INTRODUCTION TO THE THEORY OF HAZARDS

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Abstract

The paper outlines the theory of risks occurring during the use of the antropotechnical type systems. In the presented approach a logical theory of mathematical principles of reliability and man - machine systems theories have been used. Unreliability and failure of the man - machine system depends on the circumstances in which it is located for which four states is possible to identify: natural environment, environment technosphere type state, man psychological state, device technical state.

It was pointed out that into the phenomenological reality type surroundings where antropotechnical type systems is operating, potential damages and in their follows as inefficient damages and losses are possible, results processing both energy and information into the useful and awaiting results. It consists of a variety of factors forcing undesirable changes in the antropotechnical type system.

The destruction process of the antropotechnical type system under operation results external forces treatment from the environment, including technosphere type of infrastructure and internal forces of destructive processes, as well as any control errors generated by the human (e.g.: device operator, decision maker). The possible sequence of cause undesirable consequences inevitably resulted in the creation is presented as follows:

1. *primary causes type of adverse events - they are internal and/ or external factors and failure to enforce human from original reliability,*
2. *secondary causes type effect - they are damages and losses and the consequences of legal and financial nature.*

The primary causes type results with damage to the device, the inefficient operator ending destruction and degradation of environment.

It has been accepting that risky procedure is based on taken responsibility for any damages or losses, taken danger possible events of any project under consideration, as well as any results which are not known in advance. The risky decision is when we are taken any decision under uncertainty conditions and possible hazards whose consequences to be feared. It was pointed out also that in certain circumstances, dynamic assessment of acceptable level of risk is based on estimation the ability the expected remaining time to hazardous events. It was suggested that the theory of risk in practice forms the scientific basis for engineering safety as a separate discipline of technical sciences.

Keywords: *transport, antropotechnical system, risk, hazard*

1. Introduction

In the antropotechnical type systems composed as the set of man (e.g.: operator, decision maker) - device (e.g.: vehicles, ships, power equipment, transport device) - environment (e.g.: nature type environment, technical infrastructure) the specific operation tasks are mostly carry out. The actions are follows through results of the sequence of actions: a man acts on the machine/ device, which (in turn) affects the environment in order to obtain the desired reaction (e.g.: processing, replacement, etc.).

The positive outcome of the actions described above, we consider that the task of man supported by a machine, additionally support by the desirable reaction of the environment, have been successfully obtained. It is necessary to notice that during the operation the impact of the man-machine set at the environment must be effective and harmless.

In practice, the circumstances under which we may find the arrangement of man - machine - environment set not always conducive to the safe completion of the assignment, because there are the following possible hazards:

- with the proper foundation of human impacts on the machine may be accompanied by side effects, harmful to man and feedback reactions to the device,
- the assumption correct machine impacts on the environment may be accompanied by side effects and adverse secondary environment type reactions, which might be harmful for its own, for the environment and for man,
- inherently desirable turning impacts the environment on the machine may be accompanied by adverse effects on man as operator.

2. Factors constraint undesirable changes into man – machine set

The factors acting at the man – machine set include threatening external force coming from the environment, including technosphere of infrastructure and internal force of destructive processes as well as any human control errors (operator, decision maker). Forcing factors, together or separately, causing adverse changes in the states of system components: man-machine. It consists of unfavourable circumstances soundness of the exposure-expressing, presenting a hazard for man and machine separately and together for this system as a whole. They come from both external forcing factors (e.g.: environmental, atmospheric) and internal forcing factors (e.g.: fatigue, wear of, and aging).

We mean by risk damaging phenomenon caused by natural forces or by man. The threat stems from the fact that the specific factor that forces entering the conflict or the object may contribute to damage and loss of human, object and environment.

Hazard due to its nature, exists independently of the lack of our knowledge of the current technical condition of machines and undesirable phenomena in the environment. Therefore, we distinguish following menace categories: self- disclose, reveal, non- reveal.

3. The human and technical factors

One of the most important risk factors that cause the set of man – machine - environment system is making the wrong decisions in dealing with machines. Decision, making under uncertainty, can always be flawed and cause dangerous situations. Operator errors are a common cause of adverse events. Threatening event usually is the result of operator error and the confluence of technological shortcomings.

A dangerous operator error or mistake is weakened by the use of excess (redundancy of equipment or human). In addition, protection against the negative result of certain errors can be achieved through the use of tolerant system errors, for example one that does not accept incorrect input signals.

Unreliability and failure of the man – machine system depends on the circumstances in which it is located. We can replace the four states of interest to us-human – machine - environment system respectively: the environment and technosphere, environment, psychophysical and technical, human and machine. Threatening states are observable transitional and critical states of physical systems (machines) and psychopsychical (man) do not meet adequately the technical requirements and ergonomic. Fulfilment of technical requirements and ergonomic conditions the desired state of the system (security), the non-compliance creates undesirable condition (risk).

Adverse conditions of human – machine - environment system can be divided into limiting (which makes it impossible to dismiss the excess risk) and critical (crossing which causes severe destruction of the machine and the injured man). The limiting state of the system is tantamount to the achievement of the maximum permissible changes by not less than one of the structural parameters or operation types. Boundary condition is a condition that should not be exceeded, because distance prevents this danger. The critical state of the system is expressed uncoupling structural constraints caused by the disappearance of the creation of useful and parasitic constraints. Critical state is a state whose achievement is tantamount to cause irreversible damage, harm or loss.

4. Undesirable and dangerous occurrences

Events are divided into desirable and undesirable. For adverse events we include: dangerous, harmful and loss type.

Breakdown is an undesirable event that causes temporary loss of the property properties which required break in the use of the device. This event may directly contribute to the losses, and indirectly to the injury.

The accident is a dangerous event consisting in the mutual collision of technical devices, accompanied by severe consequences for men and the natural environment. It is a critical harmful and loss event causing numerous injuries reversible humans and a few deaths, environmental degradation and destruction of natural technosphere, and the creation of various types of moral and material losses and adverse consequences.

Disaster is a critical event including harmful and loss event, resulting from collisions of technical devices and environmental technosphere. Is an event that causes many people irreparable injuries and fatalities, extensive degradation of the natural environment and technosphere destruction and creation of severe moral and material losses, and no less severe financial and legal consequences.

5. Losses and damages

The concept of loss is broad and it is associated with events such as: failure (the loss is small), event (the loss and damages are substantial), catastrophe (the loss is enormous and the damage is very severe). The concept refers to the loss of all the elements of man - object - environment system.

The sequence of cause and consequences of adverse reactions can be depicted as follows:

- primary cause of adverse events: they are internal and/ or external forcing factors and the failure of man,
- primary effect of extortion, are undesirable events: damage to the device, the operator non usable with strong linkage to system destruction and environmental degradation,
- secondary effect: they are damages and losses and the consequences of legal and financial nature.

Types of damage and losses are recognized appropriately to human life (e.g.: the number of casualties, loss of life expectancy), health (e.g. physical fitness percent loss), loss of social and environmental (e.g. environment), material losses (e.g. loss of the technical device), and economic loss (e.g. financial loss).

There are the following categories and indicators of loss and damage:

- people and living creatures: the number of fatal accidents and cases of severe injury to severe disability (e.g.: deaths immediate and distant, critical psychophysical disability), number of wounded (e.g. severely and slightly wounded, and the number of people with long-term loss of health), the number of evacuees (e.g. the number of people evacuated to period longer than one year),
- measures of life resources: the space of a degraded ecosystem, the ecosystem area which the natural balance has been breaking,
- damage and material losses: loss of discount (all direct damages and indirect material, health, physical, reducing the loss of residence, legal and financial consequences); losses in material things represent the economic aspect.

6. Measures of danger and risk

Endangered man - machine systems, due to the hazardous effects of random factors forcing, carry out their tasks under uncertainty. Purpose of implementation of the adverse factors is called dangerous circumstances, and we describe in a probabilistic space. Time to occurrence of hazardous events is treated as a random variable and analyzes such unsafe factors as: the median time to limit or critical events, the intensity of a hazardous event, the expected remaining time to hazardous event, etc.

We assume that in the surrounding reality the energy and information transformation into useful results always accompanied fault, disability and further - damages and losses.

Risky procedure called them to take responsibility for any damages or losses, taken danger possible events of any project under consideration, as well as any results which are not known in advance. The risky decision is when we are taken any decision under uncertainty conditions and possible hazards whose consequences to be feared. Dynamic assessment of acceptable levels of hazards in certain circumstances, depends on the estimate of the expected remaining time to hazardous event since the emergence of his symptoms. The risks described qualitatively apply to the destruction or damage deemed to be invaluable, unique creations of nature, technology, art and culture.

Numerical measures of risk are assigned to the fields of activity in which potential losses are analyzed. Due to the nature of the consequences we divide them into: individual (for individuals), training-related activity performed (for employees), general public (the overall impact on the community), the risk of loss of property and economic losses (interference in the operation of the economy, penalties, etc.), environmental (concerns: land, air, water, flora, fauna and cultural heritage).

The formal estimate of an acceptable level of exposure requires knowledge of the frequency of occurrence of certain types of critical events and giving them to assign possible losses and damages. There are different scales of significance and severity of losses, caused damage and suffered the consequences. As well, there are rules governing the amount of contractual penalties for failure to meet obligations.

7. Conclusion

The theory of hazard in terms of practical forms the basis for safety engineering as a separate discipline of technical sciences. The theory of hazard arises from the unification of the science of objects reliability and un-safe-ability.

In the present study indicated field of knowledge concerning the unreliability and disability of the man - machine type set are transport systems. In terms of control theory, the safe transportation tasks can be described as a multi-criteria optimization problem: resolving what, where and how to transport any goods and or human taking under the consideration the risk as low as possible.

The quality of this outcome is determined by the level of fulfilment of the criteria adopted, and the solution is to determine job safety features/ indicators, the transportation trajectory/ route selection and taken under the consideration functional attributes of the transport devices available to this regard, taking also into account the circumstances that occur in relation to these opportunities.

Definition of evaluative (normative) in the field of the unsafety in transportation process may not only be no less so as there are ways to evaluate it. Any quantifiable definition of unsafety is good. There is any one definition of unsafety, but there is one a good definition of unsafety is understood as a state emergency.

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