

GENERAL CONCEPTS OF RELIABILITY

Pasichnyk Oleksandr

Ph.D., Associate Professor

Khmelnytskyi National University

Khmelnytskyi, Ukraine

Introductions. Reliability as a separate design requirement and as an independent discipline appeared relatively recently - in the middle of the 20th century.

Although the study of the consequences of failures, their causes and consequences began with the birth of manufacturing and industry. Thus, when designing the first steamships, they were equipped with traditional sails in case of engine failure. In the cities, they did not dare to introduce kerosene street heating and lay gas pipelines, fearing that in the event of an accident, the whole city would be plunged into darkness. The famous "Titanic" was considered an unsinkable ship due to its absolute, in the opinion of its developers, reliability, and probably the overestimation of its reliability played a certain negative role in the death of many of its passengers. During the First World War, the exact copy of the Titanic, the steamer Britannic was attacked by a German submarine and sank even faster than its predecessor.

Aim. The reasons for the worsening of the reliability problem in the 20th century. Although failures have always happened, but until the end of the 1st quarter of the 20th century, the life of mankind was characterized by a leisurely rhythm, so the consequences of insufficient reliability were not too serious. Starting from approximately the 30s of the last century, the industrial revolution is gaining rapid pace, which is characterized by an avalanche-like increase in the technical characteristics and power of machines and equipment, an increase in their power, heat, and electrical load, and as a result, a significant increase in the negative consequences of unreliability and failures. In 1965, an accident of exceptional scale took place in the USA, which left a huge territory of the country with a population of

more than 40 million people without electricity, lighting and electric transport for 14 hours. The cause of the accident was the failure of one relay on the switchboard of the Niagara HPP. In the Second World War, more than half of the reserve on-board radio stations of US Air Force aircraft were found to be inoperable already at the time of their installation in repair shops, i.e. immediately after receiving them from storage warehouses. The first electronic lamp computer ENIAC (Electronic Numerical Integrator and Computer - electronic numerical integrator and computer created in 1945 at the Higher Technical School of the University of Pennsylvania weighed 30 tons and consisted of 18 thousand electronic lamps. Already in the first year of his work, 19,000 spare lamps had to be used to replace the lamps that failed. On June 3, 1980, for about 10 minutes, humanity was on the verge of the Third World War due to problems in one of the computers of the American NORAD system, which activated the nuclear alarm. As it turned out later, the culprit was a defective chip worth 46 cents.

Materials and methods. The most general characteristic of any product is quality.

Quality is a set of properties that determine the degree of conformity of the product to its purpose.

Quality is a complex concept that includes at least 10 main properties: compliance with the main (service) purpose; reliability; cost; manufacturability, material capacity; safety; environmental friendliness, energy consumption; aesthetics; ergonomics; standardization; patentability.

Simultaneous performance of all indicators is often difficult, and sometimes even impossible. In practice, in many cases, two main indicators are taken - cost and reliability.

Reliability is a complex quality property. But it has a number of features, which led to the need to introduce concepts that are used only for reliability.

All terms are considered in relation to the object, under which should be understood the subject of the specified intended purpose, which is considered for the purpose of its intended use, study, research or reliability tests. An object can be a

detail, a component unit, a complex, a set, a technical system, an information and control system, etc.

Reliability is the property of the object to preserve over time within the established limits the values of operational parameters that characterize the ability to perform the necessary functions in the specified modes and conditions of use, maintenance and repair, storage and transportation.

"Operational" include parameters that can change during operation and for which the permissible limits of their change are set in the regulatory and technical documentation (NTD).

From the point of view of reliability, the object can be in working or faulty condition, operational or non-operational. The serviceable state is the state of the object in which it meets all the requirements set by NTD. If the product does not meet the NTD according to at least one requirement, then it is considered to be in a defective condition. A workable state is a state of the object in which it is able to perform or performs the specified functions, keeping the values of the specified parameters within the limits established by the regulatory and technical documentation. The state of the object, when the value of at least one given parameter, which characterizes the ability to perform given functions, does not meet the requirements of NTD, is called inoperable. The concept of "serviceable condition" is broader than the concept of "workable condition". Workable condition, in contrast to serviceable condition, satisfies only those requirements of NTD, which ensure the normal functioning of the object during the performance of the specified functions. At the same time, it may not satisfy, for example, the requirements for the object's appearance.

That is, a workable object may be faulty, but its damage is not so significant as to prevent the functioning of the object.

Reliability as a property of the object consists of the following components (properties): reliability, durability, maintainability, preservation.

An object goes into a disabled state after an event called a failure.

Failures include events after which the functioning of the product ceases or at

least one of the operating parameters exceeds the tolerance limits.

Failures are divided into functional and parametric. In the event of a functional failure, the object ceases to perform all or some of its functions, and in the case of parametric ones, one, several or all indicators of the object go beyond the permissible limits.

Object failures occur due to certain reasons. The reason for failure may be factors and (or) circumstances that arise during the design, manufacture or use of the object, causing its failure. A failure may occur as a result of the existence of one or more defects, but the appearance of a defect does not always mean a failure, that is, that the product has become inoperable.

The reasons for failure are divided into random and systematic. Accidental failures are unforeseen overloads, defects in materials and manufacturing errors that are not detected by control, errors of service personnel and failures of control systems, etc. Systematic causes are natural phenomena that cause a gradual accumulation of damage: the influence of the environment, time, temperature, radiation, friction, and functional influence.

The presence of a refusal is determined by its signs. A sign of failure is qualitative and quantitative indicators that distinguish a workable object from a non workable one. Signs of failures are established in regulatory and technical documentation. Taking into account the significant variety of failures, they are divided into types. The type of failure is the form of manifestation or phenomenon by which the failure is determined.

The transition of the object from an operational state to an inoperable state occurs as a result of certain various negative processes, which together determine the failure mechanism. A failure mechanism is a set of physical, chemical, and other processes that lead to failure.

Classification of refusals according to signs: the nature of the change in the main parameter of the object until the moment of failure (sudden, gradual); the possibility of further use of the object after its failure (full, partial); connection between refusals (independent, dependent); persistence of incapacity (permanent,

failure, intermittent); the presence of external manifestations of refusal (obvious or explicit, hidden or implicit); the cause of the failure (structural, production or technological, operational); nature of occurrence (natural, artificial); time of occurrence (during tests, during running-in, during normal operation, during the last period of operation); the possibility of elimination (those that are eliminated; those that are not eliminated); difficulty of elimination (eliminated during maintenance, eliminated during repair); place of elimination of the failure (in operating conditions, in stationary conditions); by consequences (light, medium, severe).

Results and discussion. When studying the reliability of information systems, the reliability of hardware and software should be distinguished.

Conclusions. Two circumstances are characteristic of modern hardware increasing complexity and the distribution of failures for reasons related to the areas of development and manufacturing.

The first circumstance is determined by the unstoppable increase in the complexity of hardware, both in terms of the number of elements and the criterion of structural structure. At the same time, the increase in the number of elements is not very "ahead" of the increase in the reliability of individual components. Therefore, the flow of hardware failures, although decreasing, still remains practically significant for the efficiency of functioning. With the growth of functional importance, the costs of elimination of failures increase. Also, the combination within one facility of components from different manufacturers from different countries requires new unified system approaches to establish the causes of failures, identify the culprits of the defects that caused them, and develop recommendations for corrective actions. Regarding the latter, it is important that about half of the failures are related to the scope of development, and half - to the scope of application.

LITERATURE

1. Основи об'єктно-орієнтованого програмування: навч. посіб. для студ. ВНЗ / Сорокати Р. В., Пасічник О. А., Скрипник Т. К. – Хмельницький: ХНУ, 2019. – 175 с.

2. Надійність систем: Лабораторний практикум для студентів спеціальності "Комп'ютерні науки" / О. А. Пасічник, Р. В. Сорокатий, Т.К. Скрипник. – Хмельницький: ХНУ, 2019. – 154 с.

3. Технології комп'ютерного проектування: конспект лекцій для здобувачів вищої освіти (ОР «бакалавр») спеціальності 122 «Комп'ютерні науки» / О. А. Пасічник, Р. В. Сорокатий, Т. К. Скрипник, Е. А. Манзюк. Хмельницький: ХНУ, 2021 . – 136 с.

4. Технології комп'ютерного проектування. Лабораторний практикум: для студентів спеціальності "Комп'ютерні науки та інформаційні технології" / О. А. Пасічник, Р. В. Сорокатий, Т. К. Скрипник. – Хмельницький: ХНУ, 2018. 136 с.

5. Обробка даних на ЕОМ. Лабораторний практикум для студентів спеціальності "Міжнародна інформація" / О. А. Пасічник. – Хмельницький: ХНУ, 2004. – 100 с.

6. Основи систем автоматизованого проектування : лабораторний практикум для студентів напряму підготовки "Інженерна механіка" / О. А. Пасічник. – Хмельницький : ХНУ, 2015. – 61 с.

7. Емпіричні методи програмної інженерії: лабораторний практикум для студентів напряму підготовки "Програмна інженерія" / О. А. Кравчук, О. А. Пасічник. – Хмельницький : ХНУ, 2013. – 90 с.