A study by Vink (2003) showed that consumers do not pay more attention to characteristics related to functionality or appearance. In this study two products were studied. For the first product, product functionality was more important than the product appearance, whereas for the second product, product appearance was more important than product functionality.

The results suggested that consumers do not pay more attention to characteristics related to functionality or appearance depending on the type of products. Thus, when consumers find product functionality important, this does not lead to more attention for functional related characteristics compared to appearance related characteristics. Also when consumers find product appearance important, this only moderately affects the attention to characteristics. In this case, characteristics related to appearance receive only somewhat more attention than characteristics related to functionality. Differences in the number of characteristics related to appearance and functionality is therefore not expected to lead to any differences in relative attention. Effects in the main study can therefore be attributed to the type of pictorial information and not to whether these characteristics are related to functionality or appearance of the product.

**Constructing of stimuli for the main study.** To be able to investigate the effects of type of pictorial information, a product was selected that allowed decomposition into functional and appearance related characteristics. The strength of decomposition into separate functional and appearance related characteristics, is the possibility to investigate the effects of these different characteristics on measures such as effort, uncertainty, and evaluation. Coffee makers allow for such decomposition. On the other hand, decomposition leads to rather iconic representations of the appearance related characteristics, which does not take the correlations between characteristics into account (see figure 4.1a). Obviously, information related to product appearance should not be offered to consumers this way in mass customization environments, because consumers are expected to prefer evaluating the overall appearance of the product. However, for research purposes products were decomposed in functional and appearance related characteristics in order to investigate effects of these characteristics on relative attention. Coffee makers were presented in a matrix of eight coffee makers by eight characteristics (see figure 4.1a and 4.1b). To avoid order effects, the characteristics were presented in random order for each respondent. At the start of the experiment, none of the information in the matrix was visible.

**Preliminary study.** To ensure that the relevance of the functional characteristics was similar to the relevance of the appearance related characteristics a preliminary study was conducted. Seventeen characteristics of coffee makers were included in the study. These characteristics were tested (N=19) for: (1) weight in the decision process, which is the extent to which the characteristics determine the choice of a coffee maker; (2) their relevance for the product appearance; and (3) their relevance for the product functionality. Based on the pretest, eight characteristics were chosen: capacity, coffeepot, indication on water reservoir, anti-drip, indication on coffeepot, cord length, color, and timer. The coffeepot, indication on water reservoir, indication on coffeepot, and color were most relevant for the product appearance; capacity, anti-drip, cord length, and timer were most relevant for the product functionality.
### Figure 4.1a Rating of eight coffeemakers by eight characteristics with relevant information for appearance

<table>
<thead>
<tr>
<th></th>
<th>2-12 cups</th>
<th>2-3 cups</th>
<th>2-6 cups</th>
<th>2-9 cups</th>
<th>2-3 cups</th>
<th>2-12 cups</th>
<th>2-6 cups</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Glasses</strong></td>
<td>Glass Pot</td>
<td>Glass Pot</td>
<td>Thermos jug</td>
<td>Thermos jug</td>
<td>Glass Pot</td>
<td>Thermos jug</td>
<td>Glass Pot</td>
</tr>
<tr>
<td><strong>Indicator</strong></td>
<td>No Indicator</td>
<td>No Indicator</td>
<td>No Indicator</td>
<td>No Indicator</td>
<td>No Indicator</td>
<td>No Indicator</td>
<td>Indicator</td>
</tr>
<tr>
<td><strong>Dripstop</strong></td>
<td>No Dripstop</td>
<td>No Dripstop</td>
<td>Dripstop</td>
<td>Dripstop</td>
<td>No Dripstop</td>
<td>No Dripstop</td>
<td>No Dripstop</td>
</tr>
<tr>
<td><strong>No Indication</strong></td>
<td>No Indication</td>
<td>No Indication</td>
<td>No Indication</td>
<td>No Indication</td>
<td>No Indication</td>
<td>No Indication</td>
<td>No Indication</td>
</tr>
<tr>
<td><strong>0.5 meter</strong></td>
<td>0.5 meter</td>
<td>1.5 meter</td>
<td>1.5 meter</td>
<td>0.5 meter</td>
<td>1.5 meter</td>
<td>1.5 meter</td>
<td>0.5 meter</td>
</tr>
<tr>
<td><strong>Color</strong></td>
<td>Yellow</td>
<td>Blue</td>
<td>White</td>
<td>Yellow</td>
<td>White</td>
<td>Brown</td>
<td>Brown</td>
</tr>
<tr>
<td><strong>Timer</strong></td>
<td>No Timer</td>
<td>No Timer</td>
<td>Timer</td>
<td>Timer</td>
<td>No Timer</td>
<td>Timer</td>
<td>No Timer</td>
</tr>
</tbody>
</table>

### Figure 4.1b Rating of eight coffeemakers by eight characteristics with irrelevant information for appearance

<table>
<thead>
<tr>
<th></th>
<th>2-12 cups</th>
<th>2-3 cups</th>
<th>2-6 cups</th>
<th>2-9 cups</th>
<th>2-3 cups</th>
<th>2-12 cups</th>
<th>2-6 cups</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Glasses</strong></td>
<td>Glass Pot</td>
<td>Glass Pot</td>
<td>Thermos jug</td>
<td>Thermos jug</td>
<td>Glass Pot</td>
<td>Thermos jug</td>
<td>Glass Pot</td>
</tr>
<tr>
<td><strong>Indicator</strong></td>
<td>No Indicator</td>
<td>No Indicator</td>
<td>No Indicator</td>
<td>No Indicator</td>
<td>No Indicator</td>
<td>No Indicator</td>
<td>Indicator</td>
</tr>
<tr>
<td><strong>Dripstop</strong></td>
<td>No Dripstop</td>
<td>No Dripstop</td>
<td>Dripstop</td>
<td>Dripstop</td>
<td>No Dripstop</td>
<td>No Dripstop</td>
<td>No Dripstop</td>
</tr>
<tr>
<td><strong>No Indication</strong></td>
<td>No Indication</td>
<td>No Indication</td>
<td>No Indication</td>
<td>No Indication</td>
<td>No Indication</td>
<td>No Indication</td>
<td>No Indication</td>
</tr>
<tr>
<td><strong>0.5 meter</strong></td>
<td>0.5 meter</td>
<td>1.5 meter</td>
<td>1.5 meter</td>
<td>0.5 meter</td>
<td>1.5 meter</td>
<td>1.5 meter</td>
<td>0.5 meter</td>
</tr>
<tr>
<td><strong>Color</strong></td>
<td>Blue</td>
<td>Yellow</td>
<td>Black</td>
<td>White</td>
<td>Yellow</td>
<td>White</td>
<td>Blue</td>
</tr>
<tr>
<td><strong>Timer</strong></td>
<td>No Timer</td>
<td>No Timer</td>
<td>Timer</td>
<td>Timer</td>
<td>No Timer</td>
<td>Timer</td>
<td>No Timer</td>
</tr>
</tbody>
</table>

50
4.3.2 Design
A 2x2 experiment was conducted with the variance within attribute levels (no variance versus variance) and type of pictorial information about product appearance (irrelevant for appearance versus relevant for appearance) as independent variables.

To investigate the effort spent on searching the different product characteristics with different variance within attribute levels, four product characteristics were selected. Two characteristics were multilevel and two characteristics were dichotomous. Furthermore, for each set of characteristics, one characteristic was related to product functionality and one was related to product appearance. In this way, the relative attention to multilevel and dichotomous, and functionality related and appearance related characteristics could be investigated (see figure 4.1). To investigate the influence of variance in the decision process, capacity was offered in the variance condition as multilevel characteristic. In the no-variance condition capacity was offered as one-level characteristic. In the variance condition the maximum capacity ranged from 3-12 cups in steps of 3 (see top row of figure 4.1a or 4.1b). In the no-variance condition all eight coffeemakers had a maximum capacity of 9 cups; the first rows in figure 4.1a and 4.1b were substituted by a row with maximum capacities of 9 cups only.

Two type of pictorial information conditions were created (see figure 4.1). Half the respondents were provided with images for the characteristics, relevant to the product appearance. The other half was provided with images for the characteristics, irrelevant to the product appearance.

4.3.3 Procedure
Before the start of the experiments, all functions were explained to respondents. However, they did not know which coffeemakers had which functions. This procedure ensured that respondents would not click boxes just because of curiosity. As a check, all respondents indicated at the end of the experiment why they had clicked the first box. The respondents in the no-variance condition were told that the capacity of all coffeemakers was the same, but not that the capacity was 9 cups. To remind the respondents in the no-variance condition that the capacity was the same for all coffeemakers, the boxes that held the capacity of the coffeemaker were gray instead of white.

To motivate respondents to consider every click carefully, the number of clicks was limited. Respondents were allowed to make 24 mouse clicks. A counter in the upper right corner indicated the number of remaining clicks. A pilot study indicated that respondents preferred more clicks to make a decision and thus, respondents would be motivated to carefully consider every click.

Respondents were told to search for a coffeemaker they would be willing to purchase. Clicking on a box would open this box and the respondent could evaluate the attribute level. Clicking on another box would open that box as well. The respondents in the no-variance condition had an advantage over respondents in the variance condition, because one click provided information about one eighth of all the information. Therefore, clicking on the capacity in the no-variance condition would reduce the number of clicks by one eighth of the
total number of clicks (i.e., 3 clicks). The rationale was that respondents in the variance condition needed one-eighth of their clicks to acquire the same amount of information about each characteristic.

Respondents searched the matrix and choose one of the coffeemakers. Then the respondents filled out a questionnaire. Then, they were reminded on what box they had clicked first and wrote down why they had clicked on this box first. Next, respondents in the no-variance condition wrote down why they had clicked on the attribute without variance (capacity) at least once. Finally, they indicated their gender and age and were informed about the purpose of the study. As a reward for their participation, they received a token gift.

4.3.4 Measures

All variables used in the questionnaire were measured using seven-point-scales.

Control Measures. The characteristics were pretested for (1) their characteristics’ importance, (2) their relevance for the product appearance, and (3) their relevance for the product functionality. To be able to control for the relevance of the characteristics in the experiment, these variables were measured for each characteristic.

1. **Characteristics’ importance.** Respondents are unlikely to use characteristics they consider unimportant. Therefore respondents rated the extent to which each characteristic was important for the choice of a coffeemaker was measured for each of the eight characteristics. The scale ranged from “Very unimportant” (1) to “Very important” (7).

2. **Relevance for the product appearance.** To control for differences in relevance for product appearance of the characteristics of the coffeemaker, the extent to which a characteristic was relevant for the product appearance was measured for each of the eight characteristics. The scale ranged from “Very irrelevant” (1) to “Very relevant” (7).

3. **Relevance for the product functionality.** To control for differences in relevance for product functionality of the characteristics of the coffeemaker, the extent to which a characteristic was relevant for the product functionality was measured for each of the eight characteristics. The scale ranged from “Very irrelevant” (1) to “Very relevant” (7).

4. **Characteristics clicked.** Respondents could click on eight characteristics to acquire attribute level information about the coffeemaker. These characteristics were either related to functionality or to appearance. The number of times respondents clicked on each characteristic was recorded.

5. **Reason for clicking capacity.** If respondents in the no-variance condition clicked on the characteristic without variance (capacity) at least once, they wrote down why they had done so.

Dependent Measures. All items of the dependent variables measuring decision value are included in appendix 1.

1. **Effort.** Effort was measured in three ways. Following Johnson and Payne (1985) the search time was measured. The search time was recorded from the moment a respondent started to search the matrix until a coffeemaker was chosen. Second, the perceived effort was measured using three items ranging from “Not at all” (1) to “Very” (7) difficult, fast, and easy. The number of mouse clicks on each characteristic was used as a measure of effort to investigate the effects of variance.
2. **Product uncertainty.** Both individual and relative product uncertainty were measured. *Relative product uncertainty* was measured with three items with anchors ranging from “Very uncertain” (1) to “Very certain” (7) about the best coffeemaker, best functionality, and best appearance. The reliability of the relative product uncertainty items was low. Therefore the items of the best functionality of the coffeemaker and the best overall coffeemaker were averaged to form a relative product uncertainty measure (α = .76). *Individual product uncertainty* was measured with three items, with anchors ranging from “Don’t know much about the coffeemaker” (1) to “Know very much about the coffeemaker” (7), “Don’t know enough to decide whether to buy the coffeemaker” (1) to “Know enough to decide whether to buy the coffeemaker”, and “Don’t need additional information” (1) to “Need additional information” (7).

3. **Product Evaluation.** The evaluation of the overall product was measured using six items with anchors ranging from “Not at all” (1) to “Very” (7) satisfied, good, professional, qualitative, reliable, and attractive (Raghubir and Corfman, 1999). These were averaged to form a product evaluation measure (α = .77).

4. **System Evaluation.** System evaluation was measured by three items with anchors ranging from “Not at all” (1) to “Very” (7) satisfied, easy, and appropriate. These were averaged to form a system evaluation measure (α = .86).

### 4.3.5 Respondents
Fifty-one students (61% male and 39% female) participated in the study. Respondents were randomly assigned to conditions. On average it took the respondents 10 minutes 43 seconds to complete the experiment. After they had completed the questionnaire they were informed about the purpose of the study.

### 4.4 RESULTS OF STUDY 1

#### 4.4.1 Control measures
*Characteristics’ relevance for the product functionality and appearance.* Table 4.2 shows the means for characteristics’ importance for the decision process and relevance for product appearance and functionality of the eight characteristics used in the study. The characteristics that were intended to be relevant for the product functionality (capacity, anti-drip, cord length, and timer) were perceived to be as relevant for the product functionality as for product appearance, except that color was perceived less relevant for product functionality than the other characteristics. The characteristics that were intended to be relevant for the product appearance (coffeepot, indication water reservoir, indication on coffeepot and color), were perceived to be as relevant for the product appearance as for product functionality.

Eight paired samples *t*-tests with relevance for product appearance and product functionality, of the eight characteristics, were conducted. Indication water reservoir, anti-drip, and timer were perceived to be significantly more relevant for product functionality than for product appearance (All $t > 2.8, p < .01$). Coffeepot and color were perceived to be significantly more relevant for product appearance than for product functionality (both $t > 3.0, p < .01$). No difference for capacity, indication on coffeepot, and cord length were found (All $t < 1.7, ns$).
Table 4.2: Means for characteristics’ importance and relevance for product appearance and functionality of the eight characteristics used in the study (N=51).

<table>
<thead>
<tr>
<th>Related to Characteristic</th>
<th>Importance for decision process</th>
<th>Relevance for product functionality</th>
<th>Relevance for product appearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functionality Capacity⁴</td>
<td>5.60</td>
<td>4.50</td>
<td>4.20</td>
</tr>
<tr>
<td>Anti-drip</td>
<td>4.65</td>
<td><strong>4.92</strong></td>
<td><strong>3.39</strong></td>
</tr>
<tr>
<td>Cord Length</td>
<td>4.43</td>
<td>4.22</td>
<td>3.67</td>
</tr>
<tr>
<td>Timer</td>
<td>4.24</td>
<td><strong>4.29</strong></td>
<td><strong>3.61</strong></td>
</tr>
<tr>
<td>Appearance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coffeeepot</td>
<td>5.00</td>
<td><strong>4.88</strong></td>
<td><strong>5.61</strong></td>
</tr>
<tr>
<td>Indication Water reservoir</td>
<td>5.37</td>
<td><strong>5.37</strong></td>
<td><strong>4.24</strong></td>
</tr>
<tr>
<td>Indication on coffeeepot</td>
<td>4.53</td>
<td>4.45</td>
<td>3.96</td>
</tr>
<tr>
<td>Color</td>
<td>4.51</td>
<td><strong>2.80</strong></td>
<td><strong>5.59</strong></td>
</tr>
</tbody>
</table>

Notes. **p<.01; significant differences relate to the difference in relevance for functionality and relevance for appearance.

In order to investigate hypotheses 4.1 and 4.2, four characteristics were selected. Capacity was selected as multilevel functional characteristic. Color was selected as multilevel appearance related characteristic. This was done also because there were no other multilevel characteristics. Indication scored highest on functionality and coffeeepot scored highest on appearance and thus these characteristics selected as dichotomous functional characteristic and as dichotomous appearance related characteristic respectively. Table 4.2 shows that the selected functional characteristics (capacity and indication), were perceived as more relevant for the functionality, than for the appearance of the product. Furthermore, the selected appearance related characteristics (coffeeepot and color), were perceived to be more relevant for appearance than for functionality.

Characteristics’ importance. To determine whether the characteristic’s importance was dependent on the variance within a characteristic, the perceived importance for the capacity of the coffeemaker was investigated. An analysis of variance with the variance as between-subject factor and perceived importance of the capacity of the coffeemaker as independent variable was conducted. Characteristics without variance were perceived as important as characteristics with importance (F(1,49)=.6, ns; M=5.3 versus 5.6). Thus, the within variance of a characteristic did not influence the characteristics importance.

Non-pictorial versus pictorial information. Vriens et al., (1998) found that the characteristics that are visualized were perceived as more important for the decision. Maybe respondents clicked on characteristics relevant for product appearance, because they preferred pictorial information, regardless of whether it contained relevant information for appearance. Therefore, the number of clicks on characteristics with pictures of irrelevant and relevant information for appearance (pictorial characteristics) and the number of clicks on characteristics without images (verbal characteristics) were compared. An analysis of

⁴ Means are provided for the variance condition, because this condition is considered most representative for the importance and relevance of this characteristic.
variance with pictorial and textual characteristics as within-subject variables revealed no significant differences in the number of clicks on these types of characteristics ($F(1, 50)=2.5, ns$). From this, it can be concluded that clicks on characteristics relevant for the product appearance, were not caused by respondents’ preference for pictorial characteristics.

### 4.4.2 Dependent measures

To provide test for the hypotheses, the data were analyzed by separate 2 x 2 analyses of variance with type of pictorial information and variance as between-subject factors. Three measures of effort were taken: (1) the mouse clicks used to search the different characteristics, (2) the search time, and (3) the perceived effort.

**Mouse clicks.** To investigate the differences in effort between multilevel and dichotomous characteristics (hypothesis 4.1) and differences in the effort searching characteristics related to functionality and appearance, the number of mouse clicks on four characteristics was investigated. The average number of clicks on multilevel and dichotomous functional and appearance related characteristics after 24 clicks were calculated for the variance condition. The no-variance condition was not included in this analysis, because this would introduce a confound of variance and the type of characteristic.

A paired sample $t$-test was conducted with multilevel and dichotomous characteristics revealed no significant differences of the number of attribute levels on the number of mouse clicks ($t (27)=1.1, ns, M=3.9$ versus 3.4 respectively). The number of attribute levels did not affect the number of mouse clicks of searching the product information. Hypothesis 4.1 was not supported. A paired sample $t$-test was conducted with functional and appearance related characteristics revealed no significant differences of the type of characteristics on the number of mouse clicks ($t (27)=1.1, ns, M=4.0$ versus 3.3 respectively). Characteristics related to product appearance did not take any more effort than characteristics related to product functionality. Thus, hypothesis 4.2 was not supported.

**Reason for clicking capacity.** Table 4.3 shows the number of respondents who clicked on capacity in the variance conditions. All respondents looked at capacity when there was variance in capacity, whereas only 7 respondents looked at capacity when there was no variance ($\chi(1)=27.7, p<.001$). These 7 respondents made 15 clicks on capacity in the no-variance condition.

### Table 4.3. Number of respondents who (did not) click(ed) on capacity in the variance conditions

<table>
<thead>
<tr>
<th></th>
<th>Variance within attribute levels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>($N=24$)</td>
</tr>
<tr>
<td>Clicked on Capacity</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>Total</td>
<td>24</td>
</tr>
</tbody>
</table>

---

5 Tables and statistical tests are provided for 24 clicks. Similar results were obtained for 1, 3, 5, and 10 clicks.
Two of the respondents in the no-variance condition clicked at the capacity first. Analyzing the reason for their first click revealed that they had misunderstood the instruction and that they thought there was variance. Other respondents looked at the capacity at click 5, 7, 11, 14 and 19 (out of 24). Their reasons for clicking on the no-variance characteristic, were that they had still clicks left. They also found it important to know what the capacity was (even though it was the same for each coffeemaker). These analyses show that respondents initially looked at characteristics to differentiate between products.

*Search time.* The mean search time for each condition is shown in table 4.4. Respondents searched significantly longer, when there was variance compared to no variance \((F(1, 47)=6.9, p<.01)\). However, the search time was not significantly different when corrected for the amount of information \((F(1, 47)=1.4, ns)\). Also the type of pictorial information did not affect search time \((F(1,47)=.04, ns)\).

<table>
<thead>
<tr>
<th>Table 4.4. Respondents' effort in searching for a coffeemaker.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respondents' Effort</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Search time (seconds)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Perceived effort</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

*Notes.*  
** \(p<.01\); *** \(p<.001\)

*Perceived effort.* The results for the perceived effort of respondents are presented in table 4.4 also. The analyses of variances revealed no significant results for search difficulty and speed of choice. However, respondents in the variance condition perceived more difficulty choosing the coffeemaker than in the no-variance condition \((F(1,47)=11.5, p<.001)\). No effects of the type of pictorial information and no interaction effect were found (both \(F(1,47)<3.7, ns)\).

*Uncertainty.* The results for both relative product uncertainty and individual product uncertainty are presented in table 4.5. Variance in the attribute levels leads to more uncertainty about the knowledge of the chosen coffeemaker \((F(1,47)=4.0, p<.05)\). Relevant pictorial information for product appearance leads to less uncertainty about the decision \((F(1,47)=5.0, p<.05)\). No other significant differences between conditions were found. Hypothesis 4.3a predicted that relevant pictorial information would lead to less individual uncertainty and received only partial support. Hypothesis 4.3b predicted less relative product uncertainty
uncertainty in the relevant pictorial information condition. However, no significant
differences were found (All $F(1,47)<1.2$, ns). Hypothesis 4.3b received no support.

| Table 4.5. Respondents' uncertainty in searching for a coffeemaker |
|-------------------------|-------------------------|-------------------------|
| Uncertainty measures    | Variance                | Type of pictorial information |
|                         | No Variance ($N=24$)    | Irrelevant for appearance ($N=25$) | Relevant for appearance ($N=26$) |
| Individual product uncertainty | Knowledge about the coffeemaker | 2.2* | 2.7 |
|                         | Amount of information desired | 2.8 | 3.6* |
|                         | Information to decide    | 3.6 | 3.9 |
| Relative product uncertainty |                           | 2.3 | 2.6 |

Notes. *p<.05; higher means denote more uncertainty

**Product Evaluation.** Evaluations of the coffeemaker were not influenced by either the variance within attribute levels ($F(1,47)=2.4$, ns; $M=4.6$ versus 4.3) or the type of pictorial information ($F(1,47)=3.0$, ns; $M=4.6$ versus 4.3). No interaction effects were found.

**System Evaluation.** Evaluations of the coffeemaker were not influenced by either the variance within attribute levels ($F(1,47)=1.5$, ns; $M=3.8$ versus 3.4) or the type of pictorial information ($F(1,47)=.61$, ns; $M=3.7$ versus 3.5). No interaction effects were found.

4.5 CONCLUSIONS FOR AMOUNT AND TYPE OF INFORMATION

4.5.1 Variance within attribute levels

The number of levels within an attribute (hypothesis 4.1), did not affect the effort of searching product information. The perception of the amount of information, is influenced somewhat by the variance within an attribute level. Consumers perceive more information when there is variance.

On the one hand, the effort invested on a characteristic, is not affected by the variance within attribute levels. Even when there was no variation, consumers did not invest less effort. Consequently, no differences can be expected when characteristics do have some variation within attribute levels. On the other hand, when the difference in variation becomes really large, the relative attention may be affected. When there are large differences in variation, there will also be large differences in the amount of information. This difference in the amount of information may indeed influence the relative attention spent on a characteristic. Only when differences in variation become too large effects on effort can be expected. Also
the type of characteristics (hypothesis 4.2) did not affect the effort of searching these characteristics. That means that both types of characteristics received the same amount of attention. The implications are that both characteristics take as much effort to search.
However, the experiment studied only limited variation within attributes levels. The results of this study have consequences for the number of attribute levels that should be offered in mass customization environment. Chapter 13 will discuss these implications in detail.

4.5.2 Type of pictorial information
The type of pictorial information hardly affected any of the dependent measures. This may suggest that images attract attention, because they are visual and not because they provide information about the product appearance. However, control measures showed that clicks on characteristics relevant for the product appearance, were not caused by respondents' preference for pictorial characteristics. The type of pictorial information did not influence the product evaluation and system evaluation.

Hypothesis 4.3a received only partial support; the type of pictorial information did affect one of the measures of individual product uncertainty. Three aspects of individual product uncertainty were measured: (1) the desire for additional information, (2) the knowledge gained and (3) the ability to make decision based on the provided information. No differences in the knowledge gained or the ability to make decisions based on the provided information were found. The type of pictorial information does not contribute to knowledge or ability to make a decision. Presentation of irrelevant pictorial information leads to more desire for additional information, compared to presentation of relevant pictorial information. Consumers who received irrelevant information for appearance condition seem to desire additional information about the product appearance, in order to increase their certainty about what each product offers.

Hypothesis 4.3b received no support; pictorial information was unable to reduce uncertainty about which product was the best. Apparently, pictorial information relevant for product appearance could not help consumers to determine the best product. When the product appearance is of paramount importance, the pictorial information about product appearance is likely to decrease the individual product uncertainty. However, this was not the case for coffeemakers. The appearance related characteristics were about as important as the functionality characteristics (as intended!). Therefore, relevant pictorial information for product appearance did not lead to a significant reduction in relative product uncertainty, compared to irrelevant pictorial information for product appearance.

4.5.3 Characteristics' importance
In the current study, respondents put more importance on characteristics that differentiate between products. Product characteristics importance for the decision process may be the result of two considerations. First, characteristics may be important in the decision process, because these characteristics eliminate products (elimination). Some consumers may not consider digital cameras, when they cost more than €250. Second, a characteristic may be important in the decision process, because these characteristics differentiate very well between different alternatives (ability to differentiate). Price, for example, can easily be used to differentiate between different products. Consumers using product configurators can easily
enter a maximum price (see for example Consumerdesk; www.consumerdesk.nl or Kieskeurig; www.kieskeurig.nl).

Whether consumers use characteristics for these reasons depends on the stage in the decision process. Several authors suggest that consumers first enter an elimination stage to eliminate unacceptable alternatives. In the elimination stage it is important to concentrate on characteristics that allow elimination of products. Then consumers enter a second stage: the selection stage that is used to select the most promising alternative. However, to determine which product is the best in this stage, it is more important to evaluate characteristics that differentiate between products.

Often, consumers will use characteristics to both eliminate products and differentiate between products. Consumers may look at certain characteristics, because they differentiate between products. Price may be looked at first, because it is such a differentiating characteristic. It is much easier to decide for consumers to choose a coffeemaker that costs less than €100, rather than a coffeemaker that is yellow. Unless a pictorial representation of the color is provided, consumers may never know which yellow they are going to get. The boundaries of the category ‘yellow’ are not as clearly defined as the category ‘€100.’ Thus, price may not only be considered because of its ability to eliminate, but also because price differentiates well between products.

The number of products was limited in this study; only eight products were offered. Respondents could have skipped the elimination stage and entered the decision process at the evaluation stage. In study 2 the assortment of products is increased. This makes it more likely that consumers will start in the elimination stage and will lead to more iterative decision processes which characterize mass customization environments: search, choose, evaluate, search, etc. Whether consumers really use elimination-selection stages in their decision process, is investigated in study 4 (Chapter 5).
CHAPTER 5
ASSORTMENT SIZE AND TYPE OF INFORMATION

In the current study the assortment is manipulated to demonstrate any effects of large assortment that are available in mass customization environments. In study 1 the information about product appearance was rather iconic. The current study presented the overall product appearance. Two properties of mass customization environments were investigated: the size of the assortment (small, medium, large) and the type of product information (functionality versus appearance).

5.1 ASSORTMENT SIZE

The number of alternatives, that are offered in mass customization environments, is also called the product assortment. Various researchers have investigated the effects of increasing the size of the assortment. An increase in assortment size generally (1) increases the variability of the choices, (2) decreases the accurateness of choosing the optimal bets, and (3) increases consumers’ confidence of their decisions (Payne, 1982; Payne, Bettman and Johnson, 1993). Furthermore, the size of the assortment positively influences the amount of search (Schmidt and Spreng, 1996; Srinivasan and Ratchford, 1991). However, most of the assortments in these studies were limited in range (maximum of 12 alternatives). Also, no research has directly measured the change in effort that consumers invest, when the size of the assortment increases.

Consumers can search the mass customization environment, until they find a product they like. However, the more products there are available for the consumer, the more effort is needed to interpret all this product information. Searching all the information when the assortment is large, takes more effort than searching all the information when the assortment is small. More effort is needed when consumers search a large assortment of products compared to a small assortment of products. In a retailer’s showroom, for example, consumers are likely to spend more effort on evaluating cars, when there are twenty cars on display compared to ten. So, when the assortment increases, consumers are more likely to invest effort into their search process.

Olshavsky (1979) found that increasing the product information by adding attributes to the alternatives, lead to more selective processing of attributes. For small assortments, consumers invest increasing effort to be able to search all products in the assortment. However, when the assortment increases, consumers cannot search all products and they are willing to invest a limited amount of effort. Consumers are not likely, for example, to spend five times as much effort on evaluating 100 cars compared to 20 cars. Searching large assortments takes too much effort, so consumers are not willing to search the assortment at all. This suggests an inverted-U-shape relation between the size of the assortment and the amount of effort.
H5.1 In a mass customization environment, the effort in searching product information shows an inverted-U-shape relationship with assortment size.

Knowledge about the effect that consumers want to invest in searching the assortment is very important, because manufacturers can offer almost unlimited assortments in mass customization environments. They need to know the boundary conditions for the size of the assortment. It could be disastrous for manufacturers when they are offering too much information. When consumers will not invest effort in using the system, they do not use the system at all! The amount of effort invested *per product*, is expected to decrease, when the size of the assortment increases. Consumers will invest less effort *per product* when assortment increases. We hypothesize a linear relationship between the relative effort (effort *per product*) and the size of the assortment; relative effort increases when the assortment decreases. This leads to the second hypothesis.

H5.2 In a mass customization environment, the effort *per product* decreases when the assortment size increases.

Chapter 2 discussed that under certain conditions, consumers trade off the desire to reduce effort and the desire to reduce uncertainty. The effort that consumers are willing to invest in searching an assortment also depends on both the individual and relative product uncertainty. Individual product uncertainty of a chosen alternative is expected to be the same. Consumers will collect similar amounts of information on a product they are about to choose, regardless the number of other products. Consumers try to reduce the relative product uncertainty before making a choice. However, when the assortment size increases, even this may take too much effort. Relative product uncertainty with large assortments of products, may therefore be relatively greater compared to small assortments.

H5.3 In a mass customization environment, consumers experience more relative product uncertainty when assortment increases.

5.2 **Type of Product Information**

Not only the size of the assortment, but also the type of product information, may affect the effort and uncertainty in a mass customization environment. Product information about both the functionality and the appearance should be provided, because consumers use both types of information when making customization decisions. These two types of product information may have a very different effect on the amount of product information that consumers have to process. Increasing the number of products will often increase the effort of investigating all appearances of these products, whereas the effort in investigating functionality does not necessarily increase. This is possible, because consumers can often use search engines to specify cutoff levels for price. Product configurators will only show the alternatives that meet these criteria. Using cutoff levels is impossible for characteristics related to appearance and consequently the effort in investigating product appearance increases when assortment increases. Thus, the effort in searching appearance related characteristics increases when assortment increases.
When search engines cannot be used to specify cutoff levels, characteristics related to functionality may take more effort to process than characteristics related to appearance. A pictorial representation tends to be received in an imagery system. A verbal representation is received in an independent but interconnected verbal system (Holbrook and Moore, 1981; Paivio, 1991). Treisman (1986) argues, that the processing of images is primary to the processing of words. This suggests that the processing of pictorial representations of product characteristics is less effortful than processing of verbal representation of the product characteristics. Thus, searching through assortments of products with characteristics represented verbally, takes more effort than searching through assortments of products with characteristics represented pictorially. Searching through pictorially represented product characteristics should take less effort than searching through verbally represented product characteristics. Verbal representations have to be read and interpreted to be evaluated. Evaluations of product appearance are made in a glance.

Product functionality is better communicated verbally, whereas product appearance is better communicated pictorially (see Chapter 2). This means that characteristics related to product functionality take more effort to process than characteristics related to appearance. Product assortment can grow very large in mass customization environments. This could result in information overload for consumers. As a consequence all product information cannot and should not be displayed at one computer screen. Manufacturers have various options. Two of these options are (1) to have consumers choose the functionality first and the appearance later and (2) to have consumers choose the appearance first and the functionality later. It is hypothesized that it takes consumers less effort searching the appearance of products first compared to searching the functionality of products first. This leads to the fourth hypothesis:

H5.4 In mass customization environments, consumers invest more effort when searching the functionality of products first compared with searching the appearance of products first.

As in study 1, measures of system evaluation and product evaluation were included in the experiment to study the effects of the assortment size and type of product information on these measures. Furthermore, research often shows that consumer knowledge influences the decision-making process (Alba and Hutchinson, 1987; Brucks, 1985). Respondents’ subjective knowledge might influence the effort they have to invest and the uncertainty they experience. Respondents with high subjective knowledge, may invest little effort into choosing the product. Respondents with low subjective knowledge, may invest much effort into choosing a product. High subjective knowledge may also make respondents more certain about their choices, whereas low subjective knowledge may make respondents less certain about their choices. To be able to correct for any effects on uncertainty, but also on effort and product evaluations, the subjective knowledge of respondents was measured. These were taken as covariates in all analyses.
To investigate these four hypotheses, an empirical experiment was conducted. A randomized 3 x 2 factorial design was used with assortment (small, medium versus large) and type of product information (functionality first versus appearance first) as independent variables.

### 5.3.1. Stimuli
The product chosen for the experiment was a telephone for home use. The Internet was searched to acquire a realistic set of telephone characteristics related to functionality and appearance. Four functional characteristics were selected: model, price, color, and number of pre-programmable telephone numbers (see figure 5.1a). The corresponding appearance of the product was represented by a picture (see figure 5.1b). Respondents searched a matrix of telephone characteristics using a computer program especially designed and programmed for the experiment (see figure 2a and 2b).

<table>
<thead>
<tr>
<th>Figure 5.1a Product characteristics related to product functionality</th>
<th>Figure 5.1b Product characteristics related to product appearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remini 50 HV</td>
<td></td>
</tr>
<tr>
<td>• Price: 59.95</td>
<td></td>
</tr>
<tr>
<td>• Color: Grey</td>
<td></td>
</tr>
<tr>
<td>• Programmable no.: 30</td>
<td></td>
</tr>
<tr>
<td>• Model: cord-horizontal table model</td>
<td></td>
</tr>
</tbody>
</table>

### 5.3.2 Design
To test hypotheses 5.1 through 5.3, a small, medium and large assortment of telephones was created. Respondents in the small assortment condition had the choice of 9 telephones (the 3 x 3 block in the upper left corner in either figure 5.2a or 5.2b). The respondents in the medium assortment condition had the choice of 36 telephones. In the large assortment condition respondents had the choice of 72 telephones.

To test hypothesis 5.4, two conditions for the type of product information were created. In the functionality first condition respondents were initially provided with the functionality of the telephones. They could click on the functionality of the telephones, to investigate the appearance in the upper left corner (see figure 5.2a). In the appearance first condition, respondents received a matrix with the product appearances. These respondents could click on the product appearance, to investigate the functionality of the telephone in the upper left corner (see figure 5.2b). The matrices were presented full screen on 21" monitors.

### 5.3.3 Procedure
Prior to the experiment all functions were explained to the respondents. They were explained how to operate the matrix; clicking on a cell in the matrix would reveal additional information (about functionality or product appearance, depending on the condition) in the upper left corner of the screen (see figure 5.2a and 5.2b). The respondents were to choose a
Figure 5.2a Matrix in functionality-first condition

<table>
<thead>
<tr>
<th>Brand 200</th>
<th>Samsung 2000x</th>
<th>Benaq</th>
<th>Confident</th>
<th>Choice</th>
</tr>
</thead>
<tbody>
<tr>
<td>=&gt; Price: 99.90</td>
<td>=&gt; Phone: 100</td>
<td>=&gt; Memory: 150</td>
<td>=&gt; Model: standard/earpiece model</td>
<td>=&gt; Stylus: 3/4</td>
</tr>
<tr>
<td>=&gt; Car: 200</td>
<td>=&gt; Check: 10</td>
<td>=&gt; Color: grey</td>
<td>=&gt; Model: standard/earpiece model</td>
<td>=&gt; Pen: 1/2</td>
</tr>
<tr>
<td>=&gt; USB: 100</td>
<td>=&gt; Ear: 15</td>
<td>=&gt; Material: plastic</td>
<td>=&gt; Model: standard/earpiece model</td>
<td>=&gt; Band: 1/4</td>
</tr>
</tbody>
</table>

Figure 5.2b Matrix in the 15% price condition

<table>
<thead>
<tr>
<th>Brand 200</th>
<th>Samsung 2000x</th>
<th>Benaq</th>
<th>Confident</th>
<th>Choice</th>
</tr>
</thead>
<tbody>
<tr>
<td>=&gt; Price: 99.90</td>
<td>=&gt; Phone: 100</td>
<td>=&gt; Memory: 150</td>
<td>=&gt; Model: standard/earpiece model</td>
<td>=&gt; Stylus: 3/4</td>
</tr>
<tr>
<td>=&gt; Car: 200</td>
<td>=&gt; Check: 10</td>
<td>=&gt; Color: grey</td>
<td>=&gt; Model: standard/earpiece model</td>
<td>=&gt; Pen: 1/2</td>
</tr>
<tr>
<td>=&gt; USB: 100</td>
<td>=&gt; Ear: 15</td>
<td>=&gt; Material: plastic</td>
<td>=&gt; Model: standard/earpiece model</td>
<td>=&gt; Band: 1/4</td>
</tr>
</tbody>
</table>
telephone as if they needed a new one. They were told to search as much as they liked. When they had found the telephone they wanted, they choose this telephone by clicking the button "confirm choice" in the upper left corner of the screen (see figure 5.2a and 5.2b). Next, respondents completed the dependent measures. After the respondents had completed the questionnaire, they indicated their gender and age, and were informed about the purpose of the study.

5.3.4 Measures
All variables used in the questionnaire were measured using seven-point-scales.

Control measures.
1. Characteristics’ importance. Respondents indicated to what extent their choice was determined by the provided product information with anchors ranging from “Not at all” (1) to “Completely” (7). These measures were used to determine whether respondents in the functionality first condition placed different weights on the product characteristics than respondents in the appearance first condition.

2. Subjective Knowledge. To control for individual differences in product knowledge, the subjective knowledge of the respondents was measured using four propositions from a scale developed by Flynn and Goldsmith (1999), with anchors ranging from “Completely disagree” (1) to “Completely agree” (7). Subjective knowledge expresses what respondents think they know about a specific product (Flynn and Goldsmith, 1999). The items were averaged to form an individual subjective knowledge measure (α=.87).

Dependent measures. All items of the dependent variables measuring decision value are included in appendix 1.

1. Effort. Effort was measured in three ways. Next to the search time and the number of mouse clicks (Johnson and Payne, 1985), the perceived effort was measured. The search time was recorded from the moment a respondent started to search the matrix until the “confirm choice” button was clicked. Respondents could click on the boxes to see additional information about either functionality or appearance of the product. Each mouse click was recorded up until the respondent clicked “confirm choice.” Third, the perceived effort was measured using three items ranging from “Not at all” (1) to “Very” (7) difficult, fast, and easy.

2. Uncertainty. Both individual and relative product uncertainty were measured. Relative product uncertainty was measured with three items with anchors ranging from “Very uncertain” (1) to “Very certain” (7) about the best telephone, best functionality, and best appearance. The reliability of the relative product uncertainty items was low (α=.56). Therefore the items of the best functionality of the telephone and the best overall telephone were averaged to form a relative product uncertainty measure (α=.69). Individual product uncertainty was measured with three items, with anchors ranging from “Don’t know much about the telephone” (1) to “Know very much about the telephone” (7), “Don’t know enough to decide whether to buy the telephone” (1) to “Know enough to decide whether to buy the telephone,” and “Don’t need additional information” (1) to “Need additional information” (7). These three items were averaged to form an individual uncertainty measure (α=.69).
3. **Product Evaluation.** The product evaluation was measured using five items with anchors ranging from “Not at all” (1) to “Very” (7) satisfied, good, professional, qualitative and attractive (Raghunathan and Corfman 1999). These were averaged to form a product evaluation measure (α = .81).

### 5.3.5 Respondents

One hundred and forty nine students (56% male and 44% female) participated in the study. Respondents were randomly assigned to conditions. On average it took the respondents 6 minutes 11 seconds to complete the experiment.

### 5.4 Results of Study 2

#### 5.4.1 Control measures

**Characteristics’ importance.** Respondents indicated to what extend the characteristics were important in their decision-making process (see table 5.1). Paired sample t-tests were used to determine whether the differences in the degree of importance were significantly different from each other. All pairs were significant different (All Ts > 2.1, p < .05). These results indicate that respondents’ choices were largely determined on the model, appearance, and price of the telephone and hardly on the color, number of pre-programmable telephone numbers, and the name of the telephone. Six analyses of variances with each characteristic’s importance as dependent variable and assortment size and type of information as independent variables revealed that there were no differences in the characteristics’ importance between assortment conditions or type of product information conditions (All F(1,143) < .77). No significant interaction effects (All F(1,143) < 2.6, ns) were found. The characteristics importance was independent of the assortment and type of product information conditions.

#### Table 5.1. Means for characteristics’ importance (N=149)

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Characteristics’ importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>5.7</td>
</tr>
<tr>
<td>Appearance</td>
<td>5.5</td>
</tr>
<tr>
<td>Price</td>
<td>4.8</td>
</tr>
<tr>
<td>Color</td>
<td>4.1</td>
</tr>
<tr>
<td>No. of pre programmable telephone no.</td>
<td>2.7</td>
</tr>
<tr>
<td>Name</td>
<td>1.5</td>
</tr>
</tbody>
</table>

**Subjective knowledge and gender.** To control for effects of subjective knowledge and gender, these variables were taken as covariates in all analyses of variances below. Subjective knowledge and gender did not moderate the effects of assortment size and product information type.

#### 5.4.2 Dependent measures

To provide tests for all hypotheses, the data were analyzed by separate 3 x 2 analyses of variance with between-subject factors of assortment size and product information type\(^6\).

---
\(^6\) No significant interaction effect were found in any of the analyses of variance (All F(1,143) < 3.1, ns) and hence no interaction effects are reported.
Effort. Three measures of effort were taken: (1) the number of mouse clicks, (2) the search time, and (3) the perceived effort. Table 5.2 shows the number of mouse clicks for each condition.

<table>
<thead>
<tr>
<th>Mouse clicks</th>
<th>Assortment</th>
<th>Type of product information</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Small (N=50)</td>
<td>Medium (N=48)</td>
</tr>
<tr>
<td>Total clicks</td>
<td>17.6***ab</td>
<td>37.5***a</td>
</tr>
<tr>
<td>Clicks/ product</td>
<td>2.0***ab</td>
<td>1.0***a</td>
</tr>
<tr>
<td>Total time</td>
<td>127***a</td>
<td>203***ab</td>
</tr>
<tr>
<td>Time/ product</td>
<td>14***a</td>
<td>6***a</td>
</tr>
<tr>
<td>Search difficulty</td>
<td>3.0***a</td>
<td>3.4***b</td>
</tr>
<tr>
<td>Speed of choice</td>
<td>2.9***a</td>
<td>3.4***</td>
</tr>
<tr>
<td>Ease of program</td>
<td>2.0</td>
<td>2.3</td>
</tr>
</tbody>
</table>

Notes. ** p < .01; *** p < .001; means with the same superscript are significantly different from each other

Hypothesis 5.1 predicted an inverted-U-shape relationship between effort and assortment size. Respondents clicked more when the assortment increased (F(1,143)=15.8, p<.001). Respondents searched significantly longer when the assortment increased, (F(1, 143)=13.3, p<.001). The inverted-U-shape relationship between mouse clicks and assortment size was not shown, but inverted-U-shape relationship between search time and assortment size was shown, providing mixed support for hypothesis 5.1.

Hypothesis 5.2 was investigated next. This hypothesis predicted a negative linear relationship between assortment size and effort per telephone. The number of mouse clicks per telephone decreased when the assortment increased (F(1,143)=29.2, p<.001). Larger assortments lead to less search time per telephone (F(1,143)=114.9, p=.001) Thus, large assortments lead to relatively less effort compared to small assortments, providing support for hypothesis 5.2.

Hypothesis 5.4 predicted more effort when functionality was searched first, than when appearance was searched first. The type of product information did influence the number of mouse clicks (F(1,143)= 5.8, p< .001). Respondents made more mouse clicks when they first evaluated the functionality of the telephone compared to when they first evaluated the appearance of the telephone. The number of mouse clicks was not influenced by the type of product information that was offered first (F(1,143)=.45, ns). These results provided support for hypothesis 5.4. Furthermore, an interaction effect was found (see figure 5.3) between

68
assortment size and type of product information on total clicks ($F(1,143)=5.5$, $p<.01$). Respondents clicked as much in the small and medium assortment conditions, regardless of the type of product information presented first. However, in the large condition, respondents clicked twice as much when functionality of the telephone was presented first compared with when the appearance of the telephone was presented first.

**Figure 5.3 The number of mouse clicks depending on the size of the assortment and the type of information presented**

<table>
<thead>
<tr>
<th>assortment size</th>
<th>mouse clicks</th>
</tr>
</thead>
<tbody>
<tr>
<td>small</td>
<td>17</td>
</tr>
<tr>
<td>large</td>
<td>19</td>
</tr>
<tr>
<td>largest</td>
<td>32</td>
</tr>
</tbody>
</table>

Also, the type of product information affected search time ($F(1,143)=5.7$, $p<.019$). Respondents in the functionality first condition searched longer than respondents in the appearance first condition. This result provides support for hypothesis 5.4. The type of product information did not affect search time ($F(1, 143)=2.3$, $ns$).

The results for perceived effort are also presented in table 5.2. The analyses of variances revealed significant differences for the search difficulty ($F(1,143)=8.7$, $p<.001$) and speed of choice ($F(1,143)=7.4$, $p<.001$), but not for the ease of the program ($F(1,143)=1.1$, $ns$). Tukey post-hoc analyses showed that the search difficulty was significantly different for each of the assortment conditions. Respondents perceived the same speed of choice in the small and medium assortment condition, but perceived higher speed of choice in the large condition. The type of product information did not affect perceived effort (All $F(1,143)<3.7$, $ns$).

*Uncertainty*. Hypothesis 5.3 predicted more relative product uncertainty when assortment size increases. The results for both relative product uncertainty and individual product uncertainty are presented in table 5.3. No significant effects of assortment size on individual product uncertainty were found ($F(1,143)=3.0$, $ns$). Assortment size did not influence the relative product uncertainty either ($F(1,143)=1.4$, $ns$). Respondents in all assortment
conditions, were as uncertain they had chosen the best product. Thus, no support for hypothesis 5.3 was found.

<table>
<thead>
<tr>
<th>Table 5.3: Respondents' uncertainty and evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Certainty measures</td>
</tr>
<tr>
<td>Individual product uncertainty</td>
</tr>
<tr>
<td>Relative product uncertainty</td>
</tr>
<tr>
<td>Product evaluation</td>
</tr>
</tbody>
</table>

Note. Higher means denote more uncertainty and higher evaluations

Next, the effects of type of product information on uncertainty were analyzed. No significant differences between type-of-product-information conditions on individual product uncertainty were found ($F(1,143) = 3.1$, $ns$). This means that all respondents indicated they had as much information about the products. Respondents in the functionality first condition did not perceive more information than respondents in the appearance first condition. Also no significant effects of type of product information on relative product uncertainty were found ($F(1,143) = .82$, $ns$). Thus, presenting appearance related characteristics first, leads to as much relative product uncertainty compared to presenting functionality related characteristics first.

Product Evaluation. Evaluations of the telephone were not influenced by neither the assortment ($F(1,143) = 1.5$, $ns$) nor the type of product information ($F(1,143) = 1.6$, $ns$).

5.5 Conclusions for Type of Information and Assortment Size

5.5.1 Type of product information
Respondents who were initially provided with information about product functionality, used more time choosing a product than respondents initially provided with information about product appearance, but did not click more. Respondents in both conditions were able to use both product information types. Apparently, the difference in accessibility of the information lead respondents to use the product information types initially provided (c.f. Bettman and Kakkar, 1977). Thus, respondents who initially received information related to functionality, predominantly used these representations to choose a product. Respondents who initially received information related to product appearance, predominantly used these representations to choose a product. However, all respondents based their choices on the same characteristics regardless of the information they received initially. Respondents based their choices largely on the model, appearance, and price of the telephone and hardly on the color, number of pre-programmable telephone numbers, and the name of the telephone. This demonstrates that respondents used both product information types in their choice processes.
It seems that respondents use the information initially provided, to select the products that appear promising and then investigate the additional information. Initially providing functional information leads to more search time compared to initially providing appearance related information, but not to more mouse clicks. Thus, respondents indeed seemed to invest more effort, when using functional characteristics to choose products compared using appearance related characteristics of the product. However, they perceive the same amount of effort.

The interaction effect between assortment size and type of product information on the number of mouse clicks, teaches an important lesson. Whether product information is provided first about functionality or appearance, does not matter until assortments get really large. In this study, information related to product appearance deserves priority. This information should be presented first. Respondents in the experiment made less mouse clicks, but this did not affect their product uncertainty or product evaluation. Thus, consumers evaluating product appearance first, have to invest less effort, without affecting the individual and relative uncertainty about their choices.

5.5.2 Assortment size

Effort does not proportionally increase with the assortment size. Thus, when the assortment increases, consumers invest less effort investigating each product. The overall effort shows an inverted U-shape relationship with assortment size. Initially, overall effort increases when the assortment increases. However, when the assortment becomes really large, consumers will also invest less effort in an absolute sense. How large an assortment are consumers still willing to search? When consumers are confronted with small assortments, consumers may get bored and they stop searching. On the other hand, when consumers are confronted with large assortments, they have to invest a lot of effort to search this assortment. Consumers may get tired of searching and they will stop searching. Thus, the number of products offered through product configurators should be balanced.

The search time is dependent on the assortment size. A quadratic function was calculated from the data to provide estimations of the search time for each assortment size (see figure 5.4):

\[
\text{search time} = -0.07 \times (\text{assortment})^2 + 5.96 \times (\text{assortment}) + 79
\]

According to this function, consumers search most (206 seconds) for an assortment of 43 products and do not search anymore by an assortment of 96 products. The number of mouse clicks is also dependent on assortment size. The mouse clicks were used to calculate a quadratic function for the mouse clicks as a function of assortment:

\[
\text{mouse clicks} = -0.0071 \times (\text{assortment})^2 + 1.057 \times (\text{assortment}) + 8.66
\]
According to this function, consumers click most (48 mouse clicks) for an assortment of 75 products and do not click anymore by an assortment of 157 products. However, combining these functions leads to a problem. For an assortment of 96 products, consumers would invest no time searching the assortment, but they would still make 45 mouse clicks. The number of mouse clicks should be zero for an assortment of 96 products. Using this information, the number of mouse clicks was modeled as a third order function (see figure 5.4):

\[
mouse\;clicks = -(5.57 \times 10^{4}) \times (assortment)^3 + (0.0583) \times (assortment)^2 - .94 \times (assortment) + 21.74
\]

According to this function, consumers click most (55 mouse clicks) for an assortment of 60 products. They do not click anymore by an assortment of 96 products. Combining the two functions of search time and mouse clicks shows that consumers invest most effort between an assortment of 40 and 60 products. Based on these results, no more than 40 to 60 products should be offered in a computer system when all products are presented by alternative.

Consumers search through mass customization environments, but they want to invest no more than a certain amount of effort. When manufacturers offer more than 100 products, consumers do not invest effort in using the system, i.e. they do not use the system at all! There seem to be two ways out: decreasing the perceived effort or decreasing the amount of information that consumers perceive.
Respondents perceived an equal investment of effort searching the small assortment or the large assortment. However, perceived effort in the large assortment condition was larger than in the two other assortment conditions. This suggests that consumers want to invest effort in searching an assortment until the perceived effort reaches a certain level. When this perceived level of effort is reached, the effort (as measured by mouse clicks and search time) starts to decrease. So, consumers thus seem to have some maximum level of perceived effort they want to invest in searching product information. Thus, manufacturers should carefully consider the assortment of products that is offered or make the mass customization environment easier to search. This allows consumers to keep the perceived level of effort below this maximum level. The consequences of these results for the design of mass customization environment are discussed in detail in Chapter 13.

The amount of product information, varied by assortment size, has significant effects on decision value, especially on the effort of searching the product information. The amount of information is also increased when the number of characteristics is increased. Study 3 investigates the effects of the number of characteristics on decision value.
CHAPTER 6
NUMBER OF PRODUCT CHARACTERISTICS

In mass customization environments manufacturers can easily offer large amounts of product information. There are virtually no limits to the amount of information that can be offered. Consumers have to be able to make customization choices from this information. When consumers cannot oversee the product information, they may acquire products in other ways, such as visiting retailers. Study 2 investigated the product assortment that could be offered in mass customization environments. The results showed that consumers are willing to search assortments of 40 to 60 products, but this willingness decreases after such an assortment size. Some products have more customizable characteristics than others. On the Advanta website (see figure 1.4), consumers can choose the business name that is printed on their credit card, essentially customizing one characteristic. However, the product configurator of Dell (see figure 1.7), allows for customization of 33 customizable characteristics. How does the number of characteristics affect the decision value of customization choices?

6.1 NUMBER OF PRODUCT CHARACTERISTICS

In general consumers have to invest more effort when the amount of information increases. Thus, the more information about the characteristics of a product is provided, the more effort it takes to evaluate the product. On the other hand, when more information is provided about products, consumers are better able to reduce uncertainty about what these products offer (individual product uncertainty) and therefore make it easier for consumers to make customization choices. No effects on relative product uncertainty are expected, because more product information does not necessarily make some products better than others, there is just more information available about these products. Study 1 and 2 showed that consumers invested more effort and also perceived more effort when presented with large amounts of information (either by increasing variance within the attribute level or increasing the product assortment). Limited effects of the amount of information on uncertainty were found in these studies. The assortment size did not affect product uncertainty. However, variance within an attribute level (i.e. more information) increased uncertainty. Therefore, we expect that consumers are better able to reduce uncertainty, when more product characteristics are presented. Thus, a negative linear relationship is expected between the number of product characteristics and the amount of individual product uncertainty.

H6.1 Individual product uncertainty is likely to decrease when more product characteristics are offered.

A positive linear relationship is also expected between the number of characteristics and the amount of effort that consumers have to invest. However, an interaction effect is expected depending on the type of information that is offered. Remember from study 2 that consumers' effort was reduced by offering product information about the product appearance. When this
information was presented first, consumers used less mouse clicks and less search time, but their uncertainty about the product and their product evaluations were not affected. Information about product appearance was easier to process for consumers. Therefore, consumers are expected to invest less effort, when characteristics related to product appearance are provided. Characteristics related to product appearance are easier to process than characteristics related to product functionality. Therefore it takes consumers less effort to investigate additional characteristics related to appearance compared to investigating characteristics related to functionality. Thus, consumers invest less effort in choosing out of products with 10 characteristics compared with choosing out of products with 11 characteristics and consumers invest less effort when the additional characteristic is related to appearance compared to when the additional characteristic is related to functionality. Consumers may even invest less effort in searching products with 11 characteristics of which the 11th characteristic is related to product appearance compared to searching products of which none of the characteristics is related to appearance. Why may this be so? Information about product appearance is evaluated at a glance and can be decisive for a decision. Consumers often eliminate products because they do not like the appearance of these products. Hence, adding a characteristic related to appearance leads to a decrease in effort. This leads to the following hypothesis,

H6.2 Consumers are expected to invest more effort when choosing products with more characteristics if the additional characteristics are related to product functionality, but less effort if the additional characteristics are related to product appearance.

As with previous studies (studies 1 and 2), measures of system evaluation, product evaluation, and subjective knowledge were included in the experiment to study the effects of the number of characteristics on these measures.

6.2 STUDY 3

To investigate these two hypotheses, an experiment was conducted. Three number-of-characteristics conditions were created: a condition where the product had 10 characteristics (10-characteristic condition), a condition where the product had an additional characteristic related to the product functionality (11-functional condition), and a condition where the product had an additional characteristic related to the product appearance (11-appearance condition). Respondents were randomly assigned to conditions.

6.2.1 Stimuli

Ten MP3-players were used in the experiment. All MP3-players had at least 10 characteristics, creating a matrix as shown in figure 6.1, thus creating the 10-characteristic condition. A pre-test was used to select 10 characteristics that were at least moderately important. Otherwise characteristics would be ignored by respondents and they would be irrelevant in the decision process. Two characteristics were selected that were equally important and related to product functionality and appearance. To create the 11-functional condition an 11th characteristic was added to the matrix that provided information about the dimensions of the MP3-player. To create the 11-appearance condition, an 11th characteristic
was added that provided information about the exterior of the MP3-player. To avoid order effects, the characteristics were presented in random order for each respondent. Initially none of the information in the matrix was visible for respondents.

**Figure 6.1 Matrix with 10 MP3-players with 10 characteristics each**

<table>
<thead>
<tr>
<th>MP3-Players</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radio function</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Lifespan battery</td>
<td>8 h</td>
<td>5 h</td>
<td>1½ h</td>
<td>1 h</td>
<td>3 h</td>
<td>2 h</td>
<td>3 h</td>
<td>2 h</td>
<td>9 h</td>
<td>2½ h</td>
</tr>
<tr>
<td>Download speed from PC</td>
<td>480 Mb/s</td>
<td>12 Mb/s</td>
<td>0.32 Mb/s</td>
<td>12 Mb/s</td>
<td>0.32 Mb/s</td>
<td>12 Mb/s</td>
<td>0.32 Mb/s</td>
<td>480 Mb/s</td>
<td>0.32 Mb/s</td>
<td></td>
</tr>
<tr>
<td>Random function</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Remote control</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Equalizer</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Repeat function</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Playtime</td>
<td>18 h</td>
<td>10 h</td>
<td>14 h</td>
<td>12 h</td>
<td>10 h</td>
<td>12 h</td>
<td>8 h</td>
<td>16 h</td>
<td>6 h</td>
<td>10 h</td>
</tr>
<tr>
<td>Weight</td>
<td>50 g</td>
<td>75 g</td>
<td>30 g</td>
<td>25 g</td>
<td>45 g</td>
<td>65 g</td>
<td>80 g</td>
<td>40 g</td>
<td>200 g</td>
<td>75 g</td>
</tr>
<tr>
<td>Minimal system requirements</td>
<td>Win98/ MacOS8</td>
<td>Win98/ MacOS8</td>
<td>Win98/ MacOS8</td>
<td>Win98/ MacOS8</td>
<td>Win2000/ MacOS9</td>
<td>Win95/ MacOS8</td>
<td>Win98/ MacOS8</td>
<td>Win2000/ MacOS9</td>
<td>Win95/ MacOS7</td>
<td></td>
</tr>
</tbody>
</table>

### 6.2.2 Procedure

Before the start of the experiment, respondents could practice on a 6x6 matrix with product information about washing machines. Next, all characteristics of the MP3-players used in the matrix, were explained to respondents. However, they did not know which MP3-players had which characteristics. This procedure ensured that respondents would not click boxes just out of curiosity. Respondents could use as much time or mouse clicks as they wanted.

Respondents were then told to search for an MP3-player they would be willing to purchase. Clicking on a box would open this particular box and the respondent could then evaluate the attribute level information. The box would stay open for the rest of the experiment. Each time they opened a box, they indicated whether they were satisfied with the attribute level.
information or not. This information was collected to gain insights in the decision processes of consumers when choosing products.

Respondents searched the matrix until they were ready to make a decision and then choose one of the MP3-players. The respondents then filled out a questionnaire. Finally, they indicated their gender and age and were informed about the purpose of the study. As a reward for their participation they received a token gift.

6.2.3 Measures
All variables used in the questionnaire were measured using seven-point-scales.

Control Measures.
1. Characteristics’ importance. Respondents are unlikely to use characteristics they consider irrelevant. The extent to which each characteristic was important for the choice of an MP3-player was measured for each of the twelve characteristics. The scale ranged from “Very unimportant” (1) to “Very important” (7).

2. Subjective Knowledge. To control for individual differences in product knowledge, the subjective knowledge of the respondents was measured using four items from a scale developed by Flynn and Goldsmith (1999), with anchors ranging from “Completely disagree” (1) to “Completely agree” (7). Subjective knowledge expresses what respondents think they know about a specific product (Flynn and Goldsmith, 1999). The items were averaged to form an individual subjective knowledge measure (α = .89).

3. Appreciation for customization. The appreciation for customization was measured with two items with anchors “Not at all” (1) to “Very much” (7) preference for unique products and preference for personalized products. These were averaged to form a customization appreciation measure (α = .70).

Dependent Measures. All items of the dependent variables measuring decision value are included in appendix 1.

1. Product uncertainty. Both individual and relative product uncertainty were measured. Relative product uncertainty was measured with three items with anchors ranging from “Very uncertain” (1) to “Very certain” (7) about the best MP3-player, best functionality, and best appearance. The reliability of the relative product uncertainty items was low. Therefore the items of the best functionality of the MP3-player and the best overall MP3-player were averaged to form a relative product uncertainty measure (α = .72). Individual product uncertainty was measured with three items, with anchors ranging from “Don’t know much about the MP3-player” (1) to “Know very much about the MP3-player” (7), “Don’t know enough to decide whether to buy the MP3-player” (1) to “Know enough to decide whether to buy the MP3-player”, and “Don’t need additional information” (1) to “Need additional information” (7). These three items were averaged to form an individual uncertainty measure (α = .75).

2. Effort. Effort was measured in three ways: the number of mouse clicks, the search time, and the perceived effort. Every mouse click performed while searching the matrix was recorded. Furthermore, the search time was recorded from the moment a respondent started to search the matrix until an MP3-player was chosen. Third, the perceived effort was measured using three items ranging from “Not at all” (1) to “Very” (7) difficult, fast, and easy.
3. **Product evaluation.** The evaluation of the overall product was measured using four items with anchors ranging from “Not at all” (1) to “Very” (7) satisfied, good, qualitative, and reliable (Raghurib and Corfman, 1999).

4. **System evaluation and uncertainty.** Three items measured system evaluation with anchors ranging from “Not at all” (1) to “Very” (7) satisfied, easy, and appropriate. These were averaged to form a system evaluation measure (α=.83). System uncertainty was measured with two items with anchors ranging from “Not at all certain” (1) to “Very certain” (7) about the understanding of the computer program and the familiarity of the possibilities of the computer program. These items were averaged to form a system uncertainty measure (α=.80).

**6.2.4 Respondents**

Eighty-nine students from two universities (49% male and 51% female) participated in the study. On average it took the respondents 12 minutes 2 seconds to complete the experiment. After they completed the questionnaire they were informed about the purpose of the study.

**6.3 RESULTS OF STUDY 3**

**6.3.1 Control measures**

**Characteristics’ importance.** Respondents indicated to what extent the characteristics were important in their decision-making process (see table 6.1). The results showed that all characteristics were considered at least moderately important. Respondents considered the batteries and the playtime as most important, then the weight and the download speed and then all the other characteristics. Analyses of variance were conducted with the importance of each characteristic as dependent variable and number of characteristics as independent variable. No differences between number-of-characteristics conditions were found (All $F(1,86)<3.0$, *ns*).

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Importance</th>
<th>Characteristic</th>
<th>Importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Batteries</td>
<td>6.2</td>
<td>Computer system</td>
<td>4.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>compatibility</td>
<td></td>
</tr>
<tr>
<td>Playtime</td>
<td>6.1</td>
<td>Radio function</td>
<td>4.0</td>
</tr>
<tr>
<td>Weight</td>
<td>5.3</td>
<td>Remote control</td>
<td>3.7</td>
</tr>
<tr>
<td>Download speed</td>
<td>5.3</td>
<td>Repeat function</td>
<td>3.6</td>
</tr>
<tr>
<td>Appearance</td>
<td>4.5</td>
<td>Equalizer</td>
<td>3.3</td>
</tr>
<tr>
<td>Dimensions</td>
<td>4.3</td>
<td>Random function</td>
<td>3.2</td>
</tr>
</tbody>
</table>

**Subjective knowledge and gender.** The average knowledge of MP3-players among respondents was moderate ($M=3.0$). To control for effects of subjective knowledge and gender, these variables were taken as covariates in all analyses of variance (ANCOVA). Two effects of subjective knowledge on search difficulty ($F(1,89)=11.0$, *p*<.001) and system uncertainty ($F(1,89)=8.5$, *p*<.01) were found, but the effects of the number of characteristics remained insignificant. In the other analyses, subjective knowledge and gender did not moderate the effects of the number of characteristics (All $F(1,89)<3.1$, *ns*).
Appreciation for customization. Respondents indicated their appreciation for customization. The results showed that respondents did appreciate customization (M=5.4), i.e. they appreciated unique and personalized products. No differences between number-of-characteristics conditions were found (F(2,86)=1.3, ns).

6.3.2 Dependent measures
To provide tests for all hypotheses the data were analyzed by separate analyses of variance with the number-of-characteristics as between-subject factor.

Product uncertainty. Hypothesis 6.1 predicts that individual product uncertainty will be lower when more characteristics are offered. No effect on relative product uncertainty was predicted. Table 6.2 presents the means for the individual and relative uncertainty for the number-of-characteristics conditions. The results show that respondents experienced more individual uncertainty when an additional functional characteristic was offered, but not when an additional appearance characteristic was offered (F(2,86)=5.1, p<.01). Hypothesis 6.1 received no support. As predicted, no significant differences between number-of-characteristic conditions on relative product uncertainty were found (F(2,86)=.8, ns).

<table>
<thead>
<tr>
<th>Table 6.2 Means for product uncertainty and effort</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of characteristics</td>
</tr>
<tr>
<td>10 (N=29)</td>
</tr>
<tr>
<td>11-functional (N=30)</td>
</tr>
<tr>
<td>11-appearance (N=30)</td>
</tr>
</tbody>
</table>

Product uncertainty
- Individual product uncertainty: 3.7**a, 4.5**ab, 3.7**b
- Relative product uncertainty: 3.1, 3.5, 3.1

Effort
- Mouse clicks: 33*a, 36*, 45*a
- Search time (seconds): 247*a, 293*, 326*a
- Perceived effort
  - Search difficulty: 3.2, 3.7, 3.4
  - Speed of choice: 3.4, 3.5, 3.4
  - Ease of program: 3.7, 4.0, 3.4

Notes. * p<.05; ** p<.01; higher means denote more uncertainty; means with the same superscript differ significantly from each other

Effort. Hypothesis 6.2 predicts that consumers invest more effort when more characteristics are offered, except when the additional characteristic is related to appearance. Three measures of effort were taken: the number of mouse clicks, the search time and the perceived effort. The means for these measures are presented in table 6.2. Results from the analyses of variance showed significant differences between number-of-characteristics conditions for the number of mouse clicks (F(2,86)= 3.2, p<.05) and search time (F(2,86)= 3.8, p<.05). Respondents in the 10-characteristic condition invested the least effort measured by both the number of mouse clicks (33) and the search time (247 seconds). Respondents in the 11-appearance condition invested most effort measured by both the number of mouse clicks (45)
and the search time (326 seconds). No differences were found between number-of-characteristics conditions for the perceived effort (All $F(1,86)<1.4$, $ns$). No support for hypothesis 6.2 was found.

**Product evaluation.** Evaluations of the MP3-players were not influenced by number of characteristics. The means for the four measures of product evaluations are presented in table 6.3. None of the four measures of product evaluation was affected by the number of characteristics (All $F(1,86)<1.7$, $ns$).

**System evaluation and uncertainty.** The means for system evaluation and uncertainty are provided in table 6.3. The evaluations of the system were not influenced by the number of characteristics offered to respondents ($F(2,86)=2.3$, $ns$). Also the system uncertainty was not influenced by the number-of-characteristics conditions ($F(2,86)=1.0$, $ns$).

<table>
<thead>
<tr>
<th>Table 6.3. Means for product evaluation, system evaluation and uncertainty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of characteristics</td>
</tr>
<tr>
<td>----------------------------</td>
</tr>
<tr>
<td><strong>Product Evaluation</strong></td>
</tr>
<tr>
<td>Satisfied</td>
</tr>
<tr>
<td>Good</td>
</tr>
<tr>
<td>Reliable</td>
</tr>
<tr>
<td>Quality</td>
</tr>
<tr>
<td><strong>System evaluation</strong></td>
</tr>
<tr>
<td><strong>System uncertainty</strong></td>
</tr>
</tbody>
</table>

**Note.** Higher means denote more uncertainty and higher evaluations.

**6.4 CONCLUSIONS FOR NUMBER OF PRODUCT CHARACTERISTICS**

**6.4.1 Product uncertainty**

Hypothesis 6.1 predicted that consumers would experience less individual product uncertainty when more product characteristics are presented. When there is more information available on each product, consumers would be able to reduce more uncertainty about what each product offers. However, the results showed that the individual product uncertainty increased when an additional functional product characteristic was offered (but not when an additional appearance characteristic was offered).

Respondents differed widely in the number of mouse clicks used; some used as little as 10 clicks before making a decision, whereas other used 101 clicks. This means that some respondents used as little as 10% of the product information available, whereas others used 100%. On average respondents used 36% of the information and did not use all information available. Therefore, when additional information about product functionality was provided about each product, individual uncertainty increased rather than decreased. The additional information was not examined and hence the additional information leads to uncertainty.
about the information contained in this additional characteristic. Hence, more individual product uncertainty is experienced. Product information about the product appearance has a different influence on individual product uncertainty than information about product functionality. Additional product information about product appearance leads to reduction of individual product uncertainty compared to additional product information about product functionality. Also, additional information about product appearance leads to as much individual product uncertainty as an assortment presented by products with 10 characteristics. Presenting more product characteristics, thus leads to more individual product uncertainty, but not when this additional information concerns the product appearance.

6.4.2 Effort
Hypotheses 6.2 predicted that consumers will invest more effort when an additional characteristic related to product functionality is provided and that consumers will invest less effort when an additional characteristic related to product appearance is provided. Respondents indeed invested more effort when additional functional product characteristics were presented. However, they invested most effort when additional characteristics are related to product appearance. When product information about product appearance was available, consumers seem motivated to search this product characteristic, whereas this was not the case for product information about product functionality.

In the current study, 10 functional characteristics were included in the study. In the 11-appearance condition additional information was provided about the product appearance. This different type of product information leads consumers to invest more effort in searching the assortment and did lead to more individual product uncertainty. However, when many characteristics related to product appearance are provided, then the effects of adding additional product information about product appearance may be less profound. Still, adding more characteristics for products, enhances effort and increases individual product uncertainty. Therefore manufacturers should only present the most important characteristics to consumers. Manufacturers should carefully consider the number of characteristics that they offer in mass customization environments, so consumers do not have to invest a lot of effort and remain uncertain about their customization choices. The consequences of the number of product characteristics for the design of mass customization environment will be discussed in detail in Chapter 13.

To gain more insight into how effort and uncertainty are influenced by the amount of product information, such as the number of characteristics or the assortment size, consumers’ decision processes should be investigated. Knowledge about how consumers process such information may provide better explanations of why consumers invest more effort in searching the product information or remain more uncertain about their choices. Knowledge of such decision processes may enhance product configurators. Computer systems can support consumers when making customization choices. Ideally, product configurators can detect such processing and adapt the navigation and product information that is offered, in order to support customization processes. In the next chapter, possible decision strategies are discussed and an exploratory study investigates the detection of such strategies.
CHAPTER 7

DETECTING DECISION STRATEGIES

Computerized systems allowing consumers to compare products often present product information in a matrix of alternatives and characteristics (for example, www.dealtime.com, electronics.cnet.com, www.dpreview.com/reviews/compare.asp, www.kelkoo.com, www.mysimon.com, or www.epinions.com). Consumers can use these systems to compare various features of products they consider to purchase. However, often the number of products offered through these systems is enormous. This makes it harder for consumers to make choices, increases the effort in searching the assortment and decreases satisfaction with the decision process and product choice. Many manufacturers on the Internet will provide decision support systems in the near future (Deshpandé, 2000, p. 363-364) that assist consumers making customization choices. To be able to provide assistance in making customization choices, these manufacturers need to know how consumers use product information. In other words they need to know the decision strategies or decision rules that consumers use. Such decision strategies show how consumers search and evaluate product information and how they choose products. Detecting decision strategies can only be handled on a useful scale by computer systems, because of two main reasons. First, the assistance in making customization choices should be instant; consumers do not want to wait behind their computer until they are assisted. Thus decision strategy detection should be done in real time. Second, detecting decision strategies is complex. Computers are less likely to make errors when many strategies have to be detected. An additional advantage is that decision aids are cost-efficient once a decision aid is developed.

7.1 DECISION STRATEGIES

Consumers processing product information may use various decision strategies. Two dimensions of decision strategies are often used to distinguish different strategies: whether strategies are compensatory and whether the information is processed by alternative or by characteristic (Ball, 1997; Bettman, et al., 1998; Hoyer and MacInnis, 2001). Search strategies may differ in the degree to which they are compensatory or non-compensatory. Some consumers compensate a product characteristic they do not like with a characteristic they do like, whereas others do not consider the product anymore when it has a characteristic they do not like. For example, some consumers may be willing to pay more for cars that have more engine power (compensatory strategy), whereas others may not (non-compensatory strategy). Information may be primarily processed by alternative or by characteristic. Consumers may process products by alternative, by considering multiple characteristics of one alternative before considering another alternative (Bettman et al. 1998). For example, some consumers first evaluate a car on price and engine power and then evaluate a second car on these characteristics. Other consumers may process products by considering one characteristic for several alternatives, before considering information on another characteristic (Bettman et al. 1998). For example, consumers may first evaluate the prices of
the different cars and then the engine power of these cars. The decision strategies and their characteristics are summarized in table 7.1.

Two non-compensatory strategies, that process information by alternative, are the satisficing strategy (SAT) and the conjunctive strategy (CONJ). Consumers using a satisficing strategy (Simon, 1955; Einhorn (1970) calls this a disjunctive strategy) examine alternatives sequentially in the order they are presented. Each characteristic of the alternative is investigated to see whether the attribute level meets a predetermined cutoff level. The first alternative to exceed the cutoffs for each characteristic is selected. The conjunctive strategy (Einhorn, 1970) is a strategy opposite to the satisficing strategy. Consumers using a conjunctive strategy eliminate alternatives that do not meet the predetermined cutoff level until one alternative remains. If more than one alternative remain, new cutoff levels are determined. A satisficing strategy selects an alternative and only a limited amount of information has to be processed, whereas a conjunctive strategy eliminates alternatives and demands larger amounts of information to be processed.

| Table 7.1: Characteristics of the various decision strategies |
|-----------------|----------------|-----------------|---------------|
| Strategy          | Compensatory or Non-compensatory | Processing by Type of strategy |
| Satisficing strategy (SAT) | Non-compensatory | Alternative | Selecting |
| Conjunctive strategy (CONJ)   | Non-compensatory | Alternative | Eliminating |
| Lexicographic strategy (LEX) | Non-compensatory | Characteristic | Selecting |
| Elimination-by-aspects strategy (EBA) | Non-compensatory | Characteristic | Eliminating |
| Equal-weighting strategy (EQW) | Compensatory | Alternative | Selecting |
| Majority-of-confirming-dimensions strategy (MCD) | Compensatory | Characteristic | Selecting/ Eliminating |

Two non-compensatory strategies that process information by characteristic are the lexicographic strategy (LEX) and the elimination-by-aspects strategy (EBA). Consumers using a lexicographic strategy (Bettman and Park, 1980; Klein, 1983; Olshavsky, 1979; Park, 1978; Reilly and Holman, 1977) select the alternative with the best attribute level of the most important attribute (which characteristic is considered most important may vary due to consumers’ motives). Consumers using an elimination-by-aspects strategy (Tversky, 1972) eliminate alternatives that do not meet the predetermined cutoff level for the most important characteristic. This elimination process is repeated for the second most important characteristic until one alternative remains. A lexicographic strategy selects an alternative and only a limited amount of information has to be processed, whereas an elimination-by-aspects strategy eliminates alternatives and demands larger amounts of information to be processed. Although it is conceptually possible that a lexicographic strategy could involve more than one characteristic due to ties, the chance that consumers are using elimination-by-aspects strategies rather than lexicographic strategies should increase as more characteristics are processed.
Two compensatory strategies that process information by alternative are the weighted-adding strategy (WADD) and the equal-weighting strategy (EQW). Consumers using a weighted-adding strategy assess not only all characteristics of an alternative, but also consider the importance of each characteristic (= the importance weight). Presumably, a subjective value is assigned to each possible attribute level. One alternative at a time is considered, multiplying each characteristic’s subjective value times its importance weight. The alternative with the highest value is selected. Consumers using an equal-weighting strategy (or linear compensatory or simple additive) follow a similar strategy to weighted adding, but importance weights are ignored. Thus, one alternative at a time is considered, adding the subjective values of each characteristic of that alternative. The alternative with the highest value is selected. Without asking consumers whether they used importance weights or not, these two strategies cannot be distinguished. Therefore, only equal-weighting strategies will be used in the remainder of this chapter.

One compensatory strategy where information is processed by characteristic is the majority of confirming dimensions strategy (MCD)\(^7\). Consumers using a majority of confirming dimensions strategy (Russo and Dosher, 1983) compare each characteristic for two or more alternatives. The number of times an attribute level is superior to the attribute levels of other alternatives are counted. The alternative with the minority of superior characteristics is eliminated. However, when consumers have to choose between two remaining alternatives, one might say that consumers select the alternative with the majority of superior characteristics.

To complete the possible sequence of events that may occur when consumers search for product information, a learning phase and fatigue (or boredom) phase should be included in the decision process (Swait and Adamowitz, 2001). When consumers encounter a new supplier of information, for example, a new store or a new website, they first enter a learning phase in which they explore the environment to learn about the different possibilities. A learning phase can be recognized by unstructured behavior that doesn’t seem to make sense. A fatigue (or boredom) phase may occur at the end of a search process. Fatigue or boredom may set in leading to the use of simplified or incoherent strategies.

Consumers are often constructive in their processing (Payne, Bettman and Johnson, 1993). This could lead to the use of two (or more) different decision strategies. Several authors (Haubl and Trifts, 2000; Lussier and Olshavsky, 1979; Wright and Barbour, 1977) argued that consumers often use a two-staged decision process when choices become complex. The first stage is an elimination stage, where respondents use non-compensatory strategies to eliminate unacceptable alternatives. When the number of alternatives became manageable for respondents, usually three or four alternatives, consumers enter the selection stage. In this second stage, consumers use compensatory strategies to evaluate the remaining alternatives in depth, which results in the selection of an alternative. Thus, in an elimination stage,

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\(^7\) The majority of confirming dimensions strategy are identical to the additive difference strategy (ADD) the frequency of good and bad features (FRQ) with regard to the way information is processed (by characteristic) and the compensatory nature of these decision strategies. Therefore, these two latter strategies will not be considered (for details see: Alba and Marmorstein, 1987; Bettman et al., 1998; Lee and Geistfeld, 1998; Weber, Goldstein, and Barlas, 1995).
consumers use strategies such as conjunctive and elimination-by-aspects strategies, because they are elimination strategies. In the selection stage, on the other hand, consumers use strategies such as a weighted-adding, an equal weighting, or a majority of confirming dimensions strategy. These strategies are useful when the remaining number of alternatives remains limited, such as in a selection stage. This study investigates whether such elimination-selection patterns in decision processes can be found. Thus, the first research question of this chapter addresses whether consumers use elimination-selection stages in their decision processes.

7.2 COMPUTER DETECTION OF DECISION STRATEGIES

When consumers are searching mass customization environments, they have to invest much time and effort and may need assistance making a decision. In a shop sales personnel offers such assistance; they inform consumers about the benefits and disadvantages of products. In situations where consumers interact with computers, decision aids can be designed to assist consumers in their decision processes. These decision aids should respond to information needs of consumers. When consumers need certain information, decision aids should provide this information. This means that decision aids should be able to detect such information needs. One way of doing this is to detect the decision strategy that consumers use. These decision strategies have consequences for the product information that should be offered. When consumers using compensatory strategies they need all product information, because characteristics that they do not like can be compensated by characteristics they do like. When consumers use non-compensatory strategies, only the most important characteristics have to be presented. When these characteristics are not satisfactory, consumers using non-compensatory strategies will not choose these alternatives anyway, regardless of the other characteristics. Consumers choosing by alternative initially want a lot of information about each product, whereas consumers choosing by characteristic do not. In this latter case, consumers would initially compare products on one attribute. In such cases, decision aids could reduce the information per product to one characteristic.

Ball (1997) argues that different decision strategies are characterized by different percentages of single-step and multi-step transition. A transition is a pattern of mouse clicks from one box to another in a matrix of alternatives and characteristics. A computer program can be written that detects such transitions. The program may use these transitions to differentiate between the decision strategies. Using these transitions, the program can distinguish between (1) learning phase, (2) satisficing or conjunctive strategy, (3) lexicographic or elimination-by-aspects strategies, (4) equal-weighting, and (5) majority-of-confirming-dimensions strategy. The program cannot distinguish between satisficing and conjunctive strategies, between lexicographic and elimination-by-aspects strategies nor between equal-weighting and weighted-adding strategies. For the first two pairs of strategies, this is because there is no simple way to distinguish compensatory and non-compensatory decision strategies. The computer program can only detect one decision strategy. There is no simple way to know when consumers are switching to a different decision strategy, because such a difference cannot easily be deduced from consumers’ behavior.
So how can these decision strategies be detected? The decision strategies can be detected by looking at the type and percentage of transitions. Ball (1997) distinguished six types of transitions: four single step transitions (types I, II, III, and IV) and two multi-step transitions (type V and VI). A type I transition is recorded when respondents click the same attribute level twice. Because respondents could not make such a transition, this type of transition is not considered. Ball (1997) Type II transitions are alternative transitions, where two characteristics of one alternative are considered. Type III transitions are characteristic transitions, where one characteristic is considered for two alternatives. A type IV transition is recorded when respondents make neither a type I, II, or III transition. This means that respondents click a different characteristic of a different alternative. A type V transition is a multi-alternative comparison (of two or more alternatives), where two (or more) alternatives are compared on more than one attribute. Thus, two (or more) characteristics of one alternative are considered before another alternative is considered. A type VI transition is a multi-attribute comparison (of two or more characteristics), where two (or more) characteristics are compared in the same order for each alternative. Thus, one characteristic is considered for two (or more) alternatives, before another characteristic is considered.

These single- and multi-step transitions provide clear distinctions between strategies. Satisficing and conjunctive strategies are characterized by many type II transitions, lexicographic and elimination-by-aspects strategies are characterized by many type III transitions, equal-weighting strategies are characterized by many type VI transitions, and majority-of-confirming-dimensions strategies are characterized by many type V transitions (Ball, 1997). Furthermore, many type IV characteristics in the beginning of the decision process are assumed to signal a learning phase.

Ball (1997) indicated that pure decision strategies show 100% use of certain transitions (except for a satisficing strategy). However, consumers do not use such pure strategies. Therefore, it may be reasonable to determine reasonable percentages of transitions which indicate the use of certain decision strategies. The second research question of this chapter therefore investigates the percentage of transitions that indicate the use certain decision strategies. These percentages can be used in the design of mass customization environments.

7.3 STUDY 4

An exploratory study was conducted to investigate the two research questions. First, do consumers use elimination-selection stages in their decision processes? Second, what percentages of transitions signal the use of certain decision strategies? The design, stimuli and procedure were identical to the study in chapter 4. The additional measures that were collected are presented below.

7.3.1 Measures
1. *Click-stream.* All clicks were recorded for each individual respondent. In this way all boxes that the respondent had opened and the pattern of opening boxes would be available for determining the decision strategy of each individual respondent. The click-stream was constructed by recording a two-digit number for each click, where the first
number denotes the characteristics (1: capacity, 2: coffeepot, 3: indication on water reservoir, 4:anti-drip, 5: indication on coffeepot, 6: cord length, 7: color, and 8: timer) and the last number the alternative.

2. **Characteristic Transitions** (Type II transitions; Ball, 1997). A characteristic transition was recorded every time a respondent clicked on two (different) characteristics of one alternative.

3. **Alternative Transitions** (Type III transitions; Ball, 1997). An alternative transition was recorded every time a respondent clicked on the same characteristic for two alternatives.

4. **Type IV transitions.** A type IV transition was recorded when respondents did not make either a characteristic or alternative transition.

5. **Type V transition.** A type V transition was recorded when respondents compare two or more alternatives on two or more characteristics. Thus, respondents make series of characteristic transitions (for details see Ball, 1997). The numbers of type II, III, and IV transitions used in this transition were subtracted from the relevant transitions. The type V transition was weighted by the number of clicks involved in the transition to make it comparable to the other transitions.

6. **Type VI transition.** A type VI transition was recorded when respondents compare two or more characteristics for two or more alternatives. Thus, respondents make series of alternative transitions (for details see Ball, 1997). The numbers of type II, III, and IV transitions used in this transition were subtracted from the relevant transitions. The type VI transition was weighted by the number of clicks involved in the transition to make it comparable to the other transitions.

### 7.4 Results

#### 7.4.1 Decision strategies

Two judges used these measures to classify the search strategies used by respondents. Two independent judges classified (parts of) the click-stream in five categories: (1) learning phase, (2) satisficing strategy, (3) conjunctive strategy, (4) lexicographic strategy, (5) elimination-by-aspects strategy, (6) equal-weighting strategy, and (7) majority-of-confirming-dimensions strategy. Furthermore, the judges indicated the length of the click-streams that made up the classified strategies. For example, a judge may have classified a clicks-stream as an elimination-by-aspects strategy consisting out of 14 mouse clicks, followed by a majority-of-confirming-dimensions strategy consisting of 10 mouse clicks. After discussion judges agreed on 92% of the strategies that respondents had used and agreed on 94% of the click-stream lengths. Only the strategies that the judges agreed on were included in the analyses.

The learning phase was not included as a decision strategy. Twenty-three percent of the respondents used a learning phase. In total respondents used 75 decision strategies when searching for coffeemakers. The decision strategies that were used are presented in table 7.2.

Nobody used a lexicographic strategy. A satisficing strategy wasn't used very often; only 2% of the strategies were satisficing strategies. The strategy that was used most was the majority of confirming dimensions strategy (40%).
Table 7.2. Decision strategies used by respondents to search for products

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Majority-of-confirming-dimensions strategy</td>
<td>40%</td>
</tr>
<tr>
<td>Conjunctive strategy</td>
<td>23%</td>
</tr>
<tr>
<td>Elimination-by-aspects strategy</td>
<td>23%</td>
</tr>
<tr>
<td>Satisficing strategy</td>
<td>2%</td>
</tr>
<tr>
<td>Equal-weighting strategy</td>
<td>12%</td>
</tr>
<tr>
<td>Lexicographic strategy</td>
<td>0%</td>
</tr>
</tbody>
</table>

The degree to which the decision strategies were compensatory or non-compensatory was about equal. Non-compensatory strategies were used in 48% of the cases, whereas compensatory strategies were used in 52% of the cases. Strategies that required processing by alternative (37%) were used less than strategies that required processing by characteristic (63%). Respondents used more eliminating strategies than selecting strategies. Of all decision strategies 39% were selecting strategies, such as satisficing strategies, lexicographic strategies, equal-weighting strategies, and majority-of-confirming-dimensions strategies; 61% of the strategies were eliminating strategies, such as conjunctive strategies, elimination-by-aspects strategies, and majority-of-confirming-dimensions strategies. Note that a majority-of-confirming-dimensions strategy is counted as both a selecting and an elimination strategy, because a majority-of-confirming-dimensions strategy can be viewed as either strategy.

7.4.2 Decision stages

About half the respondents (51%) used only one search strategy, whereas the other half used multiple strategies; 37% used 2 strategies, 8% used 3 strategies, 2% used four strategies, and 2% did not use any strategy (they remained in the learning phase for 24 clicks). Researchers (Haubl and Trifts, 2000; Lussier and Olshavsky, 1979; Wright and Barbour, 1977) often argued that consumers often use a two-staged decision process consisting out of an elimination stage and a subsequent selecting stage. A majority-of-confirming-dimensions strategy can be both an eliminating and a selecting strategy. For analyzing purposes we assume that majority-of-confirming-dimensions strategy is an eliminating strategy when used as an initial strategy and a selecting strategy when used later in the decision process. Did respondents indeed use an elimination-selection strategy? Table 7.3 shows the type of strategies that respondents used.

Table 7.3. The type of strategy that respondents used

<table>
<thead>
<tr>
<th>Type of strategy</th>
<th>Respondents used</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>One strategy</td>
</tr>
<tr>
<td>Elimination-selection strategy</td>
<td>0%</td>
</tr>
<tr>
<td>Elimination strategy</td>
<td>52%</td>
</tr>
<tr>
<td>Selection strategy</td>
<td>13%</td>
</tr>
<tr>
<td>majority-of-confirming-dimensions strategy</td>
<td>35%</td>
</tr>
</tbody>
</table>

89
When respondents used multiple strategies, 81% used an elimination-selecting strategy; they used one or more elimination strategies to eliminate the worst alternatives and then switched to one or more selection strategies to select the best alternative. The other 19% used elimination strategies. When respondents used one strategy, they used far more elimination strategies (52%) than selection strategies (13%). Many respondents also used majority-of-confirming-dimensions strategy as the only strategy. A majority-of-confirming-dimensions strategy can be used both as an elimination or selection strategy. Because this cannot be determined in this case, majority-of-confirming-dimensions strategies are presented as a separate category.

In summary, about half the consumers used one decision strategy, whereas the other used multi-stage decision strategies. When consumers used multi-stage decision processes, most consumers show an elimination-selection pattern. Thus, the answer to the first research question is that consumers indeed use such a two-stage strategy.

7.4.2 Computer detection
How well were the strategies detected by the computer program? To provide an answer to the second research question, the percentage of transitions that signal certain decision strategies the strategies were investigated. Remember that the computer program cannot distinguish between satisficing and conjunctive strategies, between lexicographic and elimination-by-aspects strategies nor between equal-weighting and weighted-adding strategies. Because the program cannot detect multiple strategies, the strategies from multi-stage decision strategies were analyzed separately.

The computer program correctly detected 63% of these decision strategies. The percentage of correctly detected decision strategies is presented in table 7.4. Decision strategies detected by single-step transitions (satisficing/ conjunctive and lexicographic / elimination-by-aspects strategies) could be far better detected than multi-step transitions. The percentage of strategies detected by single-step transitions is satisfactory. The percentage of the two strategies detected by multi-step transitions was poor, especially the detection of the majority-of-confirming-dimensions strategy; the computer program only detected 33% of these strategies.

To detect specific decision strategies, the computer program looked at the type of transitions. Remember that satisficing and conjunctive strategies are characterized by many type II transitions, lexicographic and elimination-by-aspects strategies are characterized by many type III transitions, equal-weighting strategies are characterized by many type VI transitions, and majority-of-confirming-dimensions strategies are characterized by many type V transitions. The last column of table 7.4 shows the average percentage of the appropriate type of transitions when the decision strategy was correctly detected. So, for the correctly detected satisficing/ conjunctive strategies, the average percentage of type II transitions was 69; the accompanying standard deviation was about 26%. The mean percentage of transitions for satisficing / conjunctive strategies is lower than the other strategies. These mean percentages can be used to answer research question two: what percentages of transitions signal the use of certain decision strategies? The mean percentages of transitions in the last column of table 7.4 provide the answers to this question. When the percentage of type II transitions reaches
70\%, respondents use a satisficing or conjunctive strategy. When the percentage of type III transitions becomes larger than 80\%, respondents use a lexicographic/ elimination-by-aspects strategy. Furthermore, when the percentage of type VI transitions becomes larger than 82\%, respondents use an equal-weighting strategy. Finally, when the percentage of type V transitions becomes larger than 84\%, respondents use a majority-of-confirming-dimensions strategy. This percentage makes the majority-of-confirming-dimensions strategy the hardest strategy to detect, which explains the low accuracy of detecting this strategy.

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Percentage correctly detected</th>
<th>Mean percentage of transitions (standard deviation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satisficing/ Conjunctive</td>
<td>82%</td>
<td>69.11% (25.86%)</td>
</tr>
<tr>
<td>Lexicographic/ elimination-by-aspects</td>
<td>93%</td>
<td>80.43% (14.92%)</td>
</tr>
<tr>
<td>Equal-weighting</td>
<td>63%</td>
<td>82.00% (24.90%)</td>
</tr>
<tr>
<td>Majority of Confirming Dimensions</td>
<td>33%</td>
<td>84.37% (21.01%)</td>
</tr>
</tbody>
</table>

The minimum percentage of appropriate type of transitions when the decision strategy was accurately detected may also provide useful information. These percentages could be taken as indications of a strategy, without providing certainty that this strategy is actually used. So, the minimal percentage of type II transitions that lead to accurate detection of the satisficing/ conjunctive strategy was 35\%. Thus, when the percentage of type II transitions becomes larger than 35\%, but lower than 70\%, this provides indications for the use of a satisficing or conjunctive strategy. When the percentage becomes larger than 70\%, then consumers surely use such a strategy. Similarly, indications for the use of lexicographic/ elimination-by-aspects, equal-weighting and majority-of-confirming-dimensions strategies are provided by the minimal percentage of transitions of 53\%, 50\%, and 42\% respectively.

### 7.5 CONCLUSIONS

#### 7.5.1 Strategy detection

It is difficult for human judges to categorize decision strategies, because consumers almost never use pure strategies. They always deviate from ideal strategies, adapting their strategies to the decision task at hand and the information that is acquired during the process. Furthermore, whether decision strategies are compensatory or non-compensatory is difficult to determine. When human judges already have difficulty with categorizing strategies, then detection by computer seems impossible. Taking this into account, it is surprising that the computer program could detect so many strategies correctly (63\%). Decision strategies that can be detected by single-step transitions (satisficing/ conjunctive, and lexicographic/ elimination-by-aspects) are most accurately detected in 82\% to 93\% of the cases. In general, consumers can be said to use a certain strategy, when the percentage of appropriate transitions becomes larger than 80\%. Furthermore, an indication for the use of a certain strategy is provided, when the percentage of appropriate transitions becomes larger than 50\%.
7.5.2 Switching decision strategies

One of the main disadvantages is that the current computer program cannot detect the use of multiple decision strategies. This is the case, for example, when a respondent uses an elimination-by-aspects strategy to eliminate all but three alternatives. The respondent then switches to an equal-weighting strategy to compare the remaining three. The trouble is that the program does not know that the respondent has switched to a different strategy. Thus, it tries to detect one strategy when there are in fact two strategies to detect. This would lead to poorer strategy detection, unless the program can detect these switches as well. Therefore, more research should investigate at what moment an individual switches from one strategy to another. A first step in this switch detection is a simplification into an elimination phase and a selection phase (Haubl and Trifts, 2000; Wright and Barbour, 1977). In the elimination phase, the number of alternatives that consumers are still considering (i.e., the consideration set) is decreasing rapidly. However, when consumers are in the selection phase, the consideration set is rather stable. A fruitful direction for further research would be to estimate the consideration set of individual respondents in order to detect a switch from elimination to selection phase. The second step is to extend this switch detection to differentiate between different decision strategies.

When researchers can differentiate between an elimination phase and a selection phase, other research questions can be answered such as:

1. Do consumers process information differently when they eliminate products on the basis of product appearance instead of product functionality?
2. Do consumers consider configurality in their choices? That is, do consumers take the effect of one characteristic on the total product appearance into account?

7.5.3 Researching decision strategies

In researching the decision strategies, we had to choose how respondents could acquire product information. The current program requires a respondent to click on a box, and then that box remains open. This allows processing to occur that can not be detected, because respondents are able to look at the open boxes. This could cause problems for trying to determine strategy from the sequence of boxes examined, because not all of the information acquisitions can be observed. That is why in Mouse lab-studies (Payne, Bettman, and Johnson, 1993) a box opens when the mouse moved into a box and a box is closed when the mouse left the box (a mouse-over procedure). That, of course, has its own problems (e.g., it imposes a stronger memory load on the respondents). Also the number of mouse clicks that respondents were able to make, was specified. This may have the effect of giving respondents an idea of how many pieces of information they should acquire (J. R. Bettman, personal communication, May 29, 2002).

Leaving the boxes open indeed allows processing that cannot be detected. On the other hand, when consumers are searching matrices in Consumer Reports, for example, all boxes are open as well. To resemble such situations more closely, the boxes were left open. Detection of processing in such cases may be possible with the use of eye-tracking equipment. Furthermore, the number of clicks that a respondent could make was limited. In this way, respondents would be motivated to carefully consider every click, thus leading to purer strategies. However, respondents may still get the idea that they have to use all these clicks.
Also, a mouse-over procedure makes it hard for respondents to compare, for example, alternatives 2 and 4 on every attribute (i.e., follow a 2-alternative majority-of-confirming-dimensions strategy for alternatives 2 and 4). However, this procedure seems to result in less effort for respondents and is more intuitive. Future work should investigate the effects of these three variables on information processing (for example, the type and amount of processing). In this way, optimal settings for these variables could be determined that are useful for both research and design of mass customization environments.

The four studies in research part I show that in many cases the type of product information that is offered in mass customization environments affects the value that consumers derive from their decision. Especially the effort consumers have to invest and the product uncertainty they experience is influenced by the amount and type of product information. The consequences for the design of mass customization environment will be discussed more extensively in Chapter 13. In research part II two product configurators will be developed to test how the presentation of product information affects decision value of customization choices.
The advantage of product configurators is the ability to offer large amounts of product information. This product information may concern product information about product functionality and about product appearance. Research part I showed that both the amount and type of information influence consumer decision value. Consumers can easily select product functionality without investigating the appearance. Characteristics related to product appearance seem to pose more problems for consumers in mass customization environments. Although consumers can evaluate product appearance at a glance, they have to investigate the appearance of each product to make such evaluations. This poses challenges for designers, because how should product appearance be presented in order to increase the decision value of customization choices? Research part II focuses on this challenge by investigating various presentation formats.

The four studies described in research part II investigate how product information should be presented in mass customization environments. Product information can be presented in many ways. Designers can use different presentation modes, presentation formats, and presentation orders. Two product configurators were designed to investigate the effects of these different presentation formats. In study 5 and 6, product configurators were developed providing overview by presenting product characteristics simultaneously and the effects of assembled and disassembled presentation formats were investigated. In study 7 and 8, product configurators prevented information overload by presenting product characteristics sequentially and the effects of presentation order were investigated.
CHAPTER 8

PRESENTATION FORMAT AND PRODUCT NEWNESS

Product information can be presented in various presentation formats. The way product information is presented in product configurators may affect customization choices. Consumers may be more likely to customize the appearance of the product when the appearance is presented, for example, whereas they are more likely to customize the functionality when the functionality is presented. Product configurators allow many product variants. Consumers may customize products they have never seen before. Using product configurators probably leads to encounters with new products. How does the newness of such products affect the customization choices of consumers? The current study (study 5) investigates the effect of product presentation format (assembled versus disassembled) and product newness (not new versus new) on customization choices.

8.1 PRODUCT PRESENTATION FORMAT

Various formats can be used to present products. Product configurators can present products by alternatives and by characteristics (Bettman and Kakkar, 1977; Biehal and Chakravarti, 1982, 1983; Jacoby et al., 1976). In the first case, products are shown without a specific emphasis on attribute levels; products are presented by alternatives, without mentioning the specific characteristics or attribute levels. The attribute levels are presented implicitly and consumers may deduct the specific attribute levels by carefully inspecting the information presented. A consumer may, for example, compare two cars and deduce the implicit information about the number of doors. However, there is no certainty that these differences will always be recognized, especially in the case of new characteristics. Therefore, product configurators should often present information about product characteristics explicitly.

8.1.1 Presenting product characteristics explicitly

Another way of presenting product information is providing information about product characteristics explicitly. This can be done in two ways; the first is presenting characteristics (without attribute levels) and the second is presenting attribute level information as well. Presenting just the product characteristics is a well-known strategy in car advertisements. Manufacturers provide information about the characteristics (e.g., radio, luxurious upholstery), but no attribute level information (e.g., brand of the radio, type of upholstery). When attribute level information is presented as well, the consumer learns about both the characteristics and their levels, such as in the case of the number of doors (2, 3, 4, or 5). The presentation of product characteristics (and its levels) in comparison to a presentation of product alternatives enhances the comprehensibility of product information. Huffman and Kahn (1998) found that consumers are more satisfied when provided with attribute level information then with characteristics alone. This is because the product information about attribute levels provides additional information.
Mass customization environments should provide information about product characteristics explicitly. A manufacturer of bicycles may, for example, offer choices between five types of frames, five types of handle bars, five types of saddles, and five types of wheels. A consumer can thus create 625 different bicycles. The designer of the product configurator may choose to show all these products by alternative; this can be done by a large list of 625 bicycles or by a website with 625 pages. It is impractical for manufacturers and overwhelming for consumers to use this presentation format. The designer may also choose to show the products by characteristic. The product configurator shows the attribute level information of each characteristic, creating a four by five matrix of attribute level information times characteristic. This allows the manufacturer to show all 625 bicycles on one screen. Consumers select the attribute levels they prefer and, hence, choose one out of the 625 possible bicycles. A presentation format presenting products by characteristic and attribute level information is preferred above presentation formats presenting products by alternative. Furthermore, the assortment that consumers perceive is influenced by the presentation format. Godek et al. (2000) presented respondents with products either presented by alternative or presented by characteristic and attribute level information. Respondents who received products presented by alternative perceived a larger assortment than respondents who received products presented by characteristics and attribute levels. Study 2 (Chapter 5) showed that large perceived assortments lead to information overload. Therefore, product configurators should provide information about product characteristics and its levels. This provides overview for consumers and is less likely to lead to information overload, because the perceived assortment is smaller.

8.1.2 Assembled or disassembled presentation format

In a product configurator, manufacturers can choose to present a product as a set of separate characteristics (disassembled presentation format). The verbal description of a product in a conjoint measurement task is an example of this product presentation format. The advantage of this format is the relative ease of developing these product presentation formats. A designer can also present such product information pictorially by providing a series of (small) pictures of the separate product characteristics. However, the disadvantage of this presentation format is that the overall product appearance remains unclear to consumers.

In many experiential and esthetic products, product characteristics are related in configural ways (Huffman and Kahn, 1998; Hollbrook and Moore, 1981a; 1981b; Veryzer, 1993; Veryzer and Hutchinson, 1998). In order to evaluate these correlations between characteristics, an assembled presentation format is necessary. Also, for more functional products, it seems better to display the assembled characteristics. A study of Dahan and Srinivasan (2000) found that products shown in an assembled visual format were better predictors of market share compared with products shown in a disassembled visual format. A practical drawback of the assembled presentation format is that every possible configuration of characteristics has to be designed and presented visually. This demands substantial design effort—designers of the bicycle customization website mentioned above had to design and visually create 625 different bicycles.
8.1.3 Product evaluations and overall uncertainty
Huffman and Kahn (1998) found that satisfaction with the presentation format positively influenced product evaluations. Assembled presentation formats convey different information than disassembled presentation formats. Assembled presentation formats allow consumers to evaluate the overall product and the correlation between characteristics. This type of presentation emphasizes the product appearance. In contrast, a disassembled presentation format emphasizes the separate product characteristics. Huffman and Kahn (1998) found that consumers prefer disassembled presentation format, when the emphasis is on the separate product characteristics. Therefore, consumers might prefer disassembled presentation formats when evaluating product characteristics. On the other hand, when consumers evaluate the overall product they can be expected to prefer assembled presentation formats. Thus, the product presentation format is expected to influence the product evaluation.

H8.1. Presenting product information in a product configurator by assembled characteristics compared to a presentation by disassembled characteristics leads to:
   a. lower evaluation of the product characteristics.
   b. higher overall product evaluations.

Alba et al. (1997) pointed out that the presentation of product information could also affect the overall product uncertainty. This uncertainty will also be affected by the amount of product information that is available to the consumer. It can be expected that both overall product evaluation and product uncertainty will increase with the amount and vividness of the information. The methods of product presentation differ in the information they provide. The presentation of product characteristics in an assembled manner provides information about the product functionality, about the appearance of the characteristics, and about the overall product appearance. A disassembled presentation approach does not provide information about the overall appearance. The difference in information between both presentation methods is expected to lead to differences in overall uncertainty.

H8.2. Presenting product information in a product configurator by assembled characteristics compared to a presentation by disassembled characteristics leads to more overall certainty.

8.2 PRODUCT NEWNESS

8.2.1 Product evaluations and overall uncertainty
Product configurators allow consumers to make a large number of product variants. The above example of the bicycle, illustrates that with only five characteristics with five levels each, consumers can create 625 bicycles. Consumers are likely to configure products that they have not encountered before. In other words, product configurators are likely to result in products, which are unique, personalized, and new to consumers. The charm of unique products is that no one else has them. The advantage of the personalized products is that the products fit better to consumer preferences. As a consequence, higher product evaluations are expected when products are new compared to known. Furthermore, in the case of new products, consumers need product information to be as complete as possible and they are
more likely to be uncertain about their choices. This need for information is less urgent in the case of existing products, and as a consequence consumers will be more certain about such choices.

**H8.3.** Product configurators presenting product information about new products compared to product information about existing products will result in

a. higher evaluations of the product characteristics.

b. higher overall product evaluations.

c. more overall uncertainty.

### 8.3 Evaluation of the Product Configurator

Product configurators should provide easy operation and navigation. When product configurators are hard to operate and navigate, consumers will not use them. Furthermore, product configurators should provide overview over the product assortment. In this way, consumers are able to oversee the possible product variants to make choices that correspond with their preferences. The *system evaluation* is the consumers’ opinion about product configurators; this includes the perceived operation, navigation, and attractiveness of the system. The system evaluation is critical for the success of mass customization environments. Consumers are only going to use product configurators if consumers consider them usable.

Designers should thus strive for high system evaluations. The presentation format is expected to influence system evaluation. Assembled representation formats provide overview and should therefore be easier to operate and navigate. Therefore, system evaluation is expected to be higher when product information is presented by assembled characteristics compared to disassembled characteristics. Thus,

**H8.4.** Presenting product information in a product configurator by assembled characteristics compared to a presentation by disassembled characteristics leads to higher system evaluation.

Consumers’ evaluation of product configurators will relate to their need for product information. Some consumers use existing product information they have stored in memory to evaluate the products that are shown by product configurators. When consumers encounter known products they need little additional information to make a decision. However, when products are new, consumers need more additional information to make reliable product evaluations.

A product configurator will usually present only limited product information. In many cases, this limited information will do, for example, when the consumer encounters known products. However, in the case of many product configurators, consumers may be evaluating products that are new to them. It can be expected that limited product information will negatively influence overall system evaluations.
**H8.5.** A product configurator that provides information about new products compared to a product configurator that provides information about known products will result in lower evaluations of the product configurator.

Consumers will be prone to rely on their knowledge about products in situations that provide little or no information. Consumers who are knowledgeable about products are more likely to recognize the relevant characteristics of the product. When consumers recognize a product or a characteristic, they activate the relevant product schema. The information for this schema may complement information that cannot be extracted from the presentation. It can be expected that in mass customization environments product knowledge will be used to substitute information that is not found in the presentation.

Consumers often have prior preferences for product characteristics (Hauser and Wernerfelt, 1990; Ratchford, 1982; Roberts and Latin, 1991; Simonson, Huber, and Payne, 1988). Consumers use these preferences to form a consideration set of three to four products and then evaluate the products in this set in more detail to make a choice (Shapiro, MacInnis and Heckler, 1997; Wilkie, 1994). Likewise, consumers using product configurators often do not want to choose a product right away. They want to save an attractive product for later reference and want to continue their search to see if they can find products that better meet their preferences (Loosschilder, 1998). Thus, consumers in mass customization environments want to construct a consideration set as well, but they want the product configurator to memorize this consideration set instead of memorizing the consideration set themselves. The product configurator used in this experiment allows for a construction of such a consideration set.

### 8.4 Study 5

To investigate these hypotheses, an empirical experiment was conducted. A randomized 2 x 2 design was used with presentation format (assembled versus disassembled) and product newness (no newness versus newness) as independent variables. A product configurator was especially designed and programmed for the study (see figure 8.1). Respondents could choose from three types of handlebars, three types of seats, and three types of wheels. The bicycle frame was provided. Respondents could thus configure 27 different bicycles.

#### 8.3.1 Stimuli

Bicycles were chosen as stimuli for this experiment for the following five reasons. First, bicycle customization is an *existing* activity. A bicycle is a product that is often customized; this is especially true for serious recreational cyclists and for professional cyclists. Second, bicycle customization is *relevant* as indicated by the number and variety of websites where consumers can customize bicycles; see for example Airborne (figure 1.6). Third, bicycle customization is *realistic*. Bicycles consist of interchangeable parts. A bicycle can have a variety of wheels or frames, and all possible combinations of characteristics exist. Fourth, bicycle customization allows for relatively easy construction of the stimuli. The parts of one bicycle easily fit onto another bicycle. Furthermore, unlike many other product categories there are also little combinations of characteristics that do not exist. Therefore, the
correlations of one characteristic with another are unlikely to affect customization choices. When these correlations do exist, customization choices are more complex. Finally, bicycle customization may result in very different bicycles and, hence, respondents are more likely to encounter new product variants they have not seen before. For the purposes of this research the number of combinations was limited to 27 different possible bicycles in order to keep the preparation of the experiment manageable.

How could respondents operate the product configurator? The selected characteristics could be changed, for example, by either clicking on the left arrow or by clicking on the preferred attribute level. When respondents wanted to change the handlebars, for example, they could click on the preferred attribute level. The slider with handlebars would then slide to the left, until the chosen handlebars were framed. The resulting bicycle (with the selected handlebars) was shown immediately on the bottom of the screen. Two types of presentation format were used. In the disassembled condition the product information was presented by disassembled characteristics (see figure 8.2a), whereas in the assembled condition the product information was presented by assembled characteristics (see figure 8.2b).
Product newness was manipulated by varying the bicycle frame. The bicycle frames that were used in the experiment are shown in figure 8.3. For the no-newness condition, an existing bicycle frame was chosen that was very common to respondents (see figure 8.3a). For the newness condition, a bicycle frame was chosen that had recently come on the market at the time of the study. To ascertain that the bicycle frame was considered really new, the bicycle frame was modified with the computer (see figure 8.3b). Respondents could never have encountered this specific bicycle frame before. Therefore this frame was considered to be new.

8.3.2 Procedure
Respondents were asked to customize three bicycles using the product configurator. The bicycles had to differ on at least one characteristic. After each respondent had customized three bicycles, they evaluated all bicycles and filled out a questionnaire. Then they were asked to select the best alternative. The dependent measures for this best alternative were used in all analyses.
8.3.3 Measures

Four dependent variables were measured along with two control measures. All measures were recorded using seven-point scales.

Control measures.
1. **Product Attractiveness.** Respondents differ in their esthetic preferences. To be able to control for these effects, product attractiveness was measured. The respondents were asked to indicate the attractiveness of the product with anchors ranging from “Very unattractive” (1) to “Very attractive” (7).
2. **Subjective knowledge.** To control for individual differences in product knowledge, the subjective knowledge of the respondents was measured using four items from a scale developed by Flynn and Goldsmith (1999) with anchors ranging from “Completely disagree” (1) to “Completely agree” (7). Subjective knowledge expresses what respondents think they know about a specific product. The items were averaged to form an individual subjective knowledge measure (α = .90).

Dependent measures. All items of the dependent variables measuring decision value are included in appendix 1.

1. **Evaluation of the product characteristics** was measured with one item. For each product the respondents indicated their evaluation of the products characteristics with anchors ranging from “Very bad combination” (1) to “Very good combination” (7).
2. **Evaluation of the overall product.** was measured using five items with anchors ranging from “Not at all” (1) to “Very” (7) satisfied, good, professional, qualitative, and reliable (Raghubir and Corfman 1999). The five items of overall product evaluation were averaged to form an overall product evaluation measure (α = .77).
3. **Overall uncertainty** was measured by six items. Every evaluation item about the bicycle was followed by an uncertainty item (“How confident are you of your answer”; Dacin and Smith 1994; Dhar and Simonson 1992) with anchors ranging from “Very unsure” (1) to “Very sure” (7). The measures of product certainty were averaged to form an overall uncertainty measure (α = 0.81).
4. **System evaluation.** The evaluation of the product configurator was measured by one item concerning the general satisfaction with the product configurator with anchors ranging from “Very dissatisfied” (1) to “Very satisfied” (7).

8.3.4 Respondents

One hundred and seventy-one students (57% male and 43% female) participated in the study. Respondents were randomly assigned to the conditions. As reward for their participation they received a small token gift. After they had completed the questionnaire they were informed about the purpose of the study.
8.4 RESULTS OF STUDY 5

8.4.1 Control Measures

*Product Newness.* The bicycle frame was manipulated to create a newness condition and a no-newness condition. To determine whether this manipulation had succeeded, respondents indicated how new the bicycle was. An ON EWAY ANOVA with newness as dependent variable and the product newness as independent variable revealed that the bicycle in the newness condition was rated newer than the bicycle in the no-newness condition ($F(1, 169) = 29.1, p < .001; M = 3.8$ versus $5.1$), indicating that the intended manipulation was successful.

*Product Attractiveness.* The respondents did not differ in their ratings for product attractiveness in the different conditions. Neither the presentation format nor product newness influenced product attractiveness (All $F(1, 169) < 1.1, ns$).

8.4.2 Dependent measures

The data were analyzed by separate 2x2 analyses of variance (ANOVA\(^8\)) with presentation format and product newness as between subject-factors. The means for all dependent measures are reported in table 8.1.

### Table 8.1 Effects of presentation format and product newness on the dependent measures.

<table>
<thead>
<tr>
<th>Dependent variables</th>
<th>Presentation format</th>
<th>Product newness</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Disassembled (N=71)</td>
<td>Assembled (N=100)</td>
</tr>
<tr>
<td>Evaluation of the product characteristics</td>
<td>5.6**</td>
<td>5.0**</td>
</tr>
<tr>
<td>Evaluation of the overall product</td>
<td>5.2</td>
<td>5.0</td>
</tr>
<tr>
<td>Overall uncertainty</td>
<td>1.7**</td>
<td>1.3**</td>
</tr>
<tr>
<td>System evaluation</td>
<td>4.1*</td>
<td>4.9*</td>
</tr>
</tbody>
</table>

Notes. * $p < .05$; ** $p < .01$; higher means denote more uncertainty and higher evaluations.

*Product evaluation.* In the disassembled condition, the emphasis is on the product characteristics. Hypothesis 8.1a predicts higher evaluations of the product characteristics in the disassembled condition compared with the assembled condition. Presentation format and product newness did influence the evaluation of the product characteristics. Table 8.1 shows that product characteristics were evaluated higher in the disassembled condition compared with the assembled condition ($F(1, 167)=7.2$, $p<.01$). Thus hypothesis 8.1a is supported. In the assembled condition the emphasis is on the overall product. Hypothesis 8.1b predicts higher overall product evaluations in this case compared with disassembled presentation of

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\(^8\) To control for effects of product attractiveness, subjective knowledge and gender, these were taken as covariates in all analysis of variances (ANCOVA). The product attractiveness, subjective knowledge and gender did not moderate the effects of presentation format and product newness (All $F(1, 169)<3.2, ns$).
characteristics. However, the presentation format did not influence the overall product evaluation \( (F(1,167)=1.2, ns) \). Therefore, hypothesis 8.1b was not supported.

Hypothesis 8.3a and 8.3b predict positive effects of product newness on evaluation of product characteristics and overall product evaluation. However, the analyses revealed that respondents in the newness condition provided lower evaluations compared with the non-newness condition. \( (F(1,167)=4.4, p<.05) \). Thus hypothesis 8.3a was not supported. Furthermore, no significant effects of product newness on the overall evaluation of the bicycle were found \( (F(1,167)=1, ns) \), thus hypothesis 8.3b was not supported either. The analyses did reveal an interaction effect between presentation format and product newness \( (F(1,167) = 7.3, p<.01) \). As can be seen in figure 8.4, in the newness condition the product was evaluated higher when presented by disassembled characteristics, whereas in the non-newness condition the product was evaluated higher when the product was presented by assembled characteristics.

![Graph showing interaction effect between presentation format and product newness on overall evaluation of the product](image)

**Overall uncertainty.** Overall uncertainty was influenced by presentation format \( (F(1,167)=7.1, p<.01) \) as predicted by hypothesis 8.2. Respondents were more certain about their evaluations when products were presented by assembled characteristics compared to products presented by disassembled characteristics. Hypothesis 8.3c predicted a positive influence of product newness on uncertainty. However, the overall uncertainty was not influenced by product newness \( (F(1,167)=1.8, ns) \). Both groups were virtually as certain about their evaluations. Thus, hypothesis 8.3c was not supported.

**System evaluation.** Hypothesis 8.4 expected a positive effect of assembled representation format on system evaluation. Respondents indeed indicated they were more satisfied with the product configurator that used an assembled presentation format compared with a product configurator using a disassembled presentation format \( (F(1,167)= 11.2, p<.001) \). This result
provides support for hypothesis 8.4. Hypothesis 8.5 predicted that product newness negatively influenced system evaluation. The product newness had no significant effect on the system evaluation \((F(1,167)=.29, \text{ ns})\), thus disconfirming hypothesis 8.5. The satisfactions with the product configurator in the newness condition did not differ from the no-newness condition.

### 8.4.3 Replication study

The hypotheses and whether they were supported are summarized in table 8.2. Study 6 – to be described in detail in Chapter 9 – offered an opportunity for replication of study 5. Study 6 was similar to study 5; respondents customized Barbies using a product configurator. They constructed three Barbies and completed measures similar to the ones used in study 5. The results of this replication study are presented in table 8.3.

<table>
<thead>
<tr>
<th>Hypotheses</th>
<th>Study 5</th>
<th>Study 6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Presentation</td>
<td>Product newness</td>
</tr>
<tr>
<td></td>
<td>format</td>
<td>format</td>
</tr>
<tr>
<td>Evaluation of</td>
<td>H8.1a +</td>
<td>H8.3a -</td>
</tr>
<tr>
<td>characteristics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall evaluation</td>
<td>H8.4b 0</td>
<td>H8.3b 0</td>
</tr>
<tr>
<td>Overall uncertainty</td>
<td>H8.2 +</td>
<td>H8.3c 0</td>
</tr>
<tr>
<td>System evaluation</td>
<td>H8.4 +</td>
<td>H8.5 0</td>
</tr>
</tbody>
</table>

Notes. "+" = effect found; "0" = hypothesis not supported; "-" = effect reversed.

### Product evaluation.

In the replication study, presentation format did not influence either the evaluation of the product characteristics (All \(F(1,115)<1.8, \text{ ns}\)) or the overall evaluation of characteristics (All \(F(1,115)<.1, \text{ ns}\)). Thus, no support was found for hypotheses 8.1a and 8.1b.

### Product uncertainty.

In the replication study, a distinction was made between two types of uncertainty – relative and individual product uncertainty – to investigate which type of uncertainty is affected by presentation format. Remember from Chapter 2 that relative product uncertainty is uncertainty about which product is the best and individual product uncertainty is uncertainty about what each product offers. Two independent ONeway analyses of variances showed no significant differences between presentation formats for relative uncertainty \((F(1,115)=.05, \text{ ns})\). However, for individual product uncertainty respondents in the assembled condition were more certain about the chosen product than respondents in the disassembled condition \((F(1,115)=5.4, p<.05)\).

### System evaluation.

Respondents were more satisfied with the product configurator in the assembled condition than in the disassembled condition \((F(1,115)=4.0, p<.05)\). Furthermore,

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*No effects of gender on any of the dependent measures were found (All \(F(1, 115)<2.3, \text{ ns}\)).*
they found the product configurator more appropriate for the task in the assembled condition than in the disassembled condition ($F(1,115)=21.7, p<.001$). However, no differences in the ease of use were found ($F(1,115)=1.5, ns$). These results provide support for hypothesis 8.4 for the greater part.

<table>
<thead>
<tr>
<th>Measures</th>
<th>Presentation format</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Assembled (N=54)</td>
<td>Disassembled (N=63)</td>
<td></td>
</tr>
<tr>
<td>Evaluation of the product characteristics</td>
<td>Satisfied</td>
<td>4.0</td>
<td>4.0</td>
</tr>
<tr>
<td></td>
<td>Good combination</td>
<td>5.2</td>
<td>5.0</td>
</tr>
<tr>
<td></td>
<td>Possible combinations</td>
<td>4.6</td>
<td>4.3</td>
</tr>
<tr>
<td>Evaluation of the overall product</td>
<td>Satisfied</td>
<td>5.6</td>
<td>5.3</td>
</tr>
<tr>
<td></td>
<td>Good</td>
<td>5.6</td>
<td>5.6</td>
</tr>
<tr>
<td></td>
<td>Qualitative</td>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Product Uncertainty</td>
<td>Relative product uncertainty</td>
<td>2.4</td>
<td>2.3</td>
</tr>
<tr>
<td></td>
<td>Individual product uncertainty</td>
<td>2.9*</td>
<td>3.4*</td>
</tr>
<tr>
<td>System Evaluation</td>
<td>Satisfaction</td>
<td>4.9*</td>
<td>4.4*</td>
</tr>
<tr>
<td></td>
<td>Ease of use</td>
<td>6.7</td>
<td>6.6</td>
</tr>
<tr>
<td></td>
<td>Appropriateness</td>
<td>5.3**</td>
<td>4.0**</td>
</tr>
</tbody>
</table>

Notes. * $p < .05$; ** $p < .01$; higher scores denote higher evaluations and more uncertainty

8.5 CONCLUSIONS FOR PRESENTATION FORMAT AND PRODUCT NEWNESS

8.5.1 Product newness
Product newness did affect the evaluation of the product characteristics and showed an interaction effect on overall evaluation together with presentation format. The other dependent measures were not affected by product newness. A positive effect of product newness on product evaluation was hypothesized. However, a negative effect of product newness on product evaluation was found. This negative effect may have been caused by consumer knowledge about products. Research on concept testing (Schoormans, Ortt, and de Bont 1995) showed an interaction between product knowledge and product newness on product evaluation. Concepts of new products could be better understood by consumers with high levels of knowledge with regard to the product category. Those who lacked these high levels of product knowledge had trouble evaluating the product. However, in situations in which rather simple new products were tested, the differences between respondents with high and low high levels disappeared (Schoormans et al. 1995). When new products are presented using a product configurator and product knowledge is low the consumer will have to rely totally on the information as it is provided by the product configurator. Therefore, the limited amount of product information available in the product configurator leads to low product evaluations.

8.5.2 Presentation format
The bicycle study used a product where functionality was more important than product appearance, whereas the Barbie study used a product where the product appearance was more
important than product functionality. Thus, the reason why representation format affected product evaluations in the bicycle study, but not in the Barbie study may be explained as follows. The effects on evaluation of product characteristics can be caused, because the bicycle is more functional than the Barbie.

_Evaluation of the product characteristics._ The high evaluations of product characteristics in the disassembled condition may be caused by the focus on the product characteristics in this condition. Respondents in the disassembled condition are likely to have focused on the characteristics of the bicycles, because presentation by disassembled characteristics makes them more salient than the overall appearance. Presentations by disassembled characteristics allow for thorough evaluation of the functional characteristics of a product, which may result in higher evaluations of product characteristics. The evaluation measures seem related to the product functionality, which indicates that the bicycles were evaluated on functional grounds. Taken together this signals a focus on both functionality and on the product characteristics, which caused the evaluation of the product characteristics. However, this was only the case for new products. As discussed above, this can be explained by the limited knowledge that consumers have available about new products. Thus, this higher evaluation of the characteristics can be caused by the focus on functionality of the product. High evaluations on the functional characteristics in the disassembled condition lead to high overall product evaluations, but only in case of new products.

_Overall product evaluation._ The overall product evaluation did not differ between the two presentation format conditions. Respondents in the assembled condition are likely to have focused on the overall product, because presentation by assembled characteristics makes the overall product more salient than the characteristics. An assembled presentation of the product allows for thorough evaluation of the product appearance. This may have lead to increased attention for the product appearance when evaluating the product. However, the measures are related to product functionality and thus any positive evaluations of the product appearance do not find its reflection in the evaluation of the overall product. Presentations by assembled characteristics do not allow for thorough evaluation of the functional characteristics and, therefore, lead to lower overall product evaluations.

An interaction effect was found between representation format and product newness (see figure 8.4). Respondents customizing a new product provided higher overall evaluations when the new product was presented by disassembled characteristics in comparison with presenting the new product by assembled characteristics. As discussed above, this can be explained by the limited knowledge that consumers have available about new products. Respondents customizing new products in the assembled condition were able to make reliable evaluations, whereas respondents customizing new products in the disassembled condition were not able to do this.

To investigate this possibility, some additional data were collected. The respondents in the disassembled condition were subjects in a post-hoc test. After they had evaluated the bicycles presented in a disassembled format, subjects were shown the same bicycle in an assembled format. The respondents evaluated the bicycle for a second time. The two evaluations were subsequently compared. The results showed that a different presentation of the same product

109
information leads to different overall product evaluations, but only in the case of newness. For respondents in the *newness condition*, the average evaluation of the bicycle presented by disassembled characteristics was 5.4. When the product was presented by assembled characteristics, the overall evaluation dropped to 4.7. There is a strong trend to significance between these two scores (*t*(35)=1.89, *p*=.065). For respondents in the *no-newness condition*, the average evaluation of the bicycle presented by disassembled characteristics did not differ from the overall evaluation of the bicycle presented by the assembled characteristics (*t*(35)=.34, *ns*; *M*=5.0 versus 5.1). This suggests consumers’ evaluations are influenced by the way the information is presented in case of new, unknown products, but not in case of known products. Respondents customizing new products could not make reliable evaluations when product information was presented as disassembled characteristics. Assembled representation formats increase reliability of overall product evaluations, especially in case of new products. The effects of product newness in the Barbie study could not be investigated, because it was not manipulated in this study.

**Overall Uncertainty.** Respondents were significantly more certain about the product they had customized in the assembled condition than in the disassembled condition. The image of the product reduces uncertainty about the product. This supports the results found in study 2 and 3, where images also reduced the individual product uncertainty, but not the relative product uncertainty. Accurate information about the overall appearance of the product cannot be extracted from the disassembled characteristics. Providing information about the product appearance is thus important to reduce respondents’ individual product uncertainty.

**Summary.** The results from research part I show that differences in the amount of information (variance, number of characteristics, and assortment) affect effort and uncertainty, but not product evaluation. The Barbie study offered more attribute levels (3-5 compared to 3), more characteristics (4 compared to 3), and hence more product variants (240 compared to 27). These differences in the amount of information could have lead to differences in effort and uncertainty. However, these measures cannot be compared; no measures of effort are available from the bicycle study. Uncertainty was measured differently, although the means (see table 8.1 and 8.3) suggest that consumers experienced less product uncertainty in the Barbie study than in the bicycle study.

The high evaluations of product characteristics in the disassembled condition tend to be caused by the salience of the separate characteristics in this condition. These functional characteristics are more easily evaluated when presented separately. The interaction of representation format and product newness on overall product evaluation is caused by unreliability of evaluations in the disassembled condition when respondents customized new products. The post-hoc test provides support for this explanation. If the explanation for the high evaluations of product characteristics is true, then we would expect this effect to disappear when these characteristics are not functional, such as the characteristics of the Barbie. This seems a plausible explanation, because the effect of representation format on evaluation of the product characteristics does indeed disappear. Furthermore, we would expect the evaluation of product appearance to be more reliable when an assembled representation format is used compared to a disassembled representation format. However, the measures of overall product evaluation correlate with functionality and this expectation
cannot be tested. Therefore, study 6 will concentrate on measuring esthetic evaluation of the overall product. In other words, to be able to fully appreciate the positive effect of an assembled presentation format on the evaluation of the product appearance, esthetic evaluation measures should be used.

8.5.3 System evaluation
Respondents provided higher evaluations of the product configurator when products were presented by assembled characteristics compared to when products were presented by disassembled characteristics. Earlier, the system evaluation was said to be critical for the success of mass customization environments. Consumers will be less likely to use dissatisfying product configurators, but are more likely to use product configurators that are usable. Such systems can make consumers more certain about the choices they make and could even enhance product evaluations. When consumers are satisfied with the process of customizing products, they may also be more satisfied with the resulting product. Thus, in other words, product evaluations and uncertainty could be mediated by system evaluations.

To show mediation, three relations must be demonstrated (Baron and Kenny, 19XX; Dhar, Nowlis, and Sherman, 2000; Luce, 1998; Mandel and Johnson, 2002). First, the independent variable, presentation format, should significantly affect the mediator, system evaluation. Second, the mediator, system evaluation, should significantly affect the dependent variables. Third, the effect of presentation format on the dependent variables should be reduced or eliminated when system evaluation is included as covariate.

Table 8.1 demonstrates the first relation for the bicycle study, because presentation format significantly affects system evaluation. To test the second relation for the bicycle study, three regression analyses were conducted with the system evaluation as independent variable and the evaluation of the product characteristics, overall product evaluation, and uncertainty as dependent variables. The results showed that system evaluation significantly affected overall product evaluation \((F(1,169)=9.2, p<.01)\) and uncertainty \((F(1,169)=10.8, p<.001)\), but not evaluation of the product characteristics \((F(1,169)=.86, ns)\). To determine whether the effects of presentation format would be reduced or eliminated when system evaluation was included (third relation), two separate analyses of variance (ANCOVA) were conducted with the presentation format as between-subjects variable, the system evaluation as covariate, and the overall product evaluation and uncertainty as dependent variables. The results showed that system evaluation does mediate overall product evaluation and uncertainty. System evaluation was a significant covariate in the first ANCOVA \((F(1,166)=10.4, p<.01)\) and eliminated the effect of presentation format on overall product evaluation \((F(1,166)=3.6, ns)\). System evaluation was also a significant covariate in the second ANCOVA \((F(1,166)=7.6, p<.01)\) and eliminated the effect of presentation format on uncertainty \((F(1,166)=3.7, ns)\).

Before the mediation analyses were conducted for the replication study the first and the third measure of system evaluation were averaged to form an overall system evaluation measure that was used in the two subsequent analyses. Only individual product uncertainty was significantly affected by presentation format. Therefore, a mediation analysis was only conducted for individual product uncertainty. Presentation format significantly affects system evaluation (see table 8.3), thus demonstrating the first relation needed to show mediation.
Next, a regression analysis was conducted with system evaluation as independent variable, and individual product uncertainty as dependent variable. The result showed that system evaluation significantly affected individual product uncertainty \(F(1,116)=23.4, p<.001\). An analysis of variance (ANCOVA) was conducted with the presentation format as between-subjects variable, the system evaluation as covariate, and the individual product uncertainty as independent variable. The result showed that system evaluation mediated individual product uncertainty in the replication study. System evaluation was a significant covariate \(F(1,116)=18.0, p<.001\) and eliminated the effect of presentation format on uncertainty \(F(1,116)=.8, ns\). As in study 5, uncertainty is mediated by system evaluation.

Before consumers will buy products (either in a traditional or an interactive environment), they have to be able to evaluate the product. The mediator analysis showed that consumers’ individual product uncertainty is mediated by the system evaluation. This means that when consumers do not like a product configurator that uses a disassembled presentation format, this in turn leads to uncertainty about the characteristics of the product. It is, therefore, essential that consumers are satisfied with the product configurator and that the product configurator is appropriate for the customization task. This shows that it is indeed critical to design product configurators that consumers like, because badly designed configurators affect their product evaluations and product uncertainty. However, disassembled presentation of functional product information may still be important to consumers, because such presentation allows for thorough evaluation of the functional characteristics of a product.

Study 6 investigates how presentation format influences esthetic evaluations for products where appearance is important. Furthermore, study 6 investigates the underlying process of product customization. Studies 7 and 8 investigate the effort, product evaluation, and product uncertainty for product configurators that present product information sequentially (instead of simultaneously as in the current study).
CHAPTER 9

PRESENTATION FORMAT AND CUSTOMIZATION PROCESSES

Holbrook and Hirschman (1982) argued for an enlarged view of consumer decision-making, which incorporates esthetic responses. For many products, consumers’ process information in a way as proposed by the information processing theory (Bettman, 1979). However, for products where the appearance is more important than functionality, and esthetic responses are likely to occur, the information process may be different. In such case, consumers have to take the correlations between attributes into account. Characteristics related to product appearance interact with each other, so that a choice of one characteristic influences the choice of another (Holbrook and Moore, 1981a). Therefore, the effects of the two presentation formats are investigated for products where the appearance is more important than functionality. In order to measure the evaluation of the product appearance, esthetic product evaluation measures are used in this study. These esthetic product evaluation measures complement the overall product evaluations measures used in study 5 (Holbrook and Hirschman, 1982).

9.1 PRESENTATION FORMAT

Product appearance and esthetics are important factors in the selection of many, if not all products (Veryzer, 2000). What is exactly understood by esthetics is not clear, although it seems to refer to affect or pleasure (Veryzer, 1993). However, most authors seem to refer to esthetics as aspects of the product appearance, such as shape, color, and texture. Product appearance and esthetics are inherently linked (Veryzer, 2000), because the product appearance encompasses esthetic aspects of the product (for example, shape, color, texture, etc.). Many factors affect consumers’ response to product appearance. Holbrook and Schindler (1994) discussed how factors like age, gender, attitudes, and personality affect responses to product appearance. Others, like Bloch (1995) have discussed how factors like culture, social context, situational factors, and individual tastes influence responses to product appearance.

Consumers use non-conscious processes to formulate preferences for product appearance; they use these rules for responses to product appearance, but they were not aware of using these rules (Veryzer, 1993). The existence of such non-conscious internalized rules is supported by studies that have examined peoples’ responses to product appearance. In a study of Veryzer (1993), the effects of relational rules as proportion and unity were shown to influence esthetic evaluations. Responses to product appearances may be affected by subtleties of the product appearance that can affect processing (Grabowska and Nowicka, 1996). Varying size, position, manner of execution, or constellation composition that make up a product’s appearance can destroy the relationship between characteristics (Cox and Cox, 1994; Fagot and Deruelle, 1997; Grabowska and Nowicka, 1996; Holbrook and Moore, 1981a; 1981b; Veryzer, 1993; Veryzer and Hutchinson, 1998).
This suggests that the presentation format of product appearance may also affect esthetic responses. An assembled presentation of the product allows evaluation of the overall product appearance and emphasizes this product appearance. Conversely, a disassembled presentation allows evaluation of the individual product characteristics and emphasizes the product functionality. Therefore, consumers are expected to prefer assembled presentation formats when making esthetic product evaluations, because such formats are more appropriate for evaluating the product appearance. Thus,

**H9.1** Presenting product information in a product configurator by assembled product characteristics compared to a presentation by disassembled product characteristics leads to higher esthetic responses.

### 9.2 Customization Processes

Efficient product configurators should allow consumers to make customization choices that take little effort, leave consumers with little product uncertainty and lead to more reliable product evaluations. In order to design efficient product configurators, knowledge about the customization process is needed. The customization process encompasses the iterative decision process of search, choice, and evaluation of product information. Knowledge about this customization process and its effects on customization choices should lead to more efficient product configurators. By exploring the order and time spend on each attribute level, insights are gained into the customization process.

An important distinction between information processing strategies is whether respondents search by alternative or by characteristic (Bettman, Luce, and Payne, 1998; Payne, 1982; Stokmans, 1991; Tversky, 1969; see also Chapter 7). First, information may be processed primarily by alternative, in which multiple characteristics of one alternative are processed before another alternative is considered. Second, it may be processed by characteristic, in which one characteristic for several alternatives are processed before information of another characteristic is considered (Bettman et al., 1998). In general, processing by characteristic is easier because it requires less cognitive load (Russo and Dosher, 1983). Consumers do not have to remember all characteristics of each alternative to make comparisons. Instead they can make comparisons per characteristic. This strategy works well when the characteristics are not correlated. However, when the characteristics are correlated, Russo and Dosher (1983) argued that the only correct processing strategy is by alternative. Product configurators can present product information either by alternative or by characteristic and consumers will be likely to process this information by alternative or by characteristic, respectively, because consumers generally process information in the way the information is presented (Bettman and Kakkar, 1977).

Similarly, in a customization process a distinction can be made between a between-attribute strategy and a within-attribute strategy. Consumers may use a *between-attribute strategy*, in which an attribute level of each characteristic is considered before other attribute levels are considered. They may also use a *within-attribute strategy*, in which different attribute levels of one characteristic are considered before considering other characteristics. A between-
attribute strategy can be used to quickly create a product. Consumers can then evaluate the concept they have created and use a within-attribute strategy to fine-tune the product. They click on the different attribute levels and evaluate the consequences for the product. A between-attribute strategy followed by a within-attribute strategy is possible when product information is provided by assembled characteristics presentation, but not when the product information is presented by disassembled characteristics. Both types of presentation formats will allow a between-attributes strategy; consumers choose attribute levels they prefer. However, only when product information is provided in an assembled format, consumers will be able to evaluate the correlations between characteristics and use a within-attributes strategy to fine-tune the product appearance. Consumers using disassembled presentation formats are unlikely to use within-attribute strategies. The use of within-attribute strategies are more likely to lead to better product appearances than the use of between-attribute strategies alone. It is therefore important to investigate how the presentation format affects these processes. Hence, using disassembled presentation formats results in product appearances that are inferior to product appearances resulting from assembled presentation formats.

Consumers are expected to switch from a between-attribute strategy to a within-attribute strategy. Initially, consumers will use a between-attribute strategy to customize a product. Then they will use a within-attribute to fine-tune the product. More specifically, consumers will use a between-attribute strategy in the first stage of the customization process and switch to a within-attribute strategy in a second stage. However, this second stage is more likely to occur for consumers receiving product information in an assembled presentation format. Only then consumers can evaluate the subtle changes resulting from changing the characteristics. Thus, consumers tend to use a between-attribute strategy in the first stage of the customization process, regardless of the presentation format, but consumers receiving product information presented by assembled characteristics tend to use a within-attribute strategy in the second stage of the customization process. This leads to the following hypothesis:

**H9.2** Consumers using a product configurator, that provides an assembled presentation format compared to a disassembled presentation format, will be more likely to use a within-attribute strategy in the second stage of the customization process, but no differences in the use of strategies are expected in the first stage of the customization process.

### 9.3 Study 6

To investigate these hypotheses, an experiment was conducted. A randomized design was used with presentation format as an independent variable.

#### 9.3.1 Stimuli

Respondents could configure 240 different Barbies. Respondents could choose between four types of faces, three types of eye colors, four types of hair styles, and five type of hair colors using a product configurator similar to the one used in study 5 (see figure 9.1).
Two types of presentation format were used. In the disassembled condition the product information was presented by disassembled characteristics (see figure 9.2a), whereas in the assembled condition the product information was presented by assembled characteristics (see figure 9.2b).
The Barbie website (www.barbie.com) was used to acquire the images used in the study. Barbies (see figure 9.1) were chosen as stimuli for this experiment for three reasons. First, Barbie customization is an existing activity (www.barbie.com). Consumers can customize various characteristics of a Barbie on the website. Consumers can choose out of a total of 864 different dolls. It is impossible to show all these on the basis of alternatives. This means that a product configurator offering Barbie customization should offer information about characteristics and its levels. Second, Barbie customization is realistic. The researcher can easily construct Barbies that differ on a variety of characteristics. The color of the eyes can be changed easily, as well as the type of face, and the style and color of the hair. Third, the parts of one Barbie can easily be exchanged with another Barbie.

9.3.2 Procedure
Respondents were instructed to customize three Barbies. They were asked to create a Barbie for their niece's birthday. They were told that they should create two additional Barbies in case the Barbie they had selected was sold out. The three Barbies had to differ on at least one characteristic. After each respondent had customized three Barbies, they evaluated the first Barbie and filled out a questionnaire. The dependent measures for the first Barbie were used in all analyses.

9.3.3 Measures
Ten dependent variables were measured. Five seven-point scale measures and five process measures were collected.

Seven-point scale measures. All items of the dependent variables measuring decision value are included in appendix 1.

1. Esthetic evaluation of the overall product was measured using 12 items with anchors ranging from “Not at all” (1) to “Very” (7) attractive, good looking, charming, beautiful, tough, feminine, cute, happy, good appearance, interesting, charismatic and personal taste.

2. Evaluation of the product characteristics was measured with three items with anchors ranging from “Very bad combination” (1) to “Very good combination” (7), “Very unsatisfied with the combination (1) to “Very satisfied with the combination” (7), and “Very unsatisfied with the choices of characteristics” (1) to “Very satisfied with the choices of characteristics” (7).

3. Evaluation of the overall product. The evaluation of the overall product was measured using three items with anchors ranging from “Not at all” (1) to “Very” (7) satisfied, good, and qualitative (Raghubir and Corfman, 1999).

4. Product uncertainty. Both individual and relative product uncertainty were measured. Relative product uncertainty was measured with two items with anchors ranging from “Very uncertain” (1) to “Very certain” (7) about the best Barbie and best appearance. These two items were averaged to form a relative product uncertainty measure (α = .84). Individual product uncertainty was measured with three items, with anchors ranging from “Don’t know much about the Barbie” (1) to “Know very much about the Barbie” (7), “Don’t know enough to decide whether to buy the Barbie” (1) to “Know enough to decide whether to buy the Barbie”, and “Don’t need additional information” (1) to “Need
additional information” (7). These three items were averaged to form an individual uncertainty measure (σ = .67).

5. *System evaluation* was measured by three items with anchors ranging from “Not at all” (1) to very (7) satisfied, easy, and appropriate.

*Process measures.* Seven variables were calculated from the data that can be categorized in three types of process measures (Payne, Bettman, and Johnson, 1988):

1. **Effort.** The *search time* was recorded from the moment a respondent started to customize the Barbie until they finished. Every *mouse clicks* used by each respondent to customize a Barbie was recorded.

2. **Relative attention to characteristics.** The proportions of mouse clicks on each characteristic and the proportions of time spent on each characteristic, provide information about the relative attention spent on each characteristic (Payne, Bettman, and Johnson, 1988). Before calculating the *proportions of mouse clicks* for each characteristic, the number of mouse clicks was adjusted for the number of within-attribute possibilities and then for the number of mouse clicks (Böckenholt and Hynan, 1994). A second measure of relative attention was calculated by dividing the variance of mouse clicks between characteristics by the maximum variance possible. This leads to a *standardized score for mouse clicks*, where 0 denotes no variance and 1 denotes maximum variance. A zero-score means that all characteristics received the same amount of attention. A larger score means that some characteristic(s) received more attention than the others. The same procedure was followed to calculate the *proportion of search time* spent on each characteristic and to calculate a *standardized score for search time*.

3. **Attribute processing strategy (APS).** The APS indicates whether respondents followed a between-attribute strategy or a within-attribute strategy. The APS can be calculated using transitions. A transition is a pattern of mouse clicks. To do this, an APS score for each respondent was calculated by taking the number of within-attribute transitions minus the number of between-attribute transitions divided by the total number of transitions. The value of the attribute processing strategy can range from -1.0 to +1.0, with negative numbers indicating between-attribute processing and positive numbers indicating within-attribute processing. Similar procedures were frequently used in information processing research (Dhar, Nowlis, and Sherman, 2000; Payne, 1976). Not every respondent will make the same number of transitions. To make the characteristic processing strategies comparable between respondents and conditions, the attribute processing strategy was adjusted for the number of transitions (Böckenholt and Hynan, 1994).

### 9.3.4 Respondents

One hundred and thirty students (46% male and 54% female) from two different universities participated in the study. Respondents were randomly assigned to conditions. As reward for their participation they received a small token gift. After they had completed the questionnaire they were informed about the purpose of the study.
9.4 Results from Study 6

9.4.1 Outlier analysis
The data were checked on outliers. Some respondents were very enthusiastic about the customization task and had invested a disproportional amount of time into the task. Including these respondents in the sample would influence the mean search time and mean clicks to a large extent. These respondents were therefore removed from the sample using outlier analysis, because their disproportional and atypical behavior would distort the results. All respondents who had a number of mouse clicks more than three standard deviations from the mean were removed from the sample (Hair et al. 1995, p. 59). The same procedure was followed for search time. Three iterations resulted in a sample of 117 respondents (46% male and 54% female).

9.4.2 Esthetic evaluation of the overall product\(^{10}\)
Factor Analysis. The esthetic evaluation of the overall product (12 items) was factor-analyzed by means of principal component analysis with varimax rotation and Kaiser normalization. The initial factor solution resulted in three factors, which accounted for 34% of the variance. All items with factor loadings below .30 on all factors were removed (Nunnally, 1967). Furthermore, in order to prevent contamination of the scale, items that cross-loaded (factor loadings of .40 or greater on more than one of the factor) were also eliminated. Three iterations resulted in 8 items distributed over three factors, which accounted for 32% of the variance. These results showed that the various items of esthetic evaluation of the overall product are relatively independent. Therefore, an overall esthetic evaluation of the overall product was calculated by averaging the 12 items that was used in further analyses.

Hypothesis 9.1 predicted higher esthetic evaluations when an assembled presentation format was used. To provide tests for the hypothesis 9.1, the data were analyzed by an analysis of variance (ONEWAY ANOVA) with presentation format as between-subject factor and overall esthetic evaluation as dependent variable. Respondents in the assembled condition did not provide significantly higher esthetic evaluations of the overall product compared to respondents in the disassembled condition ($F(1,115)=.84$, $ns$, $M=5.1$ versus 4.9). Thus, no support was found for hypothesis 9.1.

9.4.3 Customization process
Effort. The number of mouse clicks and the search time for the two presentation conditions are presented in table 9.1. Respondents in the assembled condition clicked significantly more to customize their Barbie than respondents in the disassembled condition ($F(1,115)=19.2$, $p=.001$). However, respondents in both conditions needed as much time to customize their Barbies (All $F<1.5$, $ns$). From these results can be concluded that respondents in the disassembled condition needed more search time to consider their next click.

\(^{10}\) No effects of gender on any of the dependent measures were found (All $F(1,115)<2.3$, $ns$)
Relative attention to characteristics. The relative attention was measured using two measures for the mouse clicks on characteristics and two measures for the search time on characteristics. For both the mouse clicks and search time, standardized scores and the proportions of mouse clicks and search time were calculated. First, the standardized scores for mouse clicks and search time for each characteristic were investigated. Remember that a zero-score means that all characteristics received as much attention and a larger score means that some characteristic(s) received more attention than the others. The standardized scores for both mouse clicks and search time are provided in Table 9.2.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Presentation format</th>
<th>Assembled (N=54)</th>
<th>Disassembled (N=63)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mouse clicks</td>
<td></td>
<td>11**</td>
<td>7**</td>
</tr>
<tr>
<td>Search time (sec)</td>
<td></td>
<td>32</td>
<td>32</td>
</tr>
</tbody>
</table>

Notes. * p < .05; ** p < .01

Table 9.2 shows that each characteristic was clicked as often, regardless of the condition. Two analyses of variance (ONEWAY ANOVA) were performed with presentation format as the between-subject factor and the normalized variance in the proportion of mouse clicks and search time as the dependent factors. The normalized variance in proportion of mouse clicks was .09; this is equal to a clicking behavior of clicking 12 times on one characteristic and 4 times on the other three. There were no differences in the normalized variance in the proportion of mouse clicks between conditions (F(1,115) = .11, ns). The variance in proportions of search time was significantly lower in the assembled condition than in the disassembled condition (F(1,115) = 10.4, p = .002). Thus, respondents in the disassembled condition did not spend the same amount of attention to all characteristics.

<table>
<thead>
<tr>
<th>Standardized variance in the proportion of mouse clicks and search time</th>
<th>Presentation format</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Assembled (N=54)</td>
<td>Disassembled (N=63)</td>
</tr>
<tr>
<td>Mouse clicks</td>
<td>.09</td>
<td>.08</td>
</tr>
<tr>
<td>Search time (sec)</td>
<td>.15**</td>
<td>.23**</td>
</tr>
</tbody>
</table>

Note. ** p < .01

To be able to evaluate which characteristics received most attention, the proportions in the number of mouse clicks and amount of search time were investigated. These proportions are provided in Table 9.3. Eight analyses of variance were performed to investigate any differences between presentation conditions. Two separate analyses of variance (ONEWAY ANOVA) were performed for each characteristic with presentation format as the between-subject factor and the proportions of mouse clicks and search time as the dependent factors.

The results showed differences in the proportions of mouse clicks spent on the characteristics. In the disassembled condition, respondents clicked more on the face (F(1,115) = 5.2, p = .024),
whereas in the assembled condition respondents clicked more on the hair color ($F(1,115)=10.1, p=.002$). Also differences in the proportions of search time spent on the characteristics were found. Respondents in the assembled condition spent more time on the hair color than in the disassembled condition ($F(1,115)=6.9, p=.01$). Thus, the significant difference in standardized score (see table 9.2) can be attributed to the relative attention paid to the face, but especially to the hair color. These analyses show that the importance of these characteristics depends on the format that is used to present these characteristics.

<table>
<thead>
<tr>
<th>Table 9.3. Relative attention to each Barbie characteristic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barbie Characteristic</td>
</tr>
<tr>
<td>-----------------------</td>
</tr>
<tr>
<td>Face</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Eyes</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Hair style</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Hair color</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Notes. * $p < .05$; ** $p < .01$

Attribute processing strategy. Respondents in the disassembled condition could only evaluate the characteristics on their own merits and not in relation to each other. Respondents needed at least four mouse clicks to make choices for each characteristic. To customize a Barbie, these respondents selected the attribute level they preferred for each characteristic. The resulting Barbie was likely to be chosen, because the disassembled presentation did not allow fine-tuning of the product appearance. Respondents in the disassembled condition did indeed behave this way, because 46% of the respondents customized the first Barbie in four mouse clicks (or fewer), whereas in the assembled condition only 19% of the respondents customized a Barbie in four mouse clicks (or fewer). A switch in strategy is thus expected after four mouse clicks, because four characteristics can be customized. Therefore, we assumed that stage 1 in the customization process will consist of the first 4 mouse clicks and stage 2 will consist of the remaining ones.

Did respondents in the assembled condition indeed switch from a between-attribute strategy to a within-attribute strategy after stage 1? Support for hypothesis 9.2 is found if respondents are as likely to use a between-attribute strategy in the first stage, and when respondents in the assembled condition are more likely to use a within-attribute strategy in the second stage. To test hypothesis 9.2, the attribute processing strategy scores were computed for both the first stage and the second stage (see table 9.4). Remember that a positive number indicates a tendency towards a within-attribute strategy, whereas a negative number indicates a tendency towards a between-attribute processing.
An analysis of variance with presentation format as between-subjects factor and attribute processing strategy score for the first stage as dependent variable revealed no significant differences in the use of characteristic processing strategies \((F(1,115)=1.4, ns)\). Thus, in the first stage respondents are as likely to use a between-attribute strategy. A second analysis of variance was conducted with presentation format as between-subjects factor and attribute processing strategy score for the second stage as dependent variable. As mentioned before, thirty-three percent of the respondents finished customizing their Barbie in the first stage. These respondents could not use any strategy in stage 2 (they were finished) and were not included in the second analysis. The analysis revealed that in the second stage, respondents in the assembled condition are more likely to use a within-attribute strategy than respondents in the disassembled condition \((F(1,76)=26.5, p=.001)\). Respondents in the disassembled condition kept on using a between-attribute processing strategy, whereas respondents in the assembled condition switched to a within-attribute processing strategy. This provides support for hypothesis 9.2.

<table>
<thead>
<tr>
<th>Table 9.4 Attribute processing strategy scores for the presentation conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presentation format</td>
</tr>
<tr>
<td>---------------------</td>
</tr>
<tr>
<td>Stage 1</td>
</tr>
<tr>
<td>Stage 2</td>
</tr>
<tr>
<td>Overall</td>
</tr>
</tbody>
</table>

Note. **\(p < .001\)**

### 9.5 CONCLUSIONS FOR PRESENTATION FORMAT AND CUSTOMIZATION PROCESSES

#### 9.5.1 Presentation format

The presentation format was investigated in both the bicycle study (study 5, chapter 8) and the Barbie study (study 6). A difference in functionality may have influenced the effects of presentation format. The bicycle may have been highly evaluated, because of the satisfying functionality. Only in the disassembled condition the focus on the product characteristics leads to more explicit evaluation of the functionalities, resulting in a high evaluation of product characteristics. In the assembled condition, there is no focus on the characteristics of the bicycle. The functionalities in the assembled condition are not explicitly evaluated and the product characteristics of the bicycle are not highly evaluated in this case. In the assembled condition, the functionality of the bicycle is less likely to affect the overall evaluation of the bicycle. The focus is on the overall appearance of the product. The product characteristics are not explicitly evaluated.

In the bicycle study, differences between presentation formats were only found when products were new. In the Barbie study, the newness was not investigated and no effects of presentation format on product evaluation were found. As in the bicycle study, respondents in the disassembled presentation condition were subjects in a post-hoc test. After they had
evaluated the Barbie in a disassembled presentation format, respondents were shown the same Barbie in an assembled presentation format. The respondents evaluated the Barbie for a second time completing seven measures for the esthetic evaluation of the overall product again. The first and second evaluations of were subsequently compared using seven paired sample t-tests. No significant differences were found (All t(35)<1.0, ns). This shows that the presentation format does not affect product evaluation.

9.5.2 Customization process
The analyses of customization processes show that consumers using product configurators such as the current one, use different strategies in the two stages of their customization process. Looking at the overall attribute processing strategy (APS) scores for respondents in the assembled presentation format (APS score= -0.05), it seems that these respondents are as likely to use a within-attribute as a between-attribute strategy without a clear preference for either one and without a systematic approach to the customization choices. However, when the different stages in the customization process are investigated a distinct pattern is revealed. Respondents do have a clear preference for strategies and use them in a systematic way: they use a between-attribute strategy to make an initial configuration and use a within-attribute strategy to fine-tune the product.

So how do consumers customize products? It seems they use a two-stage strategy, similar to respondents in study 4. However, customization strategies used to customize products, differ from the decision strategies used to choose products from an assortment. In the first stage of a customization strategy, consumers choose the attribute levels that provide the most value (i.e., the maximum attribute levels). When choosing characteristics of a bicycle, for example, they choose their favorite colors. In the second stage of a customization strategy, they will fine-tune their product. This means they will trade off different attribute levels. They will trade off the different colors to get a preferred combination. In study 7, the influence of presentation order on these customization processes is investigated.
CHAPTER 10

PRESENTATION ORDER AND CUSTOMIZATION STRATEGIES

Product configurators can present product information simultaneously or sequentially. Studies 5 and 6 (Chapter 8 and 9) investigated whether an assembled or disassembled presentation format should be used when presenting product information simultaneously. The results showed that new products could be especially problematic for consumers, which manifested itself in effects of presentation format on product uncertainty and product evaluation. Product configurators can also present product information sequentially. There are various product configurators that use such a sequential presentation; see the examples of Nike (figure 1.3) and Esprit (figure 1.8). Making customization choices when product information is presented sequentially may be less complex, because product characteristics are chosen one by one. The amount of information that is presented at the same time is therefore lower and information overload may be less likely to occur, because consumers can concentrate on one product characteristic at a time. Such sequential presentation formats raise issues that are different from simultaneous presentation formats. The current study focuses on one of these issues: the presentation order of characteristics.

10.1 Configurality

10.1.1 Unity.

One of the underlying assumptions of studies 3 and 4 was that consumers need an assembled presentation format, because characteristics related to product appearance are often used in a non-linear, or configural manner. Configurality refers to the dependence of a characteristic’s evaluation on the value of another characteristic, such as when consumers state they would only consider buying coffeemakers if they are black. Bettman (1971) suggested that consumers often perceive the external world in terms of configurations, rather than in terms of separate characteristics. Configurality is more likely to occur when consumers evaluate product appearance (Holbrook and Moore, 1981a). When product appearance is important in customization processes, consumers prefer products with unity among elements (Bloch, 1995). This means that consumers prefer products they perceive as unified. Unity refers to the perception of congruity among the elements of a design such that they look as though they belong together, or as though there is some visual connection that has caused them to come together (Veryzer, 1993; Veryzer and Hutchinson, 1998). Unity is a perception and may vary between consumers. Non-unity product appearances may result from customizing separate characteristics. This may occur because consumers prefer certain attribute levels when evaluated separately, but not when evaluated as an assembled product. In studies 5 and 6, only respondents who received assembled presentation formats, could fully evaluate the configurality between characteristics. Respondents who received disassembled characteristics were not able to make these evaluations, because of the non-linear way in which the characteristics affect product appearance.
10.1.2 Utility.

According to many multi-attribute and conjoint analysis models, consumers process product characteristics in a linear way. Such preference matching has been presumed by researchers and firms alike to yield products that rate highest in utility for a particular group of consumers. The utility or value that a consumer receives from a product can be considered a general combination, but not necessarily an additive function, of the value of each attribute level the product contains (Russo and Dosher, 1983), and consumers in general seek to maximize utility when making choices (Bettman, Luce and Payne, 1998; Green and Srinivasan, 1978), searching through alternatives until the product with the maximum utility is found (Moorthy, Ratchford, and Talukdar, 1997). One of the conditions that are necessary in order to calculate utility is transitivity (Ben-Akiva et al., 1999; Luce and Tukey, 1964).

Transitivity dictates that if consumers prefer watch A over watch B, and watch B over watch C, they prefer watch A over watch C. Intransitivity is shown, when consumers prefer watch C over watch A instead. Tversky (1969) shows that under certain conditions preferences violate the transitivity axiom and that these violations can be predicted. Tversky, Slovic, and Kahnemann (1990) argue that such violations have three possible causes: (1) intransitivity, (b) type of task, and (c) configurality. They argue that the primary reason for violations of the transitivity axiom is due to the type of task. Depending on the type of response that is required, consumers use the information that is compatible with the type of task. This effect was illustrated in a study by Slovic, Griffin, and Tversky (1990). Respondents predicted the 1987 market value of twelve companies on the basis of their 1986 market value (in dollars), and their 1986 rank. Half the respondents predicted the market value in dollars, whereas the other half predicted the company’s rank. Respondents were more likely to use the information compatible with the response mode. Thus, respondents who predicted the market value in dollars used the 1986 market value in dollars, whereas respondents who predicted their rank used the 1986 rank information. The type of task leads to a difference in the information used and hence to intransitive rank order between conditions.

The study in this chapter investigates the effects of configurality on customization choices. To ascertain that observed effects would not be due to the type of task, identical tasks were used to elicit customization choices. Furthermore, intransitivity experiments always concern the relations between product alternatives, whereas configurality concerns the relations between product characteristics. Thus, customization choices may be completely transitive, but still show configurality. This is illustrated by the following example. Imagine that consumers evaluate attribute levels independently of each other and rank-order these attribute levels. They prefer, for example, red over blue, blue over green, and red over green, showing transitivity. Next, they evaluate product alternatives that have a major and a minor color. They prefer a red with green product over a red with blue product, a red with blue product over a blue with green, and red with green over blue with green, thus showing transitivity. However, this example also demonstrates configurality. A combination of the color ranked first with the color ranked last is preferred over a combination of the color ranked first and the color ranked second (see figure 10.1). We assume that when consumers prefer one combination of product characteristics over another combination of product characteristics, of which the separate characteristics of the first combination are often not preferred over the separate characteristics of the latter combination.
10.1.3 Customization strategies

When making customization choices, consumers may try to maximize utility and they may try to maximize unity. These two strategies will be referred to as a utility maximization strategy and a unity maximization strategy respectively. When maximizing utility, consumers choose the most preferred characteristics on every occasion, independent of the other attribute level choices. See for example the preference ranking for colors in the example above. When maximizing unity, consumers choose the most preferred combinations of the available characteristics. This latter strategy thus takes the choices for other attribute levels into account. See for example the preference rankings for combinations of colors in the example above. This example also shows that consumers who maximize unity may not necessarily select the same characteristics (or colors) for their product as consumers who maximize utility!

These two strategies do not oppose each other though. When customizing a product in mass customization environments, consumers may try to maximize both utility and unity. Consumers will try to select an attribute level that is preferred over the other attribute levels for each product characteristic, thus maximizing utility. However, consumers will also try to select the attribute levels of each product characteristic in a way that maximizes unity. Often, consumers are able to follow customization strategies that maximize utility and unity at the same time.

The customization process that consumers use has profound consequences for how product information should be presented. When consumers customize products using utility maximization strategies, the characteristic level with the highest utility is selected. A sequential presentation format is especially suited for such evaluations and an assembled presentation format is not needed. However, when consumers customize products using unity maximization strategies, consumers should be able to evaluate the configurability between characteristics. In this case product information should be provided simultaneously in an assembled presentation format.
10.2 PRESENTATION ORDER

Some characteristics of a product are used by consumers to determine the product appearance to a greater extent than others (Olson, Kanwar, and Muderrisoglu 1979). Such determinance of characteristics is often correlated with its size or area, because the size or volume determines the extent to which the visual appearance of a product is influenced. This determinance of characteristics may be used as a point of reference for selecting other characteristics. For example, a consumer may be customizing a shoe. If the major color is red, then the consumer may tend to select other characteristics in that color as well. In this way the major color determines the appearance of the shoe to a great extent. Therefore, characteristics that are determinant for the product appearance may influence the choice of other characteristics, whereas characteristics that are not determinant for product appearance are less likely to have an influence on the choice of other characteristics. Characteristics can be offered in many presentation orders. The distinct presentation orders used here are the important-first and the important-last presentation orders.

Prior research has shown that choices can be influenced by the order in which elements of a choice set are considered (Payne, 1982; Tversky and Sattath, 1979). The order in which characteristics are offered to consumers in a mass customization environment may thus affect the customization strategy that is used. When consumers are customizing the most determinant characteristic first, they are more likely to choose the characteristics that lead to unity for subsequent choices. Such consumers may encounter a choice between two characteristics, with one characteristic preferred to the other, but leading to non-unity. This consumer may then choose the less preferred characteristic (which leads to unity), because the product appearance is already determined to a large extent by their previous choices. Imagine that consumers have to choose three colors of a shoe. They choose red as the major color. Consumers are now more likely to choose red for the next characteristics as well (i.e., improve unity), because the appearance is already determined to a great extent by choosing red as the major color. They are likely to choose the color that improves the overall appearance. Consumers who pay attention to the unity of the product will be focused on the overall product appearance. They will be more likely to choose characteristics that improve the overall product evaluation.

H10.1 Customizing the most determinant characteristic first leads to higher overall evaluations of the product compared to customizing the most determinant characteristic last.

When consumers are customizing the least determinant characteristic first, they are more likely to choose characteristics with the highest utility. So, when consumers encounter a choice between two characteristics, they are likely to choose the characteristic with the highest utility, because the product appearance is not yet determined by previous choices. Imagine that consumers have to choose three colors of a shoe once more. They choose red as the minor color (for the shoe laces for example). In this case the product appearance is not determined yet, because the contribution of the shoelaces to the overall product appearance is small. They are more likely to choose the color they like most (i.e., increase utility) for the
next characteristic. Consumers who are choosing product characteristics because of the utility, will be more likely to choose characteristics that increase the total utility of the product.

H10.2 Customizing the most determinant characteristic last leads to higher overall utility of the product compared to customizing the most determinant characteristic first.

10.3 Study 7

To investigate the hypotheses, a two-stage experiment was conducted. The first part of the experiment served as a pretest to collect color ranking. These color rankings were used in the second part of the study, where the hypotheses regarding presentation order were tested (hypotheses 10.1 and 10.2).

10.3.1 Respondents
Sixty-one students (49% male and 51% female) participated in part 1 of the study and sixty students (50% male and 50% female) participated in part 2 of the study. The age of the respondents varied between 18 and 26 ($M=21$). Respondents were randomly assigned to conditions. They completed the experiment in about 10 minutes on average. As reward for their participation they received a small token gift. After they had completed the questionnaire they were informed about the purpose of the study.

10.3.2 Part 1: Configurality
To demonstrate the effects of configurality in mass customization environments, we need to show that consumers prefer a combination of product characteristics of which the separate characteristics are not preferred when these characteristics are evaluated independently. Therefore the following procedure was used. First, respondents rank-ordered the product characteristics of a sweater. Next, respondents rank-ordered the combinations of product characteristics.

In order to collect color preferences for individual colors, respondents rank-ordered six one-colored sweaters (see figure 10.2). Using a computer, images of the sweaters were presented in random order for each respondent. Rank orders of the colors provided information about which colors are preferred by each respondent, when colors were evaluated independent of each other.

The rank orders were subsequently used to create three two-colored sweaters (see figure 10.3). In this way color preferences for combinations of colors were collected. The colors ranked 1, 2, and 5 were used to create the two-colored sweaters. Imagine that these colors were red, blue and green respectively. In this case the first sweater had red as the major color and blue as minor color (see sweater 1 in figure 10.3).
The second sweater had red as the major color as well and green as minor color (see sweater II in figure 10.3). The third sweater had blue as major color and green as minor color. Respondents' rank-ordered these three two-colored sweaters. Their behavior shows configurality when they prefer the second or third sweater over the first. Respondents indicated they preferred the color ranked second over the color ranked fifth (on one-colored sweaters). Thus, they preferred blue over green, for example. However, when the second sweater in figure 10.3 is preferred over the first sweater in figure 10.3, then a respondent prefers the color ranked fifth over colors ranked second (on two-colored sweaters), because of the configurality between characteristics. In this case, this respondent prefers green over blue, because the configurality between red and blue and the configurality between red and green. This effect is shown in see figure 10.1. This figure shows a situation where configurality is demonstrated. When evaluated individually, red and blue are preferred over green. However, in combination, red and green are preferred over red and blue.

If the respondent chooses the first two-colored sweater - not demonstrating configurality - then three new two-colored sweaters where displayed, using other colors (from the six pretested colors) in a predetermined order. Respondents were asked to choose sweaters until they demonstrated configurality.

10.3.3 Part 2: presentation order
Stimuli. In part 2 of the experiment, respondents had to choose two colors of two sections of a shoe in a product configurator especially designed and programmed for the experiment. The color of the first part presented was always provided in the color that turned out to be most preferred (independently of the other colors) in part 1. Thus this color could not be chosen by
the respondent, but was provided. For the respondent in our example this color is red. Two presentation order conditions were created. In the important-first condition the most determinant characteristic for the appearance of the shoe was provided in red (i.e., the largest section of the shoe). In the important-last condition the least determinant characteristic for the appearance of the shoe was provided in red (i.e., the smallest section of the shoe). The position of the attribute levels on the screen (left or right) was randomized for each respondent.

In both conditions respondents then made their first attribute level choice. They chose the color of the intermediate-sized section of the shoe. They could choose between blue and green, for example. Blue was preferred over green, when evaluated individually, but green was preferred over blue in combination with red, which was already selected! Thus choosing blue meant that respondents choose the preferred color, whereas choosing green means choosing the preferred combination of colors.

Next, respondents made their second attribute level choice. When choosing the last characteristic, respondents could choose between red and the color just chosen in the first attribute level choice (i.e. blue or green). Respondents could create 60 different shoes this way.

Procedure. All respondents went through five predefined stages.
1. First customization round; customizing a shoe. In this first customization round respondents customized a shoe. Respondents were offered two pair-wise choices between colors of sections of the shoes (see stimuli section).
2. First evaluation: Respondents evaluated the customized shoe.
3. Second customization round; reversing choices: In the second customization round respondents had the opportunity to reverse their choices. In the important-first conditions the two intermediate-sized sections and the two smallest sections of the shoe were customized. In the important-last condition the two intermediate-sized sections and the two largest sections of the shoe were customized. All these sections were presented simultaneously and respondents could change the colors until they were satisfied with the resulting shoe.
4. Second evaluation: The respondents evaluated the shoe resulting from stage 3.
5. Finally, other dependent measures were collected (see measures).

Measures. Seven dependent variables were collected along with three control measures. All measures used 100-point scales, using a graphical slider. To provide respondents with feedback about the score they were actually giving to each option, two boxes were included, combining these two ways of providing feedback on respondents’ answers (see figure 10.4). When the slider was moved, the scores in the corresponding boxes were automatically adjusted, keeping the total on 100.

Control measures
1. Determinance of characteristics. The degree to which the characteristics of the shoe determine the appearance of the shoe was measured using three items. For every
characteristic they indicated the extent to which the characteristic determined the appearance of the shoe on a scale from “Very little” (0) to “Very Much” (100).

2. **Focus on utility maximization.** The degree to which respondents had focused on utility maximization was measured using one item. Respondents indicated to what extent they tried to choose their preferred color every time on a scale from “Never” (0) to “All the Time” (100). This measure indicates the perceived focus on a utility maximization strategy.

3. **Focus on unity maximization.** The degree to which respondents had focused on unity maximization was measured using one item. Respondents indicated to what extent they tried to choose colors that go well together on a scale from “Never” (0) to “All the Time” (100). This measure indicates the perceived focus on a unity maximization strategy.

![Figure 10.4 Four evaluation items on 100-point scales using graphic sliders and boxes](image)

Dependent measures. All items of the dependent variables measuring decision value are included in appendix 1.

1. **Overall product evaluation.** Respondents indicated their satisfaction, fit of the different characteristics, attractiveness, and unity for both the first and second shoe. These measures were averaged to form an evaluation measure (α=.88 for first time evaluation and α=.85 for second time evaluation).

2. **Utilities of the characteristics.** For each of the pair-wise choices, respondents indicated their preference for the two colors by splitting 100 points between the two attribute levels. Fifty points was subtracted from the amount of points that an attribute level received. In
this way a utility measure was calculated for each attribute level ranging from -50 (negative utility) to +50 (positive utility).

3. **Uncertainty** with the choice of each of the characteristics. For each of the pair-wise choices, respondents indicated their uncertainty about the chosen characteristic by splitting 100 points between the two attribute levels.

4. **Overall perceived effort** of each of the choices. For each of the pair-wise choices, respondents indicated their effort concerning the choice between the two attribute levels by splitting 100 points between these two attribute levels.

5. **Initial Choice**: the choice of the intermediate section of the shoe. Respondents could choose between the color they preferred over the other color (preferred color) and the color they preferred in combination with the color already present in the shoe (preferred combination).

6. **Eventual Choice**: the choice of the intermediate section of the shoe after respondents had an opportunity to change this characteristic. As with initial choice the choices were coded preferred color or preferred combination.

7. **System evaluation** was measured by three items with anchors ranging from "Not at all" (0) to "Very" (100) satisfied, easy, and appropriate. The measures of system evaluation were averaged to form an overall system evaluation measure ($\alpha=.85$).

### 10.4 Results of Study 7

The choices of respondents in part 1 of the experiment were analyzed to investigate behavior that demonstrates configurality. Next, the responses in part 2 of the experiment were analyzed to investigate effects of presentation order.

#### 10.4.1 Configurality

We assumed that when consumers prefer one combination of product characteristics over another combination of product characteristics, the separate characteristics of the first combination are often not preferred over the separate characteristics of the latter combination. To check this assumption, the data from part 1 was analyzed. Configurality occurs when respondents prefer two colors (over four other colors) when evaluated individually, but do not prefer them in combination (over two other combinations of colors). Nearly one-third (28%) of the respondents demonstrated configurality for the first sweaters presented. In total all respondents except one, preferred a combination of product characteristics that is not preferred when the product characteristics were evaluated independently. This pretest provided the colors that were preferred separately, but not preferred in combination; these colors were used in the second part of the study.

#### 10.4.2 Presentation order

**Control measures.** Determinance for the appearance of the shoes was as expected. The largest section was considered most determinant for the appearance of the shoe and the smallest section the least. Paired-Sample $t$-tests showed that the differences in determinance were significant ($All t(59)>4.4, p<.001$). Not all respondents (21) perceived the determinance of characteristics in the assumed order, though. These differences in determinance of characteristics did not moderate the effects of presentation order.

133
We expected that respondents in the important first condition, would be more likely to focus on unity, whereas respondents in the important-last condition would be more likely to focus on utility. An analysis of variance with focus on utility and focus on unity as within-subject factor and presentation order as between-subject factor showed no support for this expectation. All respondents indicated that they were more likely to use a unity maximization strategy than a utility maximization strategy ($F(1,58)= 16.6, p<.001$). The presentation order did not affect the focus on utility or unity ($F(1,58)=0.02, ns$). No effects of gender were expected. However, males were more likely to focus on unity than females, but they were as likely to focus on utility ($F(1,58)=4.7, p<.05$). To control for gender, it was taken as covariate in all analyses of variances. Gender did not moderate the effects of presentation order. In general, respondents perceived a larger focus on unity than on utility.

**Dependent measures.** Hypothesis 10.1 predicts that choosing the most determinant characteristic first compared to last leads to higher overall product evaluations. An analysis of variance with first and second evaluation of the shoe as within-subject factor and presentation order as between-subject factor, showed that respondents evaluation of the shoe significantly increased from the first customization round to the second ($F(1,58)=28.2, p<.001; M=38$ versus 48). Furthermore, when the most determinant characteristic was customized first, respondents' evaluation of the shoe was significantly higher compared with when the most determinant characteristic was customized last ($F(1,58)=4.2, p<.05; M=47$ versus 38). Thus, hypothesis 10.1 is confirmed.

Hypothesis 10.2 predicts that choosing the most determinant characteristic last compared to first leads to higher utility. To find support for hypothesis 10.2, the utility of the initial choice for the intermediate-sized section was investigated. An analysis of variance with first and second utility of the intermediate sized section of the shoe as within-subject factor and presentation order and initial choice for the intermediate sized section as between-subject factor were performed. The utility did not decease significantly ($F(1,58)=.4, .51$). Presentation order did not influence the utility of the intermediate sized section of the shoe ($F(1,58)<.87, ns$). Thus, hypothesis 10.2 was not supported.

**Additional Analyses.** The effects of presentation order on both uncertainty with the intermediate sized section and overall perceived effort with the choice were investigated using two analyses of variance. No increase in certainty was found between the first and second customization round ($F(1,58)=.05, ns$). When respondents customize the most determinant characteristic first versus last, they were more certain about their choice ($F(1,58)=4.4, p<.05$). Overall perceived effort with the second choice did not increase between the first and second customization round and no significant effect of presentation order was found ($F(1,58)<1.1, ns$). Also the search time spent to customize the shoe was not significantly different between order conditions ($F(1,58)<.1, ns$). Thus, effort was not affected by presentation order.

**System evaluation.** On average respondents were not positive about the product configurator, but not negative either (mean=44; median 42). An analysis of variance was conducted with
presentation order as between-subject variable and system evaluation as dependent variable. System evaluation was not influenced by presentation order ($F(1,58)=.6, ns$).

10.5 Conclusions for Presentation Order and Customization Strategy

10.5.1 Presentation format and configurality
The first part of the study shows the effects of configurality. All except one of the respondents, demonstrated configurality in their behavior: 66% of the consumers demonstrated configurality in the first 4 combinations they evaluated. Effects of configurality expressed themselves in the second part of the study by increased product evaluations and stable utility, when respondents were provided with the opportunity to reverse their choices. However, presentation order does not seem to affect these choices.

10.5.2 System evaluation
System evaluation did not mediate the relation between presentation order and the dependent measures. Remember from study 5 and 6 that in order to show mediation, three relations must be demonstrated. First, the independent variable, presentation order, should significantly affect the mediator, system evaluation. This relation is not shown and thus system evaluation does not mediate the relation between presentation order and the dependent measures.

10.5.3 Reversibility
Providing consumers the opportunity to reverse their choices enhances product evaluations. However, the increase in product evaluation is not solely because consumers created superior shoes, but because they appreciate the opportunity to reverse their decision about the shoes. This enhanced perception of control increases the system evaluation, which in turn leads to increased product evaluation. For the group of respondents who did change something, the increase in product evaluation must be due to the opportunity to change the product.

10.5.4 Customization strategy
Respondents were forced to use their favorite color as basic color (for example red) and additionally had to choose two other colors. The data shows that respondents did not want to customize shoes with too many different colors. Thus, they often chose the same colors (all red for example) if they could. Respondents may prefer shoes that are provided in the same colors, because they make more unified designs.

When customizing products in a product configurator, consumers can essentially follow two customization strategies: a utility maximization strategy and a unity maximization strategy. Consumers using the first strategy choose the superior characteristic on each choice, thus maximizing the utility of each characteristic, but disregarding the unity of the product. Another strategy that consumers may follow is a unity maximization strategy. Consumers choose characteristics that go well together, in order to maximize the unity of the overall product, but disregarding the utility of each characteristic. Consumers will try to maximize both the utility and the unity of a customized product when possible. Most situations that are encountered allow for application of both strategies and this behavior may moderate the
effects of configurality. Respondents in the current study may have used both strategies. As a result the effects of configurality and presentation order were moderated. However, when these strategies are conflicting, the effects of configurality may be more profound, because the choice of a characteristic governed by maximizing utility would differ from the choice of a characteristic governed by maximizing unity. Therefore, study 8 not only manipulates the presentation order, but also the degree of conflict between the two customization strategies.
Consumers may use various customization strategies when customizing products. Next to decision strategies that imply certain decision rules (see Chapter 7), customization strategies may be used to attain certain goals. Two of such customization strategies are utility maximization strategies and unity maximization strategies, where consumers try to attain the goal of maximizing utility and unity respectively. Sometimes consumers can use both strategies, sometimes they cannot. Effects of configurality may be more profound in situations of conflicting strategies, i.e., product evaluations are depending on the presentation order that is used. Study 8 investigates the effect of presentation order (most important characteristics first versus last) in customization situations that differ in conflict (no conflict, conflict) between utility and unity maximization strategies.

11.1 Conflicting strategies

Consumers may use utility maximization strategies or unity maximization strategies. A utility maximization strategy implies that consumers will try to select an attribute level that is preferred over the other attribute levels for each product characteristic, thus maximizing utility. A unity maximization strategy means that consumers will also try to select the attribute levels of each product characteristic in a way that maximizes unity. In some cases consumers are able to use both a utility maximization strategy and a unity maximization strategy. The maximization of utility and unity coincide, such that choices governed by maximizing utility do not differ from the choices governed by maximizing unity. However, in many situations these two strategies may conflict with each other, forcing consumers to choose between one of the two strategies. These two strategies may conflict, because product characteristics related to product appearance are configural, i.e., the correlation between characteristics affect product appearance. When the strategies conflict, a choice governed by maximizing utility differs from a choice governed by maximizing unity. Such situations may occur when product characteristics are configural in nature, forcing the consumer to choose between what they perceive to be the best fit with their preferences (utility) versus what looks best together (unity). Such a conflict may be resolved in several different ways. In particular we predict that it impacts the decision value of customization choices.

H11.1. When the unity and utility maximization strategies are conflicting, compared with when the unity and utility maximization strategies are not conflicting, consumers will:

a. provide lower utility
b. provide lower product evaluations
c. experience more product uncertainty
d. invest more effort
11.2 Presentation Order

When there is much information about products, in which order should this information be presented? The shoe study (study 7) investigated the effect of presentation order on evaluations and utility, but did not explicitly test whether respondents used different customization strategies. Consumers’ use of customization strategies may depend on presentation order. When consumers are customizing the most determinant characteristic first, they are more likely to follow a unity maximization strategy for subsequent choices. Such a consumer may encounter a choice between two characteristics, with one characteristic preferred to the other, but leading to non-unity. This consumer may then choose the less preferred characteristic (which leads to unity), because the product appearance is already determined to a large extent by their previous choices. When consumers are customizing the least determinant characteristic first, they are more likely to follow a utility maximization strategy. When these consumers encounter a choice between two characteristics, with one characteristic preferred to the other, they are likely to choose the preferred characteristic; the product appearance is not yet determined by previous choices. This leads to the second hypothesis.

H11.2 When customizing a product and customization strategies are conflicting, consumers are more likely to follow a unity maximization strategy when the most determinant characteristic is customized first, whereas they are more likely to follow a utility maximization strategy when the most determinant characteristic is customized last.

11.3 Study 8

In an empirical experiment the amount of conflict and presentation order were manipulated. A randomized two by two design was used, with two levels of conflict (no conflict versus conflict) and two levels of presentation order (important characteristic first versus important characteristic last).

11.3.1 Stimuli

Bicycles were chosen as stimuli for this experiment as they are products that can be easily customized. Bicycles have easily exchangeable parts that are available in a variety of colors. The characteristics of the bicycle also differ on the degree to which they determine the appearance of the bicycle. For a bicycle, the characteristic that determines the appearance of the bicycle most should be the frame, then the handlebars, the wheels, the saddle (seat), the flask (water bottle), and the pedals, respectively (see figure 11.1). This order was confirmed in a pretest (N=19).

Two conflict (no conflict, conflict) conditions were created. Respondents made choices between attribute levels for each characteristic (i.e., two frames). Characteristics levels were identical except for the color. The six colors used in the study were pretested for each individual participant. In the conflict condition respondents faced conflict when customizing the third and fourth characteristic (see the left side of table 11.1). At this point, they had to make a choice between maximizing utility (choosing their preferred color) and unity
(choosing characteristics in the same color as their previous two choices). The pretest allowed the computer program to present such colors. In the no-conflict condition respondents were allowed to select a color that was both preferred and that matched previous choices. Thus, only the third and fourth choices are identical for both conflict conditions, because respondents choose between the colors ranked first and third in both conditions (see table 11.1). Therefore only these characteristics were subjected to analyses.

![Figure 11.1 Characteristics of the bicycle used in study 8](image)

Two presentation order conditions were created. In the important-first condition respondents customized the most determinant characteristics first (i.e. they customized the characteristics in table 11.1 from top to bottom). These respondents customized the color of the frame first, because this is the most determinant characteristic for the appearance of the bicycle. In the important-last condition respondents customize the least determinant characteristics for the appearance of the bicycle first (i.e. they customize the characteristics in table 11.1 from bottom to top). They customized the color of the pedal first, because this is the least determinant characteristic. The presented colors were dependent on prior color rankings (see table 11.1; for details see procedure).

The situation for respondents in the conflict conditions is described next. The frames were presented in the color ranked third and the color ranked sixth in the pretest. The color ranked third is the only color that can lead to unity and is therefore called the unity color, because choosing this color for all characteristics results in unity (i.e. results in a bicycle in the same color). The other colors are called non-unity colors, because choosing these colors does not
result in unity (i.e. results in a bicycle in different colors). Respondents were expected to choose their preferred color on each of the pair-wise attribute level choices (thus maximizing utility), except for the third and fourth choices in the conflict condition. The color ranked first would always be chosen for the first and second characteristic, because such choices would maximize both utility and unity. For the choice of the color for the third and fourth characteristic choices (wheels and saddle) a difference between presentation orders was expected.

<table>
<thead>
<tr>
<th>Presentation order</th>
<th>Conflict</th>
<th>No conflict</th>
</tr>
</thead>
<tbody>
<tr>
<td>Characteristic</td>
<td>Unity color¹</td>
<td>Non-unity color¹</td>
</tr>
<tr>
<td>Important first</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frame</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Handle Bars</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Wheels</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Saddle</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Flask</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Pedal</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Important last</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frame</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Handle Bars</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Wheels</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Saddle</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Flask</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Pedal</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

Notes. The highlighted boxes indicate the predicted customization choices of respondents. ¹Numbers refer to the rank order of the color determined in a pretested for each respondent. ²In the no-conflict condition the unity color is identical to the most preferred color and hence there is no conflict.

The situation for respondents in the no-conflict condition is described first. These respondents are expected to choose the unity color for each characteristic, regardless of the presentation order. Choosing the unity color maximizes both utility and unity (see right side of table 11.1).

When customizing the third characteristic in the important-first condition (i.e. wheel color) the appearance of the bicycle is determined so much by the two characteristics already chosen (i.e. the frame and the handle bars), that respondents are not likely to maximize utility, but maximize unity. Thus, respondents are likely to maximize the unity color. For the fourth choice (saddle color), the same choice is expected. These respondents have followed a unity maximization strategy instead of a utility maximization strategy, because they have chosen all characteristics in the same color (they make choices represented by the second column in table 11.1).
When customizing the third characteristic in the important-last condition (i.e. saddle color), the appearance of the bicycle is not determined by the two characteristics already chosen, because the color of the pedal and the color of the flask do have not a lot of influence on the appearance of the bicycle. Respondents are likely to choose their preferred color and choose the non-unity color! The same choice is expected for the fourth characteristic (i.e. wheel color). These respondents have then followed a utility maximization strategy instead of a unity maximization strategy, because in every pair-wise choice they have chosen their preferred color (i.e. they make the choices highlighted by a gray box in table 11.1).

Assembled feedback was provided in all conditions after each choice (see figure 11.2), because this provides respondents with the opportunity to evaluate configurality.\footnote{11}

\begin{figure}
\centering
\includegraphics[width=0.5\textwidth]{figure11.2}
\caption{Customizing characteristics of a bicycle while assembled feedback was provided in all conditions after each choice.}
\end{figure}

\subsection*{11.3.3 Procedure}
All respondents went through six predefined stages:

1. Pre-test for preference for colors: Respondents started with a pretest for color preference. If respondents know their preferences are used to construct the stimuli, they may respond more consistently than they would usually do (and hence their customization choices would not demonstrate configurality). Therefore, vacuum cleaners were used instead of bicycles, so respondents would not suspect that their preferences were used later in the

\footnote{11} This is not to get desired results, but because showing assembled feedback is important for reliable customization choices (see studies 5 and 6).
study. To further avoid that respondents would make the connection between pretest and main-study, they were told that prior the actual experiment, they would indicate their color preferences in relation to a graduation project. They rank-ordered six identical vacuum cleaners which only differed in color.

2. First customization round; customizing a bicycle: In this first customization round respondents configured a bicycle they preferred. Respondents were offered six pair-wise choices between attribute levels that differed only in color.

3. First evaluation: Respondents evaluated the customized bicycle.

4. Second customization round; reversing choices: In the second customization round respondents had the opportunity to reverse their choices. All bicycle characteristics were presented simultaneously and respondents could change the attribute levels until they were satisfied with the resulting bicycle.

5. Second evaluation: The respondents evaluated the bicycle resulting from stage 4.

6. Finally, other dependent measures were collected (see measures).

11.3.4 Measures

As in study 7, seven dependent variables were collected along with three control measures. All measures used 100-point scales, using a graphical slider. To provide respondents with feedback about how much points they were actually giving to each option, two boxes were included, combining these two ways of providing feedback on respondents’ answers (see figure 11.3).

![Figure 11.3: Evaluation items on 100-point scales using sliders and boxes.](image)
Control measures.

1. **Determinance of characteristics.** The degree to which the characteristics of the bicycle determine the appearance of the bicycle was measured using three items. For every characteristic respondents indicated the extent to which the characteristic determined the appearance of the bicycle on a scale from “Very little” (0) to “Very Much” (100).

2. **Focus on utility maximization.** The degree to which respondents had focused on utility maximization was measured using one item. Respondents indicated to what extent they tried to choose their preferred color every time on a scale from “Never” (0) to “All the Time” (100). This measure indicates the perceived focus on a utility maximization strategy.

3. **Focus on unity maximization.** The degree to which respondents had focused on unity maximization was measured using one item. Respondents indicated to what extent they tried to choose colors that go well together on a scale from “Never” (0) to “All the Time” (100). This measure indicates the perceived focus on a unity maximization strategy.

Dependent measures. All items of the dependent variables measuring decision value are included in appendix 1.

1. **Overall product evaluation.** Respondents indicated their satisfaction, fit of the different components, attractiveness, and unity for the first and second bicycle. These measures were averaged to form an evaluation measure ($\alpha=.85$ for first time evaluation and $\alpha=.82$ for second time evaluation).

2. **Utilities of the characteristics.** For each of the pair-wise choices, respondents indicated their preference for the two colors by splitting 100 points between the two attribute levels. Fifty points was subtracted from the amount of points that an attribute level received. In this way a utility measure was calculated for each attribute level ranging from -50 (negative utility) to +50 (positive utility).

3. **Uncertainty** with the choice of each of the characteristics. For each of the pair-wise choices, respondents indicated their uncertainty about the chosen characteristic by splitting 100 points between the two attribute levels.

4. **Overall perceived effort** of each of the choices. For each of the pair-wise choices, respondents indicated their effort concerning the choice between the two attribute levels by splitting 100 points between the two attribute levels.

5. **Initial Choices:** the choice of the 3rd and 4th characteristic (the wheel and the saddle) of the bicycle. Respondents could choose between the color they preferred over the other color (preferred color) and the color they preferred in combination with the color already present in the bicycle (preferred combination).

6. **Eventual Choices:** the choice of the 3rd and 4th characteristic (the wheel and the saddle) of the bicycle after respondents had an opportunity to change this characteristic. As with initial choices the choices were coded as either preferred color or preferred combination.

7. **System evaluation** was measured by three items with anchors ranging from “Not at all” (0) to “Very” (100) satisfied, easy, and appropriate. The measures of system evaluation were averaged to form an overall system evaluation measure ($\alpha=.77$).

8. **Customization strategy index (CSI).** The CSI indicates whether respondents followed a unity maximization strategy or a utility maximization strategy. A CSI score for each respondent was calculated by taking the number of unity-colors minus the number of not-
unity colors divided by the total number of colors chosen. The value of the CSI-score can range from -1.0 to +1.0, with negative numbers indicating utility maximization strategy and positive numbers indicating unity maximization strategy. Similar procedures were frequently used in information processing research (Dhar, Nowlis, and Sherman, 2000; Payne, 1976).

11.3.5 Respondents
Ninety-five students (48% male and 52% female) participated in the study. Respondents were randomly assigned to conditions. The age of the respondents varied between 16 and 29 (M=21). As reward for their participation they received a small token gift. They completed the experiment in 14 minutes 11 seconds on average. After they had completed the questionnaire they were informed about the purpose of the study.

11.4 Results of study 8

11.4.1 Control measures
Determinance for the appearance of the bicycle was as expected. The frame was considered most determinant for the appearance of the bicycle and the pedal the least. Paired-Sample t-tests showed that the differences in determinance were significant (All t>2.2, p<.05). The rank orders for the six colors on bicycles were checked against the rank order for these colors on vacuum cleaners. These rank orders were identical.

In the conflict condition, respondents were expected to focus on a unity maximization strategy in the important-first condition, and on a utility maximization strategy in the important-last condition. In the no-conflict condition respondents were expected to focus on the strategies to the same extent. No main effects of conflict or presentation order on either the focus on a utility or the focus on a unity maximization strategy were found (all F(1, 92) <2.8, ns). A paired sample t-test revealed that on average respondents indicated that they perceived using a unity maximization strategy significantly more than a utility maximization strategy (t(92)=6.1, p<.001; M=83 versus M=62). An analysis of variance with focus on utility maximization and focus on unity maximization strategy as within-subject factor and gender as between-subject factor revealed no significant differences between genders. To control for gender, it was taken as covariate in all analyses of variances. Gender did not moderate the effects of presentation order and conflict.

11.4.2 Conflicting strategies
To provide tests for hypothesis 11.1a the utility scores were analyzed. Hypothesis 11.1a expected a greater influence of configurality when there is conflict between customization strategies opposed to when there is no conflict between customization strategies. When there is conflict the utility of a characteristic is likely to be lower than when there is no conflict. Remember that only the third and fourth choices are subjected to analyses. Thus, the utility for the third and fourth choices in the conflict condition are expected to be lower than in the no-conflict condition. Table 11.2 shows the average utility per characteristic by condition.
Two analyses of variance with the first and second utility of the 3rd characteristic (wheels) and the first and second utility of the 4th characteristic (saddle) as within-subject factors and presentation format and conflict as between-subject factors were performed. The results showed no support for hypothesis 11.1a; the differences between conflict conditions were insignificant (both $F(1, 89) < 1.5, ns$). The choices for the third and fourth characteristics seemed to cause as much conflict in all conditions. Also differences between order conditions were insignificant (both $F < 2.4, ns$) and no interaction effects were found.

<table>
<thead>
<tr>
<th>Table 11.2 Average utility per characteristic</th>
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<tbody>
<tr>
<td>Customization round</td>
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</table>

Next, the measures of product evaluation were subjected to analysis. Hypothesis 11.1b expects lower product evaluations in the conflict condition. Respondents in the conflict condition that received the most determinant characteristic first, were expected to use a unity maximization strategy. These respondents were therefore expected to provide higher product evaluations. An analysis of variance with the first and second overall product evaluation as within-subject factors and presentation format and conflict as between-subject factors was performed. The average product evaluations are presented in table 11.3.

No significant differences for conflict and presentation order and no interaction effects were found (all $F(1,89) < .86, ns$). A significant difference was found ($F(1,89)=66.7, p<.001$) between the overall product evaluation of the first customization round ($M=56$) and the second customization round ($M=69$). Thus, respondents overall product evaluation increases from the first to the second customization round. No support for hypothesis 11.1b was found.

<table>
<thead>
<tr>
<th>Table 11.3 Average product evaluation per customization round</th>
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<td>Customization round</td>
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</table>

To investigate hypotheses 11.1c and 11.1d the uncertainty and overall perceived effort measures were analyzed. Respondents in the conflict condition are likely to experience conflict during the third and fourth choices, because they have to choose between unity and utility maximization strategies. Therefore, they are expected to be less certain about these choices (and to invest more effort into these decisions). For each of the pair-wise choices,
respondents indicated their uncertainty with (and effort for) the chosen characteristic by splitting 100 points between the two attribute levels. This resulted in an uncertainty score (and an effort score) for each of the chosen attribute levels. A score of zero means minimum certainty (and minimum effort), whereas a score of 100 means maximum certainty (and maximum effort).

H1.1c predicts more uncertainty in the conflict condition. Two analyses of variance with the first and second uncertainty with the 3rd characteristic (wheels) and the first and second uncertainty with the 4th characteristic (saddle) as within-subject factors and presentation format and conflict as between-subject factors were performed. The average uncertainty scores are presented in table 11.4. The results showed significant effect on uncertainty. The certainty increased significantly from the first to the second customization round ($F(1,89)=4.4, p<.05; M=54$ versus $58$). When there was no conflict, respondents in the important-first condition were significantly less certain about the 3rd characteristic (wheels) than respondents in the important-last condition ($F(1,89)=4.6, p<.05; M=50$ versus $56$). No support for hypothesis 11.1c was found.

Hypothesis 11.1d expects more effort in the conflict condition. Two analyses of variance with the first and second overall perceived effort invested in customizing the 3rd characteristic (wheels) and the first and second overall perceived effort invested in customizing the 4th characteristic (saddle) as within-subject factors and presentation format and conflict as between-subject factors were performed. The average overall perceived effort scores are presented in table 11.4. The results revealed no significant effects on overall perceived effort. No interaction effects of conflict between strategies and presentation order on overall perceived effort were found. Furthermore, the search time spent to customize the bicycle was not significantly different between conditions (all $F(1,89)<2.0$, ns). Thus, effort was not affected by conflict or presentation order. No support for hypothesis 11.1 was found.

<table>
<thead>
<tr>
<th>Table 11.4 Average uncertainty and effort per characteristic</th>
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<td><strong>Customization round</strong></td>
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<td></td>
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<tr>
<td><strong>Uncertainty</strong></td>
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<td>2</td>
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<td></td>
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<tr>
<td><strong>Effort</strong></td>
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<td>2</td>
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</tbody>
</table>

In summary, conflict between strategies did not seem to lead to lower utility, lower evaluations, more uncertainty, or more overall perceived effort in customizing the
characteristics compared to no conflict between customization strategies. Thus, it would appear that the influence of configurality does not differ between customization situations where there is conflict between customization strategies or not.

11.4.3 Presentation order

Hypothesis 11.2 predicts that consumers would use unity maximization strategies in all conditions, except the condition where they faced conflict and choose the most determinant characteristic last. A customization strategy index (CSI) was calculated, which indicates whether respondents followed a unity maximization strategy or a utility maximization strategy. To do this, a CSI score for each respondent was calculated by taking the number of unity-colors minus the number of not-unity colors divided by the total number of colors chosen. The mean scores are shown in table 11.5.

<table>
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<th>Table 11.5 Customization Strategy Index</th>
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<td>Strategy</td>
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<tr>
<td>Customization round</td>
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<td>2</td>
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<tr>
<td>Average</td>
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</tbody>
</table>

Remember, that the value of the customization strategy index can range from -1.0 to +1.0, with negative numbers indicating a utility maximization strategy and positive numbers indicating unity maximization strategy. Similar procedures were frequently used in information processing research (Dhar, Nowlis, and Sherman, 2000; Payne, 1976).

Two analyses of variance with conflict and presentation order as between-subject variables and CSI-score as dependent variable were conducted for the first and second round. The results showed that in the first customization round, respondents in the no-conflict condition used a unity maximization strategy more often than respondents in the conflict condition ($F(1,89)=13.4, p<.001; M=.60$ versus .27). No effect of presentation order was found ($F(1,89)=.2, ns$). An interaction effect between conflict and presentation order conditions was significant ($F(1,89)=8.1, p<.01$). This showed that the used customization strategy was especially affected when the most determinant characteristic was customized first. When the most determinant characteristic was presented first and there was no conflict between customization strategies, respondents used a unity maximization strategy more often compared to when there was conflict between customization strategies. Hypothesis 11.2 predicts the lowest CSI-scores for the conflict condition where respondent customized the most determinant characteristic last. This was not found in the data and hence hypothesis 11.2 was not supported.

The results of the analysis of variance for the second customization round, showed no significant differences for conflict and presentation order. No interaction effects were found.
(All 1.89<2.9, ns). To investigate whether respondents used different strategies in the second round compared to the first, an analysis of variance with CSI of the first customization round and CSI of the second customization round as within-subject variables was conducted. The results did not show a significant change in the use of customization strategies (F(1,92)=.8, ns).

11.4.5 Additional analyses

**Configurality.** If all respondents would have used a utility maximization strategy, on average they could have created bicycles with utility of 140 (minimum: 30; maximum: 300; standard deviation: 50). This utility is based on the average sum of the six added characteristic utilities. However, on average respondents created bicycles with a utility of 106, which is only 75% of the maximum utility possible. Next, all respondents had a chance to improve the bicycle by changing the characteristics in the second customization round. Roughly two-thirds of the respondents did so. Interestingly, the average utility dropped significantly to 93 (t(92)=2.2, p<.05) even though respondents improved their bicycle according to their overall evaluation. A paired sample t-tests revealed significant improvements for the evaluation of the bicycle (t(93)=8.1, p<.001) between the two rounds. Thus, the utility of the bicycle deteriorates after changing the bicycle, whereas bicycle evaluation improves. This shows that respondents used characteristics in a configural manner.

**Customization strategies.** Respondents' increased evaluation of the bicycle in the second customization round indicates an increase in unity, when utility decreases or remains stable. Thus, in the second round, utility could either increase or decrease (i.e. utility maximization and utility minimization strategies respectively) and evaluation could either increase or decrease (i.e. unity maximization and minimization strategies respectively) 12. There were 2 respondents using a unity minimization strategy and 4 using a utility minimization strategy; these were classified as undefined in table 11.6. The other used customization strategies were divided into four categories (see table 11.6). Many respondents in the conflict condition used both strategies, although the experiment was set up to prevent the use of both these strategies in the conflict conditions.

| Table 11.6 Perceived strategies: percentage of respondents who indicated a certain strategy in the second round |
|-------------------------------------------------|------------------------------------------------|------------------------------------------------|------------------------------------------------|
| Strategy | Conflict between strategies | | |
|          | No-conflict | Conflict | Average |
|          | (N=38) | (N=55) | (N=49) | (44) |
| Both     | 0.10 | 0.11 | 0.10 | 0.12 | 0.11 |
| Utility max. | 0.00 | 0.00 | 0.03 | 0.04 | 0.02 |
| Unity max. | 0.00 | 0.00 | 0.38 | 0.38 | 0.43 |
| Undefined | 0.52 | 0.28 | 0.48 | 0.46 | 0.45 |
| Total    | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

12 Only changes in utility or evaluation of more than 5% were coded as a change.
System evaluation. On average respondents were not positive about the system, but not negative either (mean=50; median 49 on 100-point scale). An analysis of variance was conducted with presentation order and conflict as between-subject factors and system evaluation as dependent variable. System evaluation was not influenced by presentation order (F(1,89)= .5, ns) or conflict (F(1,89)= .01, ns). An interaction effect between conflict and presentation order showed that in situations where there is no conflict, respondents provide higher system evaluations when the most determinant characteristic is customized first versus last (F(1,89)=7.6, p<.01). However, in situations where there is conflict, respondents provide lower system evaluations when the most determinant characteristic is customized first versus last.

To summarize, utility of the bicycles decreases after changing the bicycle in the second customization round, whereas evaluations of the bicycles increased. This shows that respondents used characteristics in a configural manner. In the conflict condition, respondents were least likely to use a unity strategy in the important-first condition. Furthermore, respondents seem to have used unity maximization strategies more than expected. Moreover, respondents seemed to have used both strategies in the condition where these two strategies were supposed to be conflicting.

11.5 Conclusions for conflicting strategies and presentation order

11.5.1 Configurality and conflicting strategies
This study demonstrated configurality, because the total utility for the bicycles decreases, whereas the evaluations of the bicycles increase at the same time. The effects of configurality were expected to be more profound when customization strategies were conflicting. In the no-conflict condition respondents made choices that were justified by neither a utility nor unity maximization strategy even though they could create products with maximum unity and high utility. Berlyne (1974a; 1974b) posits that too much unity at the expense of variety becomes boring. This may be the reason why consumers in the no-conflict condition deviated from unity.

In the present study a decrease in utility was observed when respondents had the opportunity to reverse their decisions. This may have occurred because respondents could evaluate the overall product appearance when they had this opportunity. They could try the different combinations of colors and evaluate their effect on unity. Next, they choose for combinations of characteristics that lead to higher product evaluations, but lower utility. These processes seem a plausible explanation for the observed increase in evaluation and decrease in utility, but this explanation is partially contradicted by the observed results in shoe study; the evaluation increases but the utility of the shoe remains the same in the second customization round. However, in the shoe study, only two characteristics could be customized, whereas six characteristics could be customized in the current study. It seems that two characteristics seem unable to produce enough variance in responses to get significant differences between the initial choices and final choices. This seems to account for the finding that a decrease in utility is found in study 8, but not in study 7.
Finally, the reported interaction effect between conflict and presentation order showed that in situations where there is no conflict, respondents provide higher system evaluations when the most determinant characteristic is customized first versus last, whereas in situations where there is conflict, respondents provide lower system evaluations when the most determinant characteristic is customized first versus last. Thus, consumers seem to prefer product configurators that present the most determinant characteristic first, but when customization strategies are conflicting, they provide higher system evaluations for product configurators that present the least determinant characteristic first. This seems to indicate that conflict between strategies is more salient when the most determinant characteristic is customized first.

11.5.2 Presentation order
Presentation order was designed to manipulate the use of customization strategies. Respondents would be more likely to use a unity maximization strategy (i.e. show configurality) when the most determinant characteristic was customized first, whereas they would be more likely to use a utility maximization strategy when the most determinant characteristic was customized last. On average respondents showed an inclination towards a unity maximization strategy, but no differences between presentation orders were found. Apparently, presentation order does not affect the use of customization strategies.

11.5.3 Reversibility of the decision
Both study 7 and 8 showed that providing consumers with the opportunity to change chosen attribute levels later in the customization process increased their evaluation of the product. Thus, making the decision reversible increased evaluations of the product. In study 7, this effect was even found when respondents did not change any attribute levels. The product evaluation still increased significantly, although respondents did evaluate the same bicycle! The same effect was found in study 8: respondents’ evaluation increased significantly, even when respondents did not change any characteristics of the bicycle.

In study 7, product evaluation was higher when the most determinant characteristic of the product was customized first versus customized last. Customizing the most determinant characteristic first, seems to lead to better initial choices and therefore to higher product evaluations. For respondents who did not change any characteristics in study 8, the product evaluation increased more when the most determinant characteristic was customized last rather than first ($F(1,47)=4.6, p<.05$). Again, customizing the most determinant characteristic first, lead to better initial choices and therefore to higher product evaluations.

11.5.4 Customization strategies
The results for customization strategy indexes (CSI’s) show that consumers use unity maximization strategies more often, when there is no conflict between conditions. Consumers do indeed seem to use both strategies when there is conflict. However, when they have the possibility to reverse their decision, consumers are able to compensate for the conflict between strategies and do not show differences in the use of customization strategies, product evaluation and overall perceived effort.
One big question remains: what leads to an initial choice for either a preferred color or a preferred combination? In other words, what determines the customization strategy of consumers? This choice was not affected by presentation order, but conflict between customization strategies seems related to the customization strategy that is used. However, we are unable to predict when consumers use a certain strategy. In study 7, males are more likely than females to use a unity maximization strategy, but are as likely to use a utility maximization strategy. However, this effect was not replicated in study 8. Maybe some consumers can cope with configurality better than others? Another explanation could be that in general some consumers are more likely to follow a unity maximization strategy whereas others are more likely to follow a utility maximization strategy more often. Further research may shed light on this issue.
CONCLUSIONS

Research part II investigated how product information should be presented in product configurators. The results from research part I as well as research part II are summarized in Chapter 12 in order to build a body of knowledge concerning customization strategies and customization processes. In Chapter 13 the results from the studies are used to formulate guidelines for the design of product configurators. These design guidelines are illustrated by examining the product configurators mentioned in Chapter 1 in the light of these guidelines.
CHAPTER 12

CONCLUSIONS FOR CUSTOMIZATION CHOICES

12.1 Decision Value

Decision value is an important construct in mass customization environments; it is a concept used to determine the value that consumers derive from the customization process and the resulting customized product. The value of a customization decision consists of three components: effort with the customization process, uncertainty about customization choices, and evaluation of the customized product. These components can be measured in various ways (see appendix 1); effort for example, can be measured by the mouse clicks and search time of respondents, but also by perceived effort and perceived overall effort. Seven studies reported in this dissertation studied the influence of various characteristics of the customization task on the value of the customization decision. Table 12.1 summarizes the effects of these characteristics on decision value.

Table 12.1 The effect of the characteristics of the customization task on value of the customization decision

<table>
<thead>
<tr>
<th>Characteristics of the customization task</th>
<th>Study 1</th>
<th>Study 2</th>
<th>Study 3</th>
<th>Study 5</th>
<th>Study 6</th>
<th>Study 7</th>
<th>Study 8</th>
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<tbody>
<tr>
<td>Variance</td>
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<td>Assortment</td>
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<td>✓</td>
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<td>Perceived overall</td>
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<td>Overall</td>
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<td>Relative product</td>
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<td>x</td>
<td>✓</td>
<td>x</td>
</tr>
</tbody>
</table>

Notes:
1. ✓ = effect was found; x = no effect was found; * = decision value was not measured
2. Study 4 is not included in the table, because decision value is not investigated in that study
3. Presentation order only affected system evaluation when there was no conflict between strategies.
4. Presentation format only affected overall product evaluation when products were new.
In general, the eight studies did not show an effect of the task characteristics on decision value most of the times (63%), whereas an effect was shown at other times (37%). Why did the task characteristics not influence decision value 63% of the cases and why did they influence decision value the other 37%? The remainder of this chapter will concentrate on this question. The answer to this question leads to theoretical insights and suggestions for further research.

12.1.1 Effort with the customization process
Effort with the customization process was measured in three ways: the number of mouse clicks, the search time, and the perceived effort.

*Mouse clicks.* Consumers are not willing to make substantially more mouse clicks when assortments get very large. When products are presented by alternative and assortments become larger than 60 products, consumers' number of mouse clicks decreases. However, when the assortment was presented by characteristics and their levels in the Barbie study (study 6), respondents could choose between 240 different Barbies and they were still willing to invest effort measured by the number of mouse clicks. Because of the presentation format, consumers do not seem to realize that the assortment of possible Barbies is so large. In other words, consumers do not perceive the assortment to be that large. The presentation format thus seems to influence the perceived assortment size.

Consumers make more mouse clicks when more characteristics are offered, especially when these characteristics relate to product appearance (study 3). However, in the telephone study (study 2), the type of information did not affect the number of mouse clicks. In the MP3-player study (study 3) only one of the characteristics was available to respondents. Conversely, in the telephone study, both types of characteristics were available to respondents, but one type of characteristic was presented first. Apparently, respondents felt that both types of characteristics were important in that case and invested to evaluate both characteristics related to product functionality and characteristics related to product appearance. On the other hand, when one type of product information is not presented, consumers spend more effort investigating the characteristic related to product appearance than investigating the characteristic related to product functionality. It seems that respondents always take the effort to investigate the product appearance. In the telephone study this was always possible. Conversely, in the MP3-player study, this was only possible in one condition, which leads to differences in effort.

*Search time.* When the amount of product information (either by variance, number of characteristics or product assortment) increases, consumers need more time to search, because there is more information to be investigated. Search time decreases when the amount of product information becomes very large. Also the type of product information influenced the search time in the telephone study (study 2). It takes more time to read verbal representations of functionality than to view pictorial representations of the product appearance (Holbrook and Moore, 1981; Paivio, 1991; Treisman, 1986). In our studies, characteristics related to functionality therefore take more time to investigate than characteristics related to appearance. Study 3 seems to contradict this result. When more characteristics about MP3-players were offered, consumers used more time to search when
the additional characteristic was related to appearance. This shows once more that consumers want to invest effort (in this case not mouse clicks, but search time) to investigate product appearance. The type of pictorial information does not affect search time. Characteristics did not receive attention depending on whether it was accompanied by an image relevant for product appearance. Consumers thus investigate both types of characteristics when offered and manufacturers should certainly offer information about the product appearance.

When product information was presented by characteristics and its levels, search time was not influenced by the presentation format. Respondents customized the product in 32 seconds on average, regardless of the presentation format. However, when the product information was presented by alternative, respondents searched 157 seconds on average. This large difference in search time can have two causes: (1) the amount of information is too large and respondents are not willing to invest much effort into the customization task, or (2) a presentation format by product characteristics and its levels provides overview for consumers. More research should be conducted to find the cause for this difference in effort. The presentation format influenced consumers processing efficiency. When products are presented by assembled characteristics compared to disassembled characteristics, respondents can search more efficiently. With an identical search time, they performed more mouse clicks, i.e. they were able to collect and interpret more product information.

**Perceived effort.** The perceived effort was measured in two ways; respondents either indicated their overall perceived effort or indicated their perceived effort using three items (see appendix 1). Respondents seem not easily affected in their perception of the assortment, unless there are extreme differences in the amount of information. This was the case in two situations: when the assortment contained a large number of products presented by alternative and when there was no variance in the most important characteristic of the product. When there was no variance within attribute levels, consumers perceived less effort than when there was variance. In the first case, consumers could choose one attribute level, whereas in the second case they could choose four. Customization characteristics with one attribute level cannot really be customized, so these characteristics will not be offered in product configurators. Furthermore, the variance within attribute levels is not likely to become very large. In general, the perceived effort is not likely to be influenced by variance within attribute levels. However, when the variance within attribute levels becomes very large, consumers are likely to perceive larger amount of information and they will also perceive more effort. The assortment size also influenced perceived effort, but only when assortment became larger than about 60 products. When the assortment size passed this number, the effort (as measured by mouse clicks and search time) decreased. Thus, consumers seem to have some level of perceived effort. Above this level they decrease their efforts of searching the product assortment.

**Summary.** Taken together, the effort in customization processes is affected by the amount of information and presentation format. In general, more information leads to more investments in effort. Designers should take the inverted-U-shape relationship between assortment and effort into account. Not too many products should be offered in mass customization environments, when products are presented by alternative. Ideally, the assortment should be between 40 and 60 products. When more products are offered, consumers will invest a
decreasing amount of effort, and eventually no effort at all (when about 100 products are offered). More products can be offered when products are presented by product characteristics and their levels. Appropriate presentation formats can reduce effort that consumers invest in the customization process. This effort is not influenced by type of (pictorial) information, the order in which the characteristics are presented and whether there is conflict between customization strategies. This provides designers of mass customization environments with much freedom with respect to the type of product information they want to present, as long as they provide information about both the functionality and the appearance of the product. Product characteristics can be offered in any order, because the presentation order did not affect effort. The specific strategies used to make customization choices do not have to be taken into account, because conflicting strategies does not seem to affect respondents' effort.

12.1.2 Uncertainty about customization choices

To investigate uncertainty about customization choices, the product uncertainty was measured in three ways: overall product uncertainty, relative product uncertainty, and individual product uncertainty.

Overall product uncertainty. Uncertainty measured by overall product uncertainty was not influenced by product newness. It is very fortunate that product newness does not influence uncertainty. Product configurators would be virtually useless if the newness of products had a profound influence on product uncertainty. The strength of product configurators is that consumers are able to configure new products that are unique and personalized. If consumers would also be uncertain about these customization choices, they would not consider purchasing the configured products and product configurators would be bound to fail. Consumers would not use them and they would be unprofitable.

Consumers may use various decision strategies when customizing a product. Some of these strategies cannot be used together, because they are conflicting. Such conflict does not influence overall product uncertainty. Consumers are very skillful at coping with conflicts. This is not surprising, because making (customization) choices is coping with conflict. Every purchase situation encompasses a conflict between possible choices and available resources. The possible choices (products) differ in their characteristics, and consumers have only limited resources (time, money, etc.). They cannot buy all products to acquire all product benefits and have to trade off an investment in resources versus acquiring product benefits. Because such situations are encountered in every purchase situation, consumers get very skillful at coping with conflicts such as these. Hence, conflict in customization choices does not affect overall product uncertainty about customization choices. This suggests that designers do not necessarily have to take configurality into account. Consumers can cope with correlations between characteristics reasonably well. In Mattel’s product configurator (see figure 1.2), for example, all combinations are possible. This is not likely to lead to awkward looking Barbies, because consumers can cope with correlations between characteristics.

Overall product uncertainty is influenced by presentation order, because consumers do not know what choices to expect. Thus, consumers are uncertain about what customization
choices to expect. When the characteristic that is most determinant for the product appearance is presented last, this overall uncertainty remains large during large parts of the task then when this characteristic is presented first. Overall uncertainty is also affected by presentation format because an assembled presentation format reduces overall uncertainty about product appearance. An assembled presentation format allows consumers to evaluate the correlations between characteristics. For most durables, consumers want to see how the product looks like. However, a mediation analysis showed, that the effect of presentation format on overall uncertainty was mediated by system evaluation. This can be interpreted as an effect of presentation format on overall uncertainty about the product configurator. A disassembled presentation format seems to make consumers uncertain about the product configurator and hence about the resulting customization choice. An explanation would be the following. Respondents in the disassembled condition saw the currently chosen product characteristics twice, once in the matrix and once on the bottom of the screen. They could have wondered why the product information was presented twice, which made them uncertain about the product configurators and hence about the resulting customization choice. Overall product uncertainty is based on relative and individual product uncertainty.

Relative product uncertainty. Uncertainty measured by relative product uncertainty was not influenced by any characteristic of the customization task. In case of the amount of product information, number of product characteristics and assortment size, two opposite effects seem to keep each other in equilibrium. When the product assortment increases, consumers can be more certain that the assortment contains the best product available (i.e., relative product uncertainty increases with amount of product information). However, when there is so much product information, consumers may not be willing to search all this information. The desire to reduce effort is larger than the desire to reduce relative product uncertainty. When the product assortment increases consumers can be less certain that the current choice is the best available (i.e., relative product uncertainty decreases with amount of product information). These two effects seem to nullify each other, resulting in no differences in relative product uncertainty. Further research, should attempt to measure these two aspects of relative product uncertainty and see if this nullifying effect really exists.

The type of information does not affect relative uncertainty. Whatever the information may be, when this information is provided for all products, this does no lead to reduction of relative product uncertainty. Because the information is provided for all products, this information cannot reduce relative product uncertainty. When consumers are choosing a coffeemaker, for example, presenting consumers with information about the functions compared to presenting consumers with information about appearance, does not provide an advantage to one group of consumers in determining which product is the best. They just have different information and may employ different criteria. However, because they have different information, consumers may decide (not) to buy the product. Therefore, both types of information should be presented in mass customization environments.

The type of pictorial information does not affect relative product uncertainty either. Both types of pictorial information are needed to reduce uncertainty about which product is the best. When only one type of pictorial information is offered, one type of pictorial information does not provide an advantage over another type of pictorial information in determining
which product is the best. Therefore, type of pictorial information as such does not affect relative product uncertainty. Also the presentation format cannot reduce relative product uncertainty. An assembled presentation format does allow consumers to reduce individual product uncertainty (see below), but not relative product uncertainty. Assembled presentation formats provide information about product appearance. Consumers are able to evaluate the product appearance and hence would be expected to reduce more uncertainty about which product is the best in the available assortment. Although this information is available for each product, consumers also have to invest effort in evaluating the appearance of each product. In the Barbie experiment, respondents could investigate 240 Barbies. When assortments grow large, additional information cannot reduce relative product uncertainty. The amount of information is so large, that consumers are not willing to take all this information into account. The desire to reduce effort is larger than the desire to reduce relative product uncertainty when assortments become large. As a result the presentation format does not affect the reduction of relative product uncertainty.

*Individual product uncertainty.* The amount of product information affects individual product uncertainty. When there is more information available for a product, consumers are able to reduce their uncertainty about what a product offers. The size of the assortment does not influence individual product uncertainty. When the assortment increases consumers do not necessarily search more information about each individual product. Hence no effects of assortment size on individual product uncertainty are found. However, when too much information is offered, such as a large number of characteristics, consumers do not want to invest the effort to investigate all these characteristics. In this case the amount of information increases individual product uncertainty, because consumers do not know the levels of all these characteristics. They are thus less certain about what each product offers. The number of characteristics especially affected individual product uncertainty, when the additional information was functional in nature. Adding functional information lead to more individual uncertainty, whereas adding information related to appearance did not lead to an increase in individual product uncertainty, but not to a decrease either.

In the telephone study, the type of product information does not influence individual product uncertainty contradicting the results from the MP3-player study. Consumers need both information about functionality and appearance of the product to reduce individual product uncertainty. When information is provided about product functionality, consumers are not able to fully reduce uncertainty about what the product offers, because consumers lack information about the product appearance. When information is provided about product appearance only, a similar effect occurs, because of the lack of information about product functionality. In the telephone study, respondents were able to investigate both types of information. Consumers could reduce individual product uncertainty to the same degree, regardless of the type of information they started with. However, in the MP3-player study, respondents were unable to reduce uncertainty about product appearance when additional characteristics were related to product functionality; thus causing a difference in individual product uncertainty.

The type of pictorial information in the telephone study also influenced individual product uncertainty. Because the difference in the type of pictorial information relates to information
about the product appearance, individual product uncertainty about the product appearance is affected. Relevant pictorial information about product appearance reduces individual product uncertainty (about product appearance), whereas irrelevant pictorial information about product appearance does not. Presentation format seems to affect individual product uncertainty in the same way. Products presented by assembled presentation formats provide relevant information about product appearance and hence consumers are able to reduce individual product uncertainty (about product appearance). Products presented by disassembled presentation formats often provide less relevant information about product appearance and hence are less likely to reduce individual product uncertainty about product appearance.

Summary. The aspect of uncertainty about customization choices that is most easily affected by customization characteristics is individual product uncertainty. Relative product uncertainty is never affected. Taken together, uncertainty about customization choices is affected by amount of information, the type of pictorial information, presentation order and by presentation format. In general, more product information initially leads to a decrease in individual product uncertainty, but when consumers have to process too much information the individual product uncertainty decreases. Uncertainty is not influenced by the assortment size, type of product information, product newness, and conflict. These results indicate that designers of mass customization environments should provide information about both the product appearance and functionality. Both types of information are used to reduce uncertainty about the customization choices, although one type of information does not necessarily reduce more uncertainty than the other.

Furthermore, consumers do not become uncertain about new product variants even when assortments become large or when there is conflict between decision strategies. This signals the viability of product configurators. New product variants, large assortments and conflict are inherent to mass customization environments, but do not seem to affect uncertainty negatively. However, designers do have to take the amount of product information and type of pictorial information into account when designing mass customization environments. More information about a product reduces more uncertainty. More information about products or relevant information about product appearance reduces more uncertainty than less information about product or irrelevant information about product appearance. The positive effects of these two variables on uncertainty reduction are likely to depend on the system evaluation as is shown by the effects of presentation format. Providing relevant information about product appearance in product configurators was implemented by an assembled presentation format. Such presentation formats provided consumers with relevant information about the product appearance, whereas a disassembled presentation format provided only limited information about product appearance. However, the presentation format did not directly affect uncertainty, but influenced uncertainty indirectly through system evaluation. A well-designed presentation of the product information reduced uncertainty about product configurators and hence about the customization choices made with these product configurators. Thus, it is as important to carefully consider the amount of information that is offered (i.e. amount of product information), to offer information relevant for product appearance (i.e. type of pictorial information), and to provide consumers with well-designed product configurators. Such product configurators are able to make consumers certain about
the product configurators, which in turn leads them to feel certain about the (customization) choices made with these systems.

12.1.3 Evaluation of the customized product

Product evaluation. Three aspects of product evaluation were measured: evaluation of the product characteristics, evaluation of the overall product, and esthetic evaluation of the overall product. Product evaluations were almost never influenced by a characteristic of the customization task. The esthetic evaluation of the product was not influenced by presentation format. An influence of the other characteristics of the customization task were neither expected nor tested.

Most characteristics of the customization task did not influence product evaluations. Every consumer chooses the product that they want and hence all product evaluations (whether of the characteristics, of the overall product or of the esthetics) are rather high. When the assortment is limited than one would expect product evaluations to be more different, because some consumers will like the product, whereas others do not. However, in the case of mass customization, there is a product that suits every consumer. Thus, all evaluations are expected to be high.

The lack of customization characteristics to influence product evaluations (all three aspects) signals reliability of the results and procedure invariance. Research often reports that the responses of consumers depend on the type of task that was used to elicit the responses (see Chapter 2; for an overview see Payne, Bettman, and Johnson, 1993, p. 41-48). Tversky, Sattath, and Slovic (1988) note that such dependencies of responses violate the principle of procedure invariance. Product evaluations should not depend on the way product information is presented. The reported studies in this dissertation generally show this independence. Product evaluations do not depend on the amount and type of information. This signals reliability of the results and procedure invariance.

Johnson, Payne and Bettman (1988) did find that the way product information is presented influences preferences. Consumers are responsive to the amount of effort required by search. When options are described by words instead of number, for example, people may abandon strategies that involve mental arithmetic. In this way they save themselves the effort of generating numerical equivalents of the verbal characteristics. Johnson, Payne and Bettman (1988) find that the preferences of consumers reverse when the information format becomes more complex.

In the current studies, the product evaluation is also influenced by the way information is presented. The order in which product characteristics were presented affected product evaluations in study 7 (shoes) but not in study 8 (bicycles). Remember that shoes are products where product appearance is important, whereas bicycles are products where product functionality is important. Apparently, the order in which product characteristics are presented matters for products where product appearance is important, but not for products where product functionality is important. When characteristics that have a large influence on the eventual product appearance are chosen first, consumers are better able to make the
choices that lead to high product evaluations. When such characteristics are chosen last, consumers cannot make appropriate choices and end up with products that are less satisfying.

Furthermore, the evaluations of the product characteristics were influenced by presentation format and product newness. Consumers do not like new characteristics when presented individually, because they often have no knowledge about them. Overall product evaluations are not affected by these new characteristics, probably because new characteristics can create unique and personalized products. These kinds of products are really appreciated by consumers who value customization itself. Presentation format only affected evaluation of the characteristics in study 5 (bicycles) but not in study 6 (Barbies). Remember that bicycles are products where product functionality is important, whereas Barbies are products where product appearance is important. Apparently, presentation format matters for products where product functionality is important, but not for products when product appearance is important. Product characteristics are more appropriately evaluated when presented in disassembled format. This presentation format makes immediately clear how many functionalities are incorporated into the product. Consumers thus do not have to deduct the (number of) functionalities from a disassembled format.

The evaluation of the overall product was also influenced by presentation format. This effect was mediated by system evaluations. The presentation format thus enhanced system evaluations, which in turn enhanced product evaluations. Product configurators with an assembled presentation format provide consumers with an advantage to evaluate customized products when they were new, because these consumers could evaluate the overall appearance of these products. Consumers could fully evaluate these new products because of the assembled presentations of the new product. Consumers appreciate these assembled presentation formats, which lead to high system evaluations. These high system evaluations in turn increased evaluations of new products.

Consumers will only customize products if two conditions are met: they have to appreciate customization itself and they have to appreciate the product configurator that allows them to make customization choices. If consumers do not like customization they are unlikely to appreciate the resulting products. Furthermore, when they dislike a product configurator, why would they use such a system?

*Appreciation for customization.* When consumers show no appreciation for customization, their customization choices have doubtful validity. This would be like designing cars from test-drives of consumers who dislike driving a car. Such consumers cannot make valid contributions to the driving experience of a car, because they dislike driving them. It was assumed that respondents in the various studies would appreciate customization. To check this assumption, the appreciation for customization was checked in study 3. Respondents indeed appreciated customization and thus were appropriate respondents to use in the studies.

*System evaluation.* System evaluation was influenced by presentation format and presentation order (but only when there was no conflict between customization strategies). System evaluation is only affected by the way product information is presented in product configurators. Well-designed product configurators can offer large amounts of information
about new or known products with information relevant or irrelevant for product appearance. These variables do not influence the system evaluation.

In this dissertation four ways of presenting product information in product configurators were used. Product information was either presented in a matrix of alternatives by characteristics (study 1, 3 and 4), a matrix of alternatives (study 2), a matrix with sliding rows (study 5 and 6), and sequential presentation of pairs of choices (study 7 and 8). No measures for system evaluation were taken for the second way of presenting product evaluation: a matrix of alternatives. However, it seems that simultaneously presenting all product information in a matrix of alternatives is very suited for searching and evaluating product appearance, but not suited for searching and evaluating product functionality. This latter type of information can be far better searched with search engines. Consumers indicate the cutoff levels for one or more (functional) characteristics and the product configurators present products that meet these criteria. How product information should be presented thus depends on the type of information that a consumer finds important. Product configurators should thus present the product information very differently, depending on whether a consumer chooses products on functionality or on appearance.

The evaluations of the system for the other types of product configurators were compared. Because the same measures were used to measure system evaluation in all experiments such comparison makes sense. Presenting product information in a matrix with sliding rows was preferred over a matrix of alternatives by characteristics and sequential presentation of pairs of choices. Such a product configurator seems preferred because it is more interactive than the other product configurators. The product configurator with sliding rows is more interactive, because it reacts to users of the system. The information shown depends on actions of the users and changes after an action.

Summary. It is important to create well-designed product configurators, because when consumers value product configurators, uncertainty about customization choices is low and product evaluations are high. Previous discussion shows that designers have a lot of freedom in the design of product configurators. There do not seem to be too many constraints in the design of mass customization environments. However, some are imperative for high system evaluations and hence for the success of mass customization. Guidelines for the design of product configurators are formulated in Chapter 13.

12.1.4 Conclusions

The studies in this dissertation were conducted to investigate the decision process of consumers in product configurators. Some of the results may also be applied more generally. This is especially true for the amount of information that consumers are willing to process and the type of product information they would like to see. When using computer systems to offer product information, consumers will always desire to see the product appearance. Also when consumers see a product in an Internet shop or Internet auction, they will always desire to see the appearance of the product. This means that the product assortment should not be too large. In traditional stores consumers can easily evaluate product appearance when the products are on display, but also in this case the product assortment should not be too large. Other characteristics, such as the presentation order and presentation format, have more
limited applicability. The effects cannot be easily generalized, but are important for customization choices in product configurators.

Respondents. Students, mostly of industrial design engineering of Technical University Delft, served as respondents in the experiments. There are two requirements for respondents participating in studies concerning customization choices. First, they need certain computer skills, since the studies involve computer handling. Second, respondents need to be interested in product customization. If they are not interested in customization, the validity of their customization choices is doubtful. These two requirements can be found in the student sample that was used. Students of industrial design engineering have learned more computer skills than required to operate and navigate through product configurators. Furthermore, their interest in customization was high as showed by their preference for unique and personalized products. An additional advantage of using students industrial design engineering is their open mindedness towards new ideas and technologies. Mass customization is still a rather new idea for consumers and a new technology for manufacturers. New ideas as such often encounter resistance, which negatively affects the validity of results. Because students industrial design engineering are trained to develop new ideas, they are less likely to resist such new ways of acquiring products, which adds to the validity of the results. Other demographic variables, such as gender and subjective knowledge were measured and used as covariates in the various studies. In general, these variables did not affect their decision value with customization choices.

One could say that such a sample may not be representative of individuals other than university students in the way they make customization choices. Peterson (2001) conducted a second-order meta-analysis on the use of sample composition. In general, responses of students are slightly more homogeneous than those of non-students. However, no systematic pattern to the differences was observed. This signals that researchers should be cautious in using students for their studies (Peterson, 2001).

Products. All products used in the eight studies were durables with many experience attributes, such as bicycles, shoes and coffeemakers. The benefits of such products can only be evaluated after purchase and use. Products with many search attributes are very suited for product configurators, because respondents could evaluate such benefits while making customization choices. The choice for these products may have influenced the decision processes when making customization choices. Should we have used products with search attributes in our studies?

Decision processes of choosing products with many search attributes in a store or in a product configurator are expected to be similar. In both situations consumers evaluate the benefits and make a choice. For products with many experience attributes, this decision process is likely to be different in these two situations. In the store, consumers can sometimes test the product, which provides them with a sense of experience with the product. Current product configurators as well as the product configurators used in the research part II, provide both search and experience attributes. Future product configurators are likely to offer many products with experience attributes. In order for such product configurators to be successful, knowledge is needed on consumer reactions towards choosing products in such situations.
How do consumers make decisions about products, when they have fewer opportunities to experience the benefits? They are likely to remain uncertain about their choices when products with experience attributes are acquired in product configurators. One of the main points of interest was therefore how such product uncertainty is affected by the characteristics of the customization task. The results can thus be generalized for durables that have many experience characteristics. However, future research may proof that it is also possible to offer even products with credence attributes, such as insurances, through these systems.

Method. Consumer responses were elicited by means of computer systems. Do such methods result in reliable and valid results? Studying customization choices using computer systems have several advantages over traditional research methods. Brucks (1985) names five such advantages (see also Chapter 3): (1) more precise monitoring of behavior, (2) more control over variables and procedure, (3) possibility to built contingencies into the experimental design, (4) a rich and complex environment can be created, and (5) many experiments can be run simultaneously. Because of the precise monitoring of behavior and rich and complex environments that can be created, rich behavioral data can be collected unobtrusively. Without disturbing the customization process, rich data can be collected about the respondents’ actions, such as search time, number of mouse clicks, and the characteristics that were clicked and looked at. Data cannot necessarily be collected faster with computerized research than traditional research. Many experiments can be run simultaneously using computerized research, but this is also possible for pen-and-paper questionnaires. The programming of experiments takes a lot of time and thus setting up the experiment often takes more time compared to traditional methods.

Computerized research has some additional advantages in studying mass customization environments. First, studies conducted on computer systems are more similar to the actual product configurators than studies conducted using traditional methods, such as pen-and-paper tests. Computer systems allow product configurators to be vivid and interactive. Computerized research can approximate such vividness and interactivity, which contributes to the validity of the results. Second, the procedure of the computer program is identical every time. The procedure followed by the computer program is invariant and not susceptible for the moods of the experimenter. Thus, responses are expected to be more reliable. Third, computerized research is less error prone. The computer program automatically saves responses. Statistical programs such as SPSS then read the data. No typing errors can sneak into the data, because the data is not typed in. Thus, using computerized research is less error prone, more reliable and more valid. Although most product configurators can be found on the Internet, all eight studies were carried out under laboratory conditions. In this way environmental conditions were less likely to affect the results.

When designing the product configurators used in research part II, attention was paid to the navigation and usability of the product configurators. Navigation helps consumers understand where they are, where they can go, and how they do it (Kristof and Sataran (1995). In studies 5 and 6 (bicycle and Barbie) all information was presented simultaneously. In studies 7 and 8 (shoe and bicycle) there was only one way in which respondents could go through the program. Usability was designed by minimizing the effort that consumers had to invest in using the system instead of interpreting the product information. Furthermore, feedback has
to be provided on the user’s actions. Both these aspects of usability were implemented in both product configurators in research part II. The product configurator in studies 5 and 6 was also forgiving; mistakes were easy to recover from. The product configurator in studies 7 and 8 was less forgiving, so the effects of presentation order could be studied. Finally, the product configurator in studies 5 and 6 used a metaphor of sliding rows to place the interface elements of the product configurator in a meaningful context. Many different interface elements can be used in a product configurator, such as backgrounds, windows and panels, images, video, buttons and controls, text, sound and animation (Kristof and Sataran, 1995). In the design of the product configurators, we used only limited interface elements, because every additional interface element would introduce another source of variation.

12.2 FURTHER RESEARCH

Every study raises further questions that can be investigated. As a continuation of study 8, three proposals for further research are formulated, that could provide further insights into the decision value of customization choices.

12.2.1 Enhancing system evaluation.
Considering the importance of the evaluation of the product configurator, more research should be performed to enhance system evaluations. Respondents did not value sequential presentation of pairs of attribute levels. However, such product configurators may be appreciated when customization choices become more complex. Sequential choices make the customization process easier and may result in high system evaluations for such complex customization choices. When consumers can choose between 15 different attribute levels for each characteristic, as with the customization of an Esprit watch, for example (see figure 1.8; Chapter 1), such sequential presentation of choices may receive high system evaluations. In such cases, product configurators that present customization choices sequentially, result in less effort, less uncertainty and higher product evaluations than other types of product configurators. Further research should investigate how system evaluation can be enhanced while taking the effects of the amount of product information and the type of product configurator into account.

12.2.2 Constructive feedback.
Related to this research issue, is the issue of the type of feedback. What type of feedback should be provided in product configurators? The shoe study (study 7) showed that product evaluations increased, even when respondents did change the product characteristics when they could. Respondents could have provided these higher evaluations, because of two reasons. First, respondents were unable to determine the unity of the characteristics. Second, they did not know the possible choices they could make. Up front, respondents did not know which characteristics could be customized. When they changed the product characteristics later, they did know about the possible choices, because they were provided with an overview of the characteristics. A study could investigate the reason for these higher evaluations (see figure 12.1).
In studies 7 and 8 constructive assembled feedback was used. This means that an assembled presentation of the product characteristics was constructed while respondents were choosing the characteristics. Thus at the start there was no feedback, i.e. no characteristics were visible
and hence the unity could not be determined. Every time respondents would choose a characteristic, this characteristic was presented in an assembled presentation, and allowed evaluation of unity. The further consumers get in the customization process, the better unity can be evaluated. Note, that when feedback is not constructive, such as in studies 6 and 7, the presentation of product characteristics is simultaneous and unity can be fully evaluated at any stage in the customization process. To determine the cause of increased product evaluations, an experiment may be conducted with three feedback conditions when choosing colors for the various characteristics (see figure 12.1). The first feedback condition is disassembled constructive: each time a characteristic is chosen, the chosen disassembled characteristics are shown next to each other at the bottom of the screen. There is no feedback on either the customizable characteristics or unity. The second feedback condition is disassembled black and white (disassembled B/W): all characteristics are shown in black and white at the bottom of the screen. Each time a characteristic is chosen, the characteristic takes the chosen color. There is feedback about the customizable characteristics, but not on unity. The third feedback condition is assembled: the product is constructed as in the study 5 and 6. Each time a characteristic is chosen, the color of this characteristic is updated. There is no explicit feedback about the customizable characteristics, but there is feedback on unity at all times. By contrasting these conditions, the cause of high product evaluations can be determined.

12.2.3 Measurement scales.
In studies 5 and 6 new measurement scales were used to measure the value that consumers derive from customization choices (see figure 12.2). These measurements have three distinct differences with existing measurement scales. First, a graphical slider is used. In pen-and-paper questionnaires the use of such graphical sliders is impossible, because an image on paper cannot adjust to actions of the respondents. Second, two types of response modes are combined. Respondents can pay attention to the position of the graphical slider as an indication of their answer. They can also pay attention to the numerical values at the end of the scales as an indication of their answer. Naturally, they can also pay attention to both types of presentations of these answers. Third, instant feedback is provided while respondents are answering the questions. Thus, respondents can adjust the sliders (or numerical values) for various questions (as in figure 12.2), evaluate the answers and change them when needed before proceeding to the next questions. These measurement scales are interactive, because the numbers and position of the slider react to actions of the respondent.

These measurement scales were assumed to be better suited for computerized research. First, a graphic slider suits computerized research better, because researchers cannot ask to circle their answers. Answering questions on a computer demands other response modes. Also, interactive ways of eliciting answers may be more suited, when the experiments get more interactive. Interactive measurement scales may provide pleasure and lead to involvement. Interactive and involving measurements scales may cause respondents to stay interested and invest effort into answering the questions. Second, respondents can choose which response mode to use (if not both). Some respondents may prefer one response mode, whereas other respondent may prefer another response mode. This measurement scale serves both types of respondents. Furthermore, respondents can use both types of information to answer questions more accurately. Third, observation of respondents suggests that these measurement scales are very suited, when respondents have to make comparisons. Respondents have to indicate,
for example, to what extent they think that product characteristics determine the appearance of the bicycle using the measurement scales in figure 12.2. An advantage of this measurement scale seems to be that respondents can easily adjust their answers. They provide an initial answer and adjust their answer later after evaluation of feedback on these initial answers. In this way, these measurement scales are expected to be more sensitive to differences between characteristics compared to traditional scales. Further research should investigate the reliability and validity of such measurement scales by comparing them with existing measurement scales.

Thus research could further enhance our understanding of mass customization environments. Knowledge from current studies leads to design guidelines for designers of product configurators. Chapter 13 provides these design guidelines.
CHAPTER 13

GUIDELINES FOR DESIGNING PRODUCT CONFIGURATORS

This chapter provides guidelines for designing mass customization environments. In chapter 2 we discussed how consumers make customization choices. When discussing the relevant literature, various research issues emerged, related to characteristics of the customization task. These characteristics of the customization task will have a profound influence on customization choices. Designers of product configurators should take such characteristics into account. There are three questions that need to be answered when manufacturers offer the possibility of customization choices:

1. How much product information should be offered in mass customization environments?
2. What type of product information should be offered in mass customization environments?
3. How should product information be presented in product configurators?

Central to making customization choices in mass customization environments is the notion of decision value; this is a concept used to determine the value that consumers derive from the customization process and the resulting customized product. This decision value consists of the effort with the customization process, the uncertainty about customization choices and the evaluation of the customized product. Chapter 12 discussed how the various aspects of decision value were influenced by characteristics of the customization task, so that we could better understand how consumers make customization choices. When deducing practical design guidelines from research, a different perspective is needed. Designers of mass customization environments need to know which characteristics of the customization task can be changed and what effect such change has on the decision value. Thus, the influence that the characteristics of the customization task have on the decision value is discussed.

13.1 AMOUNT OF PRODUCT INFORMATION

With respect to the first research question the amount of product information was investigated by varying the assortment size, the number of characteristics, and the variance within attribute levels.

13.1.1 Small or large product assortments?
When consumers are confronted with small assortments, they may feel they have not choice and stop searching the product assortment. When consumers are confronted with large assortments, they have to invest a lot of effort to search this assortment. Consumers may get tired of searching and they will stop searching as well. Thus, the number of products offered through product configurators should be carefully considered.

When assortments become larger, consumers initially invest more effort (as indicated by search time and mouse clicks) searching the assortment. When assortments become very large, then this investment in effort decreases. The perception of effort shows a different
pattern. When assortments become larger, consumers initially perceive an equal investment of effort. When assortments become very large, the perception of effort increases. Thus, consumers invest less effort (i.e. less search time and less mouse clicks) when their perceived effort reaches a certain level. Consumers may have some maximum perceived effort they for searching product assortments. After this level is reached, the effort (i.e., mouse clicks and search time) decreases.

This suggests, that consumers may be willing to search through these systems, but they want to invest no more than a certain level of effort. When products are presented by alternative, between 40 and 60 products can be offered. Consumers are willing to invest more effort into searching the product assortment when less than 40 products are offered. Consumers’ effort into searching the product assortment decreases, when more than 60 products are offered. An assortment of about 100 products seems too much for consumers. They are unlikely to put any amount of effort into searching the product assortment, but will rather use another product configurator or acquire products in a traditional way by visiting retailers. Does this mean that no more than 100 product variants can be offered in product configurators? No, other characteristics, such as the presentation of the product information have a profound influence on the perception of effort. Before determining the assortment size, a study should be conducted to determine the assortment size that can be offered in the specific product configurator that is designed.

Manufacturers can do two things to keep the perceived level of effort below this maximum level when customization choices are made with web-based product configurators. They should carefully consider the number of products they offer and they should make the mass customization environment easy to search. Offering consumers the possibility to customize products in-store allows for larger assortments, because sales personnel will be able to reduce consumers’ effort by offering assistance with the customization process. Assistance offered by product configurators is still in its infancy.

The perception of the assortment size may be decreased in various ways. When product information is presented by characteristics and its levels, the perception of the assortment size is smaller than when product information is presented by alternatives (Godek, et al., 2000). In the Barbie study, such presentation of product information was used to offer 240 different products. Consumers did not realize there were so many product variants available and they did not perceive to invest a lot of effort into customizing products. Thus, presentation by product characteristics and its levels seem to reduce both the perception of the assortment size and the perceived effort respectively. Just reducing perceived effort by offering product information sequentially is not recommended. Consumers did not like product configurators that offered customization choices this way and these customization choices only received moderate evaluations. It seems important to reduce both perceived effort and perceived assortment to increase the value that consumers derive from customization choices. The assortment certainly influences the decision value of customization choices.

13.1.2 Few or many product characteristics
Manufacturers should not offer too few characteristics, because consumers will demand sufficient information about each product. Furthermore, some consumers may be interested in
different characteristics than other consumers. However, not too many characteristics should be offered either. When too many characteristics are offered, consumers have to invest much effort to investigate all the levels of these characteristics. The MP3-player study (study 3) showed that consumers are not willing to investigate many characteristics. When consumers do not search all information available, they remain uncertain about what the product offers. Offering a large number of product characteristics thus leads to much effort and much individual uncertainty. Therefore, the number of product characteristics that is offered, should be carefully considered.

Consumers investigated 35 to 45 attribute levels of the products. These numbers are comparable to the number of alternatives that consumers were willing to investigate. These results suggest that 40 to 60 attribute levels can be offered to consumers. Consumers are willing to investigate this amount of product information. Thus, in other words, product configurators should aim at providing a maximum of around 40 to 60 attribute levels. Designers should consider the consequences of the number of attribute levels when designing product configurators.

13.1.3 Little or much variance within attribute levels
Variance within the attribute levels of product characteristics, i.e. different attribute levels versus one attribute level, did not affect the importance of a characteristic. Manufacturers do not necessarily have to offer large variance within their attribute levels to satisfy consumers. If two attribute-levels are very satisfying for consumers, they can choose to offer only these two attribute levels. This reduces effort in customizing the other characteristics of the product and reduces uncertainty about the product. On the other hand, consumers’ preferences differ. Even when most consumers prefer a certain attribute level, some consumers may prefer others. When consumers experience little uncertainty, more attribute levels can be offered to satisfy the needs of these consumers. However, the number of attribute levels should not become so large that consumers have to invest a lot of effort to search all these attribute levels. Designers should take the effects on uncertainty with the choices into account. When more attribute levels were offered, consumers were more uncertain about the product they choose (individual product uncertainty); this effect remained even when corrected for the number of attribute levels.

13.1.4 Detecting decision strategies
Product configurators should react to consumers’ actions as natural as if they were interacting with knowledgeable sales personnel. That means that designers of product configurators should take such interaction into account. The decision strategy used by consumers has consequences for the amount of product information that should be presented. Consumers usually start with an elimination strategy. This means that not all product information has to be presented in mass customization environments, because consumers do not use all this information. They will only use one or two characteristics to eliminate the alternatives they do not like. Thus, in this phase product configurators should start offering the most important product characteristics to consumers. However, consumers who start using selection strategies, require information about the characteristics of each product. In that case, product configurators could offer more product characteristics.
When consumers use non-compensatory strategies, they need less information about products compared to when they use compensatory strategies. Consumers using non-compensatory strategies will investigate one alternative or characteristic at a time, eliminate the product if it does not meet the criteria, and then investigate the next alternative or characteristic. Consumers using compensatory strategies need all product information because if one characteristic does not meet criteria, it can be compensated by another. For example, if consumers use an elimination-by-aspects strategy, the computer could just ask the cutoff levels for the characteristic under investigation and eliminate all alternatives that do not meet these cutoff levels.

Furthermore, whether product information is processed by alternative or by characteristic, has consequences for the way product information should be presented. Satisficing strategies and conjunctive strategies are non-compensatory and product information is processed by alternative. Consumers using a satisficing or conjunctive strategy could be aided at the moment an attribute level is not satisfactory. Suppose a consumer looks at three characteristics of a product and is not satisfied with the third characteristic. The computer program could ask the minimal attribute level for this third characteristic. Next all products are shown, that have the attribute levels of the first two characteristics and the desired attribute level for the third characteristic. In this way the information that is offered in customization environments can be adjusted to the decision strategy that is used by selecting appropriate products out of the total assortment.

13.2 Type of Product Information

In several experiments also the type of information was investigated, which relates to the second research question. Do consumers require information related to functionality or to appearance. The type of pictorial information (relevant or irrelevant for product appearance) and the type of product information (characteristics related to functionality or to appearance) were investigated.

13.2.1 Relevance for appearance of pictorial information
Designers of mass customization environments have no restraints with regard to the use of the type of pictorial information. They can use images to clarify product functionality or to show the product appearance. Images can also be used to design a corporate identity or to create a personality for product configurators. This does not have any effects on the value of customization decisions. However, when no information about the product appearance is provided through images, consumers are likely to be more uncertain about this appearance.

13.2.2 Functionality or appearance related product information types
Consumers invested as much effort searching information about product functionality as they invested effort searching information about product appearance. This signals that consumer use both types of product information to make such choices. However, product information about functionality takes more effort to process than product information about appearance as indicated by longer search times and more mouse clicks. It takes effort to read and interpret
functional information. Thus, when assortments grow large, too much information about product functionality will have negative effects on decision value.

When assortments are large, consumers use two-stage decision strategies (Lussier and Olshavsky, 1979; Wright and Barbour, 1977). In the first stage consumers will not evaluate all products in great depth (Haufl and Trifts, 2000) and do not need all the information about product characteristics. Consumers will use the characteristics that are most important to eliminate unacceptable alternatives. When product appearance is considered important, then pictorial representations about product appearance should be accompanied by the most determinant characteristics for the product appearance that consumers use to base their choice on, for example, a bicycle frame. When product appearance is less important, just the (functional) characteristics may be sufficient. A mix of limited functional and appearance related information is usually sufficient to select the most promising products in the first stage and helps consumers quickly reduce a large amount of relative product uncertainty. Consumers then enter a second stage, where they evaluate the remaining products, usually three to four products, in more detail (Wright and Barbour, 1977). From this point on, customization environments should provide more detailed descriptions of product characteristics to reduce individual product uncertainty.

Tools should be provided to help consumers in their decision process. Such a tool may be a search engine to decrease the effort of searching product functionality. Consumers can indicate cutoff levels for functional characteristics. The product configurator then only returns the alternatives that meet the criteria. Consumers desire a telephone, for example, which costs less than €100; the product configurator shows these telephones and consumers may enter the next cutoff level (for the same or another characteristic).

### 13.3 Presentation of Product Information

The third research question concerns the presentation of product information in product configurators. Various characteristics of the customization task were subjected to study. First, the influence of presentation of product characteristics on decision value was investigated by comparing assembled and disassembled presentation formats. Second, the influence of product newness on the decision value was investigated by comparing customization choices that resulted in new products with customization choices that did not result in new products. Third, the influence on decision value of product presentation when product decisions are based on product appearance was investigated in two experiments. One study used bicycles (functionality is important), whereas in another study, Barbies (appearance is important) were used. Fourth, the influence of presentation order on decision value was investigated in two studies. Conditions were compared where the most determinant characteristics for the appearance of the product was presented first versus last. Both studies also investigated the extent to which degree of reversibility influenced the decision value. Respondents were able to reverse their choice and changes in evaluation were measured.
13.3.1 Simultaneous or sequential presentation modes
Simultaneous presentation of product information leads to very high system evaluations, whereas sequential presentation of information leads to intermediate evaluations. Providing product information simultaneously seems to be preferred by consumers. Simultaneous presentation seems to provide overview of the product variants, but does not lead to information overload. Designers should thus use simultaneous presentation modes in the product configurators. Sequential presentation does not lead to information overload either, but does not provide the overview that simultaneous presentation does. Therefore, a simultaneous presentation is the preferred mode for product configurators.

13.3.2 Assembled or disassembled presentation formats
Product configurators can provide more information when products are presented by product characteristics compared to product alternatives. Such formats allow for overview and lead to a perception of a smaller assortment. Although this latter effect leads to perception of less variety, it may also prevent information overload. Product configurators should provide predominantly assembled presentation formats. This allows consumers to fine-tune their products using within-characteristic strategies. Without assembled feedback, they cannot evaluate the effects of changes to the product characteristics. It becomes increasingly easy to construct assembled presentation formats by construction in layers. This does not force designers to design all possible combinations of characteristics, but only construct the attribute levels once and built the image by using different layers. Thus, when consumers change a characteristic, only the layer of this characteristic is changed instead of the complete image. This was already applied in some of the studies reported. In study 6, for example, respondents could configure 240 different Barbies. Instead of designing 240 different images, only 16 different attribute levels of the characteristics were designed. When the eye-color was changed for example, the layer with the eye color was changed instead of the total image. These technological advancements make assembled presentation formats for product configurators feasible and affordable for manufacturers. Disassembled presentation formats lead to unreliable and invalid product evaluations, especially for new products. This was shown in study 5 were product evaluations dropped when the assembled presentation format was shown after respondents had configured and evaluated products using a disassembled presentation format. The presentation format thus affects the decision value of customization choices and assembled presentation formats are preferred in the design of product configurators.

13.3.3 Newness of products
New products are inherent to product configurators, because consumers are likely to configure new combinations of characteristics. This does not seem to pose problems for consumers, as long as product configurators provide enough information. Product information should be as complete as possible without leading to information overload. This explains the positive effect of assembled presentation formats: these formats provide respondents with information that is more complete than in disassembled presentation formats and hence allows them to evaluate new products more reliably and validly. Product newness does not affect decision value. New product characteristics can be safely offered in product configurators without effects on the decision value of customization choices.
13.3.4 Presentation order of the most determinant characteristic
Respondents' customization strategies did not seem affected by the order in which the product information was presented. However, it seems that respondents' initial customization choices are improved by presenting the most determinant characteristic first. When the least determinant characteristic is presented first, respondents provided lower evaluations of the product (see study 7) and showed a larger increase in product evaluation after an opportunity to change the product (see study 8). Furthermore, respondents were more certain about their choices when they choose the most determinant characteristic first. Presenting determinant characteristics first seems to lead to greater certainty in customization choices. Presentation order thus has some limited but determinant effects on the decision value of customization choices.

13.3.5 Reversibility of the decision
Respondents seemed very pleased with the opportunity to change the product characteristics they had chosen. Respondents' product evaluation was increased by the opportunity to reverse their decision. Even when respondents did not change anything their product evaluations increased, showing a preference for reversibility in product configurators. In the screen were they could change the characteristics all these characteristics were presented simultaneously and an assembled presentation format was used. This provided overview for respondents and allowed them to fine-tune their customization choices. The reversibility thus contributes positively to the decision value of customization choices and should be allowed when possible.

13.3.6 Customization strategies
Consumers use both utility and unity maximization strategies when customizing products. In general, consumers strive to increase the utility of customization choices, which is the value that a consumer receives from a product. Consumers also try to increase the unity of their customization choices, which is the perception of congruity among the elements of a design such that they look as though they belong together. Consumers preferable use both strategies. When making customization choices for products of which product appearance is important, consumers first make initial choices so they can evaluate how the product appearance looks. Next they fine-tune their product by trying out different attribute levels for one characteristic. Making these processes possible contributes positively to the decision value of customization choices.

How does a customization process evolve? Consumers use a two-stage customization process. In the first stage of a customization strategy consumers choose the attribute levels that provide the most value (i.e., the maximum attribute levels). When choosing characteristics of a bicycle, for example, they choose their favorite colors. In the second stage of a customization strategy, they will fine-tune their product. This means they will trade off different attribute levels. They will trade off the colors to get a preferred combination.

Product configurators should be designed carefully in order to avoid conflict between customization strategies used in these two stages. Consumers are very creative in avoiding restraints imposed by the system, but these conflicts can be better avoided by the design of the product configurators themselves. Ideally, product configurators should allow
maximization of both utility and unity. Designers should take such considerations into account when designing product configurators.

13.4 TEN GUIDELINES FOR DESIGNING PRODUCT CONFIGURATORS

The eight studies reported in this dissertation showed that not all characteristics of the customization task influence customization choices. In fact, most characteristics have only limited effects. However, there are a few notions that designers of product configurators should keep in mind when designing mass customization environments. Based on the studies of this dissertation ten design guidelines were formulated. These design guidelines cannot be interpreted without the context they are derived from to avoid oversimplification and misapplication. Designers should use these guidelines with care and take the context in which these guidelines were studied into account. The design guidelines will therefore include a referrer to paragraphs were more background information about these guidelines can be found.

The way consumers process information in general affects the way consumers make customization choices. It is therefore important to understand these processes and adapt product configurators to these processes. Norman (1993) distinguishes between two general modes of information processing: experiential and reflective processing. Experiential processing is a state of mind in which we perceive, act, and react to events around us, whereas reflective processing involves thinking, comparing, and decision-making (Preece, Rogers, and Sharp, 2002, p. 74).

The experiential processes have been studied most extensively. Researchers have studied processes of attention, perception, recognition, memory, learning, reading, speaking and listening in the context of consumers interacting with computers. Extensive research has lead to a variety of design guidelines to improve the interfaces of computer programs for consumers. The way an interface is designed can greatly affect how well consumers can perceive, attend, learn, and remember how to carry out their tasks. The reflective processes have received relatively little attention (c.f. Preece, Rogers, and Sharp, 2002). This dissertation has focused on processes, such as comparing and decision-making, and may therefore add to knowledge about reflective processes of customization choices. The findings of this dissertation are translated into design guidelines that can explain consumer behavior in product configurators.

What is the goal of these design guidelines? The goal is to increase the decision value of customization choices. This means that these guidelines lead to reliable evaluations of the customized product, little product uncertainty about customization choices, and little effort with the customization process. Why should designers of product configurators strive for reliable evaluations? When evaluations are unreliable, then there is a difference between the evaluation in the product configurator and the actual evaluation when they receive the product or not order it at all. Consumers are likely to return the product to the manufacturer if they are not satisfied with the product. Why should designers strive to reduce uncertainty? When consumers are uncertain about the choices they have made, they are less likely to
purchase products. Finally, why should designers strive to reduce effort with the customization process? When it takes consumers too much effort to use a product configurator, consumers will use other ways of acquiring products, such as visiting a regular retailer. How can designers of product configurators accomplish this?

One of the most important design tasks in designing product configurators is to enhance system evaluation. System evaluation is important because of two reasons. First, if consumers do not like the system, they are not going to use it (again). Second, system evaluation mediates the effect of customization task characteristics on product evaluations; in other words, consumers who like the system are more likely to configure products they like. System evaluation can be enhanced in various ways, but at least consumers should understand how to operate and navigate the product configurators and product configurators should be attractive.

GUIDELINES FOR OVERALL PRODUCT CONFIGURATOR

1. **Create vivid product configurators.**
   Product evaluations become reliable by making product configurators vivid. Vivid product configurators allow more reliable evaluations of the product, because product information is presented in such a way that it seems as if consumers are in the store holding the product.

2. **Create interactive product configurators.**
   Adding interactivity to product configurators enhances the evaluation of the product configurator. Such product configurators show the immediate consequences of the choices and are entertaining for consumers. In this way consumers become more involved in customization processes and consumers perceive to invest less effort in the customization process.

GUIDELINES FOR COMPARING PRODUCTS

3. **Offer tools to compare products.**
   Tools to compare products, or decision aids, reduce effort of making customization choices. Appropriate tools make it easier for consumers to compare products. The appropriate tool depends on the situation or more specifically, the decision strategy that is used. Some decision strategies demand cutoff values to determine the appropriate customization choices. Search engines can be used where consumers can specify such cutoff levels. Price is a characteristic that can be used very easily in such search engines.

4. **Use simultaneous presentation modes.**
   Presenting customizable characteristics simultaneously reduces the effort of customizing them. Simultaneously presenting customizable product characteristics provides overview, makes the information accessible and makes product comparison easy. Consumers do not have to invest effort to create overview. The information is accessible by looking at the computer screen and allows consumers to compare the various options without memorizing them.
5. **Offer no more than 50 attribute levels.**
   Careful consideration of the number of characteristics that are offered reduces effort of making customization choices and reduces uncertainty about these choices. Searching many attribute levels takes a lot of time and cognitive effort. Consumers do not invest this amount of effort. When many attribute levels are offered, consumers remain uncertain about the characteristics not investigated. This means, for example, that manufacturers can easily offer product configurators with five characteristics with five levels each (5x5= 25 attribute levels).

6. **Start with a few characteristics.**
   When few customizable characteristics are offered at the start of the customization process, consumers will develop more reliable product evaluations. Consumers can investigate the various possibilities that are offered. This is also possible when many product characteristics are offered initially, but consumers almost never do this. They often start eliminating alternatives immediately, because it would take too much effort to investigate all product information. When product configurators initially present few characteristics, consumers are more likely to make thought-out decisions and hence product evaluations are more reliable.

7. **Start with most determinant characteristics.**
   When consumers choose the most determinant customizable characteristics for the product appearance first, the uncertainty about the choices is reduced. Imagine that consumers choose the most determinant characteristics for the product appearance last. In that case they do not know what they can expect and they will be less certain about what the product offers. When consumers can choose such characteristics first, they are more certain about the resulting product during the process of customization.

8. **Provide customizable characteristics related to product appearance.**
   Allowing consumers to customize the characteristics related to appearance reduces uncertainty about their customization choices. Consumers want to influence the product appearance, besides the product functionality, or at least want to know how the product looks like. Otherwise they remain uncertain about the overall appearance and the appearance of the various characteristics. To prevent such uncertainty, the appearance of the individual product appearance should at least be shown.

9. **Show assembled characteristics of the product.**
   Product evaluations become reliable and uncertainty about the chosen characteristics is reduced, when the customizable characteristics are presented in an assembled manner. In this way consumers can evaluate the effect of chosen characteristics on the overall appearance. They do not have to form these images mentally. Because consumers can evaluate the effect of changing a customizable characteristic on the overall appearance, their evaluations are more reliable and their uncertainty about the product appearance is reduced.
10. Make customization choices reversible. When it is easy for consumers to reverse their decision, the system evaluation is enhanced. Consumers like the possibility to reverse decisions they have taken. Only the opportunity to make changes improves evaluations of the product configurator and will enhance repeated visits. Furthermore, consumers are more likely to be satisfied after they had a change to reverse their decision, because they can improve the customized product. Therefore, explicitly offer consumer the opportunity to change the characteristics of the customized product after they have chosen one.

13.5 Extending the Design Guidelines

Guidelines for overall product configurators. To achieve vividness, both sensory breadth and sensory depth of the product information should be enhanced. Product configurators should address multiple senses, such as sound, and the information provided to the senses should have high quality. Resolutions for images should be high, bit rates for video and audio as well. For web-based product configurators such vividness cannot currently be accomplished, because of bandwidth limitations. This is an opportunity for retailers. Incorporating the newest technology can enhance the vividness of in-store product configurators. Currently, this could be virtual product demonstration, where consumers would be able to interact with the product. Many consumers still feel more at ease obtaining their products at the store. Furthermore, they demand increased variety. These consumers are just waiting for retailers to implement vivid product configurators.

Guidelines for comparing products. For characteristics related to product appearance designers may develop other tools. Products could be grouped by their product personality (see Govers, 2003). Thus, consumers can look at products with a tough appearance, or they could investigate the products with a cute appearance. Consumers are able to make such judgments and generally agree on the personality that products possess. Consumers seem to be looking for products that suit them, either in personality (Govers, 2003) or otherwise. This implicates another way to make it easy for consumers to compare product information. Consumers using product configurators could build a profile, by filling out a questionnaire for example. When such questionnaires are well designed, this information could be used to select the most promising product appearances for this specific consumer.

Guidelines for presentation of product information. If designers still want to offer more attribute levels, use one of the following methods. First, only the product characteristics can be offered that are relevant for a particular usage situation. Products are used in various situations, which require different product characteristics. When consumers already know what they are going to use the product for, this eliminates various characteristics and hence reduces the number of customizable product characteristics. When consumers customize mountain bicycles to compete in mountain bicycle races, they will not need lights on their bicycles. However, if they customize mountain bicycles to go to school, they do. Second,
product configurators could use phased customization. The most important and differentiating product characteristics are presented first. Consumers can customize these product characteristics. Such sequential presentation format requires that more than one product characteristic can be customized at one screen. Next, consumers are offered the possibility to choose the current product or see advanced options with possibilities to customize additional product characteristics. Third, an advanced method to offer large numbers of product characteristics is to use the customization strategies of consumers. Previous research suggests that experts use strategies to customize products that are different from strategies that novices use (Payne, Bettman and Johnson, 1993, p. 33). When such customization strategies can be detected accurately, the product configurator may offer product characteristics depending on the strategy used.

**Guideline for choice.** One way to increase the reversibility of customization choices is to use digital consideration sets. Such digital consideration sets allow consumers to save customization choices for later reference. The product configurator memorizes these choices instead of respondents themselves, which are therefore called digital consideration sets. These digital consideration sets allow consumers to continue searching without having to keep the last product in mind. Product configurators that allow constructing digital consideration sets have an advantage over product configurators that do not allow such construction.

### 13.6 APPLYING THE DESIGN GUIDELINES

In chapter 1 several examples of current product configurators were given. To what extent do these product configurators comply with the design guidelines? The degree to which the product configurators meet the design guidelines is summarized in table 13.1.

The Smart configurator allows consumers to customize a car. All customizable characteristics are presented simultaneously and interactivity is high. Instantaneous feedback is provided about any changes to the appearance of the car. The appearance of the car can be customized. Different colors and models can be chosen and the resulting Smart is presented by assembled attributes. When consumers are not satisfied with any choices they have made, these choices can be easily reversed. The main disadvantage of this product configurator is that it does not allow consumers to change the product functionality (except from engine power). On the right of the product configurator, a list of specifications is provided that cannot be customized. However, many of these specifications may be important for consumers. When choosing products such as a car one would expect more customizable characteristics. There are no tools that can aid consumers in making customization choices. Because the number of customizable characteristics is low, such tools are not needed. However, when the number of customizable characteristics is increased, such tools seem necessary. The product configurator does indeed start with few product characteristics, but no additional characteristics can be customized. Finally, the vividness of the product configurator is low. The images are of moderate quality. Only the visual senses are stimulated. Why not provide the opportunity to hear the sound of the engine or take a virtual test-drive? Although such changes may certainly improve the product configurator, car configurators will never be
viable as in-store product configurators. Currently, consumers want to take a real test-drive, not a virtual one, before they are ready to make such a purchase. In-store product configurators could then be used to customize many customizable characteristics of the car together with sales personnel.

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</tr>
<tr>
<td>Dress shirt</td>
<td>x</td>
<td>v</td>
<td>x</td>
<td></td>
<td>v</td>
<td>v</td>
<td>v</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Airborne bicycles</td>
<td>v</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>v</td>
<td>v</td>
<td>v</td>
<td>v</td>
<td>v</td>
<td></td>
</tr>
<tr>
<td>Dell computers</td>
<td>x</td>
<td>x</td>
<td>v</td>
<td>v</td>
<td>x</td>
<td>v</td>
<td></td>
<td>v</td>
<td>v</td>
<td>x</td>
</tr>
<tr>
<td>Esprit watches</td>
<td>v</td>
<td>x</td>
<td>v</td>
<td>x</td>
<td>v</td>
<td>x</td>
<td>v</td>
<td>v</td>
<td>v</td>
<td>v</td>
</tr>
</tbody>
</table>

1 'x' = does not follow the guideline; 'v' = follows the guideline; '.' = does not apply

The Barbie doll configurator is an excellent example of a product configurator. In case of the Barbie, the number of characteristics became exceptionally large: 864 different dolls can be configured. However, there are never more than 18 attribute levels presented on the same screen. Consumers can choose 19 different types of clothing, 8 types of accessories, and 9 occasions for customizing personalities are created for a Barbie. Mattel prevented information overload by introducing customization phases. First, the doll itself is configured. Then the clothes and accessories are chosen and finally the personality of the doll. This shows how a large number of customizable characteristics can be manageable by using phased customization. The Nike ID configurator is another excellent example of a product configurator. This product configurator also allows large assortments. Nike has reduced the amount of product information that is offered, by asking consumers to choose the usage situation for the shoes. This reduces the amount of product information considerably.

The Advanta credit card configurator is not really a product configurator, although it allows customization of one characteristic: the name of the business on the card above the consumer's name. Advanta offers three types of credit cards: platinum, platinum with cash back and platinum with bonus miles. The various types of credit card conditions cannot be customized using the product configurator, but only by mediation of sales personnel. The product configurator does not actually offer various characteristics and thus the number of characteristics seems a little small. The various options that Advanta offers are not presented simultaneously. When consumers apply for a platinum credit card, they are taken to a different form than when applying for a platinum credit card with cash back. A product
configurator of Advanta could be designed that improves on these issues. A simple improvement would be to present options simultaneously; consumers are provided with one application form, where the type of credit card can be indicated. Further improvements could be to offer multiple customizable characteristics, such as the possibility to add a logo or other appearance related characteristics. Advanta could also move from cosmetic customization to collaborative customization where a product configurator would offer various customizable characteristics, for example, related to financial benefits.

The dress shirt configurator provides a large assortment of customizable characteristics in an orderly fashion. The number of characteristics is not overwhelming and the most determinant characteristics for the product appearance seem to be present. All characteristics are presented simultaneously and changes to these characteristics are shown immediately in an assembled presentation format. However, this feedback is rather schematic, and does not allow consumers to fine-tune the appearance of the shirt. Improvements to the product configurator could be made by improving the vividness of the product configurator. The sensory depth of the feedback could be improved by providing images with higher quality. The chosen pattern could be displayed on the shirt for example, so consumers can evaluate the combination of the chosen characteristics. Also tools can be added to the product configurator. Advice for particular dress shirts could be given, depending on the occasion.

Consumers can customize characteristics of bicycles using the Airborne bicycle configurator. Even the appearance of the smallest product characteristics, such as the seat collar, can be customized and its product appearance is shown. Airborne also provides phased customization. Not too many characteristics are presented initially and consumers can customize the most determinant characteristics for the product appearance first, such as the frame size and the fork. Next, consumers can order the current product or see advanced options with possibilities to customize additional product characteristics. By presenting the product information by its characteristics and its levels, the perceived size of the assortment size remains small. High quality images of the various product characteristics result in satisfactory vividness of the product configurator. Consumers can view images of the characteristics they have chosen, i.e. they can evaluate the disassembled characteristics, but they cannot evaluate the overall appearance of the bicycle, i.e. the assembled characteristics. The interaction is moderate: the price and weight are adjusted to customization choices, but the appearance is not. The decision is difficult to reverse. When a different frame is chosen, then consumers have to start customize the other characteristics all over again. Airborne’s product configurator could be improved by showing the overall appearance of the customized bicycle and increasing interactivity by providing feedback about changes in the appearance resulting from changing product characteristics.

Dell’ computer configurator uses a simultaneous presentation format, presenting all product characteristics simultaneously. Many product characteristics can be customized, providing consumers with a perception of control over their customization choices. Interactivity is moderate. The price and shipping date are adjusted according to the customization choices. Tools are provided to aid consumers in the customization process. Dell uses phased customization by guiding the consumers through various screens, before they can customize the actual product. Initially consumers are offered few characteristics, which also seem to be
the most determinant for the appearance of the computer. They see a screen where they have to select the type of computer. Then they get a screen where they have to select one of the options provided. Next they are provided with an overview of this system. When they customize this system, they customize the base system first and only then all characteristics can be customized. When consumers want to select a different type of desktop computer, they have to start all over again, going through all screens once more. This reduces the reversibility of the decision.

Furthermore, the number of attribute levels is too large. Consumers choose between 33 customizable characteristics with up to 13 attribute levels each (for a desktop computer) in the end. Phased customization should work well for Dell, but Dell could use fewer phases by grouping customization characteristics early in the customization process. This would also improve the reversibility of the decision. The vividness of the product configurator could be enhanced. Resolution of the images is low and could be improved. Evaluation of the overall appearance is therefore not always easy. For most computer systems this is not an issue currently, but computer appearance may become more important in the future in order to provide computer with competitive advantages.

Esprit's watch configurator allows easy comparison of the possible attribute levels that can be chosen for the customizable characteristics. Images of all attribute levels are provided, which also makes comparison easy. The overall appearance is constructed as consumers configure their product. Using simultaneous presentation of the customizable characteristics could enhance the product configurator. In this way consumers could also evaluate how two characteristics may affect the appearance of the watch. This would also enhance the interactivity of the product configurator. Consumers will be able to evaluate the effect on the overall appearance of the watch directly after customizing a characteristic. Currently, the overall appearance can only be evaluated after a choice for all characteristics has been made. As with the Smart configurator, consumers can only customize the appearance of the watch. It seems consumers are not in control of the functionality that is included in the watch. The number of customizable characteristics could be increased by offering the possibility to get an indication of the date on the watch or getting a water resistant watch. Consumers may also consider such functional characteristics important.

These examples of product configurators show how the guidelines for designing mass customization environments can be used to evaluate, design and improve product configurators. This overview shows where product configurators can be most easily improved. Vividness, interactivity and offering tools for comparison can be most easily enhanced; they are equal first place. Adding feedback of the overall appearance may relatively easily enhance product configurators. Ideally, the overall appearance should be adjusted when changes to the customizable characteristics are made. Furthermore, for half of the product configurators discussed, using more sensory dimensions or providing the product information in higher quality could enhance the vividness. Tools for comparison of products, is the next improvement that can be made. Often consumers had to make customization choices unaided. Designers should strive to offer tools that are suited for the specific product that is customized.
However, also the other guidelines deserve attention. Three product configurators present product characteristics sequentially, whereas simultaneous presentation would be better in providing overview. Three product configurators show either to few or too much customizable characteristics. Smart and Advanta show too little characteristics, whereas Dell shows too many. Customizing a product with so few customizable characteristics is hardly worth the effort. Consumers rather go to retailers. Dell shows too many characteristics and because of the large amount of effort, inexperienced consumers may rather go to retailers. However, experts may prefer the large amount of information. Furthermore, not many consumers will buy their cars on the Internet, but use the Internet to collect information. Still, improving the Smart configurator will contribute to this information need.

The 10 guidelines for the design product configurators are likely to lead to attractive and efficient product configurators. They allow consumers to derive value from their customization choices, by reducing effort with the customization process, reducing uncertainty about customization choices and increasing evaluation of the customized product. The challenge for designers of mass customization is to apply these design guidelines to product configurators. When they succeed many more product configurators will emerge on the Internet and on in-store computers. Then the mass production of individualized customized products and services will truly begin.
Customization choices deal with the decision-making process of consumers when they can customize the characteristics of products. Current production technology allows the production of individually customized products in an efficient way. Consumers demand increased variety. Manufacturers increasingly comply with this demand by shifting to mass customization: the mass production of individually customized products. They offer consumers the possibility to customize various product characteristics. Product configurators are developed to serve this purpose. These product configurators are computer systems on the Internet or in the store that allow consumers to influence the product design in an interactive way. Consumers can customize their own shoe using the product configurator of Nike, for example, by choosing the colors for their shoe.

The way manufacturers can implement mass customization is well described. In consumer research, decision-making process of consumers is also well described. However, there is no known research, which takes the consumers’ decision-making process during product customization into account. When making such customization decisions, consumers try to increase the value of their decisions. Decision value is a concept that is used to determine the value that consumers derive from the customization process and the resulting customized product. The value of a customization decision consists of three components: (1) effort that consumers invest in customizing the product, (2) the uncertainty about the correctness of their choices, and (3) evaluation of the customized product. There are two requirements for high decision value. First, consumers should appreciate customization. When consumers do not appreciate configuring unique and personalized products, they will not attach any value to customized products. Second, product configurators should be designed to support customization choices. Consumers may want to choose the best characteristics, and product configurators should enable and support consumers in this process.

The first component of decision value is the effort that consumers invest in customizing the product. The effort invested in the customization process relates to the time, money, physical and cognitive effort. Given identical levels of uncertainty and product evaluation, consumers will prefer less effort over more effort. In general, consumers will try to reduce the effort invested in the customization process. This effort is measured in three ways: the time used to customize products, the number of actions needed and the effort they perceive themselves.

The second component is the uncertainty about the correctness of their choices. Consumers are often uncertain about whether their decision is acceptable. Preferably, consumers would be certain about their decisions. Less uncertainty thus signals more value of the decision. Two types of uncertainty can be distinguished: individual and relative product uncertainty. Individual product uncertainty is consumers’ subjective uncertainty about what each product offers in terms of the characteristics and the provided benefits. Relative product uncertainty is consumers’ subjective uncertainty about which product is the best. Consumers want to reduce
both types of uncertainty before making a decision. The product uncertainty is measured by
asking consumers about their uncertainty, where attention is paid to both individual and
relative product uncertainty.

The last component of decision value is product evaluation. When consumers provide higher
evaluations of the product, this will contribute to the value of their decision. The product
evaluation was measured by asking people to evaluate the customized product. Product
evaluations will be rather high when consumers can customize these products themselves.
Consumers will choose those characteristics they like and hence the resulting product
evaluations are likely to be high.

There may be various characteristics of customization tasks that could influence the value of
the decision, such as the amount of information, the type of information, and the presentation
of this information. Influence of these characteristics was investigated in two research parts.
In the first research part, the influence of the amount of information and type of information
on the decision value were investigated. How does the value of a decision change, when more
products or more characteristics are offered? The amount of information that consumers have
to look at increases when more products or characteristics are offered. Consumers also have
to invest more effort to investigate this information. When a lot of information is offered,
consumers do not want to search all this information. The effort they invest decreases.
Consumers will be more uncertain about the characteristics they have not looked at.
Manufacturers should not offer too much information, because consumers will quit searching.
On the other hand, manufacturers should not offer too little information, because consumers
should feel they have a choice. The results suggest that manufacturers can offer 40 to 60
attribute levels.

Manufacturers can offer different types of product information. They can offer information
about product functionality, but also about product appearance. The characteristics that relate
to product functionality are often presented by words and numbers, such as “25 pre-
programmable telephone numbers” for a telephone. Characteristics that relate to product
appearance are often presented by images. A red color for a telephone can be presented by a
red colored box. It takes less effort to evaluate product appearance than to evaluate product
functionality. Consumers can determine in a glance whether they like the product appearance.
Evaluation of the product functionality takes more time, because the information has to be
read and interpreted. When the product appearance is not shown, then consumers will remain
uncertain about this. A product configurator should, therefore, always show the product
appearance, even when consumers cannot customize the appearance.

For the studies in the second research part, two product configurators were designed. In this
part, specific attention is paid to the way product information is presented. Different ways of
presenting product information are investigated. Product information can be presented all at
the same screen (simultaneous) or in succession (sequentially). If product information is
presented simultaneously, the overall appearance of the product should be shown. In this
way, consumers can determine how changing characteristics influences the appearance.
Consequently, consumers will be able to make reliable product evaluations. This means that
the product evaluation made in product configurators corresponds with the actual product
evaluation. Especially when new products are customized, showing the overall appearance is important. This is very likely, because product configurators can contain far more products than the shelves in a store. The chance thus increases that consumers come across new products. It is very difficult for consumers to imagine how the product appearance of a new product is affected when several characteristics are changed.

The studies in this dissertation were conducted to investigate the decision process of consumers in product configurators. However, some of the results may also be applied more generally. This is especially true for the amount of information that consumers are willing to process and the type of product information they would like to see. When using computer systems to offer product information, consumers will always desire to see the product appearance. So when consumers see a product in an Internet shop or Internet auction, for example, they will also want to see how to product looks like. Also, the product assortment should not be too large. In traditional stores, consumers can easily evaluate the product appearance when the products are on display, but the assortment should be limited.

The findings of the eight studies are used to formulate ten guidelines for the design of product configurators. When these guidelines are followed, consumers will be able to customize satisfactory products without investing a lot of effort and without much uncertainty. In other words, consumers will derive much value from such product configurators. When designers succeed in designing such product configurators, the number of product configurators in store and on the Internet will increase, and the mass production of individual customized products will truly begin.

Niels Vink
Customization Choices
ISBN 90-9016751-X
Customization choices gaat over het beslissingsproces dat consumenten doorlopen wanneer ze zelf de producteigenschappen van producten samenstellen. De huidige productietechnologie maakt het mogelijk om individueel aangepaste producten op een efficiënte wijze te produceren. Consumenten eisen steeds meer variatie. Fabrikanten gaan daarom in toenemende mate over tot mass customization, de massaproduktie van individueel aangepaste producten. Ze bieden consumenten de mogelijkheid om verschillende eigenschappen van het product aan te passen. Hiervoor worden vaak productconfiguratoren gebruikt. Dit zijn computer systemen op het Internet en in de winkel die het consumenten mogelijk maken om het productontwerp op een interactieve manier samen te stellen. Zo kunnen consumenten bijvoorbeeld hun eigen schoen samentellen met de productconfigurator van Nike, door zelf de kleuren van de schoen te kiezen.

Er is goed beschreven hoe fabrikanten het productieproces van mass customization kunnen inrichten. In consumentengedragsonderzoek is het beslissingsproces van consumenten ook goed beschreven. Er is echter geen onderzoek bekend, dat rekening houdt met het beslissingsproces van consumenten tijdens het samenstellen van producten. Bij het samenstellen van producten zullen consumenten proberen de waarde van hun beslissing zo hoog mogelijk te maken. De waarde van de beslissing is een concept dat gebruikt wordt om de waarde die mensen ontleenen aan het samenstellen van het product en het resulterende product te kunnen bepalen. Dit concept is onder te verdelen in drie componenten: (1) de moeite die mensen moeten doen om het product aan te passen, (2) de onzekerheid over de juistheid van hun uiteindelijke keuze en (3) de beoordeling van het product. Er moet dan wel aan twee voorwaarden voldaan worden. Ten eerste moeten mensen waarde hechten aan het samenstellen van producten. Als mensen geen waarde hechten aan het samenstellen van unieke en gepersonaliseerde producten, dan zullen mensen de resulterende producten ook niet waarderen. Ten tweede moet er een goed systeem zijn dat het maken van deze keuzes ondersteunt. Consumenten kunnen wel de beste eigenschappen willen kiezen, maar een productconfigurator moet dit ook toestaan en ondersteunen.

De eerste component van de waarde van de beslissing is de moeite die mensen moeten doen om het product aan te passen. Deze moeite slaat op de tijd, geld, fysieke en mentale inspanningen die consumenten moeten investeren. Bij gelijke onzekerheid en gelijke beoordeling zal minder moeite, meer waarde voor consumenten hebben. In het algemeen zullen consumenten de moeite in het samenstellen van producten dus zo laag mogelijk willen houden. De moeite die mensen investeren wordt op drie manieren gemeten: de tijd die mensen nodig hebben om een product aan te passen, de hoeveelheid handelingen die ze gebruiken en de moeite die ze zelf waarnemen.
De tweede component van de waarde van de beslissing is de onzekerheid over de juistheid van hun uiteindelijke keuze. Consumenten zijn vaak onzeker over wat voor hen een juiste beslissing is. Het liefst zullen consumenten de onzekerheid over de juistheid van de beslissing zo laag mogelijk maken. Minder onzekerheid duidt dus op hogere waarde van de beslissing. Onzekerheid over het product valt uiteen in individuele en relatieven productonzekerheid. Individuele productonzekerheid heeft betrekking op één product en is de onzekerheid over wat een product nu precies biedt. Welke eigenschappen heeft het product en welke voordelen heeft dat? Relatieven productonzekerheid is de onzekerheid over welk product het beste is. Consumenten zullen beide soorten onzekerheid willen reduceren, voordat ze een beslissing nemen. Onzekerheid wordt gemeten door mensen te vragen hoe onzeker ze zijn over de beslissing, waarbij we aandacht geven aan beide soorten onzekerheid.

De laatste component van de waarde van de beslissing is productbeoordeling. Als consumenten het product beter beoordelen, zal dit bijdragen aan de waarde van de beslissing. De productbeoordeling wordt gemeten door mensen te vragen het samengestelde product te beoordelen. Productbeoordelingen zullen vrij hoog zijn als consumenten zelf hun product kunnen samenstellen. Consumenten zullen proberen eigenschappen te kiezen die ze graag willen; beoordelen van op maat gemaakte producten zullen dus over het algemeen hoog zijn.

Er kunnen verschillende karakteristieken van een productconfigurator onderscheiden worden, zoals de hoeveelheid productinformatie, het type informatie en de presentatie van deze informatie. Deze karakteristieken kunnen invloed uitoefenen op de waarde van de beslissingen die door consumenten in deze omgeving genomen worden. Deze karakteristieken worden in twee onderzoeksgedeeltes onderzocht. In het eerste onderzoeksgedeelte van dit boek werden de invloed van de hoeveelheid productinformatie en het type productinformatie op de waarde van de beslissing voor de consument onderzocht. Hoe verandert de waarde van de beslissing als er meer producten of meer eigenschappen worden aangeboden? De hoeveelheid informatie die mensen moeten doorzoeken neemt toe. Consumenten moeten dan ook meer moeite doen om al deze informatie te bekijken. Als er echter veel informatie aangeboden wordt, dan hebben consumenten geen zin meer om al deze informatie te doorzoeken. De moeite die ze investeren neemt af. Verder zijn consumenten in dit geval onzeker over de eigenschappen die ze niet bekeken hebben. Fabrikanten moeten dus niet te veel informatie aanbieden, want dan haken mensen af. Fabrikanten moeten echter ook niet te weinig informatie aanbieden, want anders hebben consumenten het gevoel dat ze geen keus hebben. De resultaten suggereren dat fabrikanten tussen de 40 en 60 attribuutniveaus kunnen aanbieden.

Fabrikanten kunnen verschillende typen informatie aanbieden. Ze kunnen informatie over de productfunctionaliteit aanbieden, maar ook over het productuiterlijk. De eigenschappen die te maken hebben met functionaliteit worden veelal met woorden of cijfers weergegeven, bijvoorbeeld 25 voorgeprogrammeerde telefoonnummers van een telefoon. Eigenschappen die te maken hebben met het uiterlijk worden vaak met een afbeelding weergegeven. Een rode kleur van een telefoon kan bijvoorbeeld getoond worden door een rood gekleurd vakje. Consumenten hebben minder moeite met het beoordelen van productuiterlijk dan met het beoordelen van productfunctionaliteit. In één oogopslag kunnen consumenten zien of het productuiterlijk hen bevalt. Voor productfunctionaliteit duurt de beoordeling langer, omdat

Voor de studies in het tweede onderzoeksgedeelte zijn twee productconfiguratoren ontworpen. In dit gedeelte wordt specifiek aandacht besteed aan de manier waarop productinformatie gepresenteerd wordt. Zo kan productinformatie alineaal op hetzelfde scherm worden aangeboden (simultaan) of na elkaar (sequentieel).


Als productinformatie sequentieel wordt aangeboden, dan is de volgorde van belang. In één van de studies konden consumenten het productuiterlijk samenstellen. Consumenten zijn onzeker tijdens het samenstellen van het product als de belangrijkste eigenschap voor het productuiterlijk als laatste werd aangeboden, maar het had geen invloed op hun productbeoordelingen. Toch doen fabrikanten er goed aan de belangrijkste eigenschappen van een product eerst, dus bijvoorbeeld boven aan het scherm, te presenteren. Op deze manier zullen consumenten zekerder zijn over de juistheid van hun beslissing.

De studies zijn specifiek uitgevoerd om het beslissingsproces van consumenten te onderzoeken als zij hun product samenstellen. Sommige resultaten zijn echter ook breder toepasbaar. Dit geldt vooral voor de hoeveelheid informatie die consumenten bereid zijn te verwerken en het type informatie dat ze graag willen zien. Als gebruik gemaakt wordt van computersystemen dan zullen consumenten altijd graag het uiterlijk van een product willen zien. Dus als consumenten een product in een internetwinkel of op een internetveiling kopen, zullen ze in elk geval willen zien hoe het product eruit ziet. Ook zal het aanbod niet te groot moeten zijn, als richtlijn kan worden uitgegaan van een maximum van 60 producten. In traditionele winkels kunnen consumenten natuurlijk eenvoudig het productuiterlijk beoordelen als de producten aanwezig zijn, maar ook hier moet het assortiment van de winkel niet te groot zijn.

De bevindingen van de acht studies zijn gebruikt voor het formuleren van tien richtlijnen voor het ontwerpen van productconfiguratoren. Wanneer deze richtlijnen gevolgd worden, zullen consumenten in staat zijn om met weinig moeite een product samen te stellen, waar ze tevreden over zijn en waarover weinig onzekerheid bestaat dat het de juiste keus is. Met andere woorden, consumenten kunnen dan veel waarde onthouden aan zo’n
productconfigurator. Als ontwerpers erin slagen zulke productconfiguratoren te ontwerpen, zal het aantal productconfiguratoren in winkels en op het internet toenemen en zal de massaproductie van individueel aangepaste producten een vlucht nemen.

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### Appendix 1

**Measures of Decision Value**

<table>
<thead>
<tr>
<th>Decision Value</th>
<th>Questions</th>
<th>Used in study:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td><strong>Effort</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mouse clicks</td>
<td>The number of mouse clicks performed</td>
<td>✓</td>
</tr>
<tr>
<td>Search Time</td>
<td>The time used to search the program</td>
<td>✓</td>
</tr>
<tr>
<td>Perceived Effort</td>
<td>1. How difficult did you find this way of choosing a [product]? (Not difficult/ Very difficult)</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>2. How fast did you make a choice? (Not fast/ Very fast)</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>3. How easy did you find the use of the program? (Not easy/ Very easy)</td>
<td>✓</td>
</tr>
<tr>
<td>Overall perceived effort</td>
<td>1. Indicate your effort in your choosing between these two choices by splitting 100 points over these two choices.</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Uncertainty</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall uncertainty</td>
<td>1. How certain are you of your answer</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Indicate your confidence in your choice by splitting 100 points over these two choices.</td>
<td></td>
</tr>
<tr>
<td>Relative product uncertainty</td>
<td>1. How certain are you that the [product] you have chosen is the best of the offered [product]? (Very uncertain/ Very certain)</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>2. How certain are you that the [product] you have chosen has the best functionality of the offered [products]? (Very uncertain/ Very certain)</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>3. How certain are you that the [product] you have chosen has the best appearance of the offered [products]? (Very uncertain/ Very certain)</td>
<td>✓</td>
</tr>
<tr>
<td>Individual product uncertainty</td>
<td>1. How much do you know about the [product] you have chosen? (Not much/ Very much)</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>2. To what extent do you have enough information about the [product] to decide whether you would buy the [product] you have chosen? (Not enough/ More than enough)</td>
<td>✓</td>
</tr>
<tr>
<td>Decision Value</td>
<td>Questions</td>
<td>1</td>
</tr>
<tr>
<td>------------------------</td>
<td>----------------------------------------------------------------------------</td>
<td>---</td>
</tr>
<tr>
<td><strong>System uncertainty</strong></td>
<td>1. To what extent are you certain about your understanding of the computer program? (not at all certain/ very certain)</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>2. To what extent are you certain about your familiarity with the possibilities of the computer program? (not at all certain/ very certain)</td>
<td></td>
</tr>
<tr>
<td><strong>Evaluation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>System evaluation</strong></td>
<td>1. To what extent are you satisfied with this way of choosing a [product]? (not at all satisfied/ very satisfied)</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>2. To what extent did you find it difficult to choose a [product] this way? (not at all difficult/ very difficult)</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>3. To what extent do you think this is an appropriate way of choosing a [product]? (not at all appropriate/ very appropriate)</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Product Evaluation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>a. product characteristics</strong></td>
<td>1. To what extent do you think these characteristics form a good combination? (very bad combination/ very good combination)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. To what extent are you satisfied with the characteristics of the [product]? (very unsatisfied with the combination/ very satisfied with the combination)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. To what extent are you satisfied with your choices of the characteristics of the [product]? (Very unsatisfied with the choices of characteristics/ very satisfied with the choices of characteristics)</td>
<td></td>
</tr>
<tr>
<td><strong>b. overall product evaluations</strong></td>
<td>1. To what extent are you satisfied with this [product]? (Not satisfied/Very satisfied)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. To what extent do you think this is a good [product] in comparison with other [products] you know? (Very bad [product]/ Very good [product])</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>3. To what extent do you think this is a professional [product] in comparison with other [products] you know? Very unprofessional [product]/ Very professional [product])</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>4. To what extent do you find this [product] attractive in comparison with other [products] you know? (Very unattractive/ Very attractive)</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>5. What do you think of the quality of this [product] in comparison with other [products] you know? (Very low quality/ Very high quality)</td>
<td>✓</td>
</tr>
<tr>
<td>Decision Value</td>
<td>Questions*</td>
<td>Used in study:</td>
</tr>
<tr>
<td>------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>c. overall esthetic evaluation</td>
<td>1. To what extent do you think this is an attractive [product] in comparison</td>
<td></td>
</tr>
<tr>
<td></td>
<td>with other [products] you know? (Very unattractive [product]/ Very</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>attractive [product])</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. To what extent do you think this [product] is good looking? (not at all</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>good looking/ very good looking)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. To what extent do you think this [product] is charming? (not at all</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>charming/ very charming)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. To what extent do you think this [product] is beautiful? (not at all</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>beautiful/ very beautiful)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5. To what extent do you think this [product] is tough? (not at all tough/</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>very tough)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6. To what extent do you think this [product] is feminine? (not at all</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>feminine/ very feminine)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7. To what extent do you think this [product] is cute? (not at all cute/ very</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>cute)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8. To what extent do you think this [product] is happy? (not at all happy/</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>very happy)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9. To what extent do you think this [product] has a good appearance? (not</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>at all a good appearance/ very good appearance)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10. To what extent do you think this [product] is interesting? (not at all</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>interesting/ very interesting)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11. To what extent do you think this [product] is charismatic? (not at all</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>charismatic/ very charismatic)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12. To what extent does the [product] reflect your personal taste (not at all</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>very much)</td>
<td></td>
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</table>

Notes. * On the place of [product] the product category was used, for example, “coffeemakers.”
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E


F


G


K


L


M


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# INDEX

| A | decision environment | 35 |
|   | decision maker       | 36 |
|   | decision problem     | 31 |
| accountibility                      | 36 |
| accuracy-effort framework           | 25 |
| active search                       | 21 |
| adaptive approach                   | 8  |
| Advanta                               | 8, 75, 183 |
| aggregate representation            | 98 |
| aided-analytic decision strategies  | 28 |
| Airborne                              | 12, 184 |
| alternative transition              | 87 |
| amount of product information       | 45, 173 |
| appearance                           | 31, 47, 62, 113 |
| appreciation for customization      | 29, 163 |
| control                               | 29 |
| personalization                      | 29 |
| uniqueness                            | 29 |
| assembled representation format      | 114 |
| assortment                           | 31, 61 |
| attribute level                      | 45 |
| attribute levels                     | 46 |
| dichotomous                          | 46 |
| interval scales                      | 46 |
| multiple                              | 46 |
| nominal scales                        | 46 |
| attributes                            | 46 |
| credence                              | 11 |
| search                                | 10 |
| attributes                            | 10 |
| experience                            | 10 |

| B | decision process       | 28 |
| Barbie's                           | 7, 183 |
| between-attribute strategy         | 114 |
| bikes                               | 12, 101, 138, 184 |
| Bivolino                            | 9  |
| boredom phase                      | 85 |

| C | decision strategies    | 28 |
| cars                                | 182 |
| characteristic transition           | 87 |
| characteristics of the              | 87 |
| computers                           | 12, 184 |
| configurality                       | 32, 125, 126 |
| conflicting strategies              | 137, 177 |
| conjunctive strategy                | 84 |
| consideration set                   | 101 |
| constructive feedback               | 167 |
| consumer interaction                | 8  |
| adaptive approach                   | 8  |
| collaborative approach              | 9  |
| cosmetic approach                   | 8  |
| transparent approach                | 8  |
| consumer motives                    | 20 |
| context effects                     | 30, 34 |
| cosmetic approach                   | 8  |
| credence attributes                 | 11 |
| Customatix                           | 7  |
| customization choices               | 17 |
| customization of production process | 6  |
| customized standardization          | 7  |
| pure customization                  | 7  |
| pure standardization                | 7  |
| segmented standardization           | 7  |
| tailored customization              | 7  |
| customization strategies            | 127, 173 |
| customized standardization          | 7  |

| D | decision value         | 155 |
| Dell                               | 12, 75, 184 |
| designing product configurators    | 37 |
| determinance                       | 128 |
| dichotomous attribute levels       | 46 |
disaggregate representation ........................................ 98
disassembled representation format ................................ 114
dress shirts ........................................................................ 9, 184
durables ............................................................................. 10

E

effort ................................................................. 29, 76, 155, 156
elimination stage ................................................... 59, 85
elimination-by-aspects strategy .................................. 84
Esprit .............................................................................. 13, 185
evaluation ........................................................................ 155, 162
system .............................................................................. 29
experience attributes .................................................. 10
expertise .......................................................................... 23

F

familiarity ........................................................................ 23
fatigue phase ..................................................................... 85
framework
  accuracy-effort .......................................................... 25
  perceptual ....................................................................... 25
  uncertainty-effort ........................................................ 26
functionality ...................................................................... 31, 47, 62

I

individual product uncertainty .................................. 26, 47, 48,
  62, 75, 160
information clearinghouses ........................................ 11
information sources
  interpersonal relations .............................................. 22
  media ............................................................................ 21
  neutral sources ........................................................... 22
  retailers ......................................................................... 21
  internet ........................................................................... 13
  interval scales ............................................................ 46
intransitivity ....................................................................... 126
iterative decision behavior ............................................ 19

K

knowledge ........................................................................ 22, 36
expertise ........................................................................... 23
familiarity ......................................................................... 23
objective .......................................................................... 23
subjective ......................................................................... 22

L

learning phase .................................................................. 85
lexicographic strategy ................................................... 84

M

machine-interactivity .................................................... 4
Macromedia Director ..................................................... 42
majority of confirming dimensions strategy ................. 85
mass customization .......................................................... 3
measurement scales ......................................................... 169
models of consumer decision processes ...................... 17
mouse clicks ..................................................................... 156
MP3-players ...................................................................... 76
multiple attribute levels ............................................... 46

N

Nike .................................................................................... 7
nominal scales .................................................................. 46
non-analytic decision strategies ..................................... 28
non-compensatory .......................................................... 83
nondurables ...................................................................... 10
number of alternatives .................................................. 31

O

objective knowledge ....................................................... 23
ongoing search ............................................................... 17, 20
overall uncertainty .......................................................... 99, 110, 158

P

perceived effort ............................................................... 157
perceptual framework .................................................... 25
person-interactivity ......................................................... 4
post-purchase processes .................................................. 18
pre-decision process ....................................................... 17
pre-purchase search ........................................................ 20
presentation format ........................................................ 32
  presentation forms ....................................................... 33
  presentation modes ..................................................... 33
  presentation order ......................................................... 34
presentation forms ........................................................ 33
presentation mode .......................................................... 176
presentation modes ........................................................ 33
presentation order .......................................................... 34, 128, 138
product appearance ....................................................... 31, 47, 62, 113
product characteristics .................................................. 75
product concept ................................................................ 33

212
<table>
<thead>
<tr>
<th>Term</th>
<th>Page(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>utility maximization strategies</td>
<td>137</td>
</tr>
<tr>
<td>utility maximization strategy</td>
<td>127</td>
</tr>
<tr>
<td>variance within characteristics</td>
<td>45</td>
</tr>
<tr>
<td>vividness</td>
<td>5</td>
</tr>
<tr>
<td>watches</td>
<td>13, 185</td>
</tr>
<tr>
<td>weighted adding strategy</td>
<td>84</td>
</tr>
<tr>
<td>within-attribute strategy</td>
<td>114</td>
</tr>
</tbody>
</table>
accountability The degree to which the decision maker is responsible for the consequences of the decision.

accuracy-effort framework A model of how consumers make decisions. This model proposes that consumers make decisions by trading off the desire to make accurate decisions and the desire to minimize effort.

adaptive approach Manufacturers do not customize the production process and do not communicate that products are customized to consumers.

aided-analytic decision strategies Decision strategies that allow consumers to use tools. In case of computers these decision strategies are often called decision aids.

alternative transition A transition from one characteristic to another of the same alternative; also called ‘type II transition.’

appreciation for customization The degree to which consumers appreciate control over configuring unique and personalized products.

assembled representation format Representation of product characteristics as an integrated whole.

alternative Products that consumers can choose from

attribute Characteristic of a product

attribute correlation The dependence of a characteristic’s effect on evaluation on the value of another characteristic, such as when consumers state they would only consider buying coffeemakers if they are black; also called configurality

attribute levels Options consumers can choose for one product characteristic, such as the choice between 2, 3, 4, or 5 doors in a car. The numbers represent the attribute levels for the attribute ‘door.’

attribute transition A transition from one characteristic of a product to the same characteristic of another alternative; also called ‘type III transition.’

attributes Properties of a product. In this dissertation always designated as ‘(product) characteristics.’

between-attribute strategy A customization strategy that consumers may use in product configurators that use presentation by product characteristics and its levels. An attribute level of each characteristic is considered before other attribute levels are considered.

characteristics of the decision environment The characteristics that describe the decision environment, such as reversibility, significance, accountability, and time and money constraints.
characteristics of the decision problem The characteristics that are inherent in the decision problem. The characteristics that describe the decision problem can be categorized in task effects and context effects.

characteristics Properties of a product, such as number of doors in a car. Sometimes called ‘attributes.’

collaborative approach Manufacturers customize the product process and communicate that products are customized to consumers.

configurality The dependence of a characteristic’s effect on evaluation on the value of another characteristic, such as when consumers state they would only consider buying coffeemakers if they are black; also called attribute correlation.

context effects The characteristics of the decision problem associated with the particular value of alternatives in the decision problem, such as similarity and the attractiveness of the assortment.

cosmetic approach Manufacturers do not customize the product process but communicate that products are customized to consumers.

credence attributes Product characteristics that cannot be accurately evaluated even after purchase and repeated use.

customizable characteristic Properties of a product that consumers can customize.

customization choices The decision process of consumers when they customize products.

customized standardization Of the production stages - design stage, fabrication stage, assembly stage, and distribution stage – the distribution stage and the assembly stage are customized, but the design stage and fabrication stage are not.

customization strategy A decision strategy that consumers use to customize products.

decision strategy Rules that consumers use to provide guidance while making decisions.

decision value A concept used to determine the value that consumers derive from the customization process and the resulting customized product. The value of a customization decision consists of three components: effort with the customization process, uncertainty about customization choices, and evaluation of the customized product.

determinance The extent to which product characteristics determine the product appearance.

disassembled representation format Representation of product characteristics as a set of separate characteristics.

durables Products that are used multiple times and are infrequently purchased, as for example with a vacuum cleaner.

effort with the customization process The time, money, physical and cognitive effort that consumers have to invest in making customization choices.

elimination stage The first stage in a decision process modeled by an elimination and a selection stage. Consumers in the elimination stage use non-compensatory strategies to eliminate unacceptable alternatives.

evaluation of the customized product Consumers are satisfied with their customization choices, and that the product provides the desired benefits.
experience attributes  Product characteristics that allow consumers to evaluate the benefits after purchase and use.

expertise  The ability to use product information to make optimal decisions.

familiarity  The amount of purchasing or usage experience with a product.

framework  A model of how consumers make decisions

individual product uncertainty  Consumers' subjective uncertainty about what each product offers.

information clearinghouse  A way for manufacturers to communicate (some of the) experience attributes of the products to consumers by two-way interaction between consumers and manufacturers.

interpersonal relations  Source of information which can be used by consumers when they are actively searching for information, such as friends and family.

machine-interactivity  Interactivity between consumers and the product configurator

mass customization environments  Computer environments where consumers can customize products and services.

mass customization  The mass production of individually customized products and services.

media  Source of information which can be used by consumers when they are actively searching for information, such as brochures, magazines, newspapers and billboards.

moderate shoppers  Type of consumer that indicates which sources of information are used. These consumers tend not to use retailers and interpersonal relations as sources of information and only moderately search the media and objective sources.

motive  A concept used by researchers to explain the reasons for behavior. Consumers have multiple motives.

neutral sources  Source of information which can be used by consumers when they are actively searching for information, such as consumer reports, news articles, and product tests by independent organizations.

non-analytic decision strategies  decision strategies that contains of simple, pre-formulated rules.

Nondurables  Products that are consumed quickly and are often repurchased on a frequent basis, such as ice cream.

objective knowledge  The amount, type, and organization of product information that consumers actually have stored in memory.

objective shoppers  Type of consumer that indicates which sources of information are used. These consumers rely heavily on neutral sources of product information.
ongoing search Gathering of information without actually considering a specific purchase.

perceptual framework A model of how consumers make decisions. This model proposes that consumers focus on certain aspects of alternatives that are particularly salient in the decision task.

personal advice seekers Type of consumer that indicates which sources of information are used. These consumers use predominantly interpersonal relations as source of information and do not use many other sources.

person-interactivity Interactivity between people, that occurs through a medium or is unmediated, as in the case of face-to-face communication.

pre-purchase search Consciously gathering information with the intention to make a particular purchase.

presentation form A format that is used to present product characteristics to consumers. Product characteristics can be presented in numerical, verbal, or pictorial form.

presentation format The way product information is presented. The presentation format may differ in the presentation mode, the presentation order, or the information form.

presentation mode A format that is used to present product characteristics to consumers. Product characteristics can be presented in sequential or simultaneous mode.

presentation order A format that is used to present product characteristics to consumers. In this dissertation the most determinant characteristic for the appearance of the product can be presented first or last.

product concept A promising idea about a new product presented in numerical, verbal and pictorial forms.

product configurator Computerized systems that allow consumers to modify the appearance and functionality of products.

product demonstrations A way for manufacturers to communicate (some of the) experience attributes of the products to consumers by virtual demonstrations of the product that allow consumers to experience certain product characteristics.

pure customization All stages of the product process - design stage, fabrication stage, assembly stage, and distribution stage - are customized. The product is especially designed for individual consumers.

pure standardization None of the production stages - design stage, fabrication stage, assembly stage, and distribution stage - are customized.

realness The visual richness of product configurators; in this dissertation called ‘vividness.’

relative product uncertainty Consumers’ subjective uncertainty about which product is the best.

representation format They way (identical) product information is represented. In this dissertation product information can be represented by assembled or disassembled product characteristics.

reversibility The degree to which a decision can be reversed.
search attributes Product characteristics that allow consumers to evaluate the benefits prior to purchase or use.

segmented standardization Of the production stages - design stage, fabrication stage, assembly stage, and distribution stage - only the distribution stage is customized.

selection stage The second stage in a decision process modeled by an elimination and a selection stage. Consumers in the selection stage use compensatory strategies to evaluate the remaining alternatives in depth and which result in the selection of an alternative.

sensory breadth One of the two dimensions of vividness. Sensory breadth is the number of sensory dimensions simultaneously presented.

sensory depth One of the two dimensions of vividness. Sensory depth refers to the quality of the information.

significance of the decision The impact of the consequences of a decision.

store intense shoppers Type of consumer that indicates which sources of information are used. These consumers use retailers as their principal source of information.

subjective knowledge The consumer's perception of the amount of product information they have stored in memory.

system evaluation The evaluation of the product configurator. This includes the navigation, operation and attractiveness of the system.

tailored customization Of the production stages - design stage, fabrication stage, assembly stage, and distribution stage - the distribution stage and the assembly stage are customized, but the design stage and fabrication stage are not.

task effects The characteristics of the decision problem associated with the structure of the decision problem, such as presentation format, task complexity, attribute correlation and type of task.

transition A pattern of mouse clicks from one box to another in a matrix of alternatives and characteristics.

transparent approach Manufacturers customize the product process, but do not communicate that products are customized to consumers.

type I transition A transition from a characteristic to the same characteristic.

type II transition A transition from one characteristic to another of the same alternative; also called 'alternative transition.'

type III transition A transition from one characteristic of a product to the same characteristic of another alternative; also called 'attribute transition.'

type IV transition A transition from one characteristic of an alternative to a different characteristic of a different alternative.

type V transition A pair-wise comparison (of two or more alternatives), where two alternatives are compared on more than one attribute. Two (or more) characteristics of one alternative are considered before another alternative is considered.

type VI transition A multi-attribute comparisons (of two or more characteristics), where two (or more) characteristics are compared in the same order for each alternative. One characteristic is considered for two (or more) alternatives, before another characteristic is considered.
**type of pictorial information** The relevance of the pictorial information for the product appearance. Pictorial information can provide information relevant for appearance or information irrelevant for appearance.

**type of product information** The kind of product information that is provided about a product. Product information can be provided about the product functionality, but also about the product appearance.

**type of task** The way consumers are asked to provide their responses: either by choice, evaluation or matching; also called response mode.

**unaided-analytic decision strategies** Decision strategies that explore the decision in depth, but no tools, such as pen and pencil, mathematics, computer or calculator, are used.

**uncertainty about customization choices** The relative and individual product uncertainty and system uncertainty that consumers experience after they have made customization choices.

**uncertainty-effort framework** A model of how consumers make decisions. This model proposes that consumers make decisions by trading off the desire to reduce uncertainty and the desire to minimize effort.

**unity** The perception of congruity among the elements of a design such that they look as though they belong together.

**utility** The value of a product. This is a general combination, but not necessarily an additive function, of the value of each attribute level the product contains.

**vividness** The richness of information in product configurators; sometimes called ‘realness.’

**within-attribute strategy** A customization strategy that consumers may use in product configurators that use presentation by product characteristics and its levels. Different attribute levels of a characteristic are considered before considering other characteristics.
Niels Vink (April 15th 1975) finished high school in 1993. He went to the United States for a year to improve his English, where he studied liberal arts at Monroe County Community College in Monroe, Michigan. When he came back in 1994 he started Social Psychology at the University of Leiden. The next year, in 1995, he started the study Industrial Design Engineering at Delft University of Technology. He got his master's degree in Social Psychology in March 1999. In November 2000 he received his master's degree in Industrial Design Engineering.

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