Chapter 9
Monte Carlo Simulation for Reliability-Based Design of Automotive Complex Subsystems

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ABSTRACT

Design and production of high reliable and safer systems with longer life has been a challenge because of high competitive market and recent safety issues of reputable car manufacturers. In this chapter, a methodology is introduced for reliability based design of automotive system. FMEA results are used in the process of failure rate estimation. The basic failure data are adjusted by multiplicative corrective factors to account for the design and environment impacts on system failure characteristics. The system is modeled by reliability block diagram (RBD) method, simulated by an efficient Monte Carlo method. According to the results of FMEA and reliability evaluation, the structure of system is improved by reducing the components failure rates and potential change of system configuration. The components’ reliability is improved by increasing the quality of components by utilization of high quality materials and modern manufacturing techniques. The results showed the failure rate improvement for friction lining component in dry friction clutch system.

INTRODUCTION

Reliability is considered as an important characteristic of the products life performance. There are several purposes demanding on reliability improvement. This includes

1. Products become more complex; unless reliability target is not satisfied, the performance may become inadequate.

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There exists a tough competition between the industrialized nations. Products with high reliability will finally survive.

3. There is a pressure to minimize waste as the world population grows as the resources keep on shrinking.

4. Product’s high durability implies less environmental impacts (Misra, 2008).

5. Considering the warranty and callback costs, manufacturers motivates to invest more time and money into the designing phase which includes the reliability design of the product (Teixiera, 2007).

Design for reliability of automotive is an important research area, specifically in the early design phase. This requires proper knowledge about the potential failure modes and reliability characteristics of all relevant automotive parts and subsystems. The main objective of automotive design for reliability is to maximize the reliability and life time quality of products.

It is reported (Bhote & Bhote, 2004) that 80% of poor quality is caused by design. Over 90% of field failures are the result of poor design, and a high percentage of product recalls have their origin in design. Most law suits are filed on account of improper design and 70–75% of product costs are functions of design (Bhote & Bhote, 2004). Therefore, if there is any phase in the entire life cycle of a product that has maximum impact on reliability, it should be the design phase. It should be noted that reliability has found as a key product attribute in the customer’s point of view (see Figure 1). Nowadays there are an increasing number of callback reports in automotive industry due to lack of proper design which illustrates the importance of developing a reliability integration plan during the product designing phase.

In fact, reliability should be designed and built into products and systems at the earliest possible stages of product development. It is the most economical approach to minimize the lifecycle costs of the product or system. Better system reliability is achieved at much lower costs, otherwise because the majority of life-cycle costs are locked in phases other than design and development; one pays later on in the product life for poor reliability effort at the design stage. Therefore, a descent effort at the design stage offers the following advantages (Misra, 2008) of

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**Figure 1. Car purchase criteria (DAT-Report)**

*Source: Bretsche, 2008*
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