Bernd Bertsche

Reliability in Automotive and Mechanical Engineering

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Determination of Component and System Reliability

In Collaboration with Alicia Schauz and Karsten Pickard

With 337 Figures and 66 Tables

Springer

Prof.Dr. Bernd Bertsche
Universität Stuttgart
Fak. 07 Maschinenbau
Inst. Maschinenelemente
Pfaffenwaldring 9
70569 Stuttgart
Germany
bertsche@ima.uni-stuttgart.de

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Preface

Reliability and maintenance coupled with quality represent the three major columns of today's modern technology and life. The impact of these factors on the success and survival of companies and organisations is more important than ever before. Although these disciplines may be viewed as non-profitable, experience has shown that neglecting or omitting them can lead to severe consequences. This is underlined by the dramatically increasing number of callbacks. In fact, over the last fifteen years the number of callbacks has tripled.

Just recently a huge recall in the toy industry occurred due to lead contaminated toys. In the automotive industry callbacks arise regularly for several varying reasons. Since products are becoming ever more complex and the available time for development is continuously decreasing, the necessity for and influence of the three pillars: reliability, maintenance and quality, will only continue to increase in the future. Considering one classic example of a complex product, the passenger car, while bearing the callback statistics in mind, it is not surprising that the attributes "reliability" and "quality" are the two most important considerations for customers buying a new car.

This trend has been observed and confirmed over several years. The increasing demand on reliability methods combined with the importance of studying and understanding them led me to the decision to compose a book about reliability and maintenance. Originally, this book was only published in German, but requests from colleagues and companies all over Europe and the USA induced me to bring out the English translation as well. This book considers the basics of reliability and maintenance along with further improvements and enhancements which were found by extensive research work. In the following chapters, fundamentals are combined with practical experiences and exercises, thus allowing the reader to gain a more detailed overview of these crucial subjects.

The present book could not have originated without the help of the following persons, to whom I wish to express my appreciation. First of all,

many thanks to Prof. Gisbert Lechner, who was initiator of the German edition. I am grateful to Mrs. Alicia Schauz und Mr. Karsten Pickard for the translation from German into English. Through their editorial and organisational work accompanied by their dedication and commitment they together enabled and formed this book. I also would like to thank Ms. Andrea Dieter for editing and overworking the illustrations. My exceptional thanks goes to Mr. G.J. McNulty for his useful editorial suggestions. Finally, I would like to thank the publishing company Springer for their helpful and professional cooperation.

Stuttgart, Autumn 2007 Prof. Dr. B. Bertsche

Contents

1 Introduction

„It is impossible to avoid all faults“

„Of cause it remains our task to avoid faults if possible“

Sir Karl R. Popper

Today, the term reliability is part of our everyday language, especially when speaking about the functionality of a product. A very reliable product is a product that fulfils its function at all times and under all operating conditions. The technical definition for reliability differs only slightly by expanding this common definition by probability: reliability is the probability that a product does not fail under given functional und environmental conditions during a defined period of time (VDI guidelines 4001). The term probability takes into consideration, that various failure events can be caused by coincidental, stochastic distributed causes and that the probability can only be described quantitatively. Thus, reliability includes the failure behaviour of a product and is therefore an important criterion for product evaluation. Due to this, evaluating the reliability of a product goes beyond the pure evaluation of a product's functional attributes.

According to customers interviewed on the significance of product attributes, reliability ranks in first place as the most significant attribute, see Figure 1.1. Only costs are sometimes considered to play a more important role. Reliability, however, remains in first or second place. Because reliability is such an important topic for new products, however it does not maintain the highest priority in current development.

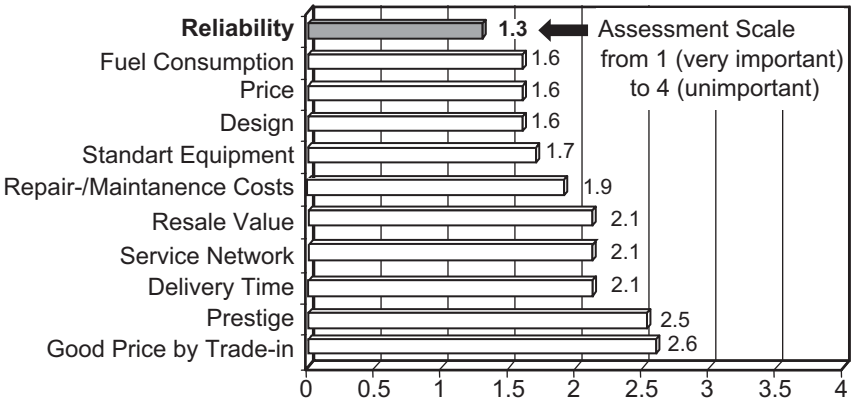

Figure 1.1. Car purchase criteria (DAT-Report 2007)

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Surveys show that customers desire reliable products. How does product development reflect this desire in reality? Understandably, companies protect themselves with statements concerning their product reliability. No one wants to be confronted with a lack of reliability in their product. Often, these kinds of statements are kept under strict secrecy. An interesting statistic can be found at the German Federal Bureau of Motor Vehicles and Drivers (Kraftfahrt-Bundesamt) in regards to the number of callbacks due to critical safety defects in the automotive industry: in the last ten years the amount of callbacks has tripled (55 in 1998 to 167 in 2006), see Figure 1.2. The related costs have risen by the factor of eight! It is also well known, that guarantee and warranty costs can be in the range of a company's profit (in some cases even higher) and thus make up 8 to 12 percent of their turnover. The important triangle in product development of cost, time and quality is thus no longer in equilibrium. Cost reductions on a product, the development process and the shortened development time go hand in hand with reduced reliability.

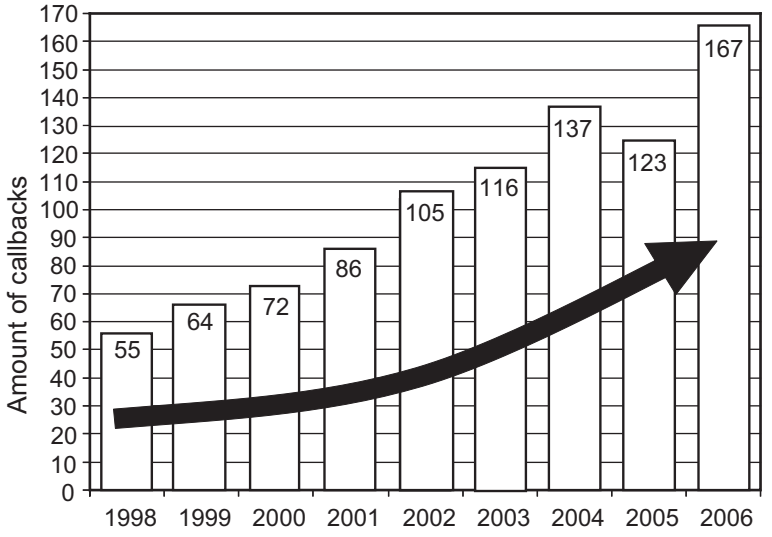

Figure 1.2. Development of callbacks in automotive industry

Today's development of modern products is confronted with rising functional requirements, higher complexity, integration of hardware, software and sensor technology and with reduced product and development costs. These, along with other influential factors on the reliability, are shown in Figure 1.3.

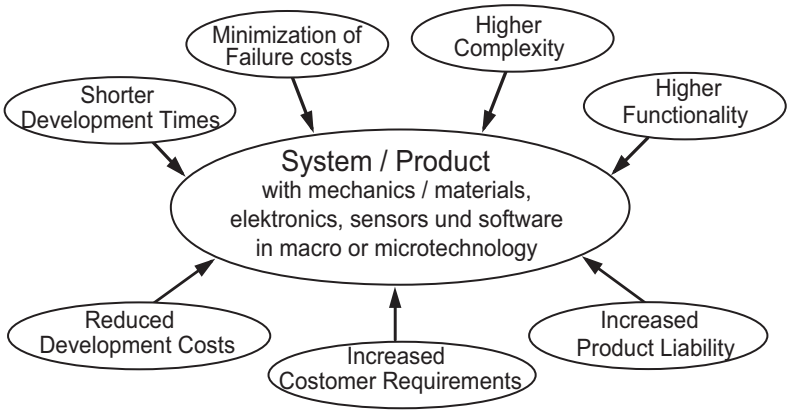

Figure 1.3. Factors which influence reliability

To achieve a high customer's satisfaction, system reliability must be examined during the complete product development cycle from the viewpoint of the customer, who treats reliability as a major topic. In order to achieve this, adequate organizational and subject related measures must be taken. It is advantageous that all departments along the development chain are integrated, since failures can occur in each development stage. Methodological reliability tools, both quantitative and qualitative, already exist in abundance and when necessary, can be corrected for a specific situation. A choice in the methods suitable to the situation along the product life cycle, to adjust them respectively to one another and to implement them consequently, see Figure 1.4, is efficacious.

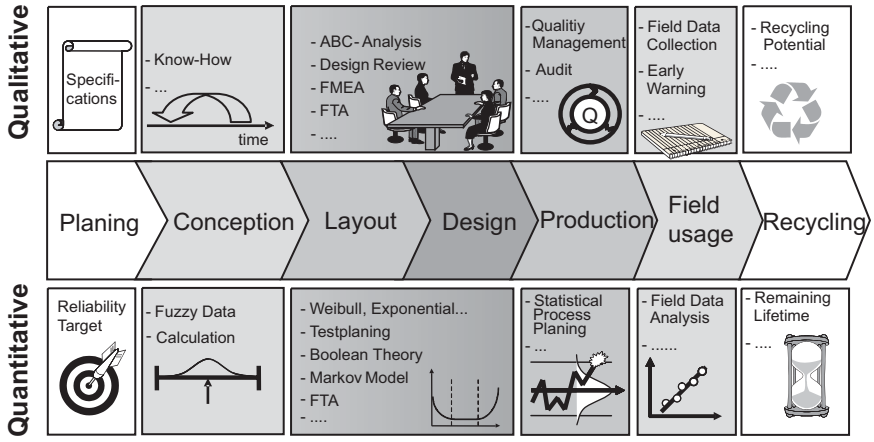

Figure 1.4. Reliability methods in the product life cycle