KOTEL 042: INTEGRATED BUSINESS AND TECHNICAL PRODUCT RELIABILITY DESIGN (BRED)

1. OBJECTIVES

The objective of the project is to develop a design module that brings the reliability consideration and the economical and business expectations into the process of product design. The module consists of a holistic business-reliability structure (Murthy) which includes elements such as: a tool for making reliability facts visible for business level decisions and a tool for including the customer view into the reliability of the product. This can be integrated into the reliability and availability allocation and analysis modules for product design developed recently by Virtanen and Hagmark in other R&D projects.

The purpose is to develop a design methodology that includes the interactions and links between the customer needs, the manufacturer business targets and the product reliability performance. This makes it possible to find and simulate in detail, which are the specific customer product reliability requirements and what influence the reliability performance has on the customer satisfaction. In addition the method enables to assure at different phases of the design process that the promised reliability performance can be delivered to the customer in accordance with the business expectations of the top management. Thus the method enables product reliability facts to be taken into account at business decision level.

2. BACKGROUND

The traditional and still dominating method for product design is focused on optimising the technical performance of a product. The customer expectations are today increasingly integrated as design requirements into the design process. However, the reliability aspects of the product are still today very poorly integrated into the design process. The reason for this is simple, there does not exist easily available and comprehensive design method or tool to integrate the reliability considerations and effects in product deign.

This is a problem today when both the customer expectations and the societal requirements are increasingly focusing more on reliability and safety aspects instead of purely technical performance. A company that has a good control of the reliability performance of its products has a considerable competition advantage both in the case of consumer products and when negotiating about availability contracts for large industrial systems.

In the design methods used today it is very much the design engineer that is responsible for the product reliability. How well this is in agreement with the customer expectations depends on how well the designer knows the end user and how well the reliability requirements have been specified. Typical problems arise when either 1) such a reliability performance is promised to the customer that cannot be achieved or 2) achieving the promised performance becomes very expensive for the company. The design method to be

developed in this research is focusing on finding solutions and tools to overcome these problems.

One basis for this research work is the pioneering work on reliability design carried out by Virtanen and Hagmark and their group at Tampere University of Technology. They have developed a new approach to reliability product design which can be divided in three parts: 1) modeling and analyzing a failure logic, 2) allocation of reliability and availability requirements and 3) simulation and calculation of reliability performance and maintenance costs.

Professor D.N.P. Murthy from the University of Queensland (UQ) in Australia is one of the leading experts and scientists in reliability engineering in the world. He has published a great number of scientific papers, books and carried out industrial consultancy in many countries in different parts of the world. He has recently developed together with Ostreas and Rausand from Norwegian University of Science and Technology in Trondheim a new method called “Reliability Performance and Specifications in New Product Development". The novel feature of this is focusing on the front end in the product development process as shown in Figure 1. This new approach as well as the large experience of professor Murthy will be benefited in the suggested project.

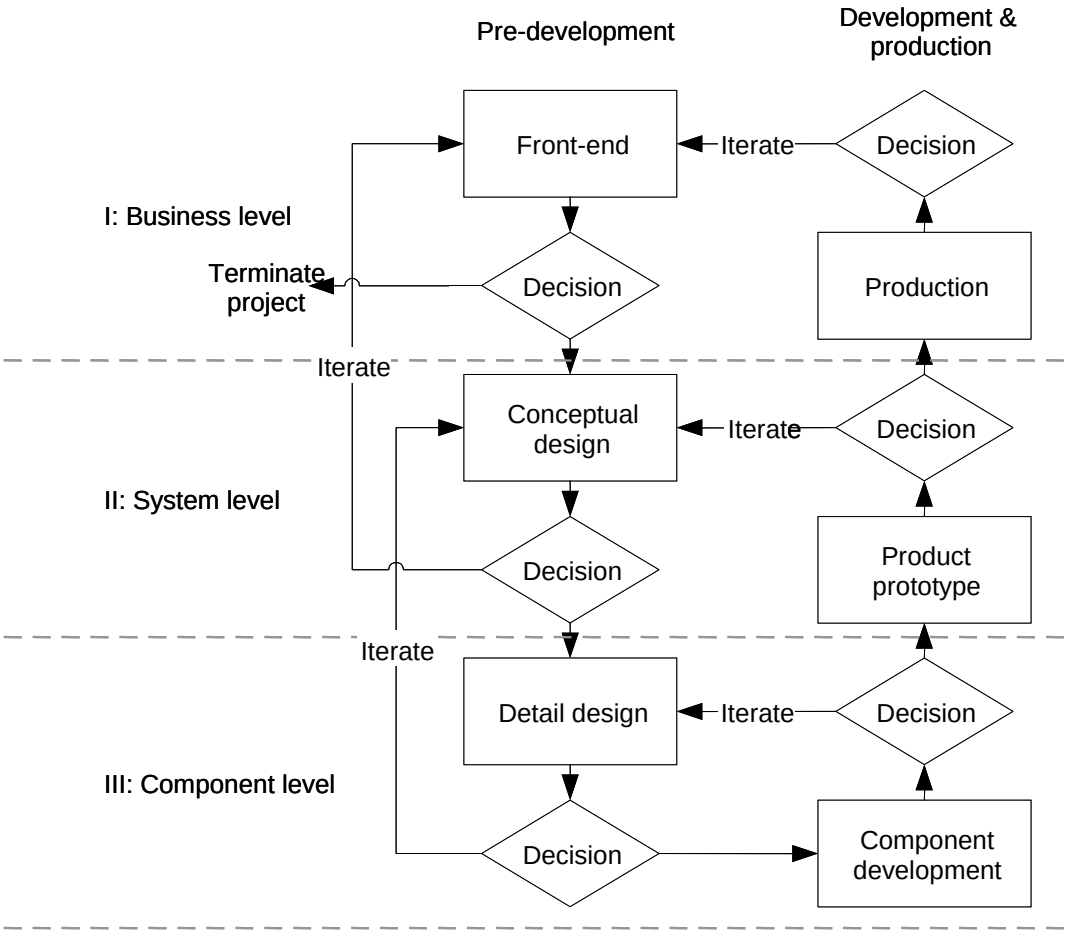

Figure 1. Integration of business, system and component levels in the product reliability design process

VTT Industrial Systems has since many years a large research and development activity going on related to different aspects of safety and reliability. These include safety design, failure analysis, component lifetime estimations, sensor development, monitoring and diagnostics, human factors, risk analysis, structural analysis and reliability calculations. In addition VTT has expertise on economical industrial and product calculations such as maintenance key figures and their integration into marketing and business strategies. This will be benefited in the project.

3. PROJECT ISSUES ANALYSIS

The three research organizations and five well-known global industrial companies that are participating in this project proposal have a long experience of product reliability analysis, development and application. In the project preparation phase they have carried out a Quality Function Deployment (QFD) study where the main research issues have been analyzed and ranked according to importance. A summary of the QFD study is below.

Table 1. Importance of research issues ranked by QFD.

Issue No	Integrated Business and Technical Product Reliability Design (BRED)	The issues importance from BRED project point of view
6	How to include the customer view into the reliability of a product? Transferring customer needs to product roadmaps / top management strategy deployment	0.561
4	Need to formulate reliability parameters on terms of cash > profit. The LCC perspective	
2	Simple tool to make reliability facts visible for top management is needed	
3	A structure and procedure forming basis for making warranty strategy decisions and maintenance contracts / extended warranty is needed	0.138
5	How to get good (=reliable) data for the reliability calculations/estimations	0.135
7	How to include the uncertainty of middlemen (between supplier and end user) and small subcontractors in the reliability estimations	0.09
1	Small cheap components cause much trouble - time between stoppages important	0.07

4. WORK PLAN

The work includes two parts: I) the development of “Decision model” and its integration to the “RAM design methods and software” (see Figure 2) and II) in parallel its implementation to five industrial cases. The experience from the industrial cases will during the process directly be used in the further development of the generic model.

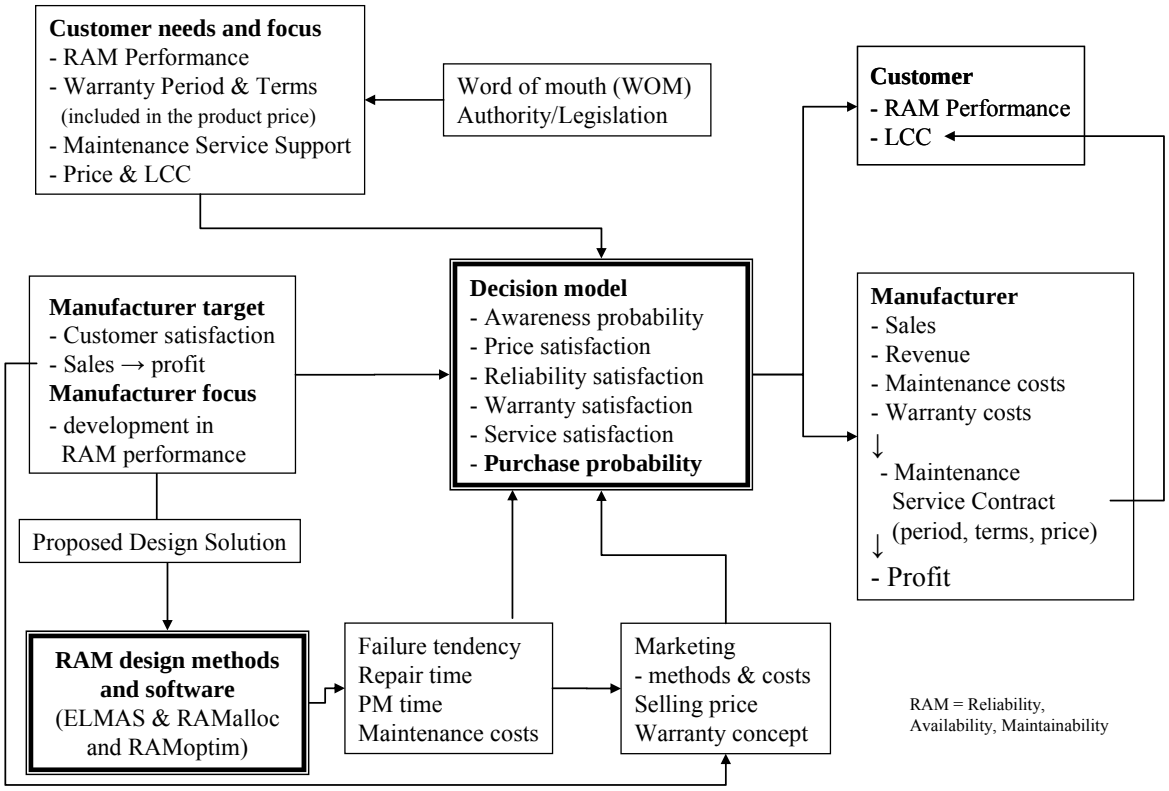

Figure 2. Concept to link the customer needs and focus, the manufacturer's target and focus and the product RAM performance

The work consists of the following tasks:

1. Specification of the generic requirements of product market research

A general concept and structure of how to integrate business requirements and product reliability characteristics is developed based on the structure shown in Figure 1. Market demands, price and competition environment, which are influenced by the customer behavior are included. In different market segments and customer groups the importance of product reliability is experienced differently and there is a considerable variety in their risk tolerance. This is taken into account in the model.

Advanced tools such as the Quality Function Deployment method will be utilised for building up the model. The result is a process and method to measure how important the product reliability aspects are from the customer point of view, how this influences on customer satisfaction and how much the customer is ready to pay for a certain reliability performance.

2. Specification of customer needs and focus

A specification method and questionnaires for defining the critical customer data that is influencing on product reliability and/or availability is developed. A method for specifying

warranty conditions and service concepts with which the customer typically assures the required product reliability and availability performance is developed.

3. Specification of manufacturer targets and focus

A method for integrating the business requirement in the product design process is developed. This includes typical business targets such as sales, market and profit targets as well as customer satisfaction, design strategies and costs. The relevant design strategies are based on reliability and maintainability considerations.

4. Development of Decision model

This part is the crucial part of the integrated design model. Commercial, technical and financial data is received from the previous tasks as shown in Figure 2. Advanced logics and tools are used to define the business parameters and reliability functions and their interactions, dependencies and priorities. The required product performance is described in reliability related parameters such as reliability, maintainability, warranty costs, service concepts and costs, manufacturing costs and life cycle costs. This information is used as an input to the product reliability and allocation analysis model.

The model offers a possibility to have a causal connection between the product RAM performance, customers satisfaction and the sales. This forms a structure and procedure for making warranty strategy decisions and maintenance contracts as well as extended warranty. The reliability facts are visualised by advanced user interface techniques to be easily presented for top management.

5. Integration of Reliability and Maintenance Costs Allocation and Analysis Model into the Decision model

Virtanen and Hagmark have developed a reliability and maintenance costs allocation and analyis models. It includes one module for modeling and analysing the product's failure logic, one for allocation of reliability and availability to the product's design and manufacturing entities, and one for the simulation and calculation of product's reliability performance and mainternance costs with the different design solutions and service concepts. In this project these models will be integrated into the Decision model to be developed in this project.

6. Industrial case 1:

7. Industrial case 2:

8. Industrial case 3:

9. Industrial case 4:

10. Industrial case 5:

11. Reporting and coordination

The work will be documented in work reports and presented in international conferences and journals. The aim is one PhD thesis, two MSc thesis, two international journal articles, three international conference presentations and several presentations at national professional meetings.

5. RESOURCES AND CO-OPERATION

The work will be carried out by:

Tampere University of Technology:
- professor Seppo Virtanen, reliability engineering and maintenance
- dr Per-Erik Hagmark, reliability mathematics, modeling and simulation
- senior researcher Heikki Pernu, reliability and maintenance cost analysis
- researcher Teemu Yli-Kovero, LCC-analysis and engineering assets management
- researcher Jussi-Pekka Penttinen, reliability mathematics and programming

VTT Industrial Systems:
- dr Kari Komonen, business economics, maintenance

University of Queensland, Australian:
- professor D.N.P. Murthy, product reliability specification and analysis

KOTEL has appointed Hannu Hossi as the responsible manager of this project.

Companies:

The project will have managing committee. Each company can name one member into that committee. Also TEKES, KOTEL and performing parties will each name a member into managing committee.

6. SCHEDULE

Practically project started in 1st of May, 2005 and to be finished 28.2.2008. The different subtasks are planned to proceed according to the schedule diagram in Figure 3.

Due to the size of this project KOTEL suggest that the interval of TEKES reporting would be 4 months.