Evolutionary product development

How “product phases“ can map the status quo and future of a product
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1 Introduction

For any organisation it is important to maintain or strengthen their market share by keeping their products and/or services up to date. Industrial designers often take part in the team that develops new products. Sometimes they even lead such teams. They can make use of a number of methods and techniques that are helpful with some of their tasks, but for others (especially for form giving) designers still need qualities such as experience and intuition. In this thesis, it will be shown that this seemingly intuitive way of working has regularities and patterns that can be reproduced. These will lead to a theory that can help a designer with the form giving of products. According to this theory, six phases can be distinguished in the life of a product. These phases will be called product phases, where each phase will be described by means of ten product characteristics. It will be shown, that in general products will follow the product phases in the same order. The aim of the research described in this thesis is two sided, since it endeavours to improve insight of a product’s life cycle, and on the other hand it strives to develop a means that can help a designer in the process of product development.

1.1 Origin of the theory of product phases

The theory of product phases originates in the design practice of the bureau Van Dijk en Eger (later: Van Dijk/Eger/Associates, nowadays: WeLL Design) that was founded in 1979. From the very beginning, the author tried to describe the experience of the bureau in terms of a model. The first publication was realised in 1987 in ‘Dutch Design’ (Eger, 1987) on the occasion of a large exhibition that five museums in the Netherlands had organised regarding design in the Netherlands. In the first publications the product phases were named ‘product levels’. As seen in the quoted text below, the first publications were not very detailed.

“Performance

The first question is whether the product performs satisfactorily. It is possible to sit on a rock, but a wooden stool at the right height makes sitting more comfortable. A back support is the next step, followed by arm-rests. Covering, cushions, colour combinations and design only come into play at a higher level of development.

Optimisation

Once the first requirement has been satisfied (i.e., the product works) optimisation is then considered. The product must work correctly, and fully satisfy the specifications. After this stage, some attention is paid to the safety of the product. At first, one may be the sole supplier, the monopolist, but at the second stage competitors emerge. Efforts then come to be focused on achieving better performance than the competitors’ product or a better price for comparable performance. Ease-of-use or ergonomics also starts to become important now.

(…)

Detail
Once performance has been satisfied and some measure of optimisation has been attained, detail appears on the scene. Now, there is very little difference between products with regards to their price/performance ratio. The manufacturer has to add some extras, such as accessories, ‘bells and whistles’ in order to give his product some added value in relation to the rest of the market. At this stage, design and detail start to occupy a more prominent position.

(...)

**Segmentation**
Design was already starting to play an important part during the detail stage, but its relevance to segmentation is even greater. At this stage, ownership of a product is no longer the decisive factor. The product’s penetration of the market is such that almost everyone has it in some form or another. Owning the product is no longer a means of expression. It can be made into a means of expression again by creating a particular ambience around the product, a lifestyle; the owner can then indicate who he/she wants to be. If a product has less of a technical role to play and more people possess it, it will reach the segmentation stage more quickly.

(...)

**Individualisation**
The last and highest stage in this series is individualisation. In this stage, the consumer himself wants to have a significant say in the design of the product. The manufacturer supplies the components which the consumer then uses to determine the end result.

(...)
This stage is well established in home furnishings market, since the consumer decides for himself what to put in his room, what to put on his walls and what to put on the floor. It would seem that individualisation is on the increase, since a consumer buying a lounge suite can customize their requirements, adding chairs, a sofa, or even a table using a system. This is quite different from the past, where the consumers choice was constrained to just a complete lounge suite (Eger, 1987, p. 69-70).

In a subsequent publication (Eger, 1991) the first five product phases were named as follows:
- performance,
- optimisation,
- itemisation,
- segmentation, and
- individualisation.

The sixth product phase, awareness, is first described in an article in *NieuwsTribune* (Eger, 1993), and afterwards in the book ‘Succesvolle Productontwikkeling’ (Eger, 1996). However, the thinking about this phase started much earlier. After a lecture at the M&M-Kongres ‘Werken aan betere resultaten’ (Eger, 1988) someone in the
audience raised the following question: “I am a manufacturer of shoes. Your product phase individualisation has already existed for some time in our market. What I would like to know is what comes next, after individualisation?” From that moment on this became a point of interest for further detailing of the theory. During subsequent lectures the first efforts were made to answer this question, finally resulting in the description published in the book ‘Succesvolle Productontwikkeling’ – see below.

“Awareness
To make clear what is meant by the product phase awareness it is necessary to go further into the need for self actualisation of Maslow’s hierarchy of needs. According to Maslow, self actualisation leads to another attitude towards life, another vision on humanity.

(...) The self actualised person wants different requirements from products and has to be approached in a different way. The self actualised person will make high demands upon products concerning functionality, form giving, span of life and environmental consequences. He is autonomous, independent, and able to remain true to himself in the face of rejection or unpopularity. He is not depending on status and will judge products primarily by their quality. This does not mean that form giving is not important. However, it does mean that the lifespan of the product is just as important, as he will find it difficult to throw it away. In some cases, such as antique furniture, the product becomes more attractive as the effects of wear become more visible (positive aging). Also, the reparability of products will become more important.” (Eger, 1996, p. 67-68)
2 Product phases

2.1 How the product phases can map the status quo and future of a product
A well-known method to analyse the different phases of development of a product is the economic product life cycle. In this life cycle the turnover of a product is measured against time. Although the economic product life cycle is a central concept in product development and marketing, questions can be raised about its predictive value. If no unexpected events occur the level of turnover may be predicted for a couple of years, but it is impossible to make predictions about the nature of product renewal or about users’ demands and wishes. However, with the help of ‘product phases’ it is possible to make overall predictions as to the functionality, the design, the pricing, the production, the promotion and the presentation of a product as well as the level of service and the social behaviour of a company.

2.2 Economic product life cycle
Theoretically the economic product life cycle has six phases (Buijs en Valkenburg, 2000). The first phase, development, shows the costs of the product before its introduction. Immediately after the introduction of the product, the pioneering phase starts. If the product is accepted on the market, a phase of fast growth will begin, leading to increased turnover: the growth phase. In general, competition will present itself during the growth phase. The next phase of the product life cycle is the maturity phase. Characteristics of this phase are: a decrease in growth and the elimination of weaker competitors. During the next two phases, saturation and decline, turnover will first reach its highest level, after which time growth will start decreasing (e.g., because of substitute products emerging in the market). During the last phase, the product will almost completely disappear. Sometimes a residual market will remain and another phase will follow: ossification.
Evidently only few products will follow this theoretical line. In addition all kinds of external factors may influence the course of the line. For example, the mandatory wearing of safety belts in the back of cars may therefore result in doubling sales of safety belts during a short period of time.

2.3 Product phases
Industrial design engineering is a young applied science. It is the aim of a science to describe, govern and explain the phenomena that takes place. In industrial design engineering this research was until now concentrated on ergonomics, marketing, design methodology, etcetera. However, very little research has been undertaken studying the relationships between form giving and the following aspects: functionality, ergonomics, production and marketing. In this thesis, the phenomena that appear during the phases of the life of a product have been summarized. These phenomena apply amongst others to the market (is the product new to the market or are there a lot of competitors?), the functionality (is it possible to improve the functionality or has it reached a high degree of perfection?), and the ergonomics (has
enough attention been paid to the product’s ease of use or is there scope for improvement?). The regularities that were found have been analysed and described. This has led to six product phases: performance, optimisation, itemisation, segmentation, individualisation, and awareness. The six phases are placed in a chronological order such that any predictions about new or future products can be made. This can be done by positioning a product, based on its product characteristics, into one of the product phases. When developing a future product, a designer can add to the product characteristics of the next product phase, thus creating added value for the intended user. In this way, the product phases can help a designer in creating the next generation of a product.

In this chapter, the product phases will be described using aspects of a product. They will be called the product characteristics. Ten product characteristics will be defined; four of them apply to the product and two of them apply to the market. The others apply to production, promotion, service and ethics. The ten product characteristics are:

1. Newness
2. Functionality
3. Product development
4. Styling
5. Number of competitors
6. Pricing
7. Production
8. Promotion
9. Service
10. Ethics

Figure 2.1 The six product phases with their product characteristics. To keep the figure simple, the product characteristics are only shown at the product Itemisation phase.
3 Description of the product phases
The product characteristics will be described by statements that can be linked to the product phases. In two studies, these statements will be tested to see if they properly describe the product characteristics together with the product phases.

3.1 Performance
From several studies it has become clear that with new products based on new technologies, functionality (i.e., the performance of the product) is the most important aspect of product development. Christensen (1997) states that in the beginning new products (he calls them disruptive innovations) perform less than the products they will replace at a later stage. Baudet (1986) says that products often start as status products, and usually perform worse than the existing alternatives – although despite this shortcoming, some people still want to own them. As an example, he mentions amongst others the first cars that were much less reliable than the usual horse drawn carriage. Dirken (1997) describes how functionality (he speaks of technical functionality) is the first important aspect of a new product. In the ‘buying hierarchy’ of Windermere Associates (Christensen, 1997) functionality comes first. If there are no products available that answer the wishes of the consumer in a satisfying way, competition takes place based upon the improvement of functionality. From the studies of the diffusion of innovations by Rogers (1995) it can be concluded that the first buyers of new products (i.e., the innovators) are attracted to those products because they are new and because they can distinguish themselves with them. The innovators have financial means at their disposal and are able to live with uncertainties. They don’t worry about the possibility that the product might not perform very well, as they are looking for new and challenging experiences.

The studies mentioned above confirm that in the early phases of the life of a product most effort is spent on improving the functionality, and that there are consumers willing to buy and use the product, despite the fact that performance of the product is usually rather poor. In his study on launch strategies of new products, Hultink found comparable results: “In early stages of the product life cycle, few competitors are around and products tend to be technology-driven and innovative. In these circumstances, prices should be relatively high.” (Hultink, 1997, p. 154)

The issue of high prices during the early stages of the product life cycle has also been reported on by Baudet (1986). In 1947, the first ballpoints would cost nearly €6,- and around 1900, a bicycle would cost about ten to twelve times the average weekly wage of a working man. The product characteristics of the product phase performance can be summarised as follows:
1. The product is new to the market and results from a ‘technology push’.
2. The performance of the product is poor.
3. Product development is aimed at improving the performance.
4. Form giving is not very important, and therefore matching form giving to different parts of the product is poor (leading to a product that is not very aesthetically pleasing).
5. There are few competitors around, and in some cases there is a monopolist.
6. The price per unit is relative high.
7. The product is designed for production with standard machining, the product usually has many parts, and assembly is often done by hand.
8. The product is promoted through fairs, free publicity, the internet, brochures in retail shops, etcetera.
9. There is no organised service organisation. (This does not mean that there is no service, since start-up companies often offer a lot of service and support.)
10. The social behaviour of the company or organisation behind the product is of no concern to the customer.

3.2 Optimisation
As mentioned before, in the first phases of the economic product life cycle the activities of designers are aimed at improving both technical and ergonomic functionality. According to the opinion of the Windermere Associates (Christensen, 1997) competition will be based on reliability when products offer almost identical functionality. At which point, claims Dirken (1997), product safety becomes more important to the consumer. Pye (1964) and Smets (1986) agree that in that stage product development is aimed at fine tuning the products on the available production methods in order to realise lower prices.

“It seems to be invariably true that those characteristics which lead people to call a design functional are derived from the requirements of economy and not of use.” (Pye, 1964, p. 35)

“We are so reluctant to acknowledge that economy has been a major influence on the design of even the most splendid things which men have made, that we often say ‘better’ when we mean ‘cheaper’.” (Pye, 1964, p. 46)

Hultink (1997) calls the second phase ‘growth’ (like in the economic product life cycle) and mentions the following characteristics: products are not totally new, but offer major improvements, the number of competitors grows and the market grows between 5 to 10%. He further states that products are promoted more actively, amongst others with sales force promotion, trade promotion and direct marketing. Baudet (1986) shows that, after a spectacular growth of the bicycle market in the first phase (in 1897 nearly 170%, in 1904 still 16%), the growth in the following years was about 10%.

The product phase optimisation is characterised by:
1. The product is new to the market or there is some consumer awareness. It results from a ‘technology’ push.
2. The performance of the product is reasonable.
3. Product development is aimed at improving performance, better reliability, improvement of ergonomics and safety.
4. Form giving is not very important, and therefore matching form giving to different parts of the product is poor.
5. There are few competitors around, but the number starts to grow.
6. The price per unit can still be relative high, although there is more competition.
7. The product is designed for production with standard machining, the product usually has many parts, and assembly is often done by hand.
8. Promotion is still predominately done through personal selling, such as fairs, free publicity, the internet, sales force promotion and trade promotion.
9. There is no organised service organisation.
10. The social behaviour of the company or organisation behind the product is of no concern to the customer.

3.3 Itemisation
Both Windermere Associates (Christensen, 1997) and Mann and Dewulf (2002) find that when vendors have improved their product to the point that they satisfy functionality and reliability, the basis of competition shifts to convenience. Customers will prefer products that are the most convenient to use and (especially in the business to business market) vendors that are convenient to deal with. For products that are mass produced, personal selling becomes impossible. With regard to these products, Hultink (1997) states that they are less innovative, although product improvement is still possible. The growth of the market is less than 5% and the number of competitors increases. As the product range grows, prices fall and costs of advertising increase. Communication channels change from personal selling strategies to direct marketing, print-, TV- and radio-advertising.

The product characteristics of the product phase itemisation are:
1. There is some consumer awareness of the product.
2. The functionality and reliability of the product are good. The ergonomics and human interface are acceptable, and the product is safe.
3. Product development is aimed at improving performance, reliability, ergonomics, human interfaces and safety. There is an endeavour to develop extra features and accessories, including special editions of the product that are developed for different trade channels and target groups.
4. The matching of the form giving of different parts (integration of form giving) of the product is good.
5. Their number is still growing, but the amount of competitors is not very high.
6. Prices start falling.
7. The number of product parts decreases, and automation becomes more important.
8. Promotion is mainly done through direct marketing, print-, TV- and radio-advertising.
9. There is a well organised service organisation to support the product.
10. The social behaviour of the company or organisation behind the product is of no concern to the customer.

3.4 Segmentation
In the first three product phases (i.e., performance, optimisation and itemisation) the focus was on improved functionality, reliability, ergonomics and safety. There was an endeavour to add extra features and accessories in order to differentiate the product from its competitors. However, there is an end to this kind of developments. There comes a time when the performance offered is actually more than the performance that is required. Delhoofden (1994) speaks of unnecessary functions. He distinguishes five sorts of functions: main functions (the reason for the consumer to buy the product), sub functions (functions that are wanted or necessary), supplementary functions (functions that are not essential, but are appreciated by the consumer), unnecessary functions (functions that are available but the consumer did not ask for) and unwanted functions (functions that are disadvantageous or harmful). Christensen (1997) speaks of performance oversupply. The product has extra features that the customer does not appreciate, the so called ‘take-it-or-leave-it’ features as described by Pine and Gilmore (1999).

“... every mass-produced product comprises a bundle of ‘take-it-or-leave-it’ features or dimensions offered to all customers. The more features bundled, the greater the likelihood of introducing some element that disqualifies the product with a particular buyer (either because he flat out doesn’t want the element or doesn’t want to incur the perceived higher price for a marginal element).” (Pine and Gilmore, 1999, p. 79)

For less complicated products, such as furniture and trinkets, the possibilities to add features or accessories are limited. Moreover, for innovators and early adopters, products become less attractive during the latter product phases. The market share is such, that the product is considered ‘to be accepted’. Owning the product is no longer distinctive, as it does not offer status. According to Rogers (1995) the innovators and early adopters are sensitive to status aspects; therefore it is advantageous for companies to strive for features that provide these aspects. Adding emotional benefits to a product is a possibility.

The product characteristics of the product phase segmentation can be summarised as follows:
1. Almost all members of the target group know the product or have heard of it.
2. The functionality, reliability, ergonomics and human interface of the product are good and the product is safe. Therefore, the customer has a lot of choice, as there is a broad product range.

3. Product development is aimed at extra features and accessories, including special editions of the product for different trade channels and target groups.

4. The matching of the form giving of different parts (integration of form giving) of the product is good. Form giving becomes more expressive (styling) and is aimed at adding emotional benefits.

5. The market penetration is high (i.e., there are a lot of competitors).

6. Since competitors’ prices are low, it is almost impossible for a company to lower their prices even further.

7. The number of product parts decreases. Production and assembly are highly automated.

8. Promotion and advertising are intensive (i.e., a lot of advertising in the media).

9. There is a well organised ‘service organisation’ to support the product.

10. The social behaviour of the company or organisation behind the product is of no concern to the customer.

3.5 Individualisation

Extrapolation of segmentation (continuous fine tuning of products on smaller target groups) leads to a well tuned product especially produced for one individual. The developments in information technology make this kind of individualisation possible (Lotgerink en Hoekstra, 1997; Peelen, 1996; Molenaar, 1999). It leads to the following description of the product phase individualisation.

1. Almost all members of the target group know the product or have heard of it.

2. The functionality, reliability, ergonomics and human interface of the product are good and the product is safe. Therefore, the customer has a lot of choice, as there is a broad product range.

3. Product development is aimed at extra features and accessories, including special editions of the product for different trade channels and target groups. Product development is also aimed at mass customisation or co-creation, allowing the customer to influence the final result.

4. The matching of the form giving of different parts (integration of form giving) of the product is good. Form giving becomes more expressive (styling) and is aimed at adding emotional benefits.

5. The market penetration is high (i.e., there are a lot of competitors).

6. Since competitors’ prices are low, it is almost impossible for a company to lower their prices even further. However, co-creation and mass customisation can offer possibilities to realise higher prices.

7. Production and assembly are highly automated.

8. Promotion and advertising are intensive (i.e., a lot of advertising in the media).

   Interactive media are used to customise the product to needs of the individual.

9. There is a well organised ‘service organisation’ to support the product.
10. The social behaviour of the company or organisation behind the product is becoming more and more important to the customer.

An important problem of this product phase is that individualisation is not possible for each product. Complicated products, such as cars, are already customised to a greater extent – although the customer can only choose from a limited number of possibilities. A system whereby a customer can submit a RAL-number for the desired colour of his car has yet to be developed. However, for less complicated products, such as a diary and a spectacle case, the possibilities are much more limited – although it is possible to order these products with one’s name printed on them, for example.

3.6 Awareness
In 1997, the market research bureau Inter/View carried out research into responsible entrepreneurship (Sikkema, 1997). This research showed that consumers are only willing to contribute to a better environment and to solving societal problems if this can be done very easily, and if it does not lead to less comfort than they are used to and there are no heavy financial burdens. The research also showed that people expect companies to play an active role in improving societal problems. According to Hafkamp (1997), a company can tempt consumers who are usually committed to purchasing luxury products, by offering them the possibility to show their involvement and buy products that have an environmental or social claim added to them.

Products that are in the product phase awareness have the following product characteristics:
1. Almost all members of the target group know the product or have heard of it.
2. The functionality, reliability, ergonomics and human interface of the product are good and the product is safe. Therefore, the customer has a lot of choice, as there is a broad product range.
3. Product development is aimed at mass customisation or co-creation, allowing the customer to influence the final result. Product development is also aimed at special editions of the product for different trade channels and target groups.
4. The matching of the form giving of different parts (integration of form giving) of the product is good. Form giving becomes more expressive (styling), but in this phase that can sometimes mean a very sober design.
5. The market penetration is high (i.e., there are a lot of competitors).
6. Since competitors’ prices are low, it is almost impossible for a company to lower their prices even further. However, co-creation and mass customisation offer possibilities to realise higher prices.
7. Production and assembly are highly automated.
8. Promotion and advertising are intensive (i.e., a lot of advertising in the media). Interactive media are used to customise the product to the individual. The
organisation communicates the ethics of the company concerning the society and the environment.

9. There is a well organised ‘service organisation’ to support the product.
10. The social behaviour of the company or organisation behind the product is becoming more and more important to the customer. The company can be successful with products that become more attractive during use (‘positive aging’).

3.7 The predictive value of product phases

As shown above, a model is presented that describes the most probable course of life of a product using the six product phases. Each product phase is described, thus making use of the product’s characteristics, such as its newness, functionality, product development, form giving, number of competitors, pricing, production, promotion, service and ethics. The value of this model to the industrial design engineer lies in the possibility to make qualitative predictions on the future of a product. These predictions can be based on the product characteristics, since each product phase has its own characteristics. Therefore, by researching the present product characteristics (i.e., a more precise analysis of the characteristics of the competitors products, that are currently in the market when a new product development is about to start) the product characteristics of the new product that is meant to be the follow up of the present products, can be defined.

With regard to the last two product phases (individualisation and awareness) some precautions are necessary. For the first four product phases mentioned in the literature, many studies were found that confirm their existence. Also, some evidence suggests that these phases do indeed appear in the proposed order of time. Although for the last two product phases, much less evidence was found. For instance, it is therefore possible that one or both of these phases form a part of the product phase segmentation. Thus, the question that has to be answered, is if the phases usually appear one after another or do they actually coincide?
4 Research questions
The following section summarizes the research that was undertaken in order to show that the product phases exist, if they appear in the expected order and if the product characteristics describe the product phases in the correct way. The following questions will be answered:

Do the described product characteristics appear in the order that is predicted by the product phases?
Are the product phases an appropriate means to help predict the future of a product based on its history?
Do products always (or most of the time) follow the product phases in the predicted sequence?
Can a phasing of the life cycle of a product based on the product phases offer designers starting points for a new product development?

4.1 Research methods
Den Hertog and Van Sluijs (1995) describe the research methods that are available for research into the effectiveness of innovations. They distinguish five groups of methods: experiment, survey, case study, action research and ethnography. For this subject, the retrospective case study and the survey are the most suitable.

4.2 Study 1: retrospective case survey
In a retrospective case study, many aspects of one case are studied. Whereas, in a survey, a few aspects of many cases are studied. The study of one case to investigate the product phases is not enough; five seem possible. The number of aspects that have to be studied are much more limited. Therefore a comparative (multiple) retrospective case survey, a method between the survey and the case study, seems the best choice – a few cases are studied based on a small number of aspects. Study 1 therefore exists based on a retrospective survey of five cases. According to Eisenhardt (1989), between four and ten cases are usually sufficient for most surveys. In Eisenhardt’s paper, she advocates choosing cases that are very different from one another, leading to better insight into the applicability of the theory.

A disadvantage of a retrospective case survey is that the cases are analysed by someone that has to know the theory of product phases. If not, this person cannot judge if the studied case meets the formulated criteria. This means that there is a risk that the researcher may (unwittingly) fit the results of his research into the theory of product phases. Another disadvantage is that consulted experts have to rely on their memory.

These problems are addressed in a second study (Study 2). In this study, a method is used that was used before amongst others by Ten Klooster (2002). While developing a method to design packaging, Ten Klooster asked experts to rank steps in the
design process that he had written on cards. There are several reasons why this method seems very suitable. Firstly, there is no interview, so the researcher cannot influence the results by the way he asks the questions. Secondly, the cards help the subject to memorise aspects that he would not have thought of by himself. Finally, this method allows for the use of experts (from different backgrounds) in order to rank the cards.

4.3 Study 2: ranking by experts
This research was carried out in two parts: a pilot study and the main study. The pilot study tests to see whether the formulations of the product characteristics are clear to the subjects and if the method used (attaching stickers with statements to a field (a large piece of paper) with indications of the time the product is on the market and the market penetration of the product) is appropriate. The statements that describe product characteristics are printed on stickers. The statements are sorted by product characteristic and collected in ten folders. These folders are then offered to the subjects in random order. Within the folders the statements are also randomised. The subjects are then asked to attach the statements in a historic way, meaning that they have to position the statements in the order they expect them to take place during the course of a product’s life cycle. Note, that it was possible to have statements take place simultaneously or on several separate occasions in time, and based on the experiences in the pilot study some small improvements were made.

For the main study, subjects were selected from a population of experienced industrial designers, design managers and marketing managers because it is expected that they have enough knowledge of the life cycle of products and are therefore able to work with the statements about the product characteristics.
5 Study 1: retrospective case survey

5.1 Introduction
In this paragraph, in a comparative multiple retrospective case survey, the history of five products are analysed. This was done by means of a literature study and with the aid of interviews of people involved with the products, such as directors, marketing managers, product managers and designers. The following products were analysed: electric shavers (paragraph 5.2), mobile phones (5.3), bicycles (5.4) shampoo packaging (5.5) and holidays (5.6).

The shaver was chosen because it is an example of a durable consumer product that has gone through a long period of product development. It is supposed that emotional benefits are not as important as they are with products like a mobile phone or a bicycle, since for friends and acquaintances it is invisible, as a shaver rarely leaves the confines of a bathroom.

The mobile phone was chosen as an example of a product that developed very quickly in a very short period of time. Moreover it is a product with a lot of exposure.

The bicycle was chosen because it is a product that people usually use for a very long time (often ten years or more) and because it has had a long history so that it seems likely that the last two product phases, individualisation and awareness, have played an important part in this product.

Shampoo packaging and holidays are selected to show that the theory of product phases is also suited for fast moving consumer goods and services. Although these products are not the prime subject of this study, it is interesting to see if the theory can be applied to them.

5.2 Electric shavers
Shavers were analysed and described on the basis of the products from Philips. Philips was chosen because it has been a market leader in shavers for over forty years. The development of the (Philips) shaver follows the theory to a great extent (see figure 5.1) (Ramakers, 1984; Baudet, 1986; Van Oost, 2003; Dijkstra, 2005). With regard to the first two phases, some information is missing concerning pricing, production, service and ethics. During the individualisation and awareness part of the product phases, only some of the product characteristics are partially met. With regards to ‘product development’ this means that new product development is aimed at different target groups, but not aimed at individuals. For the ‘number of competitors’ this means that the shaver does have a high market penetration, and there are not as many competitors as the theory proposes. For ‘pricing’ this means that there is a lot of competition for the price of the products, but this does not mean that the price can rise because the product has been customised. Finally, for ‘promotion’ the product characteristic that ‘interactive media are used to customise the product’ does not apply.
5.3 Mobile phones
In a short period of time the mobile phone has passed through all the product phases and met almost all the product characteristics (Anon., 2004; Anon., 2005a; Anon., 2005b; Karjaluoto, 2005; Srivastava, 2005). Because of the quick development of the market and the enormous amount of products sold in a short period of time, the mobile phone does not meet the product characteristics for 'production' in the product optimisation phase. Also, in the product segmentation phase, the product characteristic, 'number of competitors' is not met. The description suggests many competitors, but in reality there are only a few large manufacturers. In the third quarter of 2005 the market shares are: Nokia 33,2%; Motorola 18,5%; Samsung 13,4%; LG 6,6% and Sony Ericsson 6,5%.

Figure 5.2 Extent to which the mobile phone applies to the theory of product phases; + = applies; - = does not apply; +/- = applies only partially; ? = unknown, uncertain.

5.4 Bicycles
The bicycle follows the theory of product phases to a great part (Baudet, 1986; Bijker, 1990; Rietveld and Kuner, 1999; Van der Wal, 2005). The first three phases that are
passed through conform to the theory. Despite that, the history of the bicycle interferes with the theory in a few cases. An important explanation is that the bicycle has a long history. One can say that the bicycle even influenced history. Suburbanisation became possible amongst others by the bicycle (and later to a greater extent with the invention of the car). Thanks to the bicycle people could move further away from their work. Interferences with the theory are attributed to the Second World War, due to lack of materials and the introduction of the car and the moped. With regard to promotion, the history of the bicycle differs from the theory of product phases. Until now the advertising efforts remained rather small. Direct marketing methods are not really utilized, and advertising on radio or television is seldom.

<table>
<thead>
<tr>
<th>Product characteristics</th>
<th>Performance</th>
<th>Optimisation</th>
<th>Itemisation</th>
<th>Segmentation</th>
<th>Individualisation</th>
<th>Awareness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newness</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Functionality</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Product development</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Styling</td>
<td>+</td>
<td>+</td>
<td>+/-</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Number of competitors</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Pricing</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Production</td>
<td>+</td>
<td>+</td>
<td>+/-</td>
<td>+/-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Promotion</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Service</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Ethics</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+/-</td>
<td>+/-</td>
<td>+/-</td>
</tr>
</tbody>
</table>

*Figure 5.3 Extent to which the bicycle applies to the theory of product phases; + = applies; - = does not apply; +/- = applies only partially; ? = unknown, uncertain.*

### 5.5 Shampoo packaging

The history of the packaging of shampoo was also analysed, and was mainly based on the mark of Andrélon. This mark was chosen for two reasons. Firstly, Andrélon has always been one of the market leaders in the Netherlands, and for the most part has actually been the number one. Secondly, the design of the bottle formed an important part of the mark Andrélon. As with all of the three aforementioned products described herein, the shampoo packaging follows the theory of product phases for the most part (Van Ginkel, 1998; Anon., 2006; Rothkop, 2006). But once again there were a couple of disruptions. However, most of them were caused by external factors, such as changes in the market (consumers used to purchase shampoo from a drug store but within the space of a few years that changed to a supermarket) and the Unilever takeover. Furthermore, Andrélon never made any attempts to individualise their products, and the attempts made by Biolage Blends do not seem to be very successful until now. In this paragraph, shampoo packaging should be read as shampoo and packaging, since product development and promotion are mainly aimed at just the shampoo, and only in a few cases does the packaging play a part.
5.6 Holidays
The history of the travel agency branch also follows the theory of product phases to a great part (Elkington and Hailes, 1992; De Haan and Van der Vliet, 2005). An exception has to be made for the number of competitors in the first three product phases. Due to the easy accessibility of the market (it is not very difficult to organise a journey, as the necessary investments are not that large) and the enormous demand, there are very many competitors from the outset. The product characteristic production is not contemplated. For the characteristic styling the documentation is studied.

Figure 5.5 Extent to which vacations apply to the theory of product phases; + = applies; - = does not apply; +/- = applies only partially; ? = unknown, uncertain.

5.7 Research undertaken by master students in Industrial Design Engineering at the University of Twente
During the master course, ‘Evolutionary Product Development’ at the University of Twente, Industrial Design Engineering students analysed the history of a number of products considering the theory of product phases. In general, the students found that the products followed the theory quite well – an overview of the products that have been studied is shown in figure 5.6. 

Figure 5.6 Extent to which the shampoo packaging applies to the theory of product phases; + = applies; - = does not apply; +/- = applies only partially; ? = unknown, uncertain.
A remark that several students made, is that the product phases often overlap. For the case of a camera, Mansour (2005) states that the itemisation and segmentation phases almost completely coincide. Garde (2005) noticed the same thing for the espresso machine. Brummelman (2005) found that in the history of the watch almost from the beginning (at the end of the nineteenth century) segmentation can be found because there is a difference between watches for men and watches for women. With this exception, the watch follows the theory quite well, where the ‘real’ segmentation phase does not start until the nineties of the last century.

The students found that nine products were in the segmentation phase, seven were in the individualisation phase and three were in the awareness phase. Six of the students that concluded that their product was in the segmentation phase, said that they did not expect the product to enter the next phase (individualisation) (see figure 5.6).

<table>
<thead>
<tr>
<th>Products</th>
<th>Performance</th>
<th>Optimisation</th>
<th>Itemisation</th>
<th>Segmentation</th>
<th>Individualisation</th>
<th>Awareness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Backpack</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>+</td>
</tr>
<tr>
<td>Glasses</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>?</td>
</tr>
<tr>
<td>Moped</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>?</td>
</tr>
<tr>
<td>Camera (digital)</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>+</td>
</tr>
<tr>
<td>Computer mouse</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>?</td>
</tr>
<tr>
<td>Espresso machine</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>+</td>
</tr>
<tr>
<td>Kitchen cooker</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>?</td>
</tr>
<tr>
<td>Hairdryer</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>?</td>
</tr>
<tr>
<td>Watch</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>?</td>
</tr>
<tr>
<td>Laptop</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Mixer</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>-</td>
</tr>
<tr>
<td>Scales (for persons)</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>+</td>
</tr>
<tr>
<td>Vacuum cleaner</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>+</td>
</tr>
<tr>
<td>Iron</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>-</td>
</tr>
<tr>
<td>Electric tooth brush</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>-</td>
</tr>
<tr>
<td>Toaster</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>-</td>
</tr>
<tr>
<td>Tent</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Washing machine</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>-</td>
</tr>
<tr>
<td>Wall clock</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>-</td>
</tr>
</tbody>
</table>

Figure 5.6. The nineteen products analysed by the Industrial Design Engineering master’s students. The dots indicate if a product phase was found, the last dot indicates the phase that product is currently in; a ‘+’ indicates that the student expected that the next phase will be reached; a ‘-‘ indicates that the expectation is that the next phase will not be reached; a ‘?’ indicates that the student did not know if the next phase will be reached or that he did not make a decision about it.

5.8 Summary
In this paragraph, twenty four products are briefly analysed including the analysis of nineteen studies undertaken by the students. It can be concluded that the analysed products follow the theory as expected. In most cases some (often small)
variations are found. These variations concern the promotion (among others with the bicycle and the moped), the number of competitors (vacations) and production (glasses). Furthermore it proves to be difficult to draw a fine line between the product phases, as they sometimes overlap for a long period of time. In a number of cases, the last two phases are not found. A possible explanation can be that the phases have not yet been reached. But sometimes a question that arises is if the product is suited to reach the product individualisation phase. Finally, in a number of studies it was found that the product phase awareness can be found on a corporate level, but very rarely on a product level. For instance, the company communicates its environmental awareness but this is not reflected in their product.
6 Product characteristics

6.1 Introduction
In paragraph 3, the six product phases are described using ten aspects. These aspects are the product, the market, the production and the promotion of the product, the service around the product and the ethics of the organisation. The aspects of the product can be further divided in newness, functionality, product development and styling, the aspects of the market relate to the number of competitors and the pricing of the product (per unity). These aspects are called the product characteristics. In this paragraph statements are formulated that are suitable for testing. In the next paragraph, a test will be described that is performed to see whether the product characteristics and the product phases adequately describe what happens in reality.

6.2 Overview
An overview of the 49 statements that describe the product characteristics and to what product phase they belong is given in figure 6.1.

<table>
<thead>
<tr>
<th>Formulated statements</th>
<th>Performance</th>
<th>Optimisation</th>
<th>Itemisation</th>
<th>Segmentation</th>
<th>Individualisation</th>
<th>Awareness</th>
</tr>
</thead>
<tbody>
<tr>
<td>The product is new to the market.</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The product is known (but not well known) within the target group.</td>
<td></td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The product is well known within the target group.</td>
<td></td>
<td></td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>The market penetration of the product is high.</td>
<td>●</td>
<td></td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>The performance of the product is poor.</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The product originates from a 'technology push'.</td>
<td>●</td>
<td></td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comparatively the product has many parts.</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The performance of the product is acceptable.</td>
<td>●</td>
<td></td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>The performance and reliability of the product are good.</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>The product is easy to handle and meets ergonomic demands.</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The product is safe.</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td>The product offers much choice – there is a large assortment.</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The user is interested in adaptations of the product to extend the product life cycle (instead of discarding the product to buy a newer one).</td>
<td>●</td>
<td></td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The competitor can distinguish himself with ‘positive aging’: the product becomes more attractive to use.</td>
<td>●</td>
<td></td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The product development is mainly aimed at improving the performance of the product.</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Product development is aimed at products that have better performance, are easier to handle, and have improved reliability, ergonomics and safety.</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Product development is aimed at extra</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Features and Accessories</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------------</td>
<td>-------------------------</td>
<td>-------------------------</td>
<td>-------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Product development is aimed at different products for different market channels or target groups.</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Product development is aimed at the possibility for the user to influence the result by choosing from extra features or to have the product assembled to meet his demands.</td>
<td></td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Styling is not very important.</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>There is not much unity in the styling of the parts of the product.</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The styling of the parts of the product (integration of form) is good.</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The styling of the product is expressive.</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The competitor can distinguish himself with a well cared for design that is also simple and sober.</td>
<td></td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>There is only one or there are very few competitors.</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>There are several competitors (but not many).</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>There are a lot of competitors, and the market is highly competitive.</td>
<td></td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The price of the product (per unity) is relative high, and people find the product expensive.</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The pricing of products is competitive.</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>There is a lot of competition, prices are under pressure and are going down.</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prices have reached their lowest possible level.</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prices vary because the products are customised.</td>
<td></td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The product is designed for production with standard machines, such as lathes, and milling-, trimming-, bending- and welding machines.</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assembly of the product is mainly done by hand.</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The number of parts of the product decreases, and automation becomes more important.</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assembly of the product is highly automated.</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Production is highly automated.</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Promotion is mainly based on free publicity and trade fairs.</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Promotion is done on a small scale: trade fairs, the internet, brochures with retailers, etc.</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Promotion is done through advertising in magazines and papers, and/or on radio and TV.</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Promotion is done through direct marketing.</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Promotion activities are intensive: a lot of advertising in many different media.</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interactive media are used to attune the product to the wishes of the individual user.</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The user communicates directly with the competitor to make his individual wishes known.</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The competitor communicates about the</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethical Aspect</td>
<td>User Experience Phase</td>
<td>Product Development Phase</td>
<td>Manufacturing Phase</td>
<td>Marketing Phase</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------------------------------------------------------------------</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>There is no well organised service organisation. (This does not mean that the service is poor.)</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| There is a well organised service organisation supporting the product.        |                       | ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● ● 

*Figure 6.1 The 49 statements to be tested. The dots mark the product phase to which the statement refers.*
7 Study 2: ranking by experts

7.1 Pilot-study
This research was carried out in two parts. In the first part, the pilot-study, with four subjects a test was undertaken in order to find out if the framework of the research would function well, if the instructions were clear and if the statements (see paragraph 6) were well formulated and understandable. The subjects were (assistant) professors of the Industrial Design Engineering courses at the Universities of Delft and Twente. All subjects were familiar with the theory of product phases.

In both the pilot-study and the main study statements were printed on stickers. They were collected based on product characteristics. These collections were offered to the subjects in a changing, random order. The statements within the collections were randomised as well. The subjects were asked to arrange the statements in historical order, and to attach the stickers in the order they expect them to take place (or order of importance) in the product life cycle. It was possible to let statements take place simultaneously or on several different occasions in time. In the pilot-study, the subjects were asked about their meaning with regards to the design, the execution and the comprehensibility of the test. Based on their comments some formulations were adapted and two extra statements were added.

7.2 Main study
For the main study, subjects were selected from a population of experienced industrial designers, design managers and marketing managers because it was expected that they have enough knowledge of product life cycles and are therefore able to work with the statements about the product characteristics. The aim was to select a minimum of seventy subjects to be able to draw statistically reliable conclusions. Due to the fact that it would take a lot of time to approach these persons one by one, make appointments with them and then visit them, the approach was modified in an attempt to combine the experiment with the events whereby members of the target group would meet. In this way, four sessions could be organised that delivered sixty four subjects. Another seven subjects, all experienced industrial design engineers were then approached separately, bringing the total number of subjects to seventy one.

7.3 Working method
The working method in the main study was as follows. Each subject received, in random order, ten folders with indications of the contents: newness, functionality, product development, styling, number of competitors, pricing, production, promotion, service and ethics. Each folder contained between two and ten sheets with stickers with the statements as described in section 6, where each sheet had a statement printed on it fourteen times. This was done in order to make it clear that it is possible and allowed to affix a sticker more than once. Overall each subject
received 49 sheets with each 14 stickers, bringing the total amount of stickers to 686. Next to that, they received a piece of paper measuring 50 by 73 centimetres with indications of the time the product is on the market and the market penetration of the products. They could affix the stickers on this piece of paper (the ‘field of play’).

7.4 Composition of the group of experts
As described in section 4, ‘Research questions’, it was the intention to have experts judge and arrange the statements, and since the statements were about both product development and marketing, an attempt was made to find experts from both groups. The intention was to have a division of 50/50. This effort has not been successful, since the selected group had more than twice the number of product designers than marketers. Nevertheless, it was expected that the knowledge of marketing within the group was adequate as more than half of the subjects said that they were managers too. Managers in product development are supposed to have at least some knowledge of marketing. The level of education confirms this: 95% of the subjects studied at a university or a college of advanced technology, as the syllabus is heavily biased towards marketing. It was also the intention to have experienced subjects participate in this study. This effort has been very successful: 56% had more than five years experience, 77% more than two years.

7.5 Interpretation of the results
Based on the position of the stickers, a decision was made as to which product phase was related to the statement printed on it. In section 6, ‘Product characteristics’, figure 6.1 indicates which statement belongs to which product phase. Another thing that was indicated is that there are some statements that typify one product phase, others two or three or even a maximum of four product phases. The following criteria were used to decide if a statement can significantly be linked to a product phase. If a statement typifies only one product phase and 17% (rounded off upwards) of the stickers were affixed in the column of this phase, this can be called ‘coincidence’. (If the stickers would have been affixed randomly this would give the same result.) If a statement typifies one product phase, and 45% of the stickers have been affixed in the column of this product phase, then the conclusion will be that the statement is significantly linked to the product phase. If the number of stickers linked to the product phase is larger (or equals) 36% and is smaller than 45% the link will be called a strong indication, and if the number is between 28% and 35% it will be called an indication, etcetera. In figure 7.1 an overview is given of the criteria that were used to decide whether a link is significant, has a strong indication, an indication, a weak indication, has coincidence or is denied for statements belonging to one, two, three or four product phases.
Figure 7.1 Overview of the criteria used to decide if a statement typifies a product phase in a significant number of the cases.

### 7.6 Justification of the criteria

The criteria of figure 7.1 were defined in the following way. A statement can fit to a maximum of four product phases. Therefore, the situation where this is the case was looked at first. A demand that 95% of the stickers are affixed to these four product phases seems necessary, because if ‘coincidence’ would be the case, then 67% of the stickers would already be linked to these phases. Finally, this demand proved to be too high, since none of the statements could actually meet this demand. For each of the lower product phases, the chance of coincidence is reduced by 16,667%. It therefore seems realistic to minimize the criterion of significance with the same steps. In this way the percentages of 45, 62 and 78 were determined. Next, the difference between the situation of ‘coincidence’ and ‘significant’ was divided into three equal steps that were named ‘strong indication’, ‘indication’ and ‘weak indication’.

Based on the criteria formulated above, the presumed relationship between a statement and the associated product phases were significant in 17 cases, and in 13 cases there was a strong indication, on three occasions there was an indication, on ten occasions there was a weak indication, on five occasions no evidence of a relationship was found (‘coincidence’) and only on one occasion the result found that there was no relationship at all.

### 7.7 Conclusions regarding the product phases

Figure 7.2 indicates per product phase to what measure the statement describe the product phases correctly.
<table>
<thead>
<tr>
<th>Formulated statements</th>
<th>Performance</th>
<th>Optimisation</th>
<th>Individualisation</th>
<th>Segmentation</th>
<th>Awareness</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 The product is new to the market.</td>
<td>+++</td>
<td>+++</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 The product is known (but not well known) within the target group.</td>
<td>+++</td>
<td>+++</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 The product is well known within the target group.</td>
<td></td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
<td></td>
</tr>
<tr>
<td>4 The market penetration of the product is high.</td>
<td></td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
<td></td>
</tr>
<tr>
<td>5 The performance of the product is poor.</td>
<td>+++</td>
<td>+++</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 The product originates from a ‘technology push’.</td>
<td>+++</td>
<td>+++</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 Comparatively the product has many parts.</td>
<td>+++</td>
<td>+++</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 The performance of the product is acceptable.</td>
<td>+++</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 The performance and reliability of the product are good.</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td></td>
</tr>
<tr>
<td>10 The product is easy to handle and meets the ergonomic demands.</td>
<td>~</td>
<td>~</td>
<td>~</td>
<td>~</td>
<td></td>
</tr>
<tr>
<td>11 The product is safe.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>12 The product offers much choice – there is a large assortment.</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
<td></td>
</tr>
<tr>
<td>13 The user is interested in adaptations of the product to extend the product life</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cycle (instead of discarding the product to buy a newer one).</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14 The competitor can distinguish himself with ‘positive aging’: the product becomes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>more attractive to use.</td>
<td>++</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15 Product development is mainly aimed at improving the performance of the product.</td>
<td>++</td>
<td>++</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16 Product development is aimed at products that have a better performance, are easier</td>
<td>~</td>
<td>~</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>to handle, and have improved reliability, ergonomics and safety.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17 Product development is aimed at extra features and accessories.</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18 Product development is aimed at different products for different market channels or</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>target groups.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19 Product development is aimed at the possibility for the user to influence the</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>result by choosing from extra features or to have the product assembled to meet his</td>
<td>~</td>
<td>~</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>demands.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 Styling is not very important.</td>
<td>++</td>
<td>++</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21 There is not much unity in the styling of the parts of the product.</td>
<td>+++</td>
<td>+++</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22 The styling of the parts of the product (integration of form) is good.</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>23 The styling of the product is expressive.</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24 The competitor can distinguish himself with a well cared for design that is also</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>simple and sober.</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25 There is only one or there are very few competitors.</td>
<td>+++</td>
<td>+++</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Description</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>---</td>
<td>-----------------------------------------------------------------------------</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td>----</td>
</tr>
<tr>
<td>26</td>
<td>There are several competitors (but not many).</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>There are a lot of competitors, and the market is highly competitive.</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>28</td>
<td>The price of the product (per unity) is relative high and people find the product expensive.</td>
<td>+++</td>
<td>+++</td>
<td></td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>The pricing of products is competitive.</td>
<td>~</td>
<td>~</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>There is a lot of competition, prices are under pressure and are going down.</td>
<td>++</td>
<td>++</td>
<td></td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>Prices have reached their lowest possible level.</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>Prices vary because the products are customised.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>The product is designed for production with standard machines, such as lathes, and milling-, trimming-, bending- and welding machines.</td>
<td>++</td>
<td>++</td>
<td></td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>Assembly of the product is mainly done by hand.</td>
<td>+++</td>
<td>+++</td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>The number of parts of the product decreases, and automation becomes more important.</td>
<td></td>
<td>++</td>
<td>++</td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>Assembly of the product is highly automated.</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
<td></td>
</tr>
<tr>
<td>37</td>
<td>Production is highly automated.</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td></td>
</tr>
<tr>
<td>38</td>
<td>Promotion is mainly based on free publicity and trade fairs.</td>
<td>++</td>
<td>++</td>
<td></td>
<td></td>
</tr>
<tr>
<td>39</td>
<td>Promotion is done on a small scale: trade fairs, the internet, brochures with retailers, etc.</td>
<td>+++</td>
<td>+++</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>Promotion is done through advertising in magazines and papers and/or on radio and TV.</td>
<td>~</td>
<td>~</td>
<td></td>
<td></td>
</tr>
<tr>
<td>41</td>
<td>Promotion is done through direct marketing.</td>
<td>~</td>
<td>~</td>
<td></td>
<td></td>
</tr>
<tr>
<td>42</td>
<td>Promotion activities are intensive: a lot of advertising in many different media.</td>
<td>~</td>
<td>~</td>
<td>~</td>
<td>~</td>
</tr>
<tr>
<td>43</td>
<td>Interactive media are used to attune the product to the wishes of the individual user.</td>
<td></td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>44</td>
<td>The user communicates directly with the competitor to make his individual wishes known.</td>
<td></td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>The competitor communicates about the ethics of his company.</td>
<td>~</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>46</td>
<td>There is no well organised service organisation. (This does not mean that the service is poor.)</td>
<td>+++</td>
<td>+++</td>
<td></td>
<td></td>
</tr>
<tr>
<td>47</td>
<td>There is a well organised service organisation supporting the product.</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>48</td>
<td>The ethics of the competitor (manufacturer) is not very important for the decision of the user.</td>
<td>~</td>
<td>~</td>
<td>~</td>
<td>~</td>
</tr>
<tr>
<td>49</td>
<td>The competitor (manufacturer) can distinguish himself from the competition by its social behaviour, for example with regard to the environment or child labour.</td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Figure 7.2 Significance of the statements.

+++ = Significant
++ = Strong indication
+ = Indication
~ = Weak indication
o = Coincidence
- = Denied

7.7.1 Performance
With the exception of the statement on the social behaviour of the competitor (see statement 48, figure 7.2) it can be concluded that the product characteristics describe the product performance phase very well.

7.7.2 Optimisation
With the exception of the statements on product development (see statement 16, figure 7.2), pricing (statement 29) and the social behaviour of the competitor (statement 48) it can be concluded that the product characteristics describe the product optimisation phase quite well.

7.7.3 Itemisation
The product characteristics only reasonably describe the product itemisation phase and statements regarding the performance of the product (10 and 11), product development (16), pricing (29) and promotion (40 and 41) give a different picture. Also, the statement about the social behaviour is not correct, but that is the case for all of the product phases.

7.7.4 Segmentation
The product characteristics describe the product segmentation phase in the range of ‘reasonable’ to ‘well’. The statements regarding the promotion (40, 41 and 42), the safety (11), and the styling of the product (23) give different results. Once again, the statement about social behaviour is not correct.

7.7.5 Individualisation
The product characteristics describe the product individualisation phase with mixed success. The statements concerning the performance, product development and styling are precarious. The statements regarding the newness, the market, the production and the service have proved to be correct. The statements regarding promotion and social behaviour of the competitor are once again, inadequate.

7.7.6 Awareness
The product characteristics do not adequately describe the product awareness phase. In particular, the characteristics that typify the product phase, such as a sober design (statement 24) and the importance of ethics (statements 13 and 45) are hardly
recognised by the subjects. The statements that match with this phase are the ones that also match with the individualisation phase: newness, production, service and (only partially) the market.

7.8 Conclusion
Based on the classification by the experts, of the forty nine statements it can be concluded that they describe the product characteristics, and with that the product phases with mixed results. The first two product phases are described in the range of ‘well’ to ‘very well’. From the statement about the product performance phase, a value of 93% is confirmed by the experts. For optimisation, this percentage reaches 85. The next four phases are not described so well. Itemisation has the lowest score, as only 56% of the statements are confirmed by the experts. For segmentation, the percentage is 67, for individualisation it is 62% and for awareness it is 57%. It should be noted that the experts only deny a statement once, and that any other statements that are not confirmed are not denied either.

<table>
<thead>
<tr>
<th>Product phase</th>
<th>Number of statements (1)</th>
<th>Number confirmed (2)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance</td>
<td>15</td>
<td>14</td>
<td>93%</td>
</tr>
<tr>
<td>Optimisation</td>
<td>20</td>
<td>17</td>
<td>85%</td>
</tr>
<tr>
<td>Itemisation</td>
<td>16</td>
<td>9</td>
<td>56%</td>
</tr>
<tr>
<td>Segmentation</td>
<td>21</td>
<td>14</td>
<td>67%</td>
</tr>
<tr>
<td>Individualisation</td>
<td>21</td>
<td>13</td>
<td>62%</td>
</tr>
<tr>
<td>Awareness</td>
<td>23</td>
<td>13</td>
<td>57%</td>
</tr>
</tbody>
</table>

Figure 7.3 The percentage of the statements that were confirmed by the experts per product phase.
1) The number of statements that are concerned with this product phase.
2) The number of statements that were considered by the experts to relate to this product phase.

<table>
<thead>
<tr>
<th>Product characteristic</th>
<th>Number</th>
<th>Number of statements (1)</th>
<th>Number confirmed (2)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Newness</td>
<td>1-4</td>
<td>10</td>
<td>10</td>
<td>100%</td>
</tr>
<tr>
<td>Functionality</td>
<td>5-14</td>
<td>24</td>
<td>15</td>
<td>63%</td>
</tr>
<tr>
<td>Product development</td>
<td>15-19</td>
<td>13</td>
<td>9</td>
<td>69%</td>
</tr>
<tr>
<td>Styling</td>
<td>20-24</td>
<td>11</td>
<td>8</td>
<td>73%</td>
</tr>
<tr>
<td>Market</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of competitors</td>
<td>25-27</td>
<td>7</td>
<td>7</td>
<td>100%</td>
</tr>
<tr>
<td>Pricing</td>
<td>28-32</td>
<td>11</td>
<td>7</td>
<td>64%</td>
</tr>
<tr>
<td>Production</td>
<td>33-37</td>
<td>12</td>
<td>12</td>
<td>100%</td>
</tr>
<tr>
<td>Promotion</td>
<td>38-45</td>
<td>16</td>
<td>4</td>
<td>25%</td>
</tr>
<tr>
<td>Service</td>
<td>46-47</td>
<td>6</td>
<td>6</td>
<td>100%</td>
</tr>
<tr>
<td>Ethics</td>
<td>48-49</td>
<td>6</td>
<td>2</td>
<td>33%</td>
</tr>
</tbody>
</table>

Figure 7.4 The percentage of the statements that were confirmed by the experts per product characteristic.
1) The number of statements that are concerned with this product characteristic.
2) The number of statements that were considered by the experts to be concerned with this product characteristic.

In general, it can be concluded that the product characteristics pertaining to the product, such as: newness, functionality, product development and form giving, describe the product phases very well. The same can be said about the product characteristics pertaining to the market (the number of competitors and price), production and service. According to the experts, the two remaining product characteristics, ‘promotion’ and ‘ethics’ do not have adequate enough descriptions in order to base a conclusion.
8 Testing of the theoretic model

8.1 Introduction
The theoretic model of the product phases is described in section 3. In section 4, research questions are formulated. In the sections 5, 6 and 7 the model is tested in two ways, first by means of a retrospective case survey (section 5), then through ranking by experts (section 6 and 7). In this section, the results of these tests are evaluated and conclusions are drawn regarding the model. The section ends with some recommendations in order to refine the model, together with suggestions for further research.
In section 4, the following research questions were formulated:
Do the described product characteristics appear in the order that is predicted by the product phases?
Are the product phases an appropriate means to help predict the future of a product based on its history?
Do products always (or most of the time) follow the product phases in the predicted sequence?
Can phasing of a product’s life cycle offer designers starting points for a new product development?

8.2 Do the described product characteristics appear in the order that is predicted by the product phases?
This question can be answered on the basis of both tests. In the ranking test (study 2) forty nine statements about the product characteristics are distinguished. In seventeen cases, the experts affixed the statements so many times in the correct place that, according to the formulated criteria, this can be considered significant. In thirteen cases there is a strong indication, three times an indication and ten times a weak indication. Only on five occasions the positioning of the stickers are no better than had they been done at random, and once another position seems to be preferred. This is the case with the statement ‘The product is safe’. The theory of product phases says that in the first phase products are very rarely safe, and only in the next phase (optimisation) does safety improve. However, the experts think that products are safe from the beginning, as 22% position the stickers in phase optimisation and 17% in phase performance. According to the defined criteria, this suggests a ‘weak indication’ and ‘coincidence’ respectively. The results of the retrospective case survey and discussions with some of the subjects after the tests suggests that most people think that, because of the governmental rules of today, products that are unsafe never reach the market. Safety is then supposed to mean protection against wounds and avoidance of accidents. However, in the theory of products, this is meant in a much broader sense. The ease at which people get illegal access to computer systems or the ‘success’ of computer viruses are also defined with this statement. The retrospective case survey strongly confirms the statement that products are sometimes not safe during the first product phase. An example
includes: riding one of the first bicycles, as one had to be a true balance artist (Van der Wal, 2005). Also, some people were electrocuted by the first electric washing machines and kitchen cookers (Schol, 2005; Capota, 2005) and the first mopeds, especially the Solex, were far from safe (Van Eekelen, 2005).

8.3 Are the product phases an appropriate means to help predict the future of a product based on its history?
When this thesis was written, twenty four products had been analysed and described. Five can be found in section 5: electric shavers, mobile phones, bicycles, shampoo packaging and holidays. The remaining nineteen were described by students as a part of the master’s course on ‘Evolutionary Product Development’ at the University of Twente. Based on these cases, it can be concluded that the theory is fit to describe the history of a product. However, some cases deviated from the theory, but these were generally attributed to the influence of external factors, such as World War I or II, the growth of a competing product, etcetera.
With regard to predicting future developments: students are very capable of developing and styling new products with the aid of the theory. However, the time frame between the students designing these products and the finishing of this thesis is too short in order to judge if their designs will be seen through to fruition.

8.4 Do products always (or most of the time) follow the product phases in the predicted sequence?
The answer to this question can only be based on the retrospective case survey. In the ‘ranking by experts’ experiment, no examples of products were given. Therefore, it can be concluded that the products that were analysed, do indeed pass through the product phases in the predicted sequence. However, a few remarks have to be made with this statement. Firstly, it has been proved that it is difficult to mark the transition between the phases, and in most cases the transition is slow and over a long period of time. Secondly, it turns out that the product characteristics from previous product phases can return in the actual phase. Finally, it must be noted that the endeavour for technical innovations remains important during all of the product phases, but that the ‘real’ innovations mostly occur during the first product phases. In the latter phases they appear less frequently and have long time intervals.

8.5 Can a phasing of the life cycle of a product based on the product phases offer designers starting points for new product development?
This question only came into view with the students that worked with the model (see section 8.3). As stated in section 8.3, the students were able to work with the model and come with new product concepts. The students acknowledged this when they were asked, but it should be noted here that they had been instructed to develop a new product based on the theory. Finally, it would be interesting to ask the students many years from now (long after they had finished their studies) whether they still use the model and what they thought of the results.
9 Conclusions, discussion and recommendations

9.1 Introduction
In this section, the conclusions from the sections 5 and 7 are summarized. In section 9.3 some critical observations are made with regard to the product phases. In the last section, some recommendations are given for further detailing and investigation of the theory.

9.2 Conclusions with regard to the product phases
On the basis of both studies it can be concluded that the product phases appear in the predicted order. Some disruptions are found, but most of the times these can be explained by external factors.

9.2.1 Retrospective case survey
In most cases products follow the product phases as expected, but with some (often small) disruptions. These regard, for instance, the promotion (as is the case with the bicycle and the moped), the number of competitors (with vacations) and the production (with glasses). Furthermore, the findings revealed that it was difficult to draw a fine line between the end of one product phase and the beginning of the next, since some product phases overlap one another for long periods of time. However, in a number of cases the last two phases were not found. An explanation can be that the product has not yet reached these phases. Although, an important question that sometimes arises, is if a product is actually suited to reach the product individualisation phase. Finally, it proved that the awareness phase can often be found at a corporate level (examples are the electric shaver, the laptop, the vacuum cleaner, the washing machine and shampoo packaging), but very rarely at the product level.

9.2.2 Ranking by experts
Section 7 described how seventy one experts ranked forty nine statements – formulated in section 6. It can be concluded that they describe the product characteristics, and with that the product phases with mixed results. The first two product phases are described in the range from ‘well’ to ‘very well’. From the statement about the product performance phase, 93% is confirmed by the experts. For optimisation, this percentage reaches 85. The next four phases are not described so well. Itemisation has the lowest score, as only 56% of the statements are confirmed by the experts. For segmentation the percentage is 67, for individualisation it is 62% and for awareness it is 57%. It should be noted that the experts only deny a statement once, and that any other statements that are not confirmed are not denied by them.

9.3 Discussion
From this study, it can be concluded that the product phases form a useful aid to describe the historic development of a product and that in most cases the product phases appear in the predicted order. In this section, some seemingly conflicting findings are discussed and the predicting value of the theory is analysed.

Baudet (1986), states that products usually start as ‘status products’. Rogers (1995) also mentions status as a motive for people to be the first to purchase a new, innovative product. These statements seem to conflict with the theory of product phases, because their status seems to become important only in the product segmentation phase. However, Baudet adds to his statement that these products often “function poorly compared to existing products, but are wanted despite of that“. As an example he mentions, amongst others, the first cars that were much less reliable than the horse-drawn coaches, which were the norm in those times. With this he explains the difference between the status aspect in the first product phases and in the product segmentation phase (and the phases thereafter). During the first phases the possession of the product is discriminating (whether the product performs well or not), no activity from the designer is needed to achieve that. During the latter product phases, this is no longer the case and the designer has to deliberately add this property (emotional benefit) to his design.

Two questions that have not been discussed in great detail during the course of this study (and therefore can only be answered partially) are:
- Is it possible to predict future developments of a product?
- Does phasing of the product life cycle (in the described product phases) offer designers starting points when they are developing new products?

To answer the second question: Master’s students at the University of Twente have proved to be very able in developing the next generation of a product based on the model. Two students preferred not to design a new product but to develop an interactive website with which a consumer can design his own product. According to the students, both products are in the individualisation phase. Another student designed an electric shaver where it was possible to affix a photograph or drawing in order to personalise the product. In this way a product that is in the segmentation phase can be individualised – suitable for a Father’s Day present, for example. For some students it was difficult to design something ‘evolutionary’, as the tendency was big to make an ‘innovative jump’ instead of the ‘next, small, logical step’.

Returning to the first question – Is it possible to predict future developments of product? This has already been partly answered now. If it is possible to develop a new product based on the product phases, then it also is possible to make predictions. The question if these predictions are correct can only be answered after some time.
9.4 Recommendations
In section 9.3, some remarks were made regarding the theory of product phases. The first phases have been defined with more accuracy than the latter. It seems that the ‘career’ of a product varies considerably as time progresses. Perhaps there is an analogy between the career of a human being and that of a product? It was shown that external factors can cause a disturbance on the course of the product phases. It also appeared that it is hard to draw a fine line between two different, successive product phases, as product phases can exist concurrently. Despite these limitations, the theory of product phases has proven to be a useful thinking aid in order to make the large variation in ‘product careers’ well structured and unambiguous.

9.4.1 Education
With regards to schooling, the theory has proven to be a useful tool to teach students to incorporate the history of a product into their design process when developing a new product and to develop the next logical step instead of trying to make an ‘innovative jump’. This is important as most of the products that are developed are very rarely ‘completely new’ (and sometimes ‘not new at all’), since they are often the successors of existing products that have minimal differences from their predecessors.

9.4.2 Design practice
In his design practice, a designer can use the product phases in order to guide the new product development. He can also use it as a means in the decision process. Designers seldom decide whether a product will be manufactured and introduced into the market, since this decision is usually made by the entrepreneur or manager who is in charge of the project. However, in most cases the designer has to convince his client. When doing so he can make use of the product phases to explain why and on what grounds certain decisions were made. Finally, a designer who has his own agency can use the product phases as an acquisition tool. If he studies the history of the products of his prospect he can give them (even in the first meeting) a vision on the main lines of his future product assortment.

9.4.3 Research
As in section 9.3, there are many aspects that warrant further investigation into the theory of the product phases. For example:
- Analysing more products.
- Investigating to what extent the theory can be used for the various services.
- Researching the similarities and possible differences between consumer products and business to business products.

However, the following two aspects should have priority because they will (hopefully) remove any uncertainty concerning the last two phases.
(individualisation and awareness) and may also further improve the usability of the theory.
- Research to what degree the last two product phases form a part of the segmentation phase, or should they be considered as separate product phases?
- A study to find out to what extent designers are able to make ‘correct predictions about future products’ based on the theory of the product phases (i.e., how many developed products based upon the proposed theory have actually been successful).

With regard to this last question, the documentation and the study (after a few years) of products that were developed by students during the course ‘Evolutionary Product Development’ could give an indication. How many products developed by the students match successful products developed by companies during the same period of time? How close are their designs to those that later became a success?
References
- Baudet, H., (1986), Een vertrouwde wereld; 100 jaar innovatie in Nederland, Bert Bakker, Amsterdam.
- Bijker, W.E., (1990), The Social Construction of Technology, University of Twente, Enschede.
- Brummelman, C.A.G.S., (2005), Het Horloge, Opleiding Industrieel Ontwerpen, Universiteit Twente, Enschede.
- Capota, K.J.B. (2005), Het Fornuis, Opleiding Industrieel Ontwerpen, Universiteit Twente, Enschede.
- Dijkstra, W., (2005), De ontwikkeling van het scheerapparaat, Opleiding Industrieel Ontwerpen, Universiteit Twente, Enschede.
- Eekelen, V.J.J.J. van, (2005), Van Solex tot scooter; productfasen van de bromfiets, Opleiding Industrieel Ontwerpen, Universiteit Twente, Enschede.
- Elkington, J. and Hailes, J., (1992), Holidays that don’t cost the earth, Victor Gollancz, Londen, Engeland.
- Hout, D.F.M. van, (2005), *De Evolutie van de Laptop*, Opleiding Industrieel Ontwerpen, Universiteit Twente, Enschede.
- Muller, I., (2005), *De Stofzuiger*, Opleiding Industrieel Ontwerpen, Universiteit Twente, Enschede.
- Wal, K. van der, (2005), *Productfasen Fiets; Onderzoek & Ontwerp*, Opleiding Industrieel Ontwerpen, Universiteit Twente, Enschede.