

## MASTER

### Soft reliability problem reduction before product launch

van Eekelen, R.J.J.M.

*Award date:*  
2007

[Link to publication](#)

#### **Disclaimer**

This document contains a student thesis (bachelor's or master's), as authored by a student at Eindhoven University of Technology. Student theses are made available in the TU/e repository upon obtaining the required degree. The grade received is not published on the document as presented in the repository. The required complexity or quality of research of student theses may vary by program, and the required minimum study period may vary in duration.

#### **General rights**

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain

# **Soft Reliability Problem Reduction Before Product Launch**

**niet  
uitleenbaar**

**Master Thesis R.J.J.M. van Eekelen**



# Soft Reliability Problem Reduction Before Product Launch

**Date**

July 2007

**Author**

R.J.J.M. van Eekelen

Student number: 0466452

**Eindhoven University of Technology**

Faculty of Technology Management

Sub department of Quality and Reliability Engineering

**Daily supervisor**

Ing. W.H.J.M. Geudens

Eindhoven University of Technology

Faculty of Technology Management

Sub department of Quality and Reliability Engineering

**1<sup>st</sup> supervisor**

Prof. Dr. Ir. A.C. Brombacher

Eindhoven University of Technology

Faculty of Technology Management

Sub department of Quality and Reliability Engineering

**2<sup>nd</sup> supervisor**

Dr. Ir. P.J.M. Sonnemans

Eindhoven University of Technology

Faculty of Technology Management

Sub department of Quality and Reliability Engineering



## **Abstract**

Soft reliability problems occur more and more often in highly innovative industries due to consequences of trends in the market; companies want to reduce the amount of soft reliability problems by involving customers in their product and developing process. But it is difficult for companies to select customers for their tests. This thesis searches criteria for customer selection for soft reliability problem tests. At the end an ideal test is given with all criteria that a test must satisfy for optimal results.



## **Acknowledgements**

This master thesis is the result of my graduation project. It is the final part of my study Industrial Engineering and Management Sciences on the faculty Technology Management at the Eindhoven University of Technology.

In the beginning my research was not clearly defined, a broad scope of possible research projects was possible to investigate. After several meetings with my supervisors and discussions with them, it became clear for me which subject I would take for further investigation.

It was not possible for me to finish this thesis without the help of my daily supervisor Wim Geudens. Also meetings with Professor Brombacher were very useful for me to complete this thesis. At some point also Dr. Sonnemans joined my team of supervisors and I'm him very thankful for his ideas and comments on my thesis.

Besides my supervisors I will also thank my family, my girlfriend and all other friends who keep on supporting me during this last phase of my study. Without their support it would be very hard for me to complete this thesis.

Bob van Eekelen  
Eindhoven, July 2007





## Summary

### Introduction

In the market of high tech products like the consumer electronics market are several trends visible lately. Due to those trends the market is changing and that gives some consequences.

These are trends that are now common knowledge in the market: [Bro05][Pet03][Min05]

- Complexity of products is changing. Products are getting more and more complex, more and more features are introduced on products.
- Time to market is decreasing. Producers of high tech products must be on the market first otherwise the market is given to a competitor. Which means no profit for the companies that come on the market late.
- Legislation policies are changing. Products must have much more warranty time and much cover much more problems of the product.
- Globalization is another trend. The world is the market. Products are developed in Europa, produced in Asia and sold in America.
- Low price setting / fast price dropping is the last trend in the industry. Companies want to make their profit fast by selling as much as possible quantities in shortest time. This means low prices of the product. Competitors must also have low prices otherwise they can't survive.

These trends lead to some problems: [Bro05]

Due to shorter developing times it is more difficult for companies to produce products without faults. Besides this problem there is another big problem, the product life cycle is getting shorter and shorter, that means there is no time left to solve problems in existing products because before these problems are discovered there is already a new product (a new version). And there are getting more and more features on the product that the chance of getting problems is getting higher.

Also the amount of problems that can't be sold because no fault was found (so called no fault found problems) is increasing last couple of decades. This means that products are for instance too complex for customers. Part of the so called no fault found problems are so called soft reliability problems.

Soft reliability problems are customer experienced problems with an in-specification product. [Geu04]

This thesis will focus on soft reliability problems. Consequences of problems mentioned before are that products can't be modified before customers bought the product and give their problems to the company. [Pet06] But then a new product will already been in the developing phase. This means that products must be tested to reveal problems before the product gets on the market. This means that customers must be involved in the product development process to perform some tests to reveal problems of the product. Then those problems can be solved before the product will come on the market.

### **Research question**

After the introduction and the explanation of the problems it is clear what the problem is: There is not enough time to modify products while the product is on the market already. This means that there must be tests before the launch of the product. These tests can be executed best by ordinary customers for optimal results.

Therefore the research question of this thesis will be:

Which customers must be involved in a product development process to prevent soft reliability problems?

This research question leads to two more sub research questions:

- How can customers be categorized?
- Which product development methods involve customers in their product development process to discover soft reliability problems?

Both sub research questions will be handled first

### **Customer categorization**

Customers can be categorized in several ways. This thesis uses three methods:

- Rogers' method: Rogers divides all customers into 5 categories based on the moment that they adapt the new technology. These groups are: innovators, early adopters, early majority, late majority and laggards. The groups are not even divided: the percentages are about: 3-5%, 10-15%, 34%, 34%, 5-16% of the customer population. [Rog93]
- Saaksjarvi's method: Saaksjarvi divides the customer population into 4 categories of technology knowledge; more precisely the willingness to learn new technology. The 4 categories are: technovators, supplemental experts, novices and core experts. [Saa03]
- Lambert's method: Lambert divides customers to their place in the supply chain. He sees 3 types of customers: internal customers, intermediate customers and external customers. Those customer types have each their own soft reliability problems. [Lam06]

### **Test Methods that involve customers**

There are several test methods that involve customers in their tests. And those tests are carried out before the launch of the product on the market.

Three different methods of usability testing will be presented.

- Nielsen's method: The usability testing method according to Nielsen focuses on the experience of customers with the product. This means novices and experienced customers must perform tests (not always the same tests) to generate as much as possible soft reliability problems. [Nie93]
- University of Copenhagen method: this usability testing method focuses on many aspects of their testers: they wanted to use customers with these qualifications: novice user, experienced user, old inexperienced person, handicapped user, child, the noble and upright person and the progressive and enthusiastic young man. To

get an optimal result all these groups of customers must be involved in their tests. [Cop05]

- Dumas's method: Dumas focuses on the position of the customer in the product life cycle. From every part of the product life cycle he wants customers to perform tests. [Dum99]

Then the lead user method by Von Hippel [Hip88] will be presented. His test method involves customers (lead users) that have the ability to foresee problems in future and have the ability to get solutions for those problems.

Finally also focus groups will be presented. This method has as strength that customers must work together in small groups to discover soft reliability problems. Through cooperation they can come further in the test and thus they can discover more soft reliability problems than if they had tested the product individually. [Zan02][Gra98][UoP06]

### **Criteria**

From all these methods and views it is possible to discover criteria that were used to select customers for tests. Which qualifications must customers have to execute those tests?

At the end 10 criteria are found:

1. Different users of a product in the product lifecycle, based on Rogers' and Dumas' methods
2. Technology knowledge, based on Saaksjarvi's view
3. Place of the customer in the supply chain, based on Lambert's view
4. Experience of the customer with the product, based on Nielsen's view
5. Age of the customer, based on the method of the university of Copenhagen
6. Size of the test group, based on the focus group method
7. Quality to foresee problems in the future, based on Von Hippel's method
8. Culture, based on trends of the industry
9. Product customer interaction, based on Geudens ideas
10. Real prototype, based on all methods.

With those criteria it is possible to make a matrix where all test methods mentioned earlier will be judged with these criteria.

	Different users of a product in the product lifecycle	Technology knowledge	Place of the customer in the supply chain	Experience of the customer with the product / technique	Age of the customer	Size of the test group	Quality to foresee problems in the future	Culture	Product customer interaction	Real prototype	Total score
Usability Nielsen				+		-			-	+	
Usability university				+	+	-			-	+	
Usability dumas	+					-			+	+	
Lead user	-	+	-			-	+		+	+	
Focus group						+				+	

positive 

+
---

  
 negative 

-
---

**Figure 1: Matrix: scorecard methods vs. criteria**

Plusses in the matrix mean that the test method does take into account that criterion; minuses mean that the test method doesn't take into account that criterion. Empty places in the matrix mean that there was not enough explicit information available to make a clear judgment or that the test method doesn't focus on that criterion.

**Ideal test**

With those criteria it is possible to make an ideal test guidance:

- Different users of a product in the product lifecycle. For the ideal test you have participants from every five categories, from an innovator till a laggard.
- Technology knowledge, for the ideal test you got participants from every 4 categories, from a core expert till a technovator.
- Place of the customer in the supply chain, people from the entire supply chain must cooperate in the tests.

- 
- Experience of the customer with the product. People with less and people with a lot of experience with the products are needed for the ideal test and if possible people with an inadequate amount of experience.
  - Age of the customer, customers from every age category must participate in the tests, but only those categories that will actually buy the product.
  - Size of the test group, not only individual tests must be done but also some group sessions in focus groups are good to reveal soft reliability problems in products.
  - Quality to foresee problems in the future, some people that have this ability are needed to prevent some problems in future.
  - Culture, participants with different cultures must participate in the tests.
  - Product customer interaction, only people that will actually buy and use the product must execute the tests.
  - Real prototype, best results will get when people can perform the tests on real prototypes.

### **Practical Considerations**

The presented ideal test is too much time consuming and expensive, therefore three different considerations will be presented to solve this ideal test or to make it easier to implement.

1. The ideal test can be solved by using factorial experiments, but then again many experiments must be carried out.
  2. Criteria grouping can be done to reduce the amount of criteria, or to show which criteria are related to each other and are easy implement when 1 of those is implemented. Possible combinations are: Technology knowledge (passive), age of the customer and culture; Technology knowledge (active), experience of the customer with the product and quality to foresee problems in future; different users of a product in the product life cycle and place of the customer in the supply chain.
  3. Criteria were looked after their ability to implement and their benefits after implementation. In Figure 6.1 it became visible that 5 criteria can be implemented relatively easily with good benefits:
    2. Technology knowledge
    5. Age of the customer
    6. Size of the test group
    9. Product customer interaction
    10. real prototype
- 4 other criteria can also be implemented but are harder to implement but generate also many benefits:
1. Different users of a product in the product lifecycle
  4. Experience of the customer with the product
  7. Quality to foresee problems in future
  8. Culture



## List of Abbreviations

HRP	Hard Reliability Problem
NFF	No Fault Found
SRP	Soft Reliability Problem



## Table of Contents

<b><u>ABSTRACT .....</u></b>	<b><u>5</u></b>
<b><u>ACKNOWLEDGEMENTS .....</u></b>	<b><u>7</u></b>
<b><u>SUMMARY .....</u></b>	<b><u>9</u></b>
<b><u>LIST OF ABBREVIATIONS.....</u></b>	<b><u>15</u></b>
<b><u>TABLE OF CONTENTS .....</u></b>	<b><u>16</u></b>
<b><u>CHAPTER 1: INTRODUCTION .....</u></b>	<b><u>19</u></b>
§1.1 NEW PRODUCTS .....	19
§1.2 QUALITY AND RELIABILITY PROBLEMS .....	22
§1.3 SOFT RELIABILITY PROBLEMS.....	23
§1.4 HIGH TECH PRODUCTS .....	24
<b><u>CHAPTER 2: RESEARCH ASSIGNMENT .....</u></b>	<b><u>25</u></b>
§2.1 RESEARCH QUESTION.....	25
§2.2 STRUCTURE OF THE THESIS.....	26
§2.3 PURPOSE OF THIS THESIS.....	27
<b><u>CHAPTER 3: CUSTOMER CATEGORIZATION.....</u></b>	<b><u>28</u></b>
§3.1 ROGERS .....	28
§3.2 SAAKSJARVI.....	29
§3.3 LAMBERT .....	31
§ 3.4 CONCLUSIONS CUSTOMERS CATEGORIZATION .....	32
<b><u>CHAPTER 4: OVERVIEW TEST METHODS.....</u></b>	<b><u>33</u></b>
§4.1 INTRODUCTION .....	33
§4.2 USABILITY TESTING .....	33
§4.2.1 NIELSON.....	34
§4.2.2 UNIVERSITY OF COPENHAGEN.....	35
§4.2.3 DUMAS .....	36
§4.3 LEAD-USER METHOD.....	37
§4.4 FOCUS GROUPS.....	37
<b><u>CHAPTER 5: CRITERIA SOFT RELIABILITY PROBLEM TESTS.....</u></b>	<b><u>39</u></b>

---

§5.1 CRITERIA ORIGINATING FROM CHAPTER 3 .....	39
§5.2 CRITERIA ORIGINATING FROM CHAPTER 4 .....	40
§5.3 OTHER CRITERIA .....	41
§5.4 SOFT RELIABILITY PROBLEM TEST CRITERIA.....	42
§5.5 MATRIX: METHODS VERSUS CRITERIA .....	44
§5.5.1 USABILITY TESTING: NIELSEN .....	45
§5.5.2 USABILITY TESTING: UNIVERSITY OF COPENHAGEN.....	45
§5.5.3 USABILITY TESTING: DUMAS .....	46
§5.5.4 LEAD USER METHOD .....	46
§5.5.5 FOCUS GROUPS.....	47
<b><u>CHAPTER 6: ANALYZING DATA MATRIX AND IDEAL TEST.....</u></b>	<b>49</b>
§6.1.1 ANALYZING DATA MATRIX.....	49
§6.2 IDEAL TEST.....	50
§6.3 PRACTICAL CONSIDERATIONS.....	51
§6.3.1 FACTORIAL EXPERIMENTS.....	51
§6.3.2 CRITERIA GROUPING.....	51
§6.3.3 BENEFITS OF IMPLEMENTATION / EASE OF IMPLEMENTATION.....	53
<b><u>CHAPTER 7: CONCLUSIONS / RECOMMENDATIONS FURTHER RESEARCH.....</u></b>	<b>58</b>
§7.1 CONCLUSIONS .....	58
§7.2 RECOMMENDATIONS FURTHER RESEARCH .....	60
<b><u>REFERENCES: .....</u></b>	<b>62</b>



## Chapter 1: Introduction

This first chapter describes the environment in which this master thesis project must be carried out. This chapter will start (paragraph 1.1) with some general trends of the market and reasons why companies produce new products all the time. The next paragraph (paragraph 1.2) will describe quality en reliability problems due to the trends in the market. Also problems due to trends will be presented. In paragraph 1.3 soft reliability problems will be presented and in paragraph 1.4 high tech products will be introduced. This approach leads to the research question, which will be presented in chapter 2 and will be answered in the remaining parts of this thesis. Answers on that research question must solve problems resulted from trends and characteristics of the market.

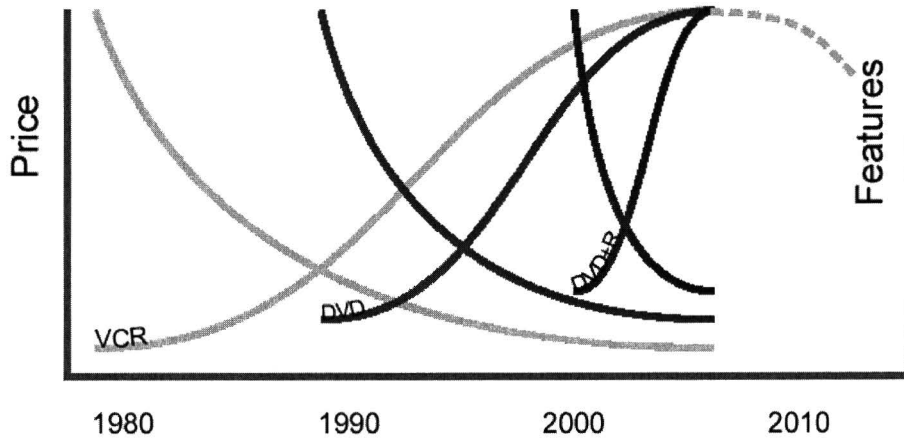
### §1.1 New products

New products come on the market all the time. But why are all these new products coming? There are several reasons why companies bring new products onto the market: [Coo93] [Win97]

1. The product life cycle is getting shorter due to growth competition.  
More competition in the market means that companies must innovate more often to keep their market share.
2. The globalization.  
The potential market consist not only of one single country or continent but of the whole world; which means that there are much more competitors active in the market.
3. Increasingly faster evolution of new technologies.  
Due to the evolution of new technologies more companies will use the new technologies in their products and if a company wants to produce as effective as they do, it also got to innovate, which means that the company will also bring new products on the market earlier.
4. The frequent changes in customer preferences.  
Customer preferences change more quickly than a decade ago; this means customers want new products earlier.

Besides the reasons mentioned above there are also some more general trends in the fast moving consuming goods industry. Because of the changes in the customer preferences the market will change and that will lead to some trends in the market. [Pet03] [Uit04] [Kar04] [Bro05]

1. The complexity of products is increasing. More and more features are involved in new products. Customers are asking for more features. Also producers of products are creating new features to get a better position in the market and sometimes other competitors may also have features so you also need that feature. In Figure 1.1 it is made visible that the increase of features in products gets faster while the price of those products drops faster (see also trend 5)



**Fig. 1.1: Increasing functionality and decreasing price [Uit04]**

2. The time-to-market is decreasing. Products must be on the market as soon as possible with all their new features. Producers of new products try to be on market first to make the largest margin.
3. Many producers are outsourcing their production and/or their R&D departments to other companies or are producing products in other parts of the world to get labor cost down.
4. Finally there is a major trend in changing legislation rules set by the government; so warranty time is getting longer and covers more.

During the last decade there is also a new trend visible in the high tech consumer electronics industry.

5. Low price setting /fast price dropping. New products will be introduced on the market with a very competitive price. In this way manufacturers get their return on investments faster and more people will be able to buy the new product because they don't need to wait till the price is dropping. It is also possible that products are put in the market with a fast price dropping strategy, only a few weeks / months at a high price and then the products will be lowered in price very fast (every couple of weeks / months); then companies also get their return on investment faster due to higher sales volumes and getting a bigger market share. [Min05]

Those trends also have influences on the product reliability. Some influences are: [Bro05]

1. More and more complex products make product (quality) validation and evaluation more complex and therefore more expensive and time consuming.
2. The increasing complexity of global business processes, combined with problems with the supporting information flows may mitigate knowledge accumulation with respect to quality and reliability.
3. The strong pressure on "time to market" requires, however, fast and efficient methods to ensure product reliability in the very early phases of a product development.
4. Since, especially with strongly innovative products used in complex field environments, there remains a strong likelihood that problems appear in the field

(either due to flaws in the process and / or due to unexpected or even unintended use of the product) a strong feedback system is needed to learn fast and efficient especially from these unexpected failures.

Next a small exhibit will be given on some trends how they influence the market today.

**Small exhibit of trends:**

The VCR's and the old-style TV were in the shops for decades; nowadays new products will there only be for a few years (see shorter developing times and product life cycles). This also means that it is getting tougher for people to adopt new techniques and technologies. In the past people were adopting to new technologies when they were still a child and bought the new products when they were grown up. But new products like I-pod's or hard disk recorders will be on the market only for a very short time (couple of years) so there will not be enough time for everybody to get familiar with the new technologies.

Besides influences of the trends mentioned before, there is another point that must be taken into account. Many people will buy products that will be almost always multifunctional where they're not ready for. Multifunctional versus single/one function products like the TV and the multi media system for playing / recording / editing etc is also an interesting trend, here also is a small exhibit of that trend.

**Another small exhibit:**

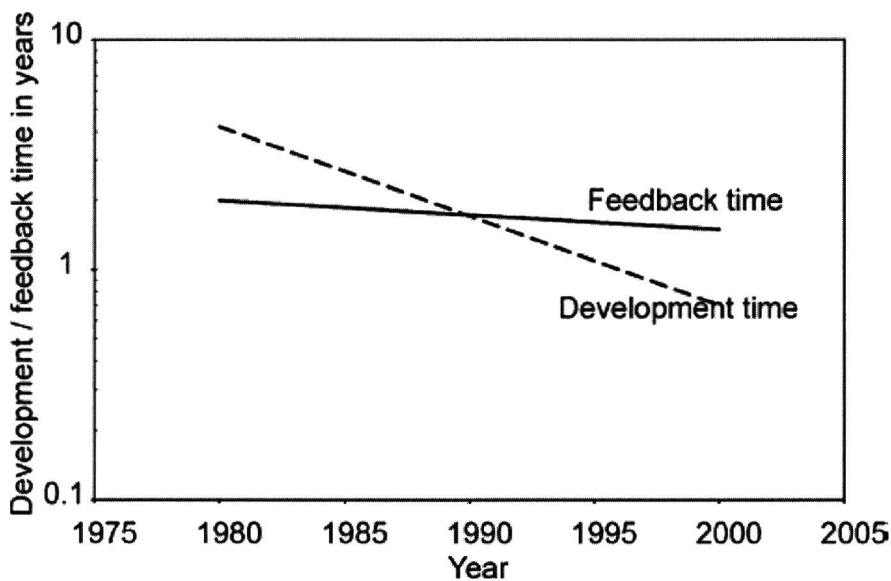
Some telecom providers offer a telecom subscription in combination with an internet subscription. Buyers might like the telecom deal but also get the internet offer. But they might not be ready for such technologies. So they will not use the internet or the internet will be used by people with less knowledge of it. Problem for the producers of such products is that they have customers with their products which were not the intended customers of the product. This gives a lot of consequences, like must the unexpected new customers been part of the usability test? Is it worth also to focus on them? Create the new group of customers bad advertising? And is that a problem? These are important questions for companies, they must be clear for them otherwise they don't know what they're doing. This thesis will focus on criteria for soft reliability tests. When companies know what to do with those new customers they can also modify their test scripts to implement also the new group of customers in their tests.

Correlated with multifunctional products and the new group of customers that will use the product, it is important that manufacturers don't forget this step in their product creation process. For whom are they making those new products? They don't know who their buyers are, which makes it difficult to make the products in such a way that they are easy to use for the buyers. This thesis will put attention on this point in trying to make clear which customers participate in a product development process to reduce the amount of problems when the product is finally launched.

**§1.2 Quality and reliability problems**

The development process is more and more shortened due to the reasons (time to market decreasing and complexity of products) mentioned in paragraph 1.1. In the past it was normal that businesses had enough time to evaluate the feedback receiving from the field and then do some modifications, but due to the changes in the markets the feedback time is now longer than the development time of a new product. This means that nowadays a call from the field can not been solved by modification of the production process because there is already a new product available; businesses aren't making the old types anymore.

Next figure (figure 1.2) gives an illustration of the decreasing developing time of new products and the feedback time which will be almost constant in time.



**Figure 1.2: Feedback time versus development time for high tech consumer electronic goods. [Bro05]**

Besides the decreasing developing time there is another point that deserves attention; over the last couple of decades the percentage of No Fault Found problems (NFF, Failures where the cause of the complaint could not be determined) is increasing fast. Brombacher shows a picture of a manufacturer of high-tech equipment, it is clear that the percentage of no fault found problems is increasing fast last decades [Bro05]: This is dealt with in more detail in the next paragraph.

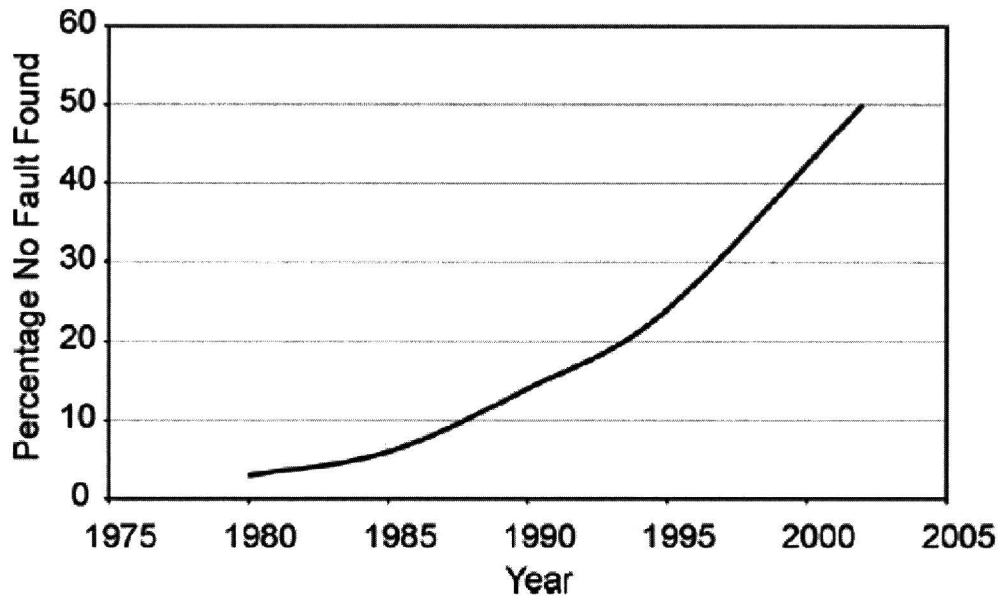


Figure 1.3: Percentage no fault found in modern high-volume consumer electronics [Bro05]

### §1.3 Soft reliability problems

In §1.2 no fault found problems were introduced. Most of no fault found problems are soft reliability problems, product is ok, but the customer is not content with the product. But what are soft reliability faults? Geudens et al have given a definition of soft reliability faults in his paper: Soft Reliability, a new Class of Problems for Innovative Products: “How To Approach Them”: The definition of a soft reliability problem is: “customer experienced problems with an in-specification product.” [Geu04] Software problems are also hard problems.

Rogers describes in his book Diffusion of Innovators 5 types of soft problems. [Rog93]

- Relative advantage: the degree to which an innovation is perceived as being better than the idea it supersedes.
- Complexity: the degree to which an innovation is perceived as relatively difficult to understand and use.
- Compatibility: the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters
- Trial-ability: the degree to which an innovation may be experimented with on a limited basis.
- Observe-ability: the degree to which the results of an innovation are visible to others.

This thesis focuses on products that will be sold on the market for high tech products. The next paragraph gives more information on high tech products.



### §1.4 High tech products

The market trends described in the first paragraph are valid for the market of highly innovative consumer goods. In this paragraph, the market of high tech products is discussed. Definition of a high tech product will be given and risks of those products will be discussed.

Meldrum [Mel95] comes to the following definition of high-tech products:

High-tech products:

- Have been developed in a highly technical environment
- Incorporate a new or advanced technology which acts as a focus for their evaluation
- Are associated with a high degree of technologically-based uncertainty on the part of both supplier and the consumer
- Are not currently accepted as natural solutions for the problems they have been designed to address
- Do not yet have an associated external infrastructure

Meldrum argued in his article: “Marketing high-tech products: the emerging themes”, over high tech products. He stated that high tech products are not always high-tech, only partly. This is because high-tech products are made from parts that were already used in other products. But these common technologies and maybe some new techniques together make a product high tech. [Mel95]

Highly innovative products have some new techniques that make them high tech. But the customers who have to buy the products are mostly averse to some new techniques. The old, common techniques are well-known so why should it be changed? If a company wants to introduce a highly innovative product, it is important that the customers must feel good. That’s a contradiction, customers must feel good with the new techniques and customers are averse of new techniques [Mel95]. This gives a lot of tension on the market when a new product is introduced. For companies it is important that the risk for the customers must be as low as possible to avoid losses. The risk of the customer is the risk for purchasing a new product that you don’t want or that you are not able to work with it. All purchases involve a risk for the buyer, but for purchasing high-tech products the issue of risk is magnified by the uncertainties associated with a new technology. this can be a risk for the consumer but also for the company.

There are two kinds of risk:

- The risk for the supplier/company is that for a new high-tech product the company got no experiences yet with how to sell it, how to distribute it or how to service it.
- Customers’ risks will be derived from a lack of experience in applying, maintaining and using technology, which will increase the chances of problems such as further costs, interruptions to supply continuity, unexpected side-effects or quality deficiencies.

## Chapter 2: Research Assignment

In chapter 1 several trends were described in the industry and some of their consequences for the reliability problems of new products. In chapter 2 the research question will be presented (paragraph 2.1), in which way this research question will be handled in future chapters of this master thesis will be presented in paragraph 2.2 and in paragraph 2.3 the purpose of this thesis.

### §2.1 Research question

In Chapter 1 an overview was made of the fast moving consumer goods industry. Some trends and consequences of those trends were presented. In particular the setting is that when a new high innovative product comes on the market nowadays the amount of soft reliability problems is relative high in comparison with years ago. The reasons therefore are the trends described in paragraph 1.1. Consequences of those trends are that the introduction of new products is getting faster and faster. If customers got some problems with their new products and they make a field call [Pet03] it will take too much time before the field call is at the product development team. That team is already creating a next generation of the product so the faults found in the field cannot be recovered in the current generation of products. So customers have bad experiences with the product and to prevent that in future it is a possibility to create new products in cooperation with customers; in that way some soft reliability faults can be prevented. [Pet06] Because when customers are involved during the development process of a new product, the product can be modified before the product launch. But which customers must be selected by the companies to do some tests in the developing phase of the product? This is exact the question where this thesis will be about.

Another problem is that companies want to save money. They can do that by combining tests. This means that soft reliability tests and hard reliability tests were done together. This means that 1 person must discover hard and soft reliability faults. That's even more difficult because he has to focus on two things. Another problem with combining tests is that it is even more difficult to select the right person for the tests. How is the person selected? On his capabilities to discover hard reliability faults, or on his capabilities to discover soft reliability faults. If 1 person must conduct both tests it is obvious that not the best results will be found for HRP and SRP's. This thesis will focus on the selection criteria for soft reliability problem tests .

This means that the initial research question will be:

#### **Initial Research question:**

*Which customers must be involved in a product development process to prevent soft reliability problems?*

There are many, many customers that buy products of the companies. When customers are involved in the product development process, companies would like to know which customers they must select. This means customers must be categorized in groups.

This leads to the first sub research question:

**Sub research question 2.1:** How can customers been categorized?

By means of a literature investigation sub research question 2.1 will be solved. The literature investigation and the results will be presented in chapter 3.

Another part of the research question is “product development process”. To tackle this part of the research question another literature investigation will be done to see which product development methods are used in the developing highly innovative products for the consumer market to discover soft reliability problems. Another sub research question can be made:

**Sub research question 2.2:** Which product development methods or techniques are used for developing highly innovative products and involve customers in their process to indicate soft reliability problems?

In chapter 4 this will be handled and the results of the research and the research itself will be demonstrated.

When an overview of the techniques and methods is given, it must be possible to see if there is any customer differentiation in product development processes. If there is some differentiation then it is possible to explain on what reasons the customers are selected to help in that specific product development process.

## **§2.2 Structure of the thesis**

This paragraph will handle the structure of the thesis. All chapters will be handled shortly to give a complete view of the thesis.

This thesis started with chapter 1 where a complete overview was given of the trends in the high tech consumer goods industry. Also terms soft reliability problem and high tech product were introduced. In chapter 2 the research question was introduced after analyzing chapter 1. Also some sub research questions were made. Sub research question 2.1 will be handled in Chapter 3: customer categorization; different views on how customers can be categorized will be passed. Then sub research question 2.2 will be dealt with in chapter 4; several product developing processes and some developing techniques will be presented that are used nowadays to reveal soft reliability problems. Goal is to see on what criteria those customers were selected for those tests. After that in chapter 5 criteria for a soft reliability problem test will be generated by reviewing chapters 3 and 4. Also a matrix will be made to show which methods and techniques from chapter 4 take which criteria into account. In chapter 6 the matrix created in chapter 5 will be used to create an ideal test and a more practical test. Then in chapter 7 the conclusions of this

thesis will be presented and the answers on the research questions will be presented and some recommendations for further research will be given. At the end of the thesis there will be a reference list.

### **§2.3 Purpose of this thesis**

The purpose of this thesis is to get answers on research questions and more insight of the customers that are involved in the product development processes. With results of this thesis it must be possible for companies to select customers for tests in their product developing processes in a more structured way. In that way the curve of no fault found problems (figure 1.3) must go down again because when customers are involved in the product development process in the right way and companies really listen to their advices and comments, the products that come on the market must have a better quality for use.

## Chapter 3: Customer categorization

In this chapter there will be a focus on sub research question 2.1 (How can customers be categorized?). The models below were selected on their relation with soft reliability problems, it is important to know on what criteria these models are made because with that information it is maybe possible to generate criteria for soft reliability problem testing. Different authors have already been written about this subject and will be presented in the next paragraphs. Rogers' view will be displayed in paragraph 3.1, Lambert's in paragraph 3.2, Marsh's in paragraph 3.3. Saaksjarvi's will be handled in paragraph 3.4. The conclusions of this chapter will be presented in paragraph 3.5.

### §3.1 Rogers

Rogers [Rog03] describes five groups of customers. These groups are formed in the way these people adopt to the new products.

There are 5 groups

- Innovators,
- Early adopters
- Early Majority
- Late Majority
- Laggards

These groups are formed in a way that the members of the groups adopt to new technologies. The innovators want to adopt every new technology. They are followed by the early adopters and so on; whereas laggards adopt new technology late. The next figure (figure 3.3), the TALC-curve, (Technology Adoption Life Cycle) shows that.

TALC curve, Technology Adoption Life Cycle

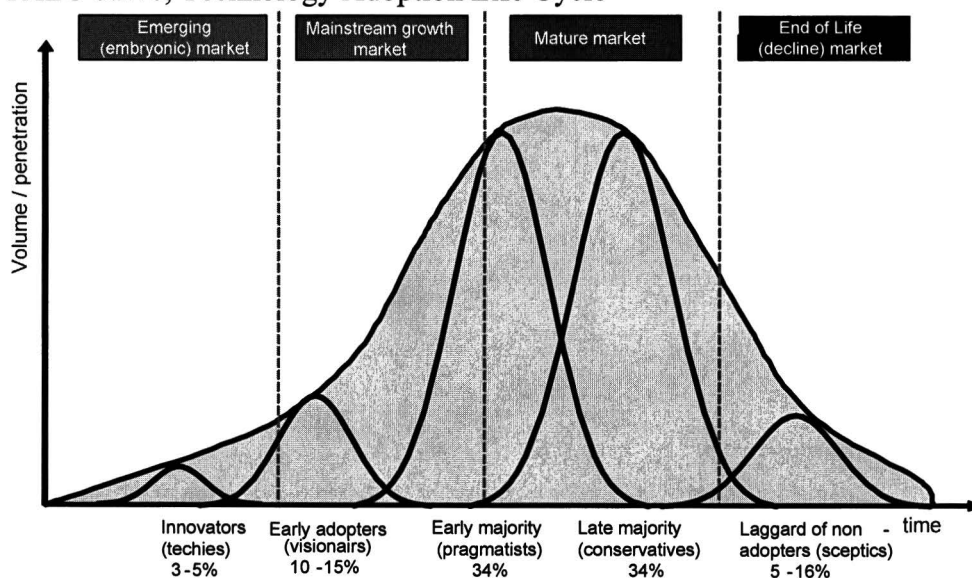


Figure 3.1: TALC curve [Rog03]

Rogers' model is clear in dividing customers into a category. When a new product comes on the market, customers will buy the product. But which customers will buy it. Mostly the innovators will buy the new product some early adapters and maybe a few early majority customers will buy it. Thus it is known who buyers are of the product. If a large group of customers is asked to fill in a questionnaire about their purchases and equipment at home a distribution can be made of which customer is an innovator and who is part of the late majority and so on. Rogers groups customers on their moment of new product adoption.

### §3.2 Saaksjarvi

Saaksjarvi [Saa03] developed another model for categorizing customers. She read the articles and books of Rogers [Rog03] and then she created her own vision. It is a model based on knowledge of the customer and his compatibility. Saaksjarvi groups customers after their knowledge of technology.

In Saaksjarvi's article: Consumer adoption of technological innovations; there are four categories of customers:

1. Technovators
2. Supplemental experts
3. Novices
4. Core experts

Ad 1. Technovator: a person who recognizes the benefits of new technology earlier than others, adopts it, and communicates these benefits to other segments.

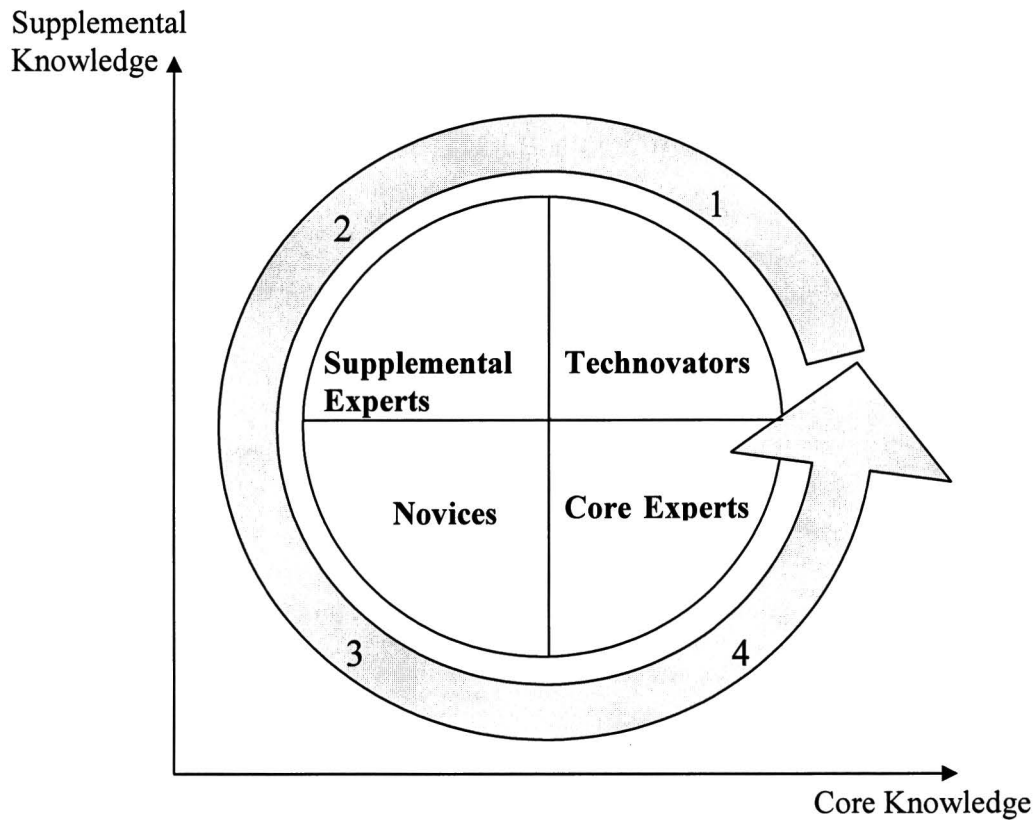
Ad 2. Supplemental experts have the advantage of being able to apply their knowledge into several different products and services; their knowledge is not constrained by a particular product or service but rather by the domain in which they operate.

Ad 3. Novices have no expertise in either core or supplemental product or service areas, which makes them more open to innovations than core experts since they have yet to establish usage patterns and attach affect to the product or service.

Ad 4. Core experts are the last group to adopt an innovation. They cannot construct a number a relational-based mappings, their knowledge creates resistance towards the innovation, reducing both comprehension and perceived net benefits.

The next figure (figure 3.2) describes coherence between supplemental knowledge and core knowledge, and the four groups of customers. Core knowledge is basic knowledge and supplemental knowledge extra knowledge / experiences of certain things. Example: supplemental experts might be low in camera knowledge (core) and high in computer knowledge (supplemental) so this group of persons was most likely to adopt a digital camera. The figure shows the 4 different groups and their positions in relation with core

and supplemental knowledge. Starting with technovators a circle can be made to supplemental experts, novices and finally core experts.



**Figure 3.2: The technology adoption cycle by Saaksjarvi [Saa06]**

The next table (table 3.1) shows the connection between knowledge and compatibility.

Model of Adoption likelihood by Saaksjarvi		
↑ <b>Technovators</b>  ↑ <b>Supplemental experts</b>  ↑ <b>Novices</b>  <b>Knowledge ↑ Core Experts</b>	Interested Solely in technology. Not in adopting the innovation Switching prone.	Interested In both technology and adopting the innovation.  more loyal towards innovation.
	Interested in new technology as an extension of their existing knowledge, but do not see a reason for the innovation.	Realize that the innovation would be beneficial to use.
	positive towards the innovation but do not feel that they are target group for the innovation ("this innovation is for technical people")	Open towards the innovation, willing to learn, usually asks for assistance from knowledgeable peers.
	Resistance towards the innovation, not willing to learn Distrust towards new technology.	Less resistance towards the innovation, willing to learn. Sees the opportunities with new technology.
compatibility → → → → →		

**Tabel 3.1: Model of adoption likelihood by Saaksjarvi [Saa06]**

This table gives a few examples of compatibility related to the 4 groups. Low at compatibility can also mean incompatibility.

### §3.3 Lambert

Lambert describes three customer types of a company. [Lam06]

- Internal customers: Customers within the organization who are next in line to receive the product. Examples could be production line workers who receive the product or customer service representatives.
- Intermediate customers: Often these are distributors who purchase a product and sell it to retailers
- External customers: The consumer of the product or service is the external customer. This class of customers has the most important requirements and they must be met, otherwise they will not purchase the product.

Lambert [Lam06] selects his groups on the place of customers in the supply chain. So are internal customers in the beginning of the supply chain, intermediate customers are in the middle of the supply chain and external customers are at the end of the supply chain. Every group has their own kind of soft reliability problems. The final group, external customers, is the largest group en therefore these group can generate most problems. But it can be interesting to focus also on the other groups because those groups have earlier



contact with the product than external customers. Those groups generate field calls first of all. But those groups will use the product in a different way than external users.

### **§ 3.4 Conclusions Customers Categorization**

In previous paragraphs methods were presented to categorize customers. Every method has their own way of categorizing customers; customers can be categorized by their new technology adoption, their knowledge and interests in new technology, their place in the market and their knowledge of the technique of the products they buy.

Next chapter will present some methods that are used nowadays to find soft reliability problems. Which criteria are used by those methods to select their participants, will be the main question of that chapter.

## Chapter 4: Overview Test Methods

This chapter gives an overview of several product development methods and techniques used nowadays to discover soft reliability problems. In the introduction of this chapter (§4.1) an explanation is given about the structure of this chapter.

### §4.1 Introduction

As mentioned in previous chapters, customers play an important role in the product development process when the goal is to prevent soft reliability faults. That’s the reason why some development processes and techniques will be described below to illustrate the role of the customer in the process.

The goal of this thesis is to get more information of customers that are involved in the product development process. The processes will be discussed below in several paragraphs and after a short description the customers used in the process will be handled. Main question is: Does customer differentiation take place in the development process? And if differentiation takes place, how or on what reasons does it take place? These are important sub-questions for this thesis, because differentiation is ok, but it is important to know how it happens. If differentiation characteristics are known then in chapter 5 criteria for soft reliability problem testing can be formulated.

First start with table 4.1 where an index of the methods and techniques that will be examined will be given and their paragraph numbers.

PDP / technique	
Usability testing §4.2	§4.2.1 Nielson §4.2.2 University of Copenhagen §4.2.3 Dumas
Lead-user method	§4.3 Von Hippel
Focus group	§4.4

**Tabel 4.1: Overview several test methods**

In the next paragraphs all methods shown in the left column of table 4.1 will be presented and at the end of each paragraph questions will be answered: Does customer differentiation take place, and if so, how is it done, on what reasons? In table 4.1 paragraphs where each method will be presented are displayed.

### §4.2 Usability testing

This paragraph gives some general information about usability testing. First some definitions will be given. Then in sub-paragraphs (§4.2.1, §4.2.2 and §4.2.3) different views on usability testing will be presented and the questions mentioned in §4.1 will be answered.

As mentioned before, first some definitions will be given on usability testing.

---

Gullett gives a definition of usability testing [Gul02]: Usability testing is the process of working with end-users directly and indirectly to assess how the user perceives a software package and how they interact with it. This process will uncover areas of difficulty for users as well as areas of strength.

Another definition is given by Gaffney [Gaf99]: Usability testing is a technique for ensuring that the intended users of a system can carry out the intended tasks efficiently, effectively and satisfactorily.

The following sub-paragraphs will give the views on usability testing of Nielson (§4.2.1), University of Copenhagen (§4.2.2) and Dumas (§4.2.3)

#### **§4.2.1 Nielson**

One guru in the field of usability testing is Jacob Nielsen. He wrote many books and articles about usability testing. Nielsen's [Nie93] main point is that companies must do some usability tests, just because they can save money. Because if they don't do usability tests, a bad-designed product will not be a commercial success and people are not happy to use it, so they will not buy a new one. And if companies don't do usability tests the costs for modifications are much higher when the product is already introduced, when it appears that the product was not well designed.

Nielson [Nie93] states that for products that are upgraded and not totally new for the market, the test panel must be created by users that have much experience with the product and people that have less experience with it. (This is also called novice and expert users) Nielsen is the only person that said that novice and expert users must not do the same tests. Only a part of the test is similar and the rest must be tasks related to the group. Nielsen doesn't tell us when someone is an experienced user and when he's a novice user. He doesn't give criteria when someone is an expert user, like you must have worked with a similar product for at least 3 years.

If there is not much money available for doing usability test then you should not take extreme users (extreme novice / extreme expert) but it is better to take more average users. Nielsen doesn't say what is much money and what is less money, because this depends on the products that must be tested. More average users must be used when less money is available because when used in practice also the more average users will use it and not just the very expert or novice users. But when more money comes available then you can spread test users into novice and expert users and you can hire a little bit more of them. Nielsen also doesn't say what the qualifications are for an average user; this means that he doesn't give any specifications.

Some products are produced for a special type of users, like a new system for dentists. Then dentist form different locations should be taken and also novice dentists and expert dentists to get the best results. Not only dentist form one dentist-practice because they can use all the same working methods and might not find as much failures as wanted by the test team.

If the product is totally new on the market then students or unemployed people can be hired to do the tests. Of course students (and the unemployed) must be selected with some interest in the new product. But keep in mind that students are young and get easier used to a new product than elder people thus that's a point of concern while doing a test with students. Students are easy to find and easy to motivate for testing new products. But when a product is new on a market also the possible users of the products can be selected to do the tests. Possible users are the targeted group for which the product is developed.

Another group of potential testers are elderly people, people who got retired. They got plenty of time to do the tests. It could be old employees of your company, in this way they keep in touch with the firm and with the new product that will be put on the market. But also here an important point of attention, they have often much of experience so not all kind of faults would be found.

Sometimes people need first some training before they can do the tests. For example if a test is on a computer and testers are not convenient with using a mouse, then they must first have some basic mouse-training before they can do the actual test.

Nielsen clearly differentiates customers: on their amount of experiences with the product. The next paragraph will give the view on usability testing by the university of Copenhagen.

#### **§4.2.2 University of Copenhagen**

The University of Copenhagen differentiates also many types of test groups more in a general way. [Cop05] They use the following types:

- Novice

This is the person who has no prior experience with this type of apparatus. This type of test person will have the most problems finding out how to use the thing, and hence find many usability errors.

- Experienced user

This is a person who has a lot of experience using a similar product. The experienced user will try the advanced features and will know where to look for problems.

- Old inexperienced person

Old people learn more slowly and their senses and motor skills are less efficient. For example, my old mom has difficulties double-clicking because the mouse doesn't tolerate even the smallest movement between the two clicks.

- Handicapped user

Letting people with various handicaps test your device can be quite revealing. If test persons with the right handicaps are not easily found then you may study various guidelines for making things accessible to handicapped persons.

- Child

Children are curious and adventurous. They want to try everything and may push your device to the limits.

- The noble and upright person

This is the type of person who will read the entire manual, including legal disclaimers, before daring to touch the ON button. This is the only person who will find errors in the printed manual, but he will never find out if your program can generate an error message.

- The progressive and enthusiastic young man

He will try all the fancy features except the Help button. Tell him to find errors and he will consider it a game to defeat your gizmo.

These are all different categories of people who can be selected for a usability test. It is clear that this view differentiates customers on their experiences and their age and other characteristics of their mind.

The next paragraph will give the view of Dumas on usability testing.

### **§4.2.3 Dumas**

Dumas is another guru in the field of usability testing. Also Dumas has his opinions on how a test group for testing new products must be constituted. Dumas [Dum99] gave in his book: A Practical Guide to Usability also some points of attention when doing usability tests.

First of all we must think broadly about the users that will use the product now and in future. When introducing a new product don't just focus on the innovators, in time also other groups of consumers have to deal with your products. So it must be suitable for more people than only the first users. For instance the latest DVD-recorder must not be developed for today's users but also for the laggards, who might buy such a product in 5-6 years.

When introducing a product for your own company, not only today's employees must work with it, they can get fired or new people must also use it due to expansion of the firm. So don't make a product for the current users but also for future users. [Dum99]

Products can be used for other purposes than it was initially introduced for. First it was only a product for one company's internal use, but later it can be used wide spread around the world, with a lot of new users using your product. This means that when you do usability tests you must not take only the current users of the product but also the future users. But it is difficult to predict which users will use the product in years.

As said before it is recommended to have people from all groups in a usability test because in time they will all use the product you will introduce on the market now. Dumas differentiates his test users on their moment of product usage.

### **§4.3 Lead-user method**

This method described in Von Hippels book [Hip88]: the sources of innovation; is a special method because customers are already involved in the process before the product development process has even been started. Lead-users identify possible features and modifications of products and give their ideas and solutions to companies. Lead-user method is a process that handles far before the concept phase of the new product.

Von Hippel defines it so: “Lead users” of a novel or enhanced product, process or service have been defined as those who display two characteristics with respect to it:

1. They face needs that will be general in a marketplace – but face them months or years before the bulk of that marketplace encounters them. And
2. They expect to benefit significantly by obtaining a solution to those needs.

Question is again, does customer differentiation take place when the lead-user method is used? Answer is yes. Not everybody is in the position to become a lead-user. A lead-user needs some special qualities like; he must be able to analyze products well and must be able to give some recommendations for further research and development. He can give the companies advices on how to make the product better, or he can say which features are still missing in the product. This means that user differentiation takes place on the knowledge of the product and their capability to anticipate on future technologies.

### **§4.4 Focus groups**

This paragraph gives an overview of the role of focus groups in the product development process.

A definition of focus groups is given by the zanzara company [Zan02]: focus group is a group brainstorming session run by a moderator. Focus groups have to perform several tasks, which are observed by the moderator and observers in another room. The tasks can be performing tasks on the product or that they have to compare one product with that of the other competitors in the market. The group size is normally between six and ten people.

Graves [Gra98] describes in his article “Customer Satisfaction” that the selection of focus groups must be based on demographics psychographics and conflict of interest issues. And if the group is selected by an independent market research firm then you will get the best results for your product.

The University of Pennsylvania [UoP06] describes also their methods for selecting customers who will participate in focus groups. One method is that they will use the contacts of the supplier. Another way is to advertise on the web that participants are needed for a focus group session; this is least preferred because you don’t know if there are enough qualified candidates that are willing to participate. Problem is that they will not tell what is needed to be qualified.

The Zanzara company [Zan02] describes in their article on focus groups that in a focus group session 10-15 ordinary people were used to generate as much as possible information for the observers of the session. They give no guideline on how these people must be selected or if there is any selection on the participants before the session starts.

In the article: “the use and misuse of focus groups” by Nielson [Nie97], is described that it is important that a focus group require several representative users to get a good discussion. And for the best results there must be more than one focus group session because discussions in one session can be sidetracked. But Nielson does not describe how the customers used for the focus group must be selected.

After reading several articles on focus groups and how they are created, it is clear that there is no customer differentiation when creating such a focus group. This means this kind of tests rely on the fact that they do the test in groups and don't pay attention to characteristics of their test users.

## Chapter 5: Criteria Soft Reliability Problem tests

This chapter will give some general criteria for soft reliability problem tests.

In chapter 3 some methods for customer classification were given. In chapter 4 some techniques for product development were given. These were all derived from literature. In literature, however, no information is available about the criteria a soft reliability test has to take into account. Defining these criteria is the first goal of this chapter. In doing this, good elements of the previous chapters are used as a starting point. In paragraph 5.5 the methods and techniques discussed in chapter 4 will be evaluated by the criteria obtained in this chapter and a matrix will be presented where all criteria and methods are compared to each other.

### §5.1 Criteria originating from chapter 3

In Chapter 3 several ways of categorizing customers were given. Now these methods will be discussed in order to select their best elements, which can be seen as criteria for the soft reliability problem test.

In paragraph 3.1 Rogers' vision was presented. His general view of categorizing customers is ordering them to their adoption of new products. This means that there is a difference by people when they adopt a new kind of product. Some will be very fast in adopting new products while others will be relatively late. This means that some people adapt to the new product when it is still at the start of its product life cycle while others adapt the product when the product is already at the end of his lifecycle. Those different kinds of customers will face different kind of soft reliability problems. Therefore the customers that use the product, when the product is in a certain part of its lifecycle, are necessary for a good test. The first criterion will therefore be the **different users in a product lifecycle**. This criterion is relevant for the research question (Which customers must be involved in a product development process to prevent soft reliability problems?) because to prevent soft reliability problems from occurring in real life you must know which customers will use the product in time and in what stage of the product life cycle.

In paragraph 3.2 Saaksjarvi's view was presented. Her view was based on Rogers' ideas but further developed. Important point in her view was the technology knowledge of the customers and their willingness to learn new technology. Customers with different levels of technology knowledge will face different kinds of soft reliability problems. This means that **technology knowledge** of the customers is another criterion for the soft reliability problem test. This criterion is relevant for the research question because every customer has different technology knowledge so every customer will perform the test differently.

Also in chapter 3 the vision of Lambert was given (paragraph 3.3). His classification of customers was based on their position in the supply chain. According to him customers at the beginning of the supply chain will have different soft reliability problems than



customers at the end of the supply chain, which is the third criterion taken into account in this chapter. This criterion will be called the **place of the customer in the supply chain** of the product. This criterion is relevant for the research question. It is important to know at which point in the supply chain faults will occur, so the most suitable user can execute tests.

## §5.2 Criteria originating from chapter 4

In Chapter 4 several product development techniques and methods were presented. These methods will also be discussed to select their good elements.

In the usability testing paragraph (paragraph 4.2) several theories were given. Nielsen's view (paragraph 4.2.1) focused in on the experience of customers with a specific kind of products. In his tests his participants must do different kind of tests, if you have a different level of experience. The reason for this is that customers with a different level of experience will face different kind of soft reliability problems. The next criterion will therefore be the level of **experience** of a customer. Every customer has his own level of experience and because customers must perform soft reliability problem tests, experience and therefore it is a relevant item in soft reliability problem testing.

The University of Copenhagen did also research on usability testing. Their idea is that best results will be obtained when as much as possible customers will be involved from as much as possible different groups. In paragraph 4.2.2 a total list of possible groups was given.

List of possible groups for usability testing:

- Novice
- Experienced user
- Old inexperienced person
- Handicapped user
- Child
- The noble and upright person
- The progressive and enthusiastic young man

This study also showed that experience of people is an important criterion for selection. Besides this criterion also the age of the customers is important. Due to differences in education customers will face different kinds of soft reliability problems. This means that it is useful to involve customers from different age in your tests. And the research question states that customers must be involved in the developing process of a new product then it is wise to know age of customers because every age has their own education history. The next criterion will therefore be **age** of the customer.

Dumas' view on usability testing was given in paragraph 4.2.3. In his view a product will have different users during the lifecycle of the product. And you made a product not only for the first user but for all users. This will lead to the same criterion as Rogers' view.

In paragraph 4.6 focus groups were handled. The idea of focus groups was that customers in small groups do some tests and discuss the specific product. More problems might get discovered because customers will come further in tests. They can combine their knowledge to achieve some level in tests. This leads to a following criterion, namely the size of the test group. Not only individuals must do tests also some small groups must execute tests to get some more reliability faults. Next criterion will therefore be the **size of the group**. Many people will not use the product alone and therefore tests in groups might be an interesting supplement to soft reliability problem testing.

In paragraph 4.4 the lead user method was discussed. The lead user method has as main characteristic that there are people that can foresee problems or modifications far before the market see them. Those people will modify the product in such a way that problems that might occur will not occur on the market. Their talent is that they can see problems that might occur in the future. This will lead to the next criterion: **Quality to foresee problems in the future**. This is a useful criterion because these testers have a special quality to foresee problems in future and are therefore useful for tests to prevent soft reliability problems.

Here is the total list of criteria obtained from reviewing the chapters above.

1. Different users of a product in the product lifecycle
2. Technology knowledge
3. Place of the customer in the supply chain
4. Experience of the customer with the product
5. Age of the customer
6. Size of the test group
7. Quality to foresee problems in the future

### **§5.3 Other criteria**

Besides these criteria, there are some more criteria that must be taking into account when doing a soft reliability problems test of a product.

#### **Culture**

When a product is sold in different countries or even on different continents it is possible that users might get some problems with it, because those users live in a different culture. Their culture might have different standards and values and therefore the product might be complex for them or difficult to make it compatible with other equipment. Therefore culture of the test person is also a criterion for the test.

Culture is also getting more important due to trends mentioned in chapter 1. Due to globalization of the market more and more different cultures get in touch with new products and will face soft reliability problems.

The research question of this thesis is: Which customers must be involved in a product development process to prevent soft reliability problems? Due to the globalization of the

---

market, product innovation is in Europe, production in Asia and sales in America, culture is an interesting criterion that must be taken into account.

### **Product customer interaction**

Not everybody in the world will buy or use the product. Therefore it is important that only those customers perform the tests that will use the product. It isn't useful to test a new car by a child or a handicapped person when it is obvious that they will never drive the car. So another criterion is that there must be any **product customer interaction**.

If other persons than the intended group of customers must test the product then problems might be found that wouldn't be found by intended customers of the product. This can cause a lot of modifications of the product while there was in fact no problem for the intended group of customers.

In the research question "Which customers must be involved in a product development process to prevent soft reliability problems?" is it clear that customers of the product must perform tests and not other people, therefore this criterion is a valuable supplement to all criteria.

### **Real prototype**

Testing with a real prototype is better for results of the test. Customers that conduct tests will obtain better results when tests are with real prototypes instead of ideas on paper or on the computer. When doing a test with real prototypes people can imagine best how a product will work and look alike in reality. Like the research question, customers must do tests to get best results; best results will be getting when doing tests on real products. Therefore this is a useful criterion.

## **§5.4 soft reliability problem test criteria**

This leads to the following list of criteria for soft reliability problems tests:

1. Different users of a product in the product lifecycle
2. Technology knowledge
3. Place of the customer in the supply chain
4. Experience of the customer with the product
5. Age of the customer
6. Size of the test group
7. Quality to foresee problems in the future
8. Culture
9. Product customer interaction
10. Real prototype

These criteria need some more details before they can be used.

Different users of a product in the product life cycle, this criterion was based on Rogers' model and therefore the guideline will be based on his thoughts. Rogers divides customers in 5 groups, groups were based on the moment that customers adapt to new

---

technology / products. The criterion will be fulfilled best when people from every category (innovators / early adopters / early majority / late majority / laggards) are present at the test. It is difficult to say how much people exactly must execute the test. It is common knowledge that there is not an endless budget and time for testing so companies will try to save money whenever they can. If it is not possible to have customers from all 5 categories then customers from category 1,3 and 5 or 2 and 4 can be taken. 1,3 and 5 for getting biggest contrast in all results and 2 and 4 to get more faults found by the larger groups of the model. How many customers from every category are needed is also difficult to say. A few will do.

Technology knowledge is the next criterion based on Saaksjarvi's ideas. She divided the customer population into 4 groups based on their technology knowledge (Technovators Supplemental experts, Novices and Core experts). These four groups are ok for the soft reliability problem test. A few people from every group will do. Also combinations of groups will do 1 and 3, 1 and 4 or 2 and 4 if money must be saved. Not 2 successive groups because those groups might found similar problems and you want to find different problems.

Next criterion is place of the customer in the supply chain. The test will be ok if from every place in the supply chain some customers will do the test.

Experience of the customer with the product is the next criterion based on Nielsen's book usability engineering [Nie93]. He also thought about sizes of the test panel and depending on budget he selects people in 2 or 3 categories. With 2 categories you get a novice group and an experienced group. When customers were divided into 3 groups again a novice group was created, a very experienced group and a group between them.

Age of the customer is also a criterion. It is not necessary to get people from every age in the test because that is too expensive and time consuming. But some children or teenagers, some customers around 30-40 years old and some 50-60 years old customers will do.

Size of the test group was also a criterion for a soft reliability problem test. Some tests can be executed with only 1 person but some tests can be done with a group of customers. The size of the group must not be too large because then results will not be optimal. When a group is too large only a few people will do the real test and others actually do nothing. Ideal size is between 6 till 10 persons.

Some people have the quality that they can foresee problems in future. So problems that might occur in future can be prevented. Only a few people that have that quality is enough to execute for a soft reliability problem test.

Next criterion is culture. Again many groups of customers are possible. Important is to have some customers from every continent where the product will be sold, like an African, an Asian and a European customer. If there are many differences between

usages of products within continents some more customers from those different cultures must be used.

Product customer interaction is the next criterion. This criterion is related with almost all other criteria. Only tests must be done with customers, which are also a target group for sales. It is useless to test a Ferrari with children and with elderly people because they will never drive in a Ferrari. And this criterion in relation with the culture criterion: it is not necessary to test your product with Africans if you're not intending to sell your product in Africa.

The criterion real prototype is the last criterion. A real prototype is needed to get best test results. With all functionalities of the product on the same place as the real product will have.

Some remarks:

It is not necessary to select people for each criterion separately. Some testers from some criteria can be combined. Criteria age, place in supply chain, technology knowledge, experience and culture can be combined so there can be 1 test person to do the test with all these characteristics, and if you find another person from a different age category, with a different culture, less technical knowledge and someone that is normally a user at the end of the product life cycle, you got another test person with again a lot of different criteria / qualities.

### **§5.5 Matrix: methods versus criteria**

This paragraph will show a matrix [table 5.1] where all methods explained in chapter 4 will be judged with criteria for soft reliability problem testing.

Every method will face all criteria and get a plus (+), or a minus (-) in the matrix (see table 5.1). A plus will be given for a criterion that is taken into account by the method, a minus for a criterion that will not be taken into account while testing with a certain method. When not enough information is available to give a criterion a plus or a minus, or when the method doesn't take into account that criterion the place in the matrix will stay empty.

Every method from chapter 4 will be reviewed to reveal their good and bad points with criteria obtained earlier this chapter in the next paragraphs. In paragraph 5.5.1 the usability testing method according to Nielsen will be presented again, in paragraph 5.5.2 the usability testing method according to the university of Copenhagen will be presented and in paragraph 5.5.3 the usability testing method from Dumas will be handled. Then in paragraph 5.5.4 the lead user method will be presented again and in paragraph 5.5.5 focus groups will be handled.

### **§5.5.1 Usability testing: Nielsen**

First the usability testing method according to Nielsen will be handled. This method will be judged against all criteria for a soft reliability problem test. Usability testing according to Nielsen implies that customers will be selected by the amount of experience they have with the product. This means that many criteria won't be possible to judge because not enough information is available on the criterion in relation with Nielsen's view. Below only criteria that score a plus or a minus will be showed. The plusses and minuses will be displayed in the matrix at the end of this chapter.

#### 4. Experience of the customer with the product

This criterion is positive for Nielsen's usability testing. He selects his test users on their experience with the product. This means a plus in the matrix.

#### 6. Size of the test group

Size of the test group criterion is negative for Nielsen's usability testing, because his test users perform individually tests and not in groups. This means a minus in the matrix.

#### 9. Product customer interaction

Next criterion is product customer interaction. Nielsen does not select his candidates on the possibility that they will once use the product, while the criterion states that only customers that will use the product once, must perform the test. So this criterion will be negative and therefore a minus in the matrix.

#### 10. Real prototype

And finally criterion real prototype, this criterion is positive because the test users can perform their tests on real products. This will therefore leads to a plus in the matrix.

### **§5.5.2 Usability testing: University of Copenhagen**

In this paragraph the usability testing method according to the University of Copenhagen will be judged with criteria obtained earlier in this chapter. This method focuses on the age of the testers and their experiences with the product. This means that also this method will not take into account all criteria. This means that again only a few criteria will get a plus or a minus in the matrix and that for the other criteria not enough information is available to make a clear judgment. Next will follow criteria that score a plus or a minus.

#### 4. Experience of the customer with the product

Experience of the customer with the product scores a plus in the matrix, because both novice and experienced users must execute the usability test.

#### 5. Age of the customer

This method does take into account the age of their test persons. From children till elderly people, all of them must perform the test. This will be a plus in the matrix.

#### 6. Size of the test group

All tests are performed individually and therefore this criterion, size of the test group, scores a minus in the matrix.

9. Product customer interaction

Usability testing according to the university of Copenhagen has so many different test users that it is obvious they won't all use the product that they're testing. This means that the product customer interaction criterion gets a minus in the matrix.

10. Real prototype

The usability test is performed with a real prototype. This means a plus in the matrix.

### **§5.5.3 Usability testing: Dumas**

In this paragraph the usability method according to Dumas will be judged with criteria for soft reliability testing obtained earlier in this chapter. Dumas's view focuses on the place of the customer in the product lifecycle. Now will follow those criteria that score a plus or a minus in the matrix. All other criteria are not possible to be judged because Dumas doesn't focus on those other criteria.

1. Different users of a product in the product lifecycle

This first criterion scores a plus in the matrix. In Dumas' view on usability testing you must not only select customers who will start buying the product but also the customers that will use the product later in the product life cycle of that product.

6. Size of the test group

The size of the test group will give a minus in the matrix because Dumas' method is made for individually testing.

9. Product customer interaction

This criterion will score a plus in the matrix because Dumas selects his test users in such a way that he will only use test users that will use the product at some time in the product life cycle.

10. Real prototype

This criterion, real prototype, scores also a plus in the matrix. Dumas' test persons execute the tests on real prototypes to get best results.

### **§5.5.4 Lead user method**

In this paragraph the lead user method will be judged with criteria. Von Hippel's method focuses on the ability of his test users to foresee problems in future and their ability to bring up solutions to problems they found. Again only those criteria that will get a plus or a minus will be shown below. All other criteria are not possible to be judged because Von Hippel doesn't focus on those criteria in his method.

1. Different users of a product in the product lifecycle

The lead user method according to von Hippel scores a minus on this first criterion, because lead users are in the first part of the product lifecycle. Otherwise their thoughts about improvements of the product will not make sense anymore.

2. Technology knowledge

On this second criterion, technology knowledge, the lead user method scores a plus in the matrix. Lead users have the ability to foresee problems and to invent some suitable solutions for problems foreseen; therefore lead users must have some technology knowledge.

3. Place of the customer in the supply chain

The place of the lead users in the supply chain is in the first part or even before the supply chain of that product actually starts. Otherwise users of the product couldn't profit of the modifications made by the lead users. Thus this is a minus in the matrix.

6. Size of the test group

Criterion 6, size of the test group, will score a minus in the matrix because lead users operate individually and not in groups.

7. Quality to foresee problems in the future

This seventh criterion, quality to foresee problems in future, scores a plus in the matrix because lead users have this ability. Through their ability to foresee problems and their ability to invent solutions for those problems, they're called lead users.

9. Product customer interaction

Lead users use the product themselves otherwise they cannot make improvements of the product. So this criterion will score a plus. Remark: lead users are not the only users of the product but they use it and therefore there is product customer interaction.

10. Real prototype

A real prototype is also needed for lead users otherwise they cannot foresee problems in future and can't they propose solutions for problems found.

### **§5.5.5 Focus groups**

In this paragraph criteria for soft reliability problem testing will be judged on the focus group method. Focus groups consist of group sessions where testers perform their tests. Again the criteria that can be judged with this method will be shown below. The remaining criteria couldn't be judged because the focus group methods don't take them into account.

6. Size of the test group

At the sixth criterion, size of the test group, there will be a plus in the matrix. Because test persons operate in groups, members will help each other to achieve results.



10. Real prototype

The tests will be executed with real prototypes to get best results. This means that test persons work in their focus group with a real product and therefore there will be plus in the matrix.

All results obtained in the previous paragraphs will be shown in the next table 5.1, it is called the matrix because all methods are crossed with criteria.

	Different users of a product in the product lifecycle	Technology knowledge	Place of the customer in the supply chain	Experience of the customer with the product / technique	Age of the customer	Size of the test group	Quality to foresee problems in the future	Culture	Product customer interaction	Real prototype	Total score
Usability Nielsen				+		-			-	+	
Usability university				+	+	-			-	+	
Usability dumas	+					-			+	+	
Lead user	-	+	-			-	+		+	+	
Focus group						+				+	

positive  
negative

+
-

**Table 5.1: Matrix: scorecard methods vs. criteria**

## **Chapter 6: Analyzing data matrix and ideal test**

In this chapter the results presented in the matrix [table5.1] will be analyzed; and an ideal test will be presented for soft reliability problem testing. First in paragraph 6.1 the matrix will be analyzed. Then in paragraph 6.2 an ideal test will be presented. Finally in paragraph 6.3 some considerations will be presented to solve the ideal test or to make that test more practical.

### **§6.1.1 analyzing data matrix**

In this paragraph the matrix [table 5.1] will be looked after to see if some conclusions can be drawn from it.

It is obvious that pluses in the matrix are ok. That means that the criterion is used by the selected method. Minuses are therefore not ok; then the selected method doesn't take into account that criterion.

It is clear that none of the methods give any attention to criterion culture. None of the methods keep in mind that products are sold worldwide and therefore used by people from different cultures with a different level of education and standards.

Criterion size of the test group scores most minuses. That's logical because all tests (except focus groups) are performed individually and don't take into account the value of a group session in tracking down failures of the product.

All methods use real prototypes for their tests to obtain best test results. Therefore the whole column in the matrix is positive with pluses. Maybe the criterion is obsolete if all methods are positive? The criterion is necessary because there are also methods that already execute tests before a prototype is available. Test persons must then perform test form prints or online. Examples of those tests are not used in this thesis.

Criterion product customer interaction scores a minus twice and two times a plus. This means that some methods use indeed only users that will indeed use the product and other methods just use test persons not looking after if they will indeed use the product. Problem with this last group of tests is that problems can be revealed and solved that might not have occurred when only persons test the product that will use the product.

Many criteria score only 1 plus or minus. This means that only 1 method sees the value of that criterion.

Especially the criterion place of the customer in the supply chain needs some more attention. This criterion scores only one minus. This implicates that none of the methods thinks about the whole supply chain of the product and the possible problems that it will bring along.

---

The column total score in the matrix is empty. Because none of the methods get a plus or minus in every category it is difficult to summarize all values. Besides that, there might also be a reason that every criterion doesn't have the same weight in the whole system of criteria. Further research is needed to give every criterion their weight.

Conclusions from matrix:

- All methods don't take into account all criteria for soft reliability problem testing.
- Some criteria are only used by 1 method.
- Soft reliability problem tests can be improved a lot by selecting the right people for the tests

## §6.2 Ideal test

In this paragraph the ideal test for soft reliability problem testing will be presented.

The ideal test must have elements of all criteria otherwise it won't be the perfect test. At the moment there is not such a test. Here's the list of criteria for the ideal test:

- Different users of a product in the product lifecycle. For the ideal test you have participants from every five categories, from an innovator till a laggard.
- Technology knowledge, for the ideal test you got participants from every 4 categories, from a core expert till a technovator.
- Place of the customer in the supply chain, people from the entire supply chain must cooperate in the tests.
- Experience of the customer with the product. People with less and people with a lot of experience with the products are needed for the ideal test and if possible people with an inadequate amount of experience.
- Age of the customer, customers from every age category must participate in the tests, but only those categories that will actually buy the product.
- Size of the test group, not only individual tests must be done but also some group sessions in focus groups are good to reveal soft reliability problems in products.
- Quality to foresee problems in the future, some people that have this ability are needed to prevent some problems in future.
- Culture, participants with different cultures must participate in the tests.
- Product customer interaction, only people that will actually buy and use the product must execute the tests.
- Real prototype, best results will get when people can perform the tests on real prototypes.

It's obvious that this kind of test with taking into account all criteria is expensive and time consuming. Therefore the next paragraph will give some practical considerations on what will be useful to do first to get an ideal result. (ideal result = revealing lot of soft reliability problems at low costs and in less time)

---

### §6.3 Practical considerations

Above the ideal test is displayed as one big test. But that ideal test provokes also some problems. Many testers must be selected and many experiments must be done to get best results. But companies have not endless time and testers with those specific qualifications to execute the tests. Finding the right people and equipment for the tests is expensive; therefore the criteria will again be looked after to see which criteria are most valuable for a company.

Three views will be presented in the next subparagraphs to solve the ideal test, or views on which criteria are most important for tests. In paragraph 6.3.1 factorial experiments will be presented, criteria grouping will be presented in paragraph 6.3.2 and in paragraph 6.3.3 a consideration will be presented on which criteria are easy to implement or generate most benefits of implementation.

#### §6.3.1 Factorial Experiments

Ideal tests can be solved with factorial experiments [Mon02] where from every criterion only a few test persons will be used and all other results will be calculated. A factorial experiments with interactions is needed because the criteria are not mutually independent. When performing a test in such a way money can be saved because a minimum of tests have to be executed. Also Baskoro [Bas06] writes in his doctoral thesis about full factorial experiments and his advice is to reduce the amount of factors as much as possible to reduce the amount of experiments. The ideal test has 10 factors (criteria) and some criteria have many levels (4 or 5) which mean that the amount of tests to be done is still very large. This is therefore a time consuming and costly method.

#### §6.3.2 Criteria Grouping

Looking at all those criteria it might be possible to group them in some categories.

In general some criteria are formulated by characteristics of methods and others by characteristics of customers. Therefore at first 2 categories will be made: methods and customers. In chapter 4 it became already clear that there were customer and method criteria because there was no customer differentiation at the focus groups. And there was at least customer differentiation at the other methods presented in chapter 4.

With those 2 categories further improvements in criteria selection must be possible. The focus will be laid on category customers because category method is too much dependent on the method used for soft reliability problem testing.

The group customers' criteria can be grouped further:  
Criteria technology knowledge, experience of the customer with the product / technique and quality to foresee problems in future can be grouped in a category active knowledge and experience.

Looking at those 10 criteria a distribution can be made.

First of all 2 criteria are dependent on the test method.

- size of the testgroup
- real prototype

Good example of this sub group of criteria is method focus groups. They score only plusses on those two criteria while they score nothing on other criteria because they don't focus on them.

Besides those 2 criteria, other criteria are mostly customer orientated:

- Different users of a product in the product lifecycle
- Technology knowledge
- Place of the customer in the supply chain
- Experience of the customer with the product
- Age of the customer
- Quality to foresee problems in the future
- Culture
- Product customer interaction

These 8 criteria can be divided further:

Customer criteria:

- Technology knowledge (passive)
- Age of the customer
- Culture

Knowledge criteria (active knowledge of technique and product)

- Technology knowledge (active)
- Experience of the customer with the product
- Quality to foresee problems in future

Time criteria

- Different users of a product in the product lifecycle
- Place of the customer in the supply chain

These product criteria have a certain overlap, place of the customer in the supply chain has a bigger scope than different users of a product in the product lifecycle.

Comment product customer interaction:

It is to specify some criteria a little bit more, like the criterion of age. In §5.4 was suggested to take a few children / teenagers, some customers around 30-40 and some customers round 50-60 years old. Only take those customers that will be using the product. If the targeted group of customers consist of customers between 30-60 years old then it is useless to use teenagers in your tests.

If this will be done for all criteria then there will be one criterion redundant. Product customer interaction will then be guaranteed by other criteria.

But further research reveals that it is not possible to neglect that criterion. Aarts [Aar03] writes in his book: the new everyday that systems are adaptive to the person that uses it. Products can change in time by users of the product. In that way it might be difficult to execute 2 tests exactly the same and therefore there is difference in the product customer interaction.

It's possible to make those groups visible in a matrix:

Criteria	Different users of a product in the product lifecycle	Technology knowledge	Place of the customer in the supply chain	Experience of the customer with the product	Age of the customer	Size of the test group	Quality to foresee problems in the future	Culture	Product customer interaction	Real prototype
Different users of a product in the product lifecycle	+									
Technology knowledge	+	+		+			+			
Place of the customer in the supply chain	+		+							
Experience of the customer with the product				+						
Age of the customer		+			+					
Size of the test group						+				
Quality to foresee problems in the future							+			
Culture		+						+		
Product customer interaction									+	
Real prototype						+				+

**Table 6.1: matrix criteria grouping**

Ellipses in table 6.1 show the correlation between criteria, when a company decides to implement criterion culture for example it's relatively easy to implement also criteria age of the customer and technology knowledge.

### §6.3.3 Benefits of implementation / ease of implementation

At the start of this thesis in figure 1.3 it was shown that the amount of no fault found problems was increasing. This means that current methods used by companies are not good enough anymore. In the matrix (table 5.1) it was obvious that none of the methods

does take into account all criteria for an ideal test. This means that current methods must be extended with some more criteria. It will get too expensive when all criteria must be extended with current methods. The effect of the final extra criterion will be less. (Decreasing yield) This means that some criteria will have a greater effect than other and some are easier to achieve than others. Below all criteria will be checked again to see if some criteria will be more profitable to add on than others. Profitability can be measured by ease of implementation and benefits for soft reliability problems prevention. All criteria will be looked at to see how they score on those two points. Finally results from all criteria will be made visible in figure 6.1.

#### 1. Different users of a product in the product lifecycle

Criterion “different users of a product in the product lifecycle” is maybe not very easy to implement in existing methods. Because you focus on a certain market with your product but the customers that will buy the product later in the product lifecycle are not well known by the companies. But with further research of the market right persons for tests can be selected and then also problems that might only be found later in the product lifecycle can be found before the product launch. Ease of implementation: hard. Benefits from implementation: high.

#### 2. Technology knowledge

Criterion “technology knowledge” is an important criterion because this thesis focuses on high tech industry where technology is important. Products are not only used by people with technology knowledge but also by people who have less technology knowledge. And both groups will discover different kinds of soft reliability problems. It is relative easy to find people with or without technology knowledge (with technology knowledge might be harder to find) this means that implementation of this criterion in existing methods is not very expensive. Ease of implementation: easy. Benefits from implementation: high.

#### 3. Place of the customer in the supply chain

Criterion “place of the customer in the supply chain” is difficult to unite with some of the methods discussed in chapter 4. None of the methods uses this criterion yet. This means none of them have some experiences with it. The focus of the producer of the product is on the market and not on the stations before a product reaches the market. But also in that stage it is possible that problems will occur, but the majority of the customers will not face them. That means that it is less important to implement this criterion into some method. Ease of implementation: easy. Benefits from implementation: low.

#### 4. Experience of the customer with the product

Criterion “experience of the customer with the product” isn’t very easy to add to existing methods; but the results of the experienced people and less experienced people can be a great help for designers of the product. The majority of customers will have an inadequate amount of experience with the product. To find those people with an extreme amount of experiences and those who have fewer experiences with the product might be difficult. Ease of implementation: hard. Benefits from implementation: high.

#### 5. Age of the customer

Criterion “age of the customer” is a criterion that can be implemented relatively easy in current test methods. The product is made for a certain group of customers, get their range of ages and then make 2-3 age-categories. In this way it is easy to discover if some age-category has more problems with the product than other age-categories. Ease of implementation: easy. Benefits from implementation: high.

#### 6. Size of the test group

Criterion “size of the test group” can easily be added to some tests. Many of the tests studied in this thesis work individually. These tests can be adapted so some parts of the tests will be performed individually and some parts in a group session. In that way also benefits from the group session will be visible for the producers of the product; and more faults will be found before product launch. Ease of implementation: easy. Benefits from implementation: high.

#### 7. Quality to foresee problems in the future

Criterion “quality to foresee problems in future” is a difficult criterion to handle. It is difficult to find customers that have the ability to foresee problems in future, but, if some were found, they can be very useful in the tests of the product. They are able to reveal many problems that might occur in future when to majority of customers will use the product. And besides revealing the problems they’re also capable to solve those problems. This means that if a company wants to invest in their search for this type of customers they can solve a lot of problems that might occur in future. Ease of implementation: hard. Benefits from implementation: high.

#### 8. Culture

Criterion “culture” can prevent a lot of problems if customers with different cultures conduct tests. Then problems in a certain part of the world can be prevented. But the costs to add this criterion to a specific method are relative high. Tests must be executed in the countries of test persons to get the perfect environment. This means that the company that produces the product must create test facilities on all continents of the world while the product is developed only in one plant on one continent. (Assumption: the product will be sold worldwide). Ease of implementation: hard. Benefits from implementation: high.

#### 9. Product customer interaction

Criterion “product customer interaction” can be added relatively easily to methods that are not using this criterion right now. Just one additional question on the entry form for test candidates will do. Then only faults will be found that real users will face. And all other problems will not be found, but that’s ok because it is only necessary to solve the problems of real customers of the product and not all problems of the product. Ease of implementation: easy. Benefits from implementation: high.

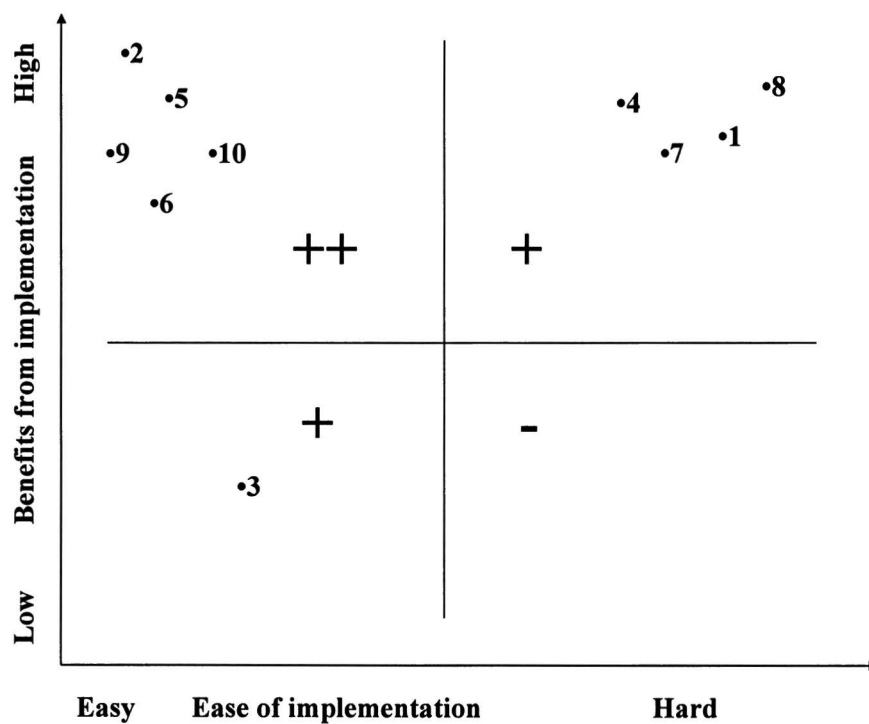
#### 10. Real prototype

All methods discussed in this thesis use a real prototype, thus in that way not an improvement can be made. But that doesn’t mean that a real prototype might be obsolete



for a soft reliability problems test. It is really important that customers of the product can execute their tests on real prototypes of the product. Ease of implementation: easy. Benefits from implementation: high.

Now it's possible to plot those criteria (figure 6.1) then it is visible which criteria are worth to be integrated in tests. There are no real scales on the axes. There are in fact four clusters (++, +, + and -) ++ means easy to implement and good benefits from implementation, + means easy to implement en low benefits from implementation or hard to implement and high benefits from implementation, - means hard to implement and low benefits from implementation.



**Figure 6.1: Ease of implementation vs. Benefits from implementation**

Legend:

1. Different users of a product in the product lifecycle
2. Technology knowledge
3. Place of the customer in the supply chain
4. Experience of the customer with the product
5. Age of the customer
6. Size of the test group
7. Quality to foresee problems in the future

8. Culture
9. Product customer interaction
10. Real prototype

In Figure 6.1 it became visible that 5 criteria can be implemented relatively easily with good benefits:

2. Technology knowledge
5. Age of the customer
6. Size of the test group
9. Product customer interaction
10. Real prototype

4 other criteria can also be implemented but are harder to implement but generate also many benefits:

1. Different users of a product in the product lifecycle
4. Experience of the customer with the product
7. Quality to foresee problems in future
8. Culture

Criterion 3 (Place of the customer in the supply chain) is easy to implement is relative easy to implement but benefits form that implementation are relative small.

## **Chapter 7: Conclusions / Recommendations further research**

This chapter will give the final conclusions and recommendations of this master thesis. In paragraph 7.1 the conclusions and answers on the research questions will be presented and in paragraph 7.2 the recommendations for further research will be given

### **§7.1 Conclusions**

This paragraph will give the conclusions of this master thesis and the answers on the research questions stated in chapter 2.

In chapter 1 and 2 the problem was presented. Due to trends in the industry it was not possible for companies to improve their product in time. Feedback of their products in the market came too slow; therefore it was necessary that tests must take place before the launch of the product, which means during the developing phase of that product. Companies were concerned about the increasing amount of no fault found problems. So-called soft reliability problems are part of it. These problems occur when different customers use the product, everybody in their own way. If companies want to lower no fault found problems then they must involve different customers in their tests for soft reliability problems. Main question: which customers with which qualities?

The research question was:

Which customers must be involved in a product development process to prevent soft reliability problems?

After that research question two additional research questions were stated.

Sub research question 2.1: How can customers be categorized?

And besides this sub research question another sub research question was needed, which current methods are used by companies to reveal soft reliability problems.

Sub research question 2.2: Which product development methods or techniques are used for developing highly innovative products and involve customers in their process to indicate soft reliability problems?

The conclusion from chapter 3 is that customers can be categorized in several ways. Rogers' view is that customers get organized by the moment they adapt new products to them. Saaksjarvi's ideas are: that customers are grouped by their technology knowledge and their willingness to learn new technology. While Lambert categorized them to the place they have in the supply chain. This is the answer on sub research question 2.1.

Then in chapter 4 several methods were presented to reveal soft reliability problems in products. Three methods for usability testing were presented, a lead-user method and a focus group method. All these methods select their customers using other criteria or use other elements from methods that are unique in comparison with other methods. This is the answer on sub research question 2.2.

In Chapter 5 all methods from chapter 3 and 4 were examined to filter criteria that are necessary to conduct a soft reliability problem test. A list of 10 criteria was found:

1. Different users of a product in the product lifecycle
2. Technology knowledge
3. Place of the customer in the supply chain
4. Experience of the customer with the product
5. Age of the customer
6. Size of the test group
7. Quality to foresee problems in the future
8. Culture
9. Product customer interaction
10. Real prototype

All methods from chapter 4 were facing these criteria and a matrix was made with these criteria (see table 5.1)

In chapter 6 the matrix was analyzed, then criteria which must answer an ideal test were presented. The ideal test must have elements of all criteria otherwise it won't be the perfect test. Here's again the list of criteria.

- Different users of a product in the product lifecycle. For the ideal test you have participants from every five categories, from an innovator till a laggard.
- Technology knowledge, for the ideal test you got participants from every four categories, from a core expert till a technovator.
- Place of the customer in the supply chain, people from the entire supply chain must cooperate in the tests.
- Experience of the customer with the product. People with less and people with a lot of experience with the products are needed for the ideal test and if possible people with an inadequate amount of experience.
- Age of the customer, customers from every age category must participate in the tests, but only those categories that will actually buy the product.
- Size of the test group, not only individual tests must be done but also some group sessions in focus groups are good to reveal soft reliability problems in products.
- Quality to foresee problems in the future, some people that have this ability are needed to prevent some problems in future.
- Culture, participants with different cultures must participate in the tests.
- Product customer interaction, only people that will actually buy and use the product must execute the tests.
- Real prototype, best results will get when people can perform the tests on real prototypes.

This ideal test concept is too much time consuming and too costly to execute. Therefore three possibilities were given to solve this problem, to make it easier to use.

1. The ideal test can be solved by using factorial experiments, but then again many experiments must be carried out.

2. Criteria grouping can be done to reduce the amount of criteria, or to show which criteria are related to each other and are easy implement when 1 of those is implemented. Possible combinations are: Technology knowledge (passive), age of the customer and culture; Technology knowledge (active), experience of the customer with the product and quality to foresee problems in future; different users of a product in the product life cycle and place of the customer in the supply chain.
  3. Criteria were looked after their ability to implement and their benefits after implementation. In Figure 6.1 it became visible that 5 criteria can be implemented relatively easily with good benefits:
    2. Technology knowledge
    5. Age of the customer
    6. Size of the test group
    9. Product customer interaction
    10. Real prototype
- 4 other criteria can also be implemented but are harder to implement but generate also many benefits:
1. Different users of a product in the product lifecycle
  4. Experience of the customer with the product
  7. Quality to foresee problems in future
  8. Culture

## **§7.2 Recommendations further research**

This paragraph will give some recommendations for further research.

### **How many customers must be used for optimal results?**

In this thesis the focus was on which customers are used in product development processes. Interesting would be to know, how much customers do you need to get an optimal result. At one side you can select more and more customers to be part of the developing process to get as many problems that must be solved before the product will come on to the market. At the other side there is an economical threat that must be dealt with, more customers mean more expenses and introducing a new product must be profitable.

### **Different products different criteria**

It is possible that different products need different tests to optimize the product. Some products need different criteria for their tests. Example for new computers it might be useful to use the criterion “quality to foresee problems in future”, while for I-pods it might be more useful to focus more on criterion “culture”.

Further research is possible in that area but also in a more general way. Criteria found in this thesis were suitable for highly innovative products. But are those criteria also suitable for other types of products?

### **More criteria**

When the focus of finding criteria for soft reliability problem testing is getting wider, that means also other branches will be involved for getting their criteria for testing, then maybe other criteria can be found that have influences on soft reliability problems.

### **How to get customers for tests**

After doing some factorial experiments it is clear which customers are needed for tests. Then it is clear what specifications a customer must have. Then it must be checked if those types of customers are possible solutions. (like a child with very much technology knowledge is hard to find or not even possible) if there are impossibilities then a new test model must be made with only suitable customers. And finally it is necessary to find the requested customer with all his unique criteria and to convince him to cooperate with the company to improve products that will be launched on the market soon.

## References:

- [Aar03] Aarts, E., Marzano, S. (2003), *“The New Everyday”* Royal Philips Electronics, 010 Publishers Rotterdam
- [Bas06] Baskoro, G. (2006), *“The Design of an Accelerated Test Method to Identify Reliability Problems during Early Phases of Product Development”* Doctoral thesis Beta, Technische Univeriteit Eindhoven.
- [Bro05] Brombacher, A.C., Sander P.C., Sonnemans, P.J.M., Rouvroye, J.L. (2005), *“Managing product reliability in business processes “under pressure””*, Eindhoven University of Technology, The Netherlands
- [Coo93] Cooper, R.G. (1993), *“Winning at new products”*, accelerating from idea to launch.
- [Cop05] Copenhagen University College of Engineering, 2005 <http://www.eit.ihk-edu.dk/subjects/mmi/usabilitytest.php>
- [Cou05] Courage C., Baxter K. (2005), *“Understanding Your Users, A Practical Guide To User Requirements Methods, Tools and Techniques”* Morgan Kaufman Publishers
- [Dum99] Dumas, J.S., Redish, J.C. (1999), *“A Practical Guide to Usability”*, Intellect Books
- [Gaf99] Gaffney, G. (1999), *“Usability Testing”* Information and design, <http://www.infodesign.com.au>
- [Geu04] Geudens, W.H.J.M., Sonnemans, P.J.M., Petkova, V.T., Brombacher, A.C. (2004), *“Soft Reliability, a new Class of Problems for Innovative Products: “How To Approach Them””*
- [Gra98] Graves, G. (1998), *“Customer satisfaction: getting it straight form the best source – using focus groups to determine customer satisfaction”* Gale group.
- [Gul02] Gullett, M. (2002), *“Usability testing”* The Code Project
- [Hip88] Hippel, E. von (1998), *“The Sources of Innovation”* New York, Oxford University press
- [Kar04] Karroum, F. (2004), *“Types of soft reliability problems and innovation segments”* Msc. Thesis, Eindhoven University of Technology

- 
- [Lam06] Lambert, (2006) <http://www.cse.psu.edu/~lambert/420/big/node144.html>
- [Mel95] Meldrum, M.J. (1995), “*Marketing high-tech products: the emerging themes*”, European Journal of Marketing volume 29, number 10, 1995.
- [Mer04] Merrill, C., Feldman, D. (2004), “*Rethinking the Path to Usability, How to Design What Users Really Want*” IT Pro, IEEE 2004
- [Min05] Minderhoud, S., Fraser, P., (2005) “*Shifting paradigms of product development in fast and dynamic markets*” Engineering and System Safety 88 127-135
- [Mon02] Montgomery, D.C., Runger G.C. (2002), “*Applied Statistics and Probability for Engineers*” Wiley 2002
- [Nie93] Nielsen, J. (1993), “*Usability Engineering*” Academic Press
- [Nie97] Nielsen, J. (1997), “*The Use and Misuse of Focus Groups*” [www.useit.com](http://www.useit.com)
- [NiL93] Nielsen, J., Landauer T.K., (1993), “*A mathematical model of the finding of usability problems*” New York
- [Pet03] Petkova, V.T. (2003), “*An analysis of field feedback in consumer electronics industry*” PhD thesis, Technische Universiteit Eindhoven
- [Pet05] Petkova, V.T., Sander, P.C. (2005), “*The value of Feedback in Consumer Electronics: a case study*” IEEE 2005
- [Pet06] Petkova, V.T., Sander, P.C., Lu, Y (2006) “*Customer Feedback Before Market Release: A Case Study*” IEEE 2006
- [Rog03] Rogers, E.M. (2003), “*Diffusion of Innovations*”, 5th edition free press New York, 1st edition 1962
- [Saa03] Saaksjarvi, M. (2003), “*Consumer adoption of technological innovations*”, European Journal of Innovation Management volume 6, number 2, 2003.
- [Uit04] Uitdenbogaard, T. (2004), “*Classification of soft reliability problems for Innovative Products*” Msc. Thesis, Eindhoven University of Technology
- [UoP06] University of Pennsylvania (2006), “*Customer Focus Groups*” Philadelphia



- 
- [Win97] Wind, J. and Mahajan, V. (1997), "*Issues and opportunities in new product development*", an introduction to the special issue. Journal of marketing research, vol 34.
- [Zan02] Zanzara (2002) "*Focus Groups vs Usability Studies*"  
<http://www.zanzara.com>