



## SELECTED PROBLEMS TO LOSS AND MAINTAIN THE PROPRIETES OF TECHNICAL OBJECTS.

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### **Abstract**

*Durability is one of the most important features of components (elements and subsystems) and technical technical objects as a whole. By durability we understand the capability of an item to maintain its useful properties under given circumstances of work and maintenance until a limit state is achieved. Borderstates are understood as states when an object for technical reasons, economic reasons or functional reasons (innovative) and/or for other essential reasons is no longer fit for use. The measure of durability of technical objects is a period of use after which a objects loses its serviceability according to its design. The moment a technical object loses its required properties is called the top border of durability. However, it is worth noting, that the moment starting from which an item is no longer fit for use is not always a distinct one. Therefore, a multi-aspect selection of criteria determinating the upper limit of operation time is the crucial issue.*

**Keywords:** durability, usability, maintainability

### **KINDS OF DURABILITY**

A loss of required usable properties characteristics can result inter alia from technical reasons, economic reasons or perished innovativeness as it is present hereinafter.

*The economic durability* is identified with retention usable properties until the moment when further maintaining of requested technical availability is found to be uneconomic. This is dependent on both economic and technical factors. An important measure of durability in light of the economic aspect is the unit price of maintaining an objects availability and the profitability of its use.

*The innovative durability* is identified with the preservation of usable features until a new generation of competitive and non-compatible technical objects appears, when at the same time a possible modernisation of an item is uneconomic. An important feature in terms of innovativeness is a prospective rise in profits due to the employment of a new generation technical objects. The necessity to terminate the use of a technical objects can be result from its incompatibility with the technospheric environment.

*The safety durability* is identified with retention already existing usable properties until hazards occur. A need to terminate the operation of an object can result from non-fulfilment of objects safety requirements in the human- object-environment system .

It is obvious that the technical durability -the physical durability to be exact - is what constitutes a reference base for all considerations on a lost worthiness of a given technical objects.

*The technical durability* is identified with retaining a required value of usable features until the possibility to maintain usable features to ensure a required level of the operational availability by means of repairs and technical services is irretrievably lost.

The technical durability expires due to the depletion of technical expendability since there is no technical possibility of upgradeability of an object .

*The measure of life (durability)* of a technical objects is the service life after the termination of which a technical objects loses its capability of use according to its designed application.

For human- object -environment systems one uses the term of liveliness, which applies to a multiple renovation (including a biological renovation) and sustaining of functions (including life functions) over a defined period of use under determined conditions. For the above systems also the notion of survival under sudden overloads (e.g. during an attack, sudden weather changes, hurricanes, tsunami, volcanic erosions) etc. is used. Due to this, an object loses irrevocably its capability of further functioning.

## LOSS OF USABLE PROPERTIES

The technical durability is considered usually at the macroscopic level and the physical durability at the microscopic level.

In case of the macroscopic level (considering constrains between objects elements and subassemblies which create the structure of a technical objects in the energetic meaning). On a microscopic level one considers interatomic constrains, which occur in material structures. The material of design elements is considered a system with a structure of constrains, superimposed onto microscopic material particles.

Considering the durability of a design material one takes into account the laws of *the physics of failure*. Therefore the *physical durability* is expressed as a limit period resulting from the loss of the hardness of its components against the effect of enforcing factors, in particular of working factors.

The art of engineering consists, inter alia, in finding the relations between defects in the substance of a design material and the failure of the technical objects as a whole.

Three destructive phenomena play the basic role: fatigue, metal corrosion and wear due to friction. The first process results in fractures and breaks of shaped pieces. The result of the two other phenomena, is a loss of the surface material layer, called wear. The results of these phenomena decide, inter alia, whether the usefulness of an objects can be technically restored.

Exceeding the permissible values of usable features (states of characteristics) related to a correct functioning of an object, causes a variety of unwanted phenomena and events.

Such damages may leave an object in an unwanted technical state, in which this item does not fulfill its required usable functions; loses the capability of repairing it and/or it does not satisfy safety requirements..

According to a thorough analysis the durability is define with two notions - *strength and resistance (hardiness)*

**The strength** is a property dfine the capability of a design material subjected to allowable loads to maintain required usable properties. It is understood as a capability of maintaining - maintainability - of the internal cohesiveness of a material until permissible working loads are exceeded.

One distinguishes an immediate strength and fatigue strength, i.e. a capability of a repeated taking on of usable loads. In the latter case, a destructive process, called a fatigue occurs and results in brittle ruptures, slip ruptures and split ruptures as well as in plastic and elastic deformations.

The probability of occurrence of this kind of damage is a basis to determine the upper limit of the use-time of design elements.

The strength is a property, therefore a physical value, expressed in units of measure, which consequently can have particular numerical values.

**The resistance** is a feature which define the capability of a structural material and associations of technical objects elements to maintain the required element characteristics and associations when subject to impact of external and internal forcing factors..

The requisite cohesiveness of a system is maintained thanks to the internal energy of cohesion binding material parts of a system.

There are three basic factors, which contribute to maintaining the system's resistance; these are: proper strength of an item, properly selected load acting on an item and a controlled speed of deterioration of objects characteristics.

The resistance can be regarded as a non-measurable feature (a behaviour manifestation). E.g. technical objects can have a resistance or not. This resistance can be described only approximately as very low, low, high or very high etc

## **PRESERVATION OF OBJECTS USABILITY**

Considering technical technical objects as consisting of assemblies, association of kinetic and static elements, one considers them as macro systems of a structure of constrains superimposed on cooperating design elements.

As a result of destructive processes within systems of associated design elements *natural and imparted usable constrains disappear* as well as *parasite constrains develop*. This is the reason why components lose their worthiness and consequently rendering useless of the objects as a whole. One distinguishes two extreme states of technical objects.

The first extreme state being the one in which an item loses its capability of processing and transferring energy (due to evolved additional parasitic constrains and/or disappearance of useful constrains).

The second extreme technical state is a state when an item loses its capability of performing working moves and obtainment of a required speed of relocation – movement (due to a change of purposeful constrains to restricted constrains and due to an elastic deformation of constrains and kinematical pairs under the impact of forces and temperature).

According to a thorough analysis the durability is described with a set of two notions *maintainability and supportability*.

**The maintainability** – a feature of a machine and technical equipment, define its capability of performing maintenance as well as service and repair steps within a given time.

These steps are: repairs to restore a requisite condition (state), a technical service to maintain a required condition and a technical inspection to determine the technical condition of a technical object.

*The tractability of maintenance* consists in features, which enable easy services and repair of a technical objects as well as keeping a technical objects in a required condition by way of an appropriate strategy of maintenance.

*The strategy of maintaining* of a demanded technical operational stand-by is a rational time schedule of inspections of the technical objects condition and preventing steps or upgrading steps. This strategy consists in a determination of such work periods of technical objects, which satisfy to the best advantage technical, organisational and cost limitations.

The measure of the maintainability can be e.g. such a 'physical value' like performed technical steps or a property (a behaviour manifestation), e.g. a technical objects shows the capability of maintenance or repair or it does not .It can be also definite - not clearly - as a very low, low, high or very high etc. capability.

**The supportability** – a feature expressing a *serviceability* and usefulness of technical equipment and means to maintain a machine in a required technical state.

As a result of very advanced technical progress, the use of machines is more and more dependent on professional maintenance. Performing maintenance and technical checks calls for modern inspection and measuring devices, availability of service with spare parts and appropriate consumables. Logistic service guarantees safe and effective use of technical objects.

A measure of the *supportability* can be e.g. such a physical quantity as a required diagnosing time, spare parts delivery time etc. or e.g. a feature of behaviour like accessibility or non-accessibility of services [0,1]. It can also be described approximately as a very low, low, high or very high professionalism of maintenance.

## CONCLUSIONS

Therefore in order to estimate durability the following aspects have to be determined:

- a technical aspect: *lack of technical means of restoring a required technical condition* due to an overly dispersed energy of internal structural cohesiveness of an object
- an economic aspect: *non-profitability of further use* due to an excessive rise in unit operating costs
- aspects of innovation: innovative manufacture of technical objects of *an increased output*,
- *new properties and better compatibility* as a result of new requirements for use, which are a consequence of a new generation of solutions.

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