Application of Reliability Engineering: a Detailed Study

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***Abstract*— In the present competitive world, the competitiveness between the organizations has increased demands on production systems. The Customer satisfaction depends upon the production systems, capability to deliver the quality goods and services on time. To do so, the systems must be reliable. The advanced technology is very complex and includes different types of components such as software, hardware, human factor. Reliability is principal property of the system, which is an important parameter to decide the life of any biological and human made system. The application of reliability engineering is overviewed in this paper. The paper discusses the performance of the system and explains about the importance of the reliability in evaluating the life of the system. Higher reliability depends on maintainability, availability and testability of the product.**

Keywords: Dependability, Maintainability, Fault tree analysis, Availability, Probability, Complexity, industrial automation,

I. INTRODUCTION

The development of science and technology are the needs of the modern society for racing against each other. To meet the customer demand, the industries always goes towards the automation in their industrial production activities. The technology of industrial automation and their product is increasing every day. In present scenario, the development of such an automation acquired lots of importance. The uncertainty in material and manufacturing parameters has to be considered in the designing in any product. In designing a mechanical component safety factor is comprehensively used, which is industry specific and determined by the engineers experience. In the competitive world, reliability analysis is playing a prominent role in the production of component and to indicate the life of the component. [1] to [3].

Reliability engineering is the branch of engineering that deals with the dependability in the product life cycle management. Dependability or reliability, explains the ability of a system or component to work under stated conditions for a specified period. In theoretically, reliability defines the flip-flop of the success. As pointed out by the Martin, developing the reliability models, by considering the strength degradation is an important issue for reliability estimation. [4]. The purpose of reliability testing is to find the problems for the failure of the component and ultimately to provide the confidence that the system should meets its reliability requirement. Reliability testing may be performed at several levels and there is number of testing techniques are available to check the reliability of the component. Geidl and Saunders [5] have given reliability equation to estimate the reliability by introducing time-dependent elements into the equation. Somasundaram and Dhas [6] put forward a generalized equation to estimate the dynamic parallel system reliability. Noortwijk and Weide [7] developed a reliability model, in which load and strength are described as two random variables in the processes. Labeau et al. developed the framework of a dynamic reliability platform and identified its main constituents [8].

II. RELIABILITY AND QUALITY

The concept of reliability is as old as human being He has long been concerned with the problem of unreliability of the product used. However, this reliability science is new concept to the world and it is still under growing stage. [9].

In simple, the reliability means the probability that a failure may not occur in a given interval of time. A more rigorous definition of reliability for given period of time under stated operating condition is as follows, A unit of reliability is the unit probability that the unit will performs its intended function adequately. The reliability of the product depends on four essential segments. [10]:

1. Probability
2. Intended function
3. Time
4. Operating conditions

If T is the failure time occurs, then the given environmental probability time, that it will not fail before its reliability is

$$R(t) = P(T > t) \longrightarrow (1)$$

Thus, the function of reliability is always depends on time and environmental conditions. Since the numerical probability, value should always between one and zero, i.e.

$$R_1(0) = 1,\ R_1(\infty) = 0 \longrightarrow (2)$$

And R_1 (t) is a non increasing function between these limits

Quality of a device is the measure of excellence or a state of being free from defects. It is not concerned with elements of time and environment. Equipment, which has undergone all quality tests, may not necessarily be more reliable. Quality is associated with the manufacture where as reliability is primarily associated with the design. In a way reliability is the ability of the unit to maintain its quality under specified conditions for a specified time.

Causes of failures and Unreliability

The specific causes of failures of components and equipment in a system can be many. A few of them are listed below [11]:

a. Poor design
b. Wrong manufacturing technique
c. Lack of total knowledge and experiments
d. Complexity of equipment
e. Poor maintenance policies
f. Organizational rigidity and complexity
g. Human errors

III. RELIABILITY MODELING AND TESTING

Reliability modeling is the process of estimating and knowing completely about the reliability of a component or a system prior to its implementation. The two types of analysis are often used for modeling the complete system behavior i.e Fault Tree Analysis and Reliability block diagram. The sources of input come from many ways. In all cases, the used data should be taken carefully, as predictions are only valid in some cases. Often predictions are made to take the decision by comparing the alternatives.

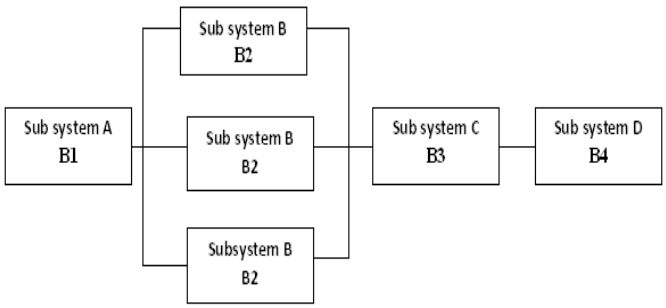

Figure 1. A reliability block diagram

The reliability test is conducted, to discover potential problems with the design as early as possible and finally to give confidence, that the system meets its reliability requirements Reliability testing will be conducted at various levels and there are different types of testing. Complex systems may be tested at component, circuit board, unit, assembly, and sub subsystem and system levels [12].

It is not possible to test all system requirements. The cost is very high to test few systems, few takes long duration to observe, and some test utilizes limited test ranges etc. The desired level of statistical confidence also plays a role in reliability testing, the confidence on statistical analysis increases the test time or the number of items tested. To testing the reliability, the plans are designed to achieve the required reliability at the specified confidence level with the few number of test units and test time. Different test plans result in different levels of risk for the developer and the user. The desired reliability, statistical confidence, and risk levels for each side influence the final test plan. The customer and developers should agree in advance, on how reliability requirements will be tested [13].

A key aspect of reliability testing is to define a failure. Although this failure, which is obtained, is not clear and clarified, there are many situations where it is not clear whether a failure is really the fault of the system. Variation in test conditions, operator differences, weather and unexpected situations create differences between the producer and the end user. One idea to address the issue is that to use a scoring conference process is to define the statement of work. The team considers each trail and the score obtained by each team will act as points for success or failure. This scores points obtained by the trail is the result used by the reliability engineer.

At the requirement stage, the reliability engineer develops a test strategy with the end users. The test strategy makes a trade-offs between the needs of the reliability organization, which wants a much data as possible, and constraints such as cost, time duration and resource availability. For each test, the test planning and methodologies are developed for each reliability test, and results are documented.

IV. RELIABILITY TEST REQUIREMENTS

The requirement for testing the reliability of the component is first to estimate the probability of failure needs to be justified. Testing reliability requirements is not an easy task due to several reasons. For testing the reliability, by the single test it is not possible to obtain a enough statistical data [14]. However, incase of multiple tests or long duration tests for testing the reliability of the product is not cost effective.

The required confidence level and reliability level greatly affects the development of the product and it give risk to both the user and producer. Hence, there is lot of care should be taken to select the best combination requirements. The testing of the reliability can be done at various levels, such as component level, subsystem level and system level. Hence, there are number of factors must be considered during testing and operations of the product such as extreme temperature and humidity, shock, physical or security violation etc.

The reason for the priority emphasis is the most effective way of doing the task, in terms of minimizing costs and

generating reliable product. To perform the reliability analysis, the primary skills that are required are:

a. The ability to understand and forecast the possible causes of failures which will be happens
b. The knowledge about the prevention of the causes for the failures
c. The knowledge about the design and data analysis

A reliability program is very complex learning and knowledge oriented for the product and processes. It is supported by leadership, which is built on the skills with in your team, integrated into business processes.

A reliability program is used to make the detailed documentation exactly about what best practices are required for a particular system, as well as clarifies the customer requirement for reliability assessment. For large-scale complex systems, the reliability program plan should be a separate documentation, which has to be maintained. The determination of human resources and financial resources required for testing and other tasks is critical for a successful program. In general, the amount of work required for an effective program for complex system is large.

The program of reliability is widely used to compute and to enhance the availability of a system by increasing the focus on testability and maintainability and not on reliability. The increase in the maintainability of the product is very easier than improving the reliability of the product. The estimation of maintainability is also generally more accurate. Reliability plan should always been clearly focused on the control of availability, proper reliability program plan should always regularly address the RAMT analysis in its total context.

Reliability Engineering solutions are generally found by having a focus on the design and not on the manufacturing process. Solution are found in different ways, for example by simplifying a system and therefore understanding more mechanisms of failures involved, detailed calculation of material stress levels and required safety factors, finding possible abnormal system load conditions and also to increase design robustness against variation from the manufacturing variances and related failure mechanism. Furthermore, reliability engineering is system level solutions, like designing, redundancy and fault tolerant systems in case of high availability needs.

V. CONCLUSION

In this paper, reliability engineering was studied. The application of reliability engineering over viewed. To increase the life expectation of the system a theoretical approach of the reliability analysis is attempted by creating reliability models and studying the causes for the failures**.** A reliability study has brought out the fact that many failures can be possessed by the improper design and over stressing of component. The paper provides information about why reliability is important, furthermore, they give an overview of all the aspects of reliability engineering, including the need for reliability requirements and other factors that are affected by poor reliability such as safety, competitiveness, goodwill, maintenance costs and ultimately profit.

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