RELIABILITY,COMPONENT OF INDUSTRIAL PRODUCTION QUALITY

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Abstract:*The reliability defined through probability, reflects the measurement of the product's quality depending on time. We use the probability parameters as aleatory variables, the density functions of probability, the distribution functions.*

Keywords: reliability, probability, variable

1. Using the mathematical instrument of the reliability.

The general, accepted definition of the reliability is that probability viewed as a device ready to fulfil its specific functions without faults in a certain period of time, within a framework of operating terms before hand specified.

From this definition we may deduce that reliability differs in point of meaning from the notion of output quality control, i.e. through control we measure quality in point zero of the product's life-span while reliability reflects the measurement of product's quality during time. Reliability is quality control plus time.

As reliability is defined though probability the reliability theory has on its basis the usage of probability parameters like aleatory variables, the functions of probability density and distribution

distribution function. The faults distribution U(t) is defined as being the probability of an aleatory variable be no bigger than t or at an aleatory test:

$$U(t) = \sum_t u(t) \text{ or } U(t) = \int_{-\infty}^{t} u(t)dt \tag{1}$$

where: *u(t)* stands for density function of probability for aleatory de faults (time up to incoming faults)

This is the non-reliability function, as we speak of the fault's appearance and may be interpreted as being the probability of a fault emerging before a moment t.

If the aleatory variable is discrete, the sign of integral is replaced by sum.

The reliability function or the probability of a device not to break down before the moment *t,* is:

$$R(t)=1-U(t)=\int_{t}^{\infty} u(t)dt \tag{2}$$

The probability of faultiness in a period of time $[t_1,t_2]$ is expressed by the reliability function:

$$u(t)dt=\int_{t_1}^{t_2} u(t)dt = R(t_1) - R(t_2) \tag{3}$$

The frequency of faults emerging in the period of time $[t_1,t_2]$or the fault quota Φ(t) is defined as a ratio between the probability of the fault being produced it that time, on condition of not being produced before t_1 and the duration of time $[t_1,t_2]$

$$\Phi(t) = \frac{R(t_1)-R(t_2)}{t_1-t_2} \cdot \frac{1}{R(t_1)} \tag{4}$$

The momentary rate of the faults *Z(t)* is defined as a limit to the fault density when the interval extends to zero.

$$Z(t) = \frac{u(t)}{R(t)} \tag{5}$$

Specific functions of density and distribution commonly used are: normal function (Gauss), exponenţial function, gamma function, Weibull function, Rectangular function.

If the product is realised by n reference points, and the faultiness of whatever leads to the product' faultiness, then the product's reliability function will become:

$$R(t) = \prod_{i=1}^{n} R_1(t) = R_1(t) \cdot R_2(t) \dots R_n(t) \tag{6}$$

where $R_i(t)$ represents the reliability function of reference point i.

2. Reliability prediction and analysis .

Predicting reliability is the process by which we estimate numerically the capacity of a product to fulfil its function requested without faults. The measures used by this are: R(t) – probability of surviving without fault after a period of time; average life span or its apposite the faultiness quota λ in case we cannot replace the faulty components: average period of time for good running when we are replacing faulty components.

In predicting the faults it's necessary to anticipate the frequency various faults may manifest. Thus, the most dangerous are the faults produced when certain reference points of the product become inactive, coming up as a spontaneous damage without any preliminary symptoms.

Another sort of faults is represented by those caused due the incompatibility between tolerance limits of product and the reference point.

The most practical predictive method supposes: defining the product and its manifestation that will be considered faulty: drawing the block chart of reliability, drawing up the list of each block components; selecting the data concerning reliability of the components.

Establishing the adequate faults of distribution for every component: establishing the adequate reliability factor through its function *R(t),* establishing the distribution of faulty systems due to their faulty components.

3.Designing reliability .

As the reliability prediction corresponds to the case when we know the number and type of basic components forming the product, the designer is given only the reliability conditions requested by the product.

The first stage in designing is distribution of reliabilities restrictions of the whole product among its main reference points. Then follows, the process of establishing the average range of faulty components for every principal reference point.

The results obtained are compared to the existing data about average range of faultiness to verify whether the requested terms are being accomplished with the elements taken into view. Otherwise, to reach the wanted reliability the designer has to use one of the following methods:

- finding better components as for reliability
- simplifying the project to use less components and not to disturb the operating performances of the equipment:
- applying methods of increasing the components' reliability
- using redundancies whenever necessary

In the reliability technique, redundancy may be defined as the existence of several means to realise a certain characteristic. Generally speaking, all those means have to go wrong so that the system becomes faulty.

If we assume a simple system made up of two elements in parallel with A_1, having a faultiness probability p_1 and A_2, having a probability p_2, then the possibility of the whole system be disrupted will be calculated according to the formula:

$$P = p_1 \cdot p_2 \tag{7}$$

And the reliability or probability of not displaying any faults is R calculated as follows:

$$R = 1-P=1- p_1 \cdot p_2 \tag{8}$$

Consequently the redundancy in parallel, is a solution to increase the system's reliability in case other methods cannot be applied. Generally speaking if there are in parallel components, the probability of the whole system become faulty at t *(time)* is $P(t)$ calculated accordingly:

$$P(t)=p_1(t) \cdot p_2(t) \ldots p_m(t) \tag{9}$$

And the probability of non - faulty working is given by formula:
In the components reliabilities equal then:

$$P(t) = p(t)^m \tag{10}$$
$$R(t) = 1 - p(t)^m \tag{11}$$

It's quite impossible for two elements made within the output according to the same specifications be similar. The variability of the components' characteristics leads also to the system's variability consisting of those elements. The designer may check the implications of this variability if he has got enough information about specific variations of the components' characteristics either at their first usage or according to the time and request. If these aren't taken into consideration in running the respective system, we'll get to a worsening reliability due the uncontrolled influence of these parameters

4. Testing reliability.

To measure reliability, statistical data are being and processed product' related to the product service performance within the requested interval of time. This can be done by observing a certain number of products under service, measuring the intervals when these didn’t go wrong and the number of flaws, which appear during observation period. After we got sufficient data about the moments of faultiness we can quite accurately estimate the average running time without flaws.

The issue of treating reliability is more complicated where there are very little information or they merely don’t exist, about the formula of time faultiness distribution specific the reference points or the products on the whole. In this case we use a sample on which basis we estimate the form of distribution and its parameters.

The testing reliability essentially consist of establishing the distribution of a statistical data parameter and estimation of the parameter.

Establishing the confidence according to which we can admit that from the analysis of the respective sample, it results that the effective value of the parameter is situated within the limits of the concrete interval. Finding the answer to the question whether each reference point of the product has a certain average life span and establishing the measure which guarantees us these will be confirmed during services. Substantiation of the sample's size and of time consumption for the necessary attempts. For the testing reliability, we separately analyse the situation of aleator, faultiness at complex products, the situation of confidence limits of aleatory defaults, the evolution in time of these ones according to Weibull distribution and the achievement sequential test of reliability.

5. Conclusions

The variability of the components characteristic produced during the output leads also to the variability of the system's characteristics consisting of those elements.

The designer may examine the implications of this variability if he's got sufficient information about specific variations of the components' characteristics either at their first usage or according to the time and request.

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