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RISK TREATING IN EARLY LIFECYCLE PHASES

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Abstract: Identification and treatment of risks in early phases of a product lifecycle are becoming more commonplaces nowadays. Since state-of-art companies that want to keep up with competitors have to consider all actions which might prevent loses or customer's dissatisfaction. This paper deals with a new risk management procedure concerning the early phases of a product lifecycle. Proper risk identification in early phases may result in mitigation or removal of an impact that might cause considerable property, health or the environment losses in late phases of a product lifecycle. Phases of conceive and design are considered as early phases in this study. It is always very complicated to assess risks in an early phase of a project since almost no data is available. Therefore, this procedure has been developed to help to manage such risks. Procedure combines so far known methods and adds new possible steps that may be taken advantage of.
Keywords: Risk Management, Product Lifecycle, Conceive, Design

INTRODUCTION

Currently, risk management is an integral part of every state-of-art production enterprise because running enterprises always goes with various kinds of risks. Therefore, it is necessary to develop and improve ways of implementation of a risk management system into enterprise processes. Risks are supposed to be managed across all levels of organization and considered in terms of finance, environment and occupational safety. As far as production enterprises are concerned, it is also necessary to transfer the risk management to produced products. Every product has its product lifecycle where it is needful to consider various influences which enter the product lifecycle and manage risks here. The product lifecycle and its managing have become a present standard and a part of the information structure of modern enterprises. Due to comprehensibility and definiteness, it consists of several phases. This helps to make risk management easier because it is feasible to manage risks for each phase separately. This study deals with the phases of conceive and design that are considered to be the early phases of a product lifecycle. Managing risks at the beginning of a product lifecycle is very important because this action may be beneficial in the future phases and save a considerable amount of money, company's reputation or even human health.

PRODUCT LIFECYCLE MANAGEMENT

The product lifecycle is based on the principle of a biological cycle, i.e. the process from birth to death. This theory is the same for a product and it can also be understood as a process which is one of the other enterprise processes. In risk management, all participating subjects must understand the relation between project management processes and the other enterprise processes. The project lifecycle is the natural framework for investigation of relations and processes in the field of project management. It is described as a means of defining of the beginning and end of a project and its phases. The form of life cycle definitions varies by industry areas but it is also various within the same industry for different organizations and businesses. In project management, the risk approach changes in various stages. This depends on how much information is available and what the extent of the project progress is. The most common lifecycle description covering all phases is seen in Figure 1.

Figure 1: Common lifecycle phases

The product life cycle or PLM (Product Lifecycle Management) is a control process from conception through design and production to service and disposal. PLM includes people, data, processes, business systems and provides the main information flow for companies. Simultaneously, PLM systems help organizations in copying with an increasing complexity and engineering tasks of new products development for global competitive markets [1].

Low-quality data in the process of a product origin means a considerable problem of higher costs. Number of components of all today's products and its shape complexity are still increasing. This trend is clearly seen in all industries. It is not an exception when the number of product components is not just in the tens of thousands but hundreds of thousands or even in six figures (automotive, marine, aviation and aerospace industry) [2]. Therefore, it is necessary to prevent the risk of failures from the very beginning of the lifecycle of each product.

RISKS IN THE PHASE OF CONCEIVE

At the beginning of each product's life cycle is always the customer who expresses its needs and these needs must be heard. There is no universal voice of the customer (VOC), each is unique and very diverse. Customers have many different requirements. Even within a single purchasing unit may appear different requirements [3]. All these voices must be considered and balanced in order to develop a truly successful product. For a better understanding of customer needs, a discussion with him should be held where it is important to identify the basic needs of the customer. First, his involvement is necessary to define requirements, answer questions of developers and then to advice and criticise the actual product development process or evaluation of a prototype design, etc.

General requirements should be divided into more specific details - the customer should be urged to thoroughly clarify and express its demands until they make a perfect sense. Such practices often lead engineers of highly technological products to fundamental findings that ease of use and durability are usually more important for the customer than the latest technology. Besides expressed needs of the customer, it is also needed to identify the unspoken ones. Needs considered as only a conjecture and therefore unmentioned, they can be identified through the preparation of a tree of functions. When all the needs of the customer are collected, it must be properly organized.

Voice of customer is usually the input for CTC. Critical to customer (CTC) are measurable standards of performance for a product or service that are essential in order for that product or service. Critical to Customer items are those which are particularly important to the customer, as defined through a process of assessing the Voice of the Customer by methods from survey to interview to focus groups. CTC provides a simple method for prioritizing and selecting appropriate input requirements for this process. CTC items are reflected internally in Critical to Quality (CTQ) criteria. Then, CTC and CTQ are inputs for further risk analysis as the Delphi method. The next input for the primary risk analysis of the entire product lifecycle is so-called Lessons learned. A recommendation, based on analysed experience, from which others can learn in order to improve their performance. It is necessary to consider whether a similar product was developed in the past and what risks occurred and how they were treated. Then, the same counter-measures must be applied to the current product or eventually with improvements.

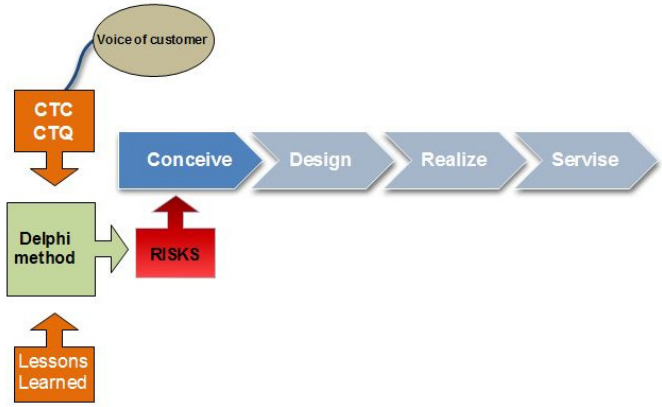

Figure 2: Risk identification in the phase of conceive

As it was mentioned above, the input for primary risk analysis should be CTC, CTQ and Lessons Learned as it is seen in Figure 2. Since it is not possible to quantify risks in the first phase of the lifecycle, it is necessary to carry out only a qualitative estimate. For these purposes, it is

suitable to choose the Delphi method or some of methods according to [4]. Then, all identified risks will come through all phases. Before the single risk analysis, it is needed to define a terminology which will be used during the entire lifecycle.

In this phase, it is not difficult to carry out any changes. In consequent product phases, the possibility and ease of any change go down and a price of a change and a risk rapidly grows in time since the product is committed to technology, configuration and performance. Therefore, it is necessary to identify all risks in the first two phases when it is still possible to make changes and counter-measures with ease. Unidentified risks in the phases of realize and service may endanger the financial achievement of the whole project [5]. The level of ease of changes in single phases is seen in Figure 3.

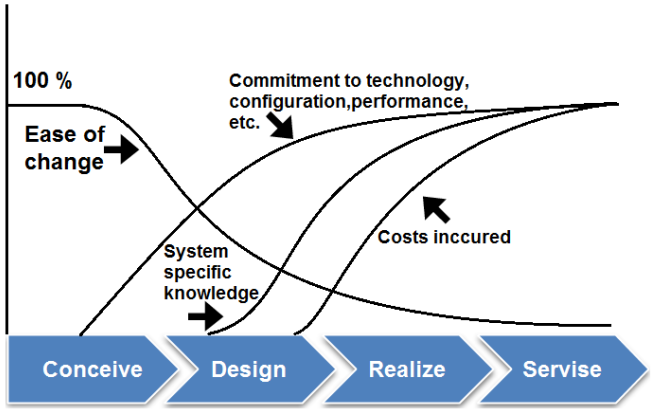

Figure 3: Ease of change, commitment to technology and costs during the product lifecycle [4].

RISK IN THE PHASE OF DESIGN

A design risk assessment is the act of determining potential risk in a design process, either in a detailed design, consequent analysis or simulation, validation and possible tool design [6]. It provides a broader evaluation of a design beyond just CTQs, and enables to eliminate possible failures and reduce the impact of potential failures. Risks from the conceive phase are transferred to the phase of design and new risks must be assessed after simulation and clarification as seen in Figure 4.

Making a prototype and simulations, it can considerably help in identification of product risk aspects. Also, a simulation of treating the product and its placing into the working environment are important. Here, it is possible to estimate the risk probability which is already quantitative. For the better understanding of customer's requirements, it is suitable to set an appointment with a customer and introduce the prototype. Then, it is possible to adjust it according to customer's needs. From the way of the customer's treating with the prototype, it is likely to observe other possible risks. For the risk assessment, the method from [7] was used.

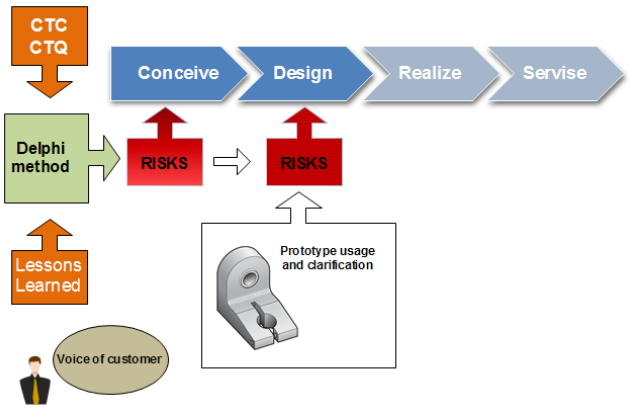

Figure 4: Process of risk identification in the design phase

In this study, probability level is divided into five levels: very likely, likely, possible, unlikely and very unlikely. The relative description of probabilities is shown in Table 1. Further, the level of impacts of events is divided also into five levels: very serious, serious, moderate, minor and negligible. The exact criteria description depends on a certain product as seen in Table 2. The higher levels of both, the more serious issue may occur.

Table 1: Probability level

Level	Description	Probability [%]
5	Very likely	1 – 0,1
4	Likely	0,1 – 0,01
3	Possible	0,01 – 0,001
2	Unlikely	0,001 – 0,0001
1	Very unlikely	less than 0,0001

Table 2: Impact level

Level	Description	Criterion
5	Very serious	
4	Serious	
3	Moderate	Depends on the event
2	Minor	
1	Negligible	

Table 3: Example of a table with assessed risks

Item	Event	Probability level	Impact level	Probability index	Impact index	Risk value
1-...	Risk	1-5	1-5	0-1	0-1	0-1,41

After identification of all risk events, it is needed to determine the probability R_p *and impact* R_I *index*

of a given event and the consequent risk value R as it seen in Formula 1. Calculations of the probability and impact indexes are described in Formulas 2 and 3.

$$R = \sqrt{R_I^2 + R_p^2} \quad (1)$$

where,

$$R_p = \frac{\mu_p - min}{R_{FP}} \quad (2)$$

$$R_I = \frac{\mu_I - min}{R_{FI}} \quad (3)$$

From Formula 2, μ_p refers to the mean of probability level. From Formula 3, μ_I refers to the mean of impact level, min refers in both cases to the minimum of the k – level table, set to 1. R_{FI} and R_{FP} refer to the full distance of k – level table minus 1, both values are 4 ($R_{FP} = R_{FI} = 4$). All counted indexes and values are recorded in the table. An example is seen in Table 3.

BASEBALL FIELD DIAGRAM

Risk value R is divided into five priority areas, from A to E, where A represents the area of the highest priority. Risk value R combines the probability index R_p and the impact index R_I. With one index as horizontal axis and the other as the vertical axis, a diagram reminding of a sector of a baseball field can be drawn. Whose bottom left corner represents the lowest coordinates (0,0) and whose upper right corner is the largest coordinates (1,1) as seen in Figure 5.

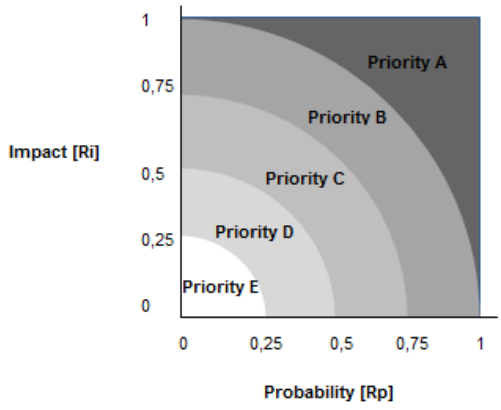

Figure 5: Baseball field diagram

There are five priority areas in the diagram. The priority area A represents risks of the highest priority and it is necessary to carry out immediate counter-measures. The area of B represents risks of the high priority. It has the next highest priority for resources for management and control, and so on, down to the probability area E where risks may be neglected.

CASE STUDY

For instance, this may be applicable for a new printed circuit boards (PCB) development or for custom made PCBs. When a customer requires special treatment or PCBs determined for special environmental conditions. Practical examples of treating risks and the Baseball field diagram are shown below.

Conceive

A customer requires a product line of printed circuit boards with a perfect level of cleanliness, accuracy and all PCBs must be perfectly soldered. This may be considered as a Voice of Customer and these three drivers are critical to quality of a product. It is seen in Figure 6 and this is the input for the phase of conceive. It is always necessary to listen to the customer's voice and his wishes from which drivers for CTQ may be deduced. When a similar product was produced in the past, all issues concerning its quality should be counted on and considered for the new product. This is called Lessons Learned as also seen in Figure 6.

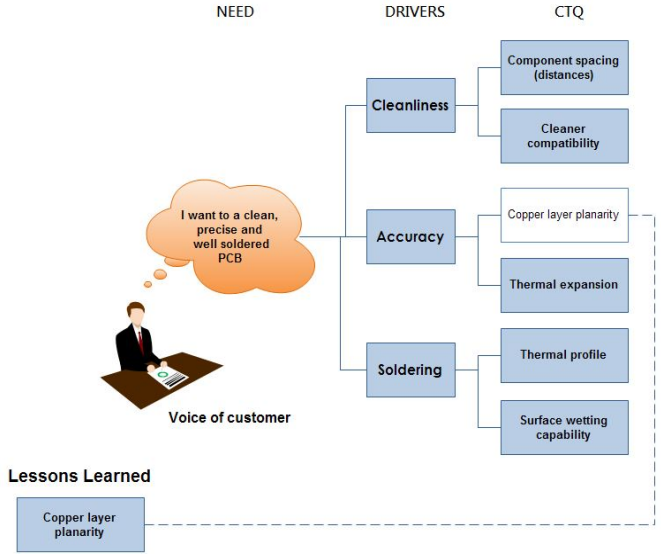

Figure 6: Critical to quality diagram

Methods such Delphi may be also used for further risk identification. Then, all these identified risks are taken into consideration and become the input for the next phase, the phase of design.

Design

In the phase of design, it is required to assess identified risks and find out their risk values, if applicable. The aim of this is to prioritize risks and initiate countermeasures according to priorities. In

Table 4, assessed risks are seen with their risk values. Items including the issue of accuracy are named A, the issue of cleanliness C and the issue of soldering S. The risks concerning customer's requirements are seen and evaluated. Probability values should be based on real observation and simulation data or when we consider Lessons Learned cases, there it is possible to use the data from a real production and adjust it to the new product. Impact relies on the certain event or importance of a customer's requirement. The more important to the customer the bigger value is required.

Table 4: Risk value

Item	Risk	Probability grade	Severity Grade	Probability	Severity	Risk value
1A	Thick copper design may cause lack of planarity	4	3	0,75	0,5	0,90
2A	Shrinkage, some materials do not shrink uniformly	2	2	0,25	0,25	0,35
1C	Spacing	3	2	0,5	0,25	0,56
2C	Compatibility with greater diversity of materials	2	2	0,25	0,25	0,35
1S	Thermal profile issue	3	4	0,5	0,75	0,90
2S	Surface wetting capability	4	4	0,75	0,75	1,06

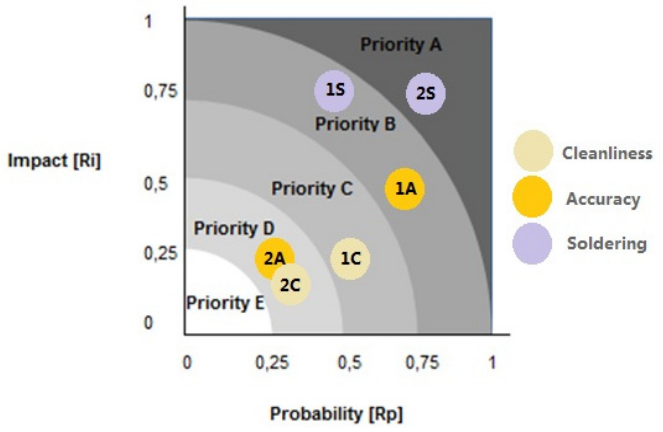

Figure 7: Application of the Baseball field diagram

From these values, it is counted the risk value and the treatment priority from the baseball field diagram, as seen in Figure 7. In this case, the most serious issue seems to be surface wetting capability concerning proper soldering. This item gets the highest priority. The other items are treated consequently according to priority ranking such thermal profile issue, thick copper design ect.

CONCLUSION

Ever-increasing financial, time and qualitative demands force current companies and project teams to consider all possible risks and their consequences which might have fatal impacts. Right awareness, considering and consequent risk management at the beginning of the project can mean a multiple saving at its progression or end. Risk management throughout the entire product lifecycle is slowly becoming a standard practice, but appropriate methods and procedures are not always used. This study offers a possible way how to treat risk in the first phases of the product lifecycle where is still possible to make significant changes without incurred costs that would considerably endanger the financial achievement. Identified risks can be used for a decision whether to continue the production of a product or make significant changes. Performing this analysis can result in mitigation of property, health or the environment losses. This case study enables a better view of the issue of risk management of the product lifecycle and shows a possible way of usage. Further research will be devoted to next product lifecycle phases in order to create a unique methodology.

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