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131 - Applied mechanics

Part 1





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1. The concept of information technology

Plan

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1.1. Informatics and information technologies

The results of scientific research show that information and scientific knowledge in recent years have played an increasing role in society. Information today is spoken of as a strategic resource of society, which determines the level of development of the state, its economic potential and position in the world community. Thus, according to some data, the volume of expenditures for the development of the information sphere in the United States today exceeds the expenditures for the development of the fuel and energy complex of this country.

In many developed countries today the process of transition from industrial to information society is actively underway. In these conditions, the means of creating and using information resources in any developed country must be at the level of modern requirements. Such means are:

- scientific methodology used in the information sphere of society;
- software and hardware informatization;
- modern information technologies.

These tools in recent years are increasingly used in almost all areas of social practice. As for information technology, by increasing the efficiency of information resources, they act not only as the most important tool in the information sphere of society, but also as a powerful catalyst for the development of scientific and technological progress. That is why the problem of development and improvement of information technologies today occupies one of the priority places in the strategy of scientific, technical and socio-economic development of the advanced countries of the world, is an important aspect of their national policy.

At the same time, if we talk about the fundamental scientific aspects of the problem of information technology development, then, as it may seem surprising, the situation here leaves much to be desired. After all, so far information technology, as a scientific field of research, has not been formed. There are no objective criteria for the effectiveness of different types of information technology and methods of their quantitative comparative evaluation. Methods of analysis and synthesis of highly efficient information technologies have not been developed at the required level. There is not even a generally accepted classification of

information technology, although some attempts are already being made in all these areas.

So, for example, the universal quantitative criterion of efficiency of information technologies economy of social time which is reached as a result of their social use is offered. After all, it has long been known that any savings, in the end, can be reduced to saving time. However, this approach to information technology has not yet received the necessary development, although it seems very promising.

Therefore, today it should be noted that there is a significant lag of theoretical developments in the field of information technology from the needs of social practice, which is growing rapidly. After all, the world is on the threshold of a new civilization, which is rightly called the post-industrial information society. Information and scientific knowledge will be given priority development in this society, which will significantly reduce the cost of other types of resources and solve on this basis many modern global problems of civilization.

The most important distinguishing feature of this civilization will be the widespread and highly efficient use of information and its most highly organized form - scientific knowledge. Information and scientific knowledge will be not only strategic resources and factors in the development of society, but also the most common in this society objects and results of work.

Using information, scientists pin their hopes on solving global energy and environmental problems of society, as well as problems of further development of science, education and culture, achieving a new level of intellectual and spiritual development of man and society, its transition to safe and sustainable development.

The fundamental basis of the new technological structure of society, most likely, will be highly efficient information technologies, for the implementation of which will be used a variety of computer science tools based on new physical principles. In the coming years we should expect the emergence of a number of fundamentally new scientific and practical results. Thus, the current predictions about the formation and formation of post-industrial information civilization are quite realistic and are confirmed by the real course of the historical process.

It is logical now to ask the question of what period of the XX century should be considered the beginning of the formation of the information society. Some researchers believe that this period is the early 70's. After all, it was at this time that such innovations in computer science as displays, information storage devices on magnetic disks, as well as general-purpose telecommunication systems appeared and began to spread widely. These achievements, as well as the development of alphanumeric and graphical methods of presenting information in computer systems and became the decisive factors that made possible the widespread use of computer and information technology not only in research and defense, but also in economics, finance , founding practice. But most importantly, these achievements have given a powerful impetus to the development of automated information systems and new information technologies, which are today the main core of the process of informatization of society, its scientific, technical and socio-economic progress.

The next powerful impetus in the development of informatization of society is associated with the emergence in the early 80's of the microprocessor element base of computer science. The result was the emergence and rapid spread of personal computers, as well as small microprocessors, built into various technological and household devices, appliances and equipment. All this caused a real boom in the field of production technology, significantly changed the entire information technosphere that surrounds man.

You quickly get used to the good. Today, a business person can no longer imagine his life without a mobile phone and personal computer, and any modern institution is inconceivable without its own automated information system, electronic copying equipment and access to the international information and telecommunications network. No one will be surprised by a personal computer such as Core i5 on the desk of an ordinary student and even a schoolboy. After all, this information and computing system today has such functional capabilities that only systems that belonged to the SUPEREOM category at that time could have only 10-15 years ago.

Due to the rapid development of information technology in recent years, the information sphere of society is changing uncontrollably, thus having a strong impact on all other aspects of people's lives and activities. The living and working conditions of people in developed countries in the middle of the XXI century will be as different from modern ones as the living conditions of our time are different from the living conditions in Russia during the reign of Tsar Peter the Great.

In the new highly automated information society, people will have not only completely new opportunities, but also new problems - the problem of information inequality of people in the new information environment and information security of man and society, as well as the entire biosphere of our planet.

It is quite possible that in the new highly automated information environment, which is already being formed in the developed countries of the world community, there will be other fundamentally new global problems, the content of which today can only be guessed. One of these problems was pointed out in his review lecture on physics by the famous English scientist S. Hawking. Today, he heads the same department in Cambridge that was once headed by Isaac Newton. In a lecture given in 1998 in Washington to US President Bill Clinton and his entourage, Hawking noted another new danger posed by the uncontrolled development of the intellectual capabilities of cyber devices and automated robots. He believes that if this process continues at the same pace as it is today (and no real constraints on the development of this process are yet visible), then in the XXI century it is likely that humanity will have to fight for its place under the sun not only with the formidable forces of Nature, but also with a new highly organized artificial civilization. The basis of this civilization, according to the scientist, will be biorobots and artificial intelligence systems based on high-power computer networks.

Assumptions of this kind today seem fantastic. They can be considered just a joke, a game of the mind of a genius who, being for many years confined to a wheelchair and forced to communicate with people around him, only with the help of a computer, has not lost not only optimism but also a very enviable feeling

humor. However, in every joke there is a share of truth. This folk wisdom has been repeatedly confirmed by practice. Especially in cases where predictions are made by ingenious people with special intuition, a kind of "inner vision". History convincingly shows that when it comes to scientific and technological progress, the objective reality of its development often surpasses the boldest and seemingly fantastic predictions.

1.2. The concept of information technology as a scientific discipline

Currently, there is a rapid development of the global process of informatization of society. At the same time, the whole information environment of society is radically changing. New automated information technologies penetrate into almost all areas of social practice and become an integral part of the new, information culture of mankind.

That is why today the problem of formation of information technology as an independent scientific discipline on methods of creating highly efficient information technology (in the usual, narrow sense of the term), ie a kind of theory and methodology of information technology design, is extremely relevant and important.

Thus, in addition to the already widely used in science and practice, the concept of information technology as a way of rational organization of some information process, which is often repeated, it is necessary to develop a new, broader understanding of the meaning of this term. And in this case, it will denote an independent section of science, just as it is in relation to the very concept of "technology".

The object of research of information technology, as a scientific discipline, should be information technology (in the narrow sense of the term), ie ways of rational organization of information processes.

The subject of research for information technology as a science should be the theoretical foundations and methods of creating information technology, as well as their design and effective implementation.

For the development of information technology in this sense, we have to go through the entire cycle of formation of this new scientific direction in the coming years; classify different types of information technologies, develop criteria for their comparative analysis and quantification of efficiency, create methods for the synthesis of high-performance technologies based on the latest advances in basic science, as well as the use of information elements and information systems using new physical principles.

It is possible that for the successful development of this science will also have to create a number of new scientific disciplines, in particular - the theory of information interaction in nature and society. It seems important to pay special attention not only to such traditional and more or less studied phases of information processes, as coding, processing and transmission of information. In addition, it is necessary to deal with much more complex phases of these processes, which are practically not yet studied by modern science. These are the phases of information generation, as well as its reception (perception) by

information systems, in particular - such complex and little studied as human consciousness and subconscious.

Only then can we learn to create and practically use really high-performance information systems and technologies, which will have to become the technological basis for the development of civilization in the XXI century.

1.3. The structure of the visual field of information technology

The visual field of information technology, as a scientific direction, at the initial stage of its formation will most likely be the following priorities:

1. Development of methods of structuring and classification of information technologies of different types and purposes according to their characteristics.
2. Development of criteria for the effectiveness of information technology, methods for their optimization and comparative quantitative evaluation.
3. Identification of promising areas of information technology development in the coming years, as well as scientific methods that should underlie them.
4. Defining the principles of building promising tools for the implementation of highly efficient information technologies of the new generation.

1.4. The place of information technology in the modern system of scientific knowledge

The above definitions of the object and subject of research of information technology as a scientific discipline, as well as analysis of the content of its priorities give reason to conclude that information technology as a science should be part of the natural sciences. And in much of his research, it will be characterized as a technical science, which is one of the sections of basic computer science.

The theoretical basis for information technology as a science should be achievements in the field of theoretical informatics and, above all, in the field of general information theory (BTI) - the new fundamental scientific discipline, which is already being actively formed in recent years.

Fundamentally important for the development of information technology should also be the results of research in a number of other sciences, such as cognitology, semiotics, semantics, information psychology. After all, to create fundamentally new information technologies of the future, we will need to know well the processes and factors that contribute not only to the effective perception of information by human consciousness and subconscious, but also factors that contribute to its best memory and adequate understanding.

In other words, promising information technology should not only be focused on the person, but also allow him to develop certain qualities that contribute to the perception, memorization, analysis and understanding of the meaning of information. In the modern scientific literature, such technologies are increasingly called creative technologies.

Thus, we can assume that new prospects will open up for the development of creative technologies in the coming decades. These technologies will be especially widely used in the system of education and special professional training.

1.5. Definition of information technology and information system

Technology when translated from Greek means art, skill, ability, and these are processes. The process should be understood as a set of actions aimed at achieving the goal. The process must be determined by the chosen strategy and implemented through a set of different tools and methods.

Information technology (IT) - a process that uses a set of tools and methods for collecting, processing and transmitting data (primary information) to obtain new quality information about the state of an object, process or phenomenon (information product). The explanatory dictionary of informatics gives the following definition: "IT - a set of methods, production processes and software and hardware, combined into a technological chain that provides collection, storage, processing, output and dissemination of information to reduce the complexity of the use of information resources, increase their reliability and efficiency ".

The set of methods and production processes of IP determines the principles, techniques, methods and measures governing the design and use of software and hardware for data processing in the visual field. Information resources - a set of data that represent value to the organization (enterprise) and speakers as material resources. These include data files, documents, texts, graphics, knowledge, audio and video information. The process of data processing in the IS is impossible without the use of hardware and software.

The purpose of the use of IT - the production of information for human analysis and decision-making on its basis to perform any action, as well as reducing the complexity of the use of information resources.

Information system (IS) - an interconnected set of tools, methods and personnel used to store, process and issue information in favor of achieving this goal.

Information technology is a process, and the information system is the environment. Thus, information technology is a more capacious concept than the information system, ie it can exist outside the sphere of the information system.

1.6. Stages of information technology development

There are several views on the development of information technology using computers, which are determined by different signs of division.

A sign of division - the type of tasks and processes of information processing.

1 stage. (60-70 years) - data processing in computer centers in the mode of collective use. The main direction of information technology development was the automation of routine human actions.

Stage 2 (since the 80's) - the creation of information technology aimed at solving strategic problems (long-term, long-term).

A sign of division - the problems that stand in the way of informatization of society.

Stage 1 (until the end of the 60's) is characterized by the problem of processing large amounts of data in terms of limited hardware capabilities.

Stage 2 (until the late 70's.) Is associated with the spread of computers series IBM / 360 / The problem of this stage - the lag of software from the level of hardware development.

Stage 3 (since the early 80's) - the computer becomes a tool for non-professional users, and information systems - a means of supporting its decision-making. Problems - the maximum satisfaction of user needs and creation of the corresponding interface of work in the computer environment.

Stage 4 (since the early 90's) - the creation of modern technology of inter-organizational relations and information systems. The problems of this stage are very numerous. The most significant of them are:

- development of agreements and establishment of standards, protocols for computer communication;
- organization of access to strategic information;
- organization of information protection and security.

A sign of division is the advantage that computer technology brings

Stage 1 (since the early 60's) is characterized by a fairly efficient processing of information when performing routine operations with a focus on centralized collective use of data center resources. The main criterion for assessing the effectiveness of the information systems created was the difference between the funds spent on development and saved as a result of implementation. The main problem at this stage was psychological - poor interaction between users for whom information systems were created, and developers due to differences in their views and understanding of the problems. As a result of this problem, systems were created that were poorly perceived by users and, despite their large enough capabilities, were not fully utilized.

Stage 2 (from the mid-70's) is associated with the advent of personal computers. The approach to the creation of information systems has changed - the orientation is shifted towards the individual user to support their decisions. The user is interested in the development being carried out, contact with the developer is established, there is a mutual understanding of both groups of specialists. This stage uses both centralized data processing, typical for the first stage, and decentralized, which is based on solving local problems and working with local databases in the user's workplace.

Stage 3 (since the early 90's) is associated with the concept of analysis of strategic advantages in business and is based on the achievements of telecommunications technology distributed information processing. Information systems aim not only to increase the efficiency of data processing, but also to help the manager. Appropriate information technology should help achieve the intended goals.

A sign of division - types of technology tools.

Stage 1 (until the second half of the XIX century) - "manual" information technology, the tools of which were: pen, inkwell, book. Communication was carried out manually by sending letters, packages, dispatches by mail. The main purpose of technology is to present information in the right form.

Stage 2 (from the end of the XIX century) - "mechanical" technology, the tools of which were: typewriter, telephone, dictaphone, equipped with more advanced means of delivery mail. The main purpose of technology is to present information in the right form by more convenient means.

Stage 3 (40 - 60's of the twentieth century) - "electric" technology, the tools of which were: large computers and related software, electric typewriters, copiers, portable dictaphones.

The purpose of technology is changing. The emphasis in information technology begins to shift from the form of information presentation to the formation of its content.

Stage 4 (since the early 70's) - "electronic" technology, the main tools of which are large computers and created on their basis automated control systems (ASOVI) and information retrieval systems (IPS), equipped with a wide range of basic and specialized software complexes. The center of gravity of technology is even more shifted to the formation of the content of information for the management environment of various spheres of public life, especially the organization of analytical work. Experience was gained in the formation of the substantive side of management information and prepared a professional, psychological and social base for the transition to a new stage of technology development.

Stage 5 (since the mid-80's) - "computer" ("new") technology, the main tool of which is a personal computer with a wide range of standard software products for various purposes. At this stage, the process of personalization of ASOVI, which is manifested in the creation of decision support systems by certain professionals. Such systems have built-in elements of analysis and intelligence for different levels of management, are implemented on a personal computer and use telecommunications. In connection with the transition to a microprocessor base, technical means of household, cultural and other purposes are subject to significant changes. Global and local computer networks are beginning to be widely used in various fields.

1.7. New information technology

New information technology - information technology with a "friendly" user interface that uses personal computers and telecommunications.

The basis of the new IT are: distributed computer technology, friendly software, communications development. The non-programmer user is given the opportunity to communicate directly with the computer by working in a dialog mode. At the same time, powerful software and hardware (databases, expert systems, decision support, etc.) create comfort in work.

The concept of "New IT" can be considered from a practical and theoretical point of view. From a practical point of view - a set of automated processes of circulation and processing of information, descriptions of these processes, tied to a specific visual area. From a theoretical point of view, the new IT is a scientific and technical discipline, which examines the problems of development and application of automated processes of circulation and processing of information.

The concept of the new IT, based on the widespread use of personal computer technology, is based on three main principles: integration, flexibility, interactivity.

The new IT is characterized by:

- the user's work in the mode of data manipulation (the user sees and acts, not knows and remembers);
- end-to-end information support at all stages of information flow on the basis of an integrated database;
- paperless process of document processing, in which only the final version of the document is recorded on paper, and the intermediate versions and the necessary data are communicated to the user through the screen of the PC display;
- interactive (dialog) mode of problem solving with wide possibilities for the user;
- the possibility of collective execution of documents on the basis of a group of computers, united by means of communication;
- the possibility of adaptive restructuring of forms and methods of presenting information in the process of solving the problem.

There are two ways to implement new information technology (NIT) in local information structures, based on the adaptation of NIT to the organizational structure, on the rationalization of the organizational structure.

In the first method of implementation, the NIT is adapted to the organizational structure, there is only a local modernization of the methods that have been formed. There is a division of functions between technical workers (operators) and specialists (administrators), merging the function of collecting and processing information with the decision-making function.

The second way to implement NIT involves streamlining the organizational structure: the organizational structure is modernized so that IT gives the greatest effect. The main strategy is the maximum development of communications and the development of new organizational relationships, previously economically impractical. The productivity of the organizational structure increases because the data archives are rationally distributed, the amount of information circulating through the system channels is reduced and a balanced efficiency of each management level of the tasks is achieved.

Thus, the first method of implementing NIT is focused on the existing structure of the institution (the degree of risk from the introduction of NIT is minimized, as the organizational structure does not change); the second - for the future structure.

As an area of scientific and technological progress, covering mainly the numerous applications of computer and telecommunications technology in almost all areas of organizational management, NIT is developing rapidly. Its revolutionary significance lies in the radical restructuring and acceleration of the process of creating new technology and implementing new technologies. A clear example of this is the use of design automation system (CAD) and automated research systems (ASNI), the use of which can accelerate the process of transformation of new scientific knowledge into a specific technology.

NIT combines new communication technologies based on local and distributed computer networks, processing of management information based on PCs and specialized workstations, as well as the development of management decisions based on artificial intelligence.

The most effective use of NIT is manifested in two important areas of management:

1) automation of design of operational planning and management of industrial production: CAD systems, ASOVI, ASNI, etc .;

2) automation of organizational management (founding activities in its various aspects): text systems, e-mail, voice mail, database management system and so on.

According to scientists and experts, NIT is currently one of the main means of supporting, creating and providing fundamentally new technologies: electron-beam, plasma, pulsed, biological, radiation, chemical, and others.

Thus, the task of developing a strategy for the development of NIT and its interaction with industry, management, science and other areas of public practice becomes extremely important and relevant.

NIT, as a new area of STP, characterizes a number of features that significantly distinguish it from other areas of science and technology:

- dynamism (technology of use, generations of many hardware and software change twice in a five-year period);
- the ever-increasing level of technical complexity of the components of NIT components, which causes the need for continuous training of both developers and users of information systems;
- deep and long-term impact on the development of productive forces and production relations;
- a high degree of potential efficiency under the following conditions: standardization, the scale of the infrastructure of the national economy, timely organizational support for the introduction of new tools and methods of NIT.

NIT is a set of many forms, methods, skills of application of all variety of computer equipment and means of communication in the field of collection, processing, storage and transfer of information. The NIT uses the achievements of systems engineering, computer systems theory, programming technologies, ergonomics, design and other applied sciences of information technology.

1.8. Properties of information technology

The use of IT allowed to present in a formalized form, suitable for practical use, a concentrated expression of scientific knowledge and practical experience for the implementation and organization of social processes. This saves labor, time, energy, material resources required for these processes. Therefore, IT plays an important strategic role that is growing rapidly. This is due to a number of their properties:

• IT allows to activate and effectively use the information resources of society, which saves other types of resources - raw materials, energy, minerals, materials, equipment, human resources, social time.

• IT implements the most important, intellectual functions of social processes.

• IT allows you to optimize and in many cases automate information processes during the formation of the information society.

• IT provides information interaction of people, which promotes the dissemination of mass information. They are quickly assimilated by the culture of society, remove many social, domestic and industrial problems, expand domestic and international economic and cultural ties, affect the migration of the population around the planet.

• IT occupies a central place in the process of intellectualization of society, in the development of education, culture, new (screen) art forms, in the promotion of masterpieces of world culture, the history of human development.

• IT plays a key role in the processes of obtaining, accumulating and disseminating new knowledge. The first direction - information modeling - allows to carry out "computational experiment" even in those conditions which are impossible in natural experiment because of danger, complexity, expensiveness. The second direction, based on the methods of artificial intelligence, allows to find solutions to problems that are poorly formalized, problems with incomplete information, with fuzzy initial data. It is about creating metaprocedures that are used by the human brain. The third direction - based on the methods of cognitive graphics - a set of techniques and methods of figurative representation of the conditions of the problem, which allow you to immediately see the solution or get a clue to find it. It opens up the possibility of human cognition of oneself, the principles of functioning of one's consciousness.

• IT allows to implement methods of information modeling of global processes, which provides the ability to predict many natural situations, increased social and political tensions, environmental disasters, major technological accidents.

Informatization of society provides internationalization of production. An indicator of the scientific and technical capacity of the country is the foreign trade balance of professional knowledge. It is realized by the market of licenses of production processes, "know-how" and consultations on application of science-intensive products. For example, the United States transfers about 80% of innovations to subsidiaries in other countries. When they master the proposed technology, a new technology is ready in the United States, that is, they implement an advanced cycle. The evolution of the world market gives advantages to a country that transfers knowledge-intensive products that include new technologies and modern professional knowledge. There is a trade in an invisible product: knowledge, culture. There is an imposition of a stereotype of behavior. That is why in the information society, strategic resources are information, knowledge, creativity. And since talents are not created, it is necessary to form a culture, ie conditions in which talents develop and prosper. Computer technology has a huge impact here through distance learning, computer games, computer videos and other information technologies. The social impact of the information revolution will be a synthesis of Western and Eastern thought.

2. Criteria for the effectiveness of information technology

Plan

2.1. Private performance criteria
2.2. Specifics of information technology implementation
2.3. General criterion of information technology efficiency
2.4. Distinctive features of high-efficiency technologies and basic principles of their design
2.5. The main scientific directions of information technology development
2.6. The human factor in advanced information technologies
2.7. Methodological apparatus of science as information technology

2.1. Private performance criteria

To optimize and quantify the effectiveness of possible options for designed or existing information technologies, it is necessary to correctly choose the criteria for their effectiveness.

• Functional criteria, the values of which characterize the degree of achievement in this technology of the desired characteristics of the information process, which are necessary for the user. Such characteristics may be, for example:

- volume-time characteristics of the information process being implemented (data transfer rate, memory capacity for information storage, etc.);
- reliable characteristics of the implementation of the information process (the probability of correct transmission or conversion of information, the level of its noise immunity, etc.):
- parameters that characterize the degree of achievement of the main end result of the information process, which is realized with the help of this technology (correctness of speech or image recognition, quality of the formed graphic information, etc.).

• Resource criteria, the values of which characterize the quantity and quality of different types of resources required for the implementation of this information technology. Such resources can be:

- material resources (instrumental and technological equipment necessary for the successful implementation of this technology);
- energy resources (energy costs for the implementation of the information process with this technology);
- human resources (number and level of training of personnel required for the implementation of this technology);
- time resources (amount of time required for the implementation of the information process with this technology of its organization);
- information resources (composition of data and knowledge necessary for the successful implementation of the information process).

2.2. Specifics of information technology implementation

The main types of resources in the production sphere are material and energy resources. That is why the greatest attention in the technologicalization of industrial production processes is paid to resource-saving and energy-saving production technologies. As for information technologies, there is a rather significant specificity. For example, energy resources for information technology, as a rule, are of secondary importance, because information processes by their nature have a relatively low energy consumption compared to the power processes that are implemented in mechanical and energy technologies of industrial production.

Information technology is the main means of forming and using information resources of society. However, their fundamental feature is that for their functioning they themselves need the use of information resources. These resources in the form of databases and knowledge can be entered into the memory of the information system in advance, as well as enter it from the outside in the process of implementing the information process.

A typical example of such technologies are expert systems. These technologies, as a rule, use the already accumulated experience in the organization of this or that information process. At the same time, it is possible to significantly reduce the level of requirements for professional qualification of users of the expert system, which can give a significant economic and social effect.

For example, one of the largest computer companies in the United States once experienced an acute shortage of highly qualified specialists to configure control systems for storage of information on large magnetic disks. The way out of the situation was found by developing and implementing a special expert system at the enterprises of this firm, which provided an opportunity to carry out this operation by specialists already existing at the firm. At the same time, the quality of setting the control devices turned out to be quite high.

Despite the fact that the creation and implementation of this expert system cost the company about 100 thousand dollars, these costs quickly paid off, as the company was able to continue to produce its high quality products in the required volumes.

This example shows that information technology allows not only to form knowledge, but also to use it economically. In other words, they also have the properties of resource-saving technologies.

2.3. General criterion of information technology efficiency

Resource efficiency criteria allow to compare different types of technologies. In addition, they provide an opportunity to quantify the effect obtained as a result of the application of these technologies in terms of their social utility in terms of saving various types of resources of society.

That is why the most common criteria for comparative assessment of production technologies are energy criteria. After all, energy consumption in socially useful production is one of the most important indicators of the level of technological development of modern society.

However, the most common indicator of technology of any kind (production, social or information) should be recognized as saving social time, which is achieved as a result of using this technology. This criterion, proposed by Academician VG Afanasiev and PG Kuznetsov as one of the most general measures of society, it seems to us quite suitable for a comparative quantitative assessment of the effectiveness of different types of information technology. It is well known that any savings can ultimately be reduced to time savings. Moreover, according to PG Kuznetsov, which is shared by the author of this work, it is the budget of social time and is the main resource for livelihood and development of modern society.

Indeed, for the practical implementation of any process of development of society (economic, intellectual or spiritual) it is necessary that society has the opportunity to spend for these purposes some part of its total resource of social time. In other words, some "free resource" of social time is needed, which should remain in the social time budget of society in addition to the costs of other "articles" of this budget related to solving the problems of simple reproduction and livelihood of society.

Thus, the most useful from a social point of view for society are those information technologies that save the most social time, freeing it up for other purposes, in particular - for the purposes of society.

The above approach radically changes the traditional point of view on the effectiveness of certain types of information technology, which today are evaluated, as a rule, only by functional criteria. For example, from the point of view of saving social time for society, the use of information technologies in the field of public service is very effective (in trade, catering, savings banks, ticket offices, etc.). After all, it is in this area that the most significant losses of social time occur today, which could be used to achieve the goals of society development.

Of course, the use of saving social time as a general criterion for the effectiveness of information technology today is not yet provided with the necessary methodological developments. However, I would like to emphasize that this approach seems to us extremely promising. After all, it not only allows to create the necessary scientific and technological basis for the practical implementation of the widely promoted humanistic slogan: "Everything is for the good of man!", But also changes the worldview, its attitude to the social role and importance of information technology.

2.4. Distinctive features of high-efficiency technologies and basic principles of their design

Let us now consider the most important distinctive features that indicate the high potential efficiency of different types of technologies and thus allow us to identify promising areas of their development. At the same time, we will first consider the already traditional mechanical and energy technologies in order to identify some general principles and patterns that take place there, and then extend them to information technology.

Concentration of resources in space.

One of the main principles of creating highly efficient technologies is the principle of concentration of resources in space. Indeed, because the first tools created by man are based on the use of this principle. Invented by primitive people cutting tools, such as knives and plows, allowed people to concentrate on their blades resources of their muscular strength and the strength of pets and get due to this fundamentally new opportunities for tillage and materials, ie to perform socially useful work, vital to people for their existence.

The same principle is used in the creation of efficient energy technologies, where the concentration of energy flows in space is also carried out. In creating the foundations of the theory of thermal machines, G. Leibniz showed that it is the density of energy flow is the main factor that determines the capabilities of a heat engine to carry out work.

The following fundamentally important regularity was revealed. It turned out that less energy used at higher densities is able to perform a much larger amount of work compared to those cases where large amounts of low-density energy are used.

This pattern was later used in the creation of laser technology, when the flux of coherent radiation is specially concentrated in very small volumes of space. Laser technology has already proven its high efficiency in various fields of practical use. Today they are one of the most promising areas for further technological development of society. From a theoretical point of view, these expectations are quite justified, because laser technology allows to obtain energy streams of exceptionally high density, which can not be created in any other way. That is why modern physicists associate their hopes of finally obtaining a controlled thermonuclear reaction with the use of laser technology.

Concentration of resources over time.

Another principle of creating highly efficient technologies is the principle of concentration of resources over time. Typical examples of the use of such technologies are blacksmithing, as well as all other types of mechanical technologies that use impact energy.

The invention of the hammer was probably one of the greatest technological achievements of mankind, which allowed him to solve a number of complex problems in construction and industrial production. Impact is also used in energy technologies, where the so-called pulse technologies are already being actively developed. They allow you to create a high concentration of energy in very short periods of time, but sufficient to obtain the final beneficial effect, which can not be achieved in any other way. Therefore, an important quantitative feature of high-efficiency technologies is the indicator of the power of the energy flow, which when used can be created in the technological process.

R. Leibniz pointed out the fundamental importance of the concept of power in his works on the theory of thermal machines.

Combined technologies

Technologies of this kind use the principles of concentration of resources in space and time at the same time. Typical examples of such technologies are all those types in which shocks with pointed surfaces or sharp pulses of radiant energy

are used. Such technologies include milling and sawing materials, cutting operations, as well as needle operations in the garment industry and some others.

Technologies of this kind are very effective. It is not for nothing that they have long been used in various weapons. Sword and dagger, battle ax and spear, bow and crossbow - all these weapons have been used by humans for thousands of years due to their high impact. And now many types of weapons use the principle of simultaneous concentration of energy in space and time. For example, the cumulative projectile of a modern portable anti-tank missile system has the ability to pierce armor with a thickness of about 800 mm. This is achieved due to the fact that in the rocket itself, in addition to the explosive, there is also a needle-shaped core made of hardened steel, which literally pierces the armor of the tank, heated by a cumulative projectile.

Vector resource orientation.

I would like to draw the reader's attention to another fundamental feature of high-performance technologies. It is that these technologies allow not only to create a sufficiently high concentration of mechanical force or energy flow in space and time, but also to direct them in a specific direction. And the concentration of this focus is also extremely important.

Thus, in order to create a sufficiently effective technology, it is necessary to ensure that we have the means to concentrate the resources used in this technology in space and time, as well as for the concentrated action of these resources in a well-defined direction.

For example, it is hard to believe that a simple sewing needle can easily pierce a thick five-kopeck coin. However, this is exactly the experience the author of this article [?] Had to observe in one of the school physics lessons. At its carrying out the needle, a hammer and the present, instead of a plastic stopper are necessary. The experiment is as follows. The plug is pierced with a needle so that it fits into it almost completely. The tip and eye of the needle should protrude only slightly at the ends of the plug. Then the stopper with a needle is set with the tip down strictly perpendicular to the plane of the coin and lightly hit the end of the stopper with a hammer. And everything is ready, the needle easily pierces the coin!

This experiment is very effective, it is easy to reproduce at home as a kind of focus. However, it is very revealing as an example of highly efficient combined technology. After all, it simultaneously uses all three basic principles of concentration of resources (in this case - mechanical force): in space (on the tip of the needle), in time (hammer blow) and in the direction (this function is performed by the plug). Hence the very impressive end result.

2.5. The main scientific directions of information technology development

If we talk about the substantive areas of development of information technology as an independent scientific theory, then here we have the most promising following main areas.

1. Creation of new methods of information compression in order to increase the level of its concentration within some very limited volumes of space. It may be

useful to introduce new concepts such as "information density" and "information flow density". By analogy with other types of technologies based on energy use, we can expect that increasing the density of information flows will provide qualitatively new results in a number of practical applications of information technology. It will only be necessary to determine the value of those threshold levels of information density, which will allow to obtain these new qualities in certain information systems.

2. Continuing the analogy with energy types of technologies, we can assume that high-efficiency can be pulsed information technologies, which will provide compression of information flows not only in space but also in time. It is not for nothing that people have long used different types of "brainstorming", methods of "deep immersion" and other similar ways to increase the efficiency of information processes both at the stages of generating new information and at the stages of its perception and understanding.

It is possible that in the arsenal of scientific terminology of information technology as a science will have to introduce such a new concept as "power information flow". This concept will characterize the intensity of information processes over time and, perhaps, will largely determine their effectiveness.

Thus, in the development of information technology as a science can be very useful to use general principles and patterns of other types of technology (mechanical and energy), as well as analogies in those patterns that link their effectiveness with general principles. we are the functioning of natural systems, and above all - the objects of living nature.

The problem of semantic compression of information.

It is possible to point out one more perspective direction of development of information technologies which is specific only for technologies of this kind. We are talking about the development and practical use of methods of "semantic compression" of information. The fact is that to increase the efficiency of information use it is necessary to compress not only in space and time, but also semantically. In other words, it is necessary to make so that as a result of use of this or that kind of information technology a kind of "information cone" was formed, the top of which would be the main target function of the optimized information process.

Practical examples of this type of technology can be the processes of forming problem-oriented segments from large databases. Depending on the purpose of using such a segment (research or educational process), it could begin, respectively, with a problem-solving or review article on the problem being studied. Then, in order to expand the analyzed visual field, there could be scientific articles or reviews devoted to the disclosure of the content of individual components of this problem. Finally, information would be provided on the latest results of its research, applications for inventions and discoveries in this field, scientific forecasts.

Semantic concentrators.

Naturally, the formation of such problem-oriented segments of databases and knowledge is a very time-consuming task and will require the involvement of

highly qualified specialists for these purposes. However, the effectiveness of the use of such segments for scientific purposes, as well as in the education system can be very significant. After all, the very "architecture" of the array of information, which is formed in this way helps the user to focus on increasingly "dense" areas of information, ensuring the concentration of his consciousness on those semantic areas that should quickly lead to the solution of a problem.

At the same time, the "conical structure" of semantic information segments allows the researcher to periodically return to the starting positions and examine certain information "slices" of this problem in a sufficiently representative field of data and knowledge.

Information technologies of this kind are proposed to be called "semantically concentrated". We can assume that in the future in the process of developing methods of artificial intelligence and their applications in the field of creation and use of information systems will also be created and special automated "semantic concentrators". They can be represented in the form of software and hardware complexes, specifically focused on creating semantically concentrated segments on the given parameters of the problem area. The initial information for the operation of such semantic concentrators will most likely be distributed databases in the global information networks of our planet, which are already being actively formed today.

2.6. The human factor in advanced information technologies

It seems fundamentally important that promising information technologies, which will be widely used by society at the beginning of the XXI century, would be initially focused on man, would take into account his ability to perceive information and the formation of new knowledge based on it.

In this regard, very promising areas of research and development are different methods of representation and use of information in the form of images. These can be different types of graphics, cartographic information, three-dimensional and color images, as well as various types of animation.

Representation of information in the form of images is one of the most effective methods of its compression in space. In addition, the visual channel of human perception of information is the most broadband among all other available channels for obtaining information. Therefore, the transmission of information through this channel can be carried out at very high speeds and, therefore, it is here that the highest indicators of the power of information flows can be achieved, which are necessary to increase the efficiency of information technologies. It is not for nothing that they say: "It is better to see once than to hear a hundred times."

Thus, the development of methods of computer graphics, pictographic interfaces of human interaction with information technology, multimedia technologies, geographic information systems, as well as virtual reality systems - all these are current and very promising areas fundamental and applied research for information technology as a scientific field.

The development of these studies and the practical use of their results on the basis of new generations of rapidly advancing information technology in the

coming years can give very tangible and socially significant results in various fields of human activity. These results, of course, will change the whole way of life and activities of people in the new highly automated information environment, will lead to the creation of an information society.

2.7. Methodological apparatus of science as information technology

The above approaches to the consideration of the main problems of information technology as a science allow us to consider the methodology of science as a kind of information technology of a fairly high level. After all, if from the standpoint of the information approach to analyze the methodological apparatus of modern science, we will easily find in it all the basic functions of information technology.

Indeed, there are also functions of information compression, which are performed by the apparatus of formalized representation of knowledge used in science in one or another visual field.

An example of such an apparatus is mathematics. After all, one of its most significant achievements is the possibility of presenting rather complex dependencies in a rather compact form. This allows the researcher to fully examine certain fragments of the phenomenon under study, to analyze its possible limit states and to draw conclusions as a result.

A typical example here is the mathematical apparatus of synergetics, where a method for presenting the basic characteristics of self-organizing systems in phase space has been developed and widely used. Analyzing the possible trajectories of the system in this space, presented in the form of so-called attractors, the researcher immediately focuses his attention on the most important parameters, which essentially depend on the possibility of a particular path of development of this system (in synergy). they are called parameters of the order of the system). Thus from its field of view practically all secondary factors of process of functioning of system are excluded, ie there is a semantic concentration of information, there are obvious signs and properties of information technology.

Analysis of the methodological apparatus of science from the point of view of information technology as a science can be quite useful not only for science but also in practical terms. This approach, in principle, allows us to determine the most promising areas of development of the methodological apparatus of science. A comparative analysis of the effectiveness of this apparatus in different sectors of scientific knowledge, which could provide additional orientation for its development, can also be fruitful here.

Thus, the formation of information technology as an independent scientific field can be very useful for the development of science itself in terms of further improvement of its methodological apparatus.

3.1. Basic classes of information technologies

Classification of information technology, apparently, will be one of the priorities of information technology as a science. Today, the classification of

information technology is carried out mainly on certain grounds related to the area of their practical use, ie for purely pragmatic reasons.

According to the purpose and nature of use, it seems appropriate to distinguish the following two main classes of information technology:

• basic (providing) information technologies;

• applied (functional) information technologies.

Basic information technologies are the most effective ways to organize individual fragments of certain information processes associated with the transformation, storage or transmission of certain types of information.

Basic-type information technologies can be classified according to the task classes they target. Basic technologies are based on completely different platforms, which is due to the difference between the types of computers and software environments, so when they are combined on the basis of visual technology there is a problem of system integration. It is the need to bring different IT to a single standard interface.

Examples of such technologies may be information compression technology, its encoding and decoding, pattern recognition and the like

A characteristic feature of basic information technologies is that they are not intended for the direct implementation of specific information processes, but are only those of their basic components, on the basis of which the applied information technologies are then designed.

Thus, the main purpose of basic information technology is to achieve maximum efficiency in the implementation of some fragment of the information process based on the use of the latest advances in basic science. That is why basic information technology is the main part of the object of research of information technology as a science.

The main task of applied information technology is the rational organization of one or another fully specific information process. This is done by adapting to this particular use of one or more basic information technologies that allow the best implementation of individual fragments of this process. Therefore, the main scientific problems in the field of applied information technology can be considered the following:

1. Development of methods of analysis, synthesis and optimization of applied information technology.

2. Creating a theory of information technology design of various types and practical purposes.

3. Creating a methodology for comparative quantitative assessment of different options for building information technology.

4. Development of requirements for hardware and software automation of information technology implementation processes.

For example, the work of an employee of the credit department of the bank using a computer necessarily involves the use of a set of banking technologies to assess the creditworthiness of the borrower, forming a loan agreement and term obligations, calculating payment schedules and other technologies implemented in any information technology: DBMS and so on Transformation of providing

information technology in its pure form into a functional one (modification of some commonly used tools into a special one) can be done both by a specialist designer and by the user himself. It depends on how complex such a transformation is, that is, on how accessible it is to the user. These opportunities are expanding more and more as the providing technologies become more friendly year by year.

Another example of applied information technology is the technology of entering speech information into a computer. From a technological point of view, the whole information process here is divided into several successive stages, each of which uses its own basic technology. Such stages in this case are:

1. Analog-to-digital conversion of the speech signal and input of the received digital information into computer memory. The basic technology here is analog-to-digital conversion, and this technology is implemented, usually in a hardware way using special electronic devices, the characteristics of which are optimized in advance and are well known to designers.

2. Isolation in the composition of digital language information of individual phonemes of the language in which the speech was spoken, and their identification with the typical "images" of these phonemes stored in the memory of the computer system. The basic technology here is image recognition technology.

3. Transformation of linguistic information into textual form and implementation of procedures for its morphological and syntactic control. The basic technologies here are the procedures of morphological and syntactic control of the text, formed on the basis of analysis of linguistic information, and making the necessary corrections related to the correction of errors.

The above example quite clearly illustrates the principle of formation of applied technology by adapting a number of pre-developed basic technologies required for the implementation of this information process. This approach not only saves a lot of time for developers of applied information technologies, but also largely guarantees their high efficiency in cases where advanced and well-established basic technologies are used.

Visual IT - a set of software for the implementation of typical tasks or processes in a particular area. For example, the 1C-accounting package.

Distributed functional IT is used when solving a problem, its functions are performed by several employees in several workplaces, and each employee performs one or more functions in one workplace (see also "Distributed information processing").

3.2. Classification according to the user interface

The set of methods of user interaction with the application is called the user interface. An application is a package of applications for a specific field of application and use of information.

The user interface includes three concepts: application communication with the user, user communication with the application and the communication language defined by the software application developer.

The properties of the interface are specificity and clarity. One of the

important functions of the interface is the formation of the user's same response to the same actions of applications, their consistency. Reconciliation should be performed in three aspects:

- physical, which refers to technical means;
- syntactic, which refers to the sequence and order of appearance of elements on the screen (language of communication) and the sequence of queries (language of action);
- semantic, which refers to the values of the elements that make up the interface.

Interface consistency saves user and developer time. For the user the time of studying and then use of system decreases, the number of errors is reduced, there is a feeling of comfort and confidence. The agreed interface allows the developer to select common blocks, standardize individual elements and rules of interaction with them, reduce the design time of a new system.

The user interface depends on the interface provided by the operating system.

Classification of IT by type of user interface allows us to talk about the system and application interface. And if the latter is associated with the implementation of some functional IT, the system interface is a set of methods of interaction with the computer, which is implemented by the operating system or its add-on. Modern operating systems support command, WIMP and SILK interfaces. Currently, the problem of creating a social interface (social interface)

The command interface is the simplest. It provides a system prompt for entering a command. For example, in the MS-DOS operating system, the invitation looks like C: \>, and in the UNIX operating system, it is usually a dollar sign.

The WIMP interface stands for Windows (Image) Menu (Pointer). A window containing images of programs and action menus is displayed on the screen. A pointer is used to select one of them.

SILK-interface is decrypted - Spich (language) Image (image) Language (language) Knowledge (knowledge). When using the SILK-interface on the screen on a language command there is a movement from one search images to others on semantic semantic connections.

The public interface will include the best solutions of WIMP and SILK interfaces. It is assumed that when using the public interface you will not need to know the menu. Screenshots will clearly show the way forward. Moving from one search image to another takes place through semantic semantic connections.

3.3. Classification according to the degree of interaction with each other

Information technologies differ as they interact with each other. They can be implemented by various technical means: the interaction of discrete and network, as well as using different concepts of data processing and storage: distributed information base and distributed data processing.

3.4. Classification of IT by type of information processed

The classification of IT by the type of information processed is presented in the table. 1.

Table 1

Types of processed information	Types of information technology	
1. Data	DBMS, algorithmic languages, spreadsheets	Integrated packages
2. Text	Word processors and hypertext	
3. Graphics	GPUs	
4. Knowledge	Expert systems	
5. Objects of the real world	Multimedia tools	

This classification is somewhat conditional, as most of these ITs allow you to support other types of information. Thus, word processors provide the ability to perform primitive calculations, spreadsheets can process not only digital but also textual information, as well as have a built-in graphics generation device. However, each of these technologies is still more focused on the processing of information of a certain kind.

Obviously, the modification of the elements that make up the concept of IT, allows the formation of a huge number of them in different computer environments.

3.5. The concept of the platform

A variety of hardware and operating systems have forced system developers to introduce the concept of a platform. The platform determines the type of hardware and software on which you can install the purchased information technology. It has a complex structure.

The main component of the platform is the type of computer, which is determined by the type of processor: Macintosh, Atary, Sincler, Intel and so on.

The next component is the operating system running on a particular processor. For example, Windows NT runs on many types of processors: Intel, MIPS, ALPHA, Power PC.

Many ITs do not depend on additional hardware and the availability of other software. They are called computer IT. For example, these include word processors, graphics, spreadsheets.

Part of IT depends on additional equipment. For example, network IT depends on network equipment: modems, adapters, communication channels, and so on and the software that serves them.

Part of IT requires additional equipment and special software to maintain it. For example, multimedia technology uses CD-ROM drives, video cards, sound cards, and so on. And because multimedia technology can be used in computer networks, it also depends on network equipment.

The latest IT is a product of integration of different IT. Therefore, their platform depends on all structural parts: the type of processor, the OS running on it, the type of additional equipment that supports this hardware software.

3.6. Problems and criteria for choosing information technology

When choosing IT you need to consider the following main factors:

- total sales (only one in ten packages is in demand on the market);
- increase the productivity of the user (the user does what the computer can not do);
- reliability;
- information security measure;
- necessary memory resources;
- functional capacity (opportunities provided);
- ease of operation;
- quality of intelligent interface;
- the ability to connect to a computer network;
- price.

You should also consider the platform of the software being used and the docking with it. Recently, additional requirements apply to applications:

- common interface for access to various databases;
- ensuring distributed data processing;
- modular structure that allows you to buy and build functional IT applications in stages;
- the ability to process a variety of information, including language, audio and video information;
- electronic exchange of information for commercial transactions;
- multiplatform.

3. Personal PAN technologies. Medical technology of monitoring and distributed data storage and processing. Scheme of organization of remote monitoring. Remote telemonitoring using implanted devices.

General classification and basic concepts of computer networks.

A computer network is a set of computers connected by communication channels.

The main functions of computer networks:

- ensuring general access to information;
- general access to software resources and equipment;
- exchange of information (data transfer) between computers;
- fast data exchange between users;
- Storage and processing of large amounts of data;
- load distribution between computers;
- distributed data processing;
- remote management of data and equipment;
- redundancy of data and resources to increase security and resilience to failures.

And a number of other features.

The main components of a computer network are: computers, equipment for data processing and transmission, including communication lines, special network software.

At the software level, network protocols are provided by network protocols, network device drivers, and network operating systems that provide network access, network management, network resource use, proprietary resources for network clients, network hardware and protocols, and a variety of other functions. .

There are special network operating systems (for example, Windows Server), but now all operating systems have built-in network functions.

Any device on a computer network that is connected to any other network device is called a network node or host. Nodes can be computers, mobile phones, PDAs, as well as special network devices such as a router, switch or hub, and others.

General classification of computer networks.

Different approaches are used to classify computer networks, and there are several main features of the classification, which intersect.

By appointment:

- computer networks - designed mainly to solve problems of users with data exchange between network subscribers;
- information networks - focused mainly on providing information services to users;
- mixed networks - combine the functions of the first two.

By territorial distribution.

Local Area Networks (LAN - Local Area Network) - have a closed infrastructure, combines computers, usually of one organization, which are located compactly in one or more rooms (buildings). Local area networks are closed networks, access to them is allowed only to a limited number of users for whom work in such a network is directly related to their professional activities. The local network may consist of several logically or physically separate parts - network segments, as well as the means to access other local and global networks.

Regional (city) networks, Intranet (MAN - Metropolitan Area Network) combine computers between institutions that are located within one or more cities in the region. Such networks connect many regional subscribers and local computer networks of the city, provide access to global networks. An example of such a network is a city computer network, which performs the functions of storage and processing of utility payment data, which unites utility, postal, financial and other organizations.

Wide Area Networks (WANs) now cover large areas of most countries in all geographical regions. Global networks are usually created and maintained by large telecommunications, private or public companies to provide paid services to subscribers. The global network allows you to combine regional, national, international networks and subnets. As a rule, global networks are open and service-oriented for any user. Examples of such networks are the Internet, USERNET and others.

Corporate global and local area networks combine computers, usually of large international or national industrial and financial organizations. The corporate network is closed to third parties, and within the network there is a system of restricting access to information. A limited number of users have full access rights, and most network users can only perform a limited list of operations. Corporate networks include banking, tax, insurance, information networks and a number of others. For example, the global corporate network SWIFT is an international interbank system for transmitting information and making payments.

Wireless personal area networks (WPAN) are used for wireless communication of various devices, including computers, household and office equipment, communications, etc. The range of WPAN is from a few meters to several tens of meters. WPAN is used both to connect individual devices to each other and to connect them to higher-level networks, such as the World Wide Web.

Virtual (logical) local area networks (VLANs) are a group of remote computers with a common set of requirements that interact in such a way that while on a global network, they function as if they were connected to a local area network, regardless of their physical location. The traffic of such a network is completely isolated from other nodes of the global or local network. A VLAN has the same properties as a physical LAN, but allows endpoints to group together even if they are not on the same physical network.

By type of functional interaction (network architecture).

Networks with a dedicated server (client-server architecture) provide for the allocation of special computers that organize the work of the network, which provides centralized management. In such a network, data processing or network

load is distributed between service providers, called servers, and service customers, called customers. Clients and servers communicate over a computer network and can be either a variety of physical devices or software.

A client or workstation is typically a personal computer that is the workstation of network users and uses server resources and network services.

Server - a computer allocated for sharing by network members, distributes and delivers network resources and network services to customers. In particular, the server provides access to the client from the local network to the global network.

A dedicated server is a computer that functions only as a server and is not used as a client or workstation. It is specially optimized for fast processing of requests from network clients and provides security and data protection.

Peer-to-peer networks do not provide for the allocation of special computers that organize the network. In such a network, all computers are equal. Each computer functions both as a client and as a server. Each user, connecting to the network, makes part of the resources on his computer available to other users (disk space, printers, files) and uses the resources provided to the network by other users.

Peer-to-peer networks are relatively simple, cheaper than server-based networks, but have a lower level of data protection and require more powerful computers than dedicated server networks.

By type of network topology: common bus, star, ring, cellular, hierarchical (tree), lattice and others.

By type of data transmission medium:

- wire (telephone wire, coaxial cable, twisted pair, fiber optic cable);
- wireless (data transmission over radio waves in a certain frequency range).

By data rate.

- low speed (up to 10 Mbps);
- medium speed (up to 1000 Mbps);
- high-speed (over 1000 Mbit / s).

There are a number of other classification features of computer networks.

Topology of computer networks

Network topology determines the ways of organizing physical connections, layouts and connections of computers and other network devices.

It should be noted that the concept of topology refers primarily to local area networks, in which the structure of connections can be easily traced. In global networks, the connection structure is usually hidden from users and is not of fundamental importance, because each communication session is carried out independently of the network topology in its own way.

There are many ways to connect network devices, of which there are several basic topologies: common bus, star and ring. Other methods are combinations of basic topologies.

In the general case, such topologies are called mixed or hybrid, but some of them have their own names. The choice of a network topology determines the

requirements for equipment, type of communication lines, network management methods, network expansion capabilities, etc.

The common bus (Bus network) is the basic topology of a computer network (Fig. 3.1), which uses a single cable called a backbone or segment, along which all computers (nodes) that have equal rights are connected. Data from the transmission node of the network is distributed on the bus in both directions only in turn, not simultaneously, because the communication line is the same (half-duplex mode). Signals that have reached the ends of the cable are reflected from them. There is an overlap of signals, which leads to their distortion and attenuation. Therefore, to prevent the display of the signal, at the ends of the cable of the common bus set special devices -terminators.

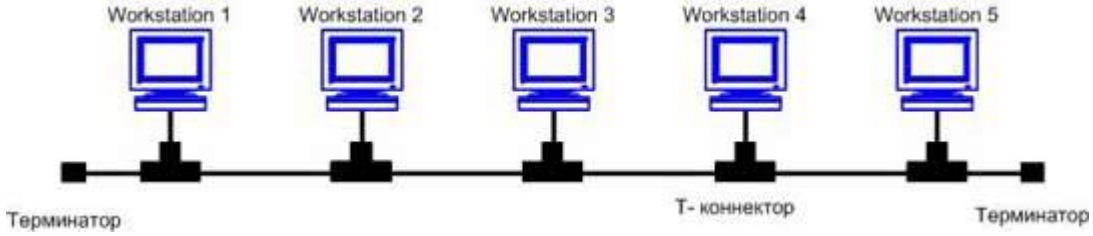


Figure 3.1 - Network bus topology type "common bus"

Star (Star network) - the basic topology of the computer network (Fig. 3.2), in which all network computers are connected either to the central node -Computer-server (active star), or to a special device -concentrator or switch (passive star), forming a physical segment of the network. Such a network segment can operate both separately and as part of a complex network topology (usually a "tree"). All information exchange between computers is exclusively through a central node, which relays, switches and directs information flows in the network.

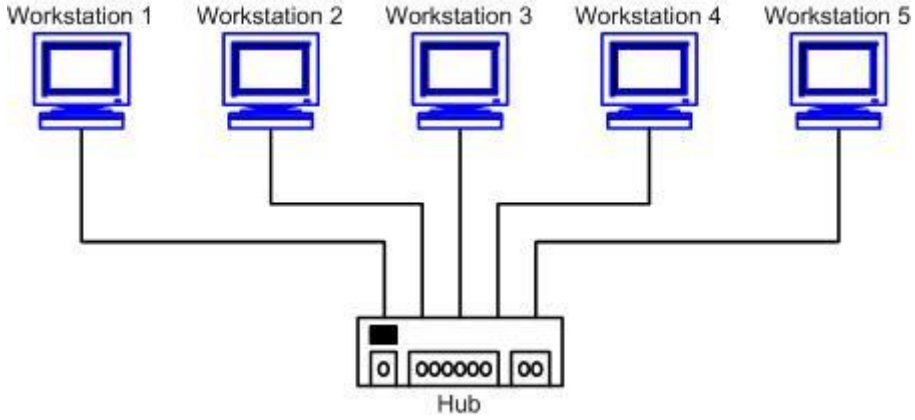


Figure 3.2 - Star-type network topology

Networks with star topology have high performance, good scale, but the final number of workstations in the network is limited by the number of ports in the central node, the operation of which determines the performance of the entire network.

Ring (Ring network) - the basic topology of computer networks (Fig. 3.3), in which each computer is connected by communication lines with only two other nodes: from one it only receives information, and the other only transmits it, and

all connected nodes are involved in receiving and transmitting data. Each computer in the ring retransmits (restores) the signal and transmits it in only one direction.

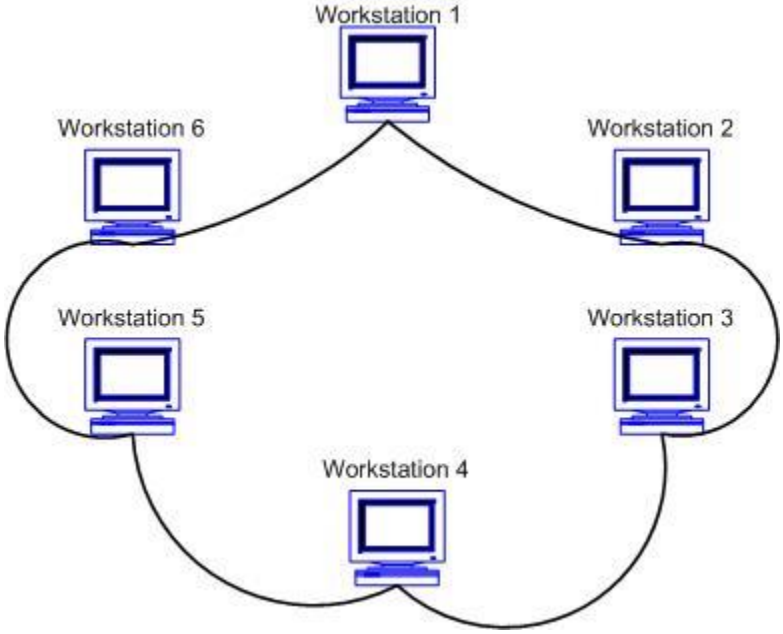


Figure 3.3 - Network topology of the "ring" type

The method of transmitting data over the ring is called token transmission. A token is a special sequence of bits transmitted over a network. There is only one token in each network, and the destination list is generated by the computer that is the token generator. The token is transmitted in a ring sequentially from one computer to another until it is found whose address matches the address of the recipient. The token is then removed from the network. The speed of the marker is comparable to the speed of light. Thus, in a ring with a diameter of 200 m, the marker can circulate with a frequency of 477 376 rpm.

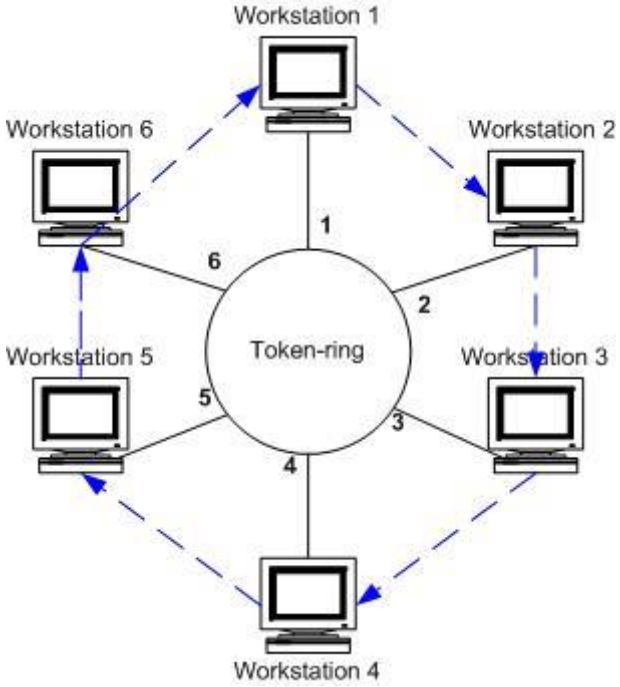


Figure 3.4 - Scheme of transmission of the marker

Double ring topology of computer networks, which is performed on the basis of two ring communication lines. For each ring, information is transmitted in opposite directions. The purpose of such a solution is to increase (ideally twice) the speed of information transfer. In addition, if one of the cables is damaged, the network can work with another cable.

Hierarchical (tree) topology of computer networks (Fig. 3.4), which can be considered as a combination of several stars. The network consists of two or more end nodes and at least two intermediate nodes. In such a network, there is only one path between any two nodes. As with a star, a tree can be active or passive. At an active tree in the centers of association of several communication lines there are the central computers, and at passive - concentrators. The network is implemented, as a rule, in complex systems with tens or even hundreds of subscribers.

Cellular is a topology of computer networks in which each computer of the network is connected to all other working nodes of the same network by a separate cable. A network with a cellular topology has a high redundancy and reliability. The signal from the sending computer to the receiving computer can take different routes, so a cable break does not affect network performance. Mesh-networks are used in combination with other topologies when building large networks.

Other types are used to build computer networks.

The work of a computer network is to transfer data from one computer to another. In this process, the following tasks can be identified:

1. Data recognition;
2. Splitting data into managed blocks;
3. Adding information to each block about the location of the data and the recipient;
4. Adding information for synchronization and error checking;
5. Moving data to the network and sending them to a given address.

Network operating system in performing these tasks and for the interaction of computers in the network strictly follows certain rules (set of commands, operations, procedures). These rules are called protocols. (They regulate every network operation. Standard protocols allow software and hardware from different vendors to interact properly.

Telecommunication support of IT.

In order to make a correct diagnosis, the doctor must be able to be near the patient and examine him regularly or promptly, in the event of a problem situation. Unfortunately, this picture is idealized and for various reasons unfeasible due to the lack of qualified medical staff, the concentration of specialists in large cities, the high cost of their services. But experience shows that with minimal patient input, the diagnosis is made in minutes or seconds, and a visit to the doctor may be delayed for a long time, which in turn may reduce the effectiveness of treatment. Based on this, reducing the time of transmission of primary information from patient to medical professional and his recommendations back to the patient is an important task of modern medicine. To do this, you must meet two conditions: 1)

quickly connect to the transmission channel, 2) have a high transmission rate or small amount of data. In the first case, the result is achieved by directly connecting to the transmission channel of the medical device, for which it must have a suitable modem, and the second condition is realized by choosing the correct ratio of channel speed and the amount of transmitted data. And the speed often does not have to choose, but the volume can be reduced by using different data archivers. Consider different technologies and channels of information transmission in terms of their application in medical technology. There are two main areas of wired (cable) technology - a dial-up telephone line, represented in our country by a large company "Ukrtelecom" and other smaller companies, and networks based on Ethernet technology, private or those provided by Internet providers. The dial-up telephone line is a paid public channel (installed in almost all apartments and institutions). Typically, the subscriber is provided with a two-wire analog channel to connect the phone, which is used for voice transmission.

A modem is used to communicate with the medical device over the telephone line. There are many modems for personal computers, both built-in and external. From the PBX, the analog channel is digitized with a bit rate of 8 bits and a repetition rate of 8 kHz. This digitization theoretically allows to transmit information on such a channel at a speed not exceeding 64 kbit / s, and in practice - up to 56 kbit / s. To increase the transmission speed, special equipment is used, which is connected both by the subscriber and by the telephone exchange and is called a DSL modem. It should be noted that modern PBXs already have a built-in DSL-modem. Such a refinement allows data to be transmitted at speeds up to 2 Mbps, but requires additional equipment. A significant inconvenience of such a transmission channel at the required speeds can be considered only the need for physical connection to a telephone line, which is not always convenient, and sometimes impossible, say, in portable (derivative) conditions. Although it happens that this transmission channel is the only one where there is no coverage area by wireless channels, especially in rural areas. This channel provides Internet access services. As for Ethernet networks, they should be divided into two groups. The first group is a local area network in which the transmitted information does not go beyond it. In the second case, this network is only a link in the data chain and in most cases belongs to ISPs. Such networks are developed mainly in large cities. Physical connection to the device here should not cause inconvenience due to the standard for a detachable connection. But a significant disadvantage when connecting portable devices to such networks can be individual software network settings, which must be entered when connecting to a new network. Wireless technologies and information transmission channels will also be divided into two large groups. The first group includes those means of data transmission that work over long distances. As a rule, they have a wide coverage area, mostly national, and belong to commercial organizations. These are, first of all, large national GSM operators, smaller CDMA operators and novice WiMAX operators. The second group includes local data means that operate at a distance of ten to hundreds of meters and do not require payment per unit of transmitted information. These are tools that work on WiFi technology, BlueTooth, ZigBee and universal transceivers,

[8]. GSM (Global System for Mobile Communications) is a standard for second generation 2G digital mobile communications, which works with time division multiplexing and is the most developed and widespread of all mobile technologies. The GSM standard provides the following services for voice and data transmission: voice channel - full-speed audio codec 13 kbit / s; speech codec with half the transmission speed of 5.6 kbit / s; improved language codec 12.2kbit / s. GSM-operators are represented in our country by the following companies that have their own base stations: MTS, Kyivstar, Life, which have national coverage. The third-generation UMTS 3G communication standard, based on the GSM standard, allows voice, data and video to be transmitted much faster than GSM networks. A voice codec with a variable bit rate is used for voice transmission. HSDPA (High-Speed Down link Packet Access) is a high-speed packet data transmission from a base station to a mobile phone. The transfer rate from the base station to the mobile device reaches 3.6 Mbps. The reverse speed is much lower.

In Ukraine, the third generation network has a band of 1900-2100 MHz. CDMA (Code Division Multiply Access) is a code division multiple access technology that initiated standards for second-generation cdmaOne cellular communications and the further development of the third-generation CDMA2000 standard. A distinctive feature of these channels is the higher bandwidth, which reduces the density of base stations and, consequently, reduces the cost of services provided. The connection of the CDMA2000 standard is represented in Ukraine by several companies, of which PeopleNet can be mentioned. It has significant advantages over other operators due to rapidly growing national coverage and high quality services. Unlike GSM networks, the PeopleNet network is not so busy. There is a huge choice of equipment for work in GSM and CDMA networks, but the greatest interest is medical equipment that can be integrated. Such equipment usually has a long service life, open architecture and powerful software support. Built-in GSM equipment is presented on the market by many companies, such as Nokia, Sony Ericsson, Siemens, Wavecom, SimCom and others. Popular models include SimCom's low-cost SIM300 GSM modem and Wavecom's Q24 line, which has an open architecture. The situation with CDMA modules is a bit worse, because Qualcomm has a license for CDMA technology, and as a result, the choice of built-in modules is small. Among the most available are Wavecom's Q2438 and the AnyDATA model line. All of the above models have a built-in TCP / IP stack, which simplifies the integration of these modules into devices. And the fact that the GSMQ24 and CDMA2000 Q2438 lines have the same size and interface makes it possible to use these communication channels without changing the hardware of the devices with software updates.

WiMAX is a new fourth-generation 4G broadband data technology based on the IEEE802.16 standard and its IEEE802.16 substandards for out-of-line IEEE802.16e mobile transmission. This technology is designed for use in urban environments to connect local and regional networks. In other words, it provides wireless Internet access to the end user. However, there is the problem of equipment compatibility for different manufacturers, as well as the problem of incompatibility of stationary and mobile equipment. Currently, there is only one

operating WiMAX operator in Ukraine - the company "Ukrainian New Technologies" (TMAlternet), which forms a national WiMAX network at frequencies in the 3.6 GHz band. Coverage exists only in large cities - Kyiv, Kharkiv, Donetsk, Dnipropetrovsk, Odessa and Lviv. The speed, according to the company, is 4 Mbps in both directions. Local wireless data technologies. WiFi (Wireless Fidelity) is a wireless data transmission technology based on the IEEE802.11 standards, which is designed to build local area networks in whole or in part, in combination with wired Ethernet. Possible options for point-to-point operation or in infrastructure mode: at least one access point and at least one client. There are several varieties (IEEE802.11a, IEEE802.11b, IEEE802.11g), which differ in different baud rates. The transfer rate is from 11 Mbps to 108 Mbps with the possibility of reducing it to 1 Mbps, which is well suited for those cases where you can not lay a cable. Roaming is possible when using several access points.

BlueTooth is a wireless data technology designed to build personal communication channels. Used to work with devices such as laptops, PDAs, mobile phones, headphones and, in other words, is an alternative to a wired connection. Can work in a small network of up to 7 devices, but is mainly used for point-to-point connections. The operating frequency range is within 2.4 GHz. The maximum transfer rate is -720 kbps for the 1 specification and up to 2.1 Mbps in the 2 specification. Depending on the class of the device, the range is from 1 to 100 meters. In medical technology, it can be used to communicate devices with a personal computer or as an intermediate link in data transmission via mobile phone. In this class of devices the most successful are the modules of the National Semiconductor company, such as LMX9820, LMX9830, LMX9838. They are very small in size and relatively low cost for their functional characteristics. Of the services provided to the user, the most interesting is the serial port emulation service, which allows the user to see their device in the operating system as a COM port.

The main requirement for a computer system that defines the technology of solving problems using a PC and summarizes other requirements is the transformation of the machine into a convenient partner for the user in solving problems that arise in professional activities. The user-friendliness of the software product is generally more important than the performance of the PC. In this case, they must meet the following requirements: a) work in conditions of distortion, interference and errors of the user, resulting from the orientation of these tools on the mass user, who has minimal training; b) adaptation, due to the inexpediency of their focus on a narrow group of users; c) openness, due to the inability to anticipate all changes in the interests of users in the operation of these tools; d) independence from the inclusion in different configurations of specific computer systems. Thus, first, the means of the end user level are focused on adapting to those with different, including low qualifications. Secondly, the difference is that the end-user level tools must provide the whole process of solving the problem, starting with the emergence of its information needs. Third, the end-user level tools must provide a common solution to the problem in close cooperation with the PC.

It is almost impossible to personally build a computer system for each user, focused on meeting its requirements, so use two ways to solve this problem.

The first way is to create specialized systems focused on meeting the requirements of certain classes of users. Ensuring success in individual personal cases, this path does not provide a general solution to the problem.

The second way is aimed at creating basic computer tools focused on solving a wide range of tasks that adapt in one way or another to the specific requirements of individual user groups. The implementation of each of the intelligent functions is provided by an appropriate set of tools. The inclusion of the latter in the configuration of the corresponding computer system allows to provide an intelligent end-user interface for solving a certain class of problems. At the same time, the latter gets the opportunity to form a personal operating environment that best meets his professional needs and individual skills. This information processing technology, which covers the entire process of solving the problem (from the end user to some information needs to meet it) and involves the direct participation of the end user at all stages of the solution, makes qualitatively new requirements as a joint organization of the task, and to the functions of individual parts of the human-machine system (LMS).

This is due to the fact that in the traditional technology of solving the problem using a PC was reduced to the correct execution of the specified sequential steps of the instructions and a priori certain rules of transition from one sequence to another.

5. Basic information about popular approaches to modeling in biomechanics

The science of biomechanics studies the motor activity of living systems in all its manifestations. The object of biomechanics is the motor activity of living systems, and the subject - the laws of its use in various fields.

Given that biomechanics, as a science, arose at the junction of classical mechanics and biology, as well as dynamic anatomy, physiology, psychology and pedagogy, its development went in several parallel directions: mechanical, functional-anatomical and physiological.

The mechanical direction, begun by the works of Leonardo Da Vinci and D. Borelli (who in 1697 wrote a treatise "On the movements of animals"), develops the idea of changing the movements of living systems under the action of applied forces according to the laws of classical mechanics. Nowadays, the mechanical approach to the study of human movements, which allows to determine the quantitative measure of motor processes - one of the foundations of biomechanics, which will never lose its significance. Biomechanical schools in the USA, Germany, Poland, Spain, etc., including the Ukrainian one, pay great attention to the structure and properties of the human musculoskeletal system and its motor actions.

However, a purely mechanical approach to the study of human motor actions often leads to unjustified simplifications, which underestimate the specifics of living things, give a mechanistic explanation of hierarchically higher biological

and social forms of motion of matter by mechanical factors. Biomechanics is not an "applied to living" mechanic, as understood by some experts with technical or mathematical education, but an independent modern science that studies the mechanical laws of motion of living systems from the standpoint of a systems approach.

Functional-anatomical direction originated in the study of the structure of the human body in dynamics. Professor MF Ivanitsky and his student Professor MA Jafarov founded the Ukrainian School of Dynamic Anatomy, developed a theory of unity and interdependence of the form and function of a living organism, and for the first time introduced a special course in biomechanics (originally called dynamic) into the curriculum of the Lviv State Institute of Physical Culture. anatomy). The world-famous Russian anatomist PF Lesgaft, whose students consider themselves and these scientists, introduced a new approach to studying the anatomy of the human body under the influence of exercise, describing and analyzing movements in the joints, determining the participation of individual muscles in maintaining body position and its movements .. Since 1877, a special course "Theory of bodily movements" (later - "Theory of Movements") Lesgaft and his students read to students of physical education courses and students of the Institute of Physical Education.

Knowledge of the morphological features of biomechanical systems provides a serious justification for physical and technical training.

The physiological direction of the development of biomechanics was initiated by the ideas of nervousness, the doctrine of higher nervous activity and the latest achievements of neurophysiology. IM Sechenov, IP Pavlov, PK Anokhin, one of the founders of modern biomechanics MO Bernstein and others revealed the reflex nature of motor actions and mechanisms of nervous regulation in the interaction of the organism with the environment, and their study of regulatory mechanisms of the CNS, neuromuscular apparatus of man give an idea of the exceptional complexity and perfection of the processes of controlling its motor actions.

Today, the analysis of any exercise is based on the main principles of motor control: adaptation of control impulses during the motor task to specific conditions of its performance, elimination of deviations (corrections) from the chosen behavior, and the ring nature of control processes by analyzing sensory signals.

Only a systematic combination of advanced achievements of all these areas of development of modern biomechanics allows to correctly understand the essence of motor (motor) actions of living systems and actively improve them.

Stages of biomechanical analysis.

In order to evaluate individual movements, to compare them with each other, determine their biomechanical characteristics. There are biokinematic, biodynamic and energy characteristics of human body movements. They have different purposes: kinematic characterize the external picture of motor activity, dynamic carry information about the causes of changes in movement, energy give an idea of mechanical performance and efficiency.

The procedure of analysis of motor activity (biomechanical analysis) consists of the following stages:

1. Study of the external picture of motor activity. First of all, find out what motor actions it consists of and what is the sequence of these motor actions. For example, a school physical education lesson consists of a series of exercises. It should be borne in mind that the nature, duration and intensity of previous exercises affect the quality of the next.

Studying the external picture of motor activity, register biokinematic characteristics: distance and time reference systems; spatial characteristics (coordinates of a point, body, system of bodies, trajectories of points); temporal characteristics (moments of time, duration of movement, pace and rhythm of movements); spatio-temporal characteristics (velocity and acceleration of points and body).

It is especially important to know the duration of individual parts of the movement (phases), a graphical representation of which is a chronogram. The chronogram of motor action characterizes the technique (Fig. 2), and the chronogram of motor activity - the first thing to pay attention to when analyzing sports tactics.

2. Finding out the causes that cause and change movements. They are not available for visual inspection and for their analysis it is necessary to register biodynamic characteristics: inertial characteristics (body weight, moment of inertia); force characteristics (forces, moments of forces, momentum of force and momentum of moments of forces). The most important thing here is the magnitude of the forces acting on a person from the outside and created by his own muscles.

3. Determining the topography of working muscles. At this stage, it is determined which muscles and what is the mechanism of their participation in exercise. Knowing which muscles mainly provide the motor activity for which a person prepares himself, you can select from a variety of physical exercises those that promote the development of these muscles and their coordination.

Depending on what part of the total muscle mass is involved, there are: global muscle work (more than 2/3), regional (1/3 to 2/3) and local (less than 1/3). Yes, runners, swimmers, skiers do global muscle work. Regional includes, for example, muscular work performed during some general gymnastic exercises (pull-ups on the crossbar, lifting the legs and upper torso from a supine position, etc.).

You can get an idea of which muscles are involved in each exercise by recording their electrical activity. The more intensely the muscle works, the higher its electrical activity and the greater the amplitude of the electromyogram.

It is well known that different movements differ in kinematics and dynamics. Similarly, the electromyographic portrait of movements is different in different exercises. But, as RSPerson writes, "even rather difficult movements if they are automated enough (for example, walking and other locomotions, usual household, professional and sports movements), have more or less constant drawing of excitation of muscles not only at repetition of movement by one person, but also by different people ".

4. Determining energy expenditure and how energy is used for working muscles. To answer these questions, bioenergetic characteristics are recorded: the work of forces, power, mechanical energy of the body - kinetic and potential.

Along with the values of energy consumption, efficiency is important, the higher the share of useful energy consumption in relation to total energy consumption. It is estimated, for example, that 20% of highly qualified runners increase the efficiency of running by moving the runner in the list of the best from 10th to 1st place.

5. Identification of optimal motor modes (the best technique of motor actions and the best tactics of motor activity) is carried out at the final stage of biomechanical analysis. Here the degree of conformity of the optimum options of technics and tactics really takes place is estimated.

Optimal (from the Latin ortimus - the best) is the best option of all possible. In sports (and recently in health-improving physical culture) there is a constant search for the best options of equipment and tactics and to determine the degree of compliance of the motor mode, which is actually observed, optimal. This solves the problem of optimizing motor activity or its rationalization (if you can not achieve the ideal, but you can get closer to it).

Optimization is the choice of the best option from among the possible ones. But what is the best option for physical activity? There is no general answer to this question, because it all depends on the specific situation and the goal. Yes, a person fleeing from persecutors does not think about beauty and economy. The main thing is to run fast. Another thing, a gymnast who performs free exercises. She strives to move as best as possible, in accordance with the aesthetic canons of her sport. In these situations, people's goals are different. Therefore, the criteria of optimality are different, ie the indicators that are used to assess the degree of achievement of the goal.

The efficiency of motor activity is inversely proportional to the energy expended per unit of work performed or a meter of distance traveled. This is the most important criterion of optimality.

Mechanical productivity is higher the more work is done in a certain time or the faster this work is done.

6. The main components of the joints of the human body

The structure of the joints.

One of the most important properties of a living organism is movement in space. This function in mammals (and humans) is performed by the musculoskeletal system. ORA includes the bones of their joints and muscles. ORA is divided into two parts:

- Passive part - bones and their joints (w-16%, h-18%);

- The active part - muscles (w-38%, h-42 -%). All the bones of the human body and vertebrates are connected by various means in a harmonious system, which provides on the one hand a fairly high strength, and on the other hand creates significant mobility of the components of the joint. The science that studies bone connections is called arthrology. The nature of the connection depends on the structure and function of a particular link. A joint is a fixed joint of 2 or more bones with a slit-like cavity between them. Each joint has 4 obligatory structural elements (components): 1. At least two articular surfaces (facies articulares), which

are covered with hyaline cartilage and have: - articular fossa (fossa articularis); - the head of the joint; articular head (caput articulare). 2. Articular capsule (capsula articularis), which consists of: - fibrous membrane; fibrous layer (membrana fibrosa; stratum fibrosum); - synovial membrane; synovial layer (membrana synovialis; stratum synoviale), which has synovial folds (plicae synoviales) and synovial villi (villi synoviales). 3. Articular cavity (cavitas articularis), which may have: - articular nook (recessus articularis); - synovial vagina (vagina synovialis); - synovial sac (bursa synovialis). 4. Synovia (synovia) - synovial fluid that moistens the joint surfaces. It is produced by cells of the synovial layer. For the normal functioning of many joints, in addition to the basic elements, auxiliary formations are needed. Auxiliary elements of the joint: ligaments, intra-articular cartilage, menisci, synovial folds, synovial bags, articular lip, sesamoid bones.

Classification of joints.

Joints are structurally divided into: - simple joints (articulationes simplices), which consist of two articular surfaces (facies articulares); - complex joints (articulationes compositae) with more than two articular surfaces (facies articulares); - combined joints (articulationes combinatae), which are anatomically separated, but connected by a common function; - complex joints (articulationescomplexae), in the cavity of which there are articular discs (disci articulares) or articular menisci (menisci articulares), which divide the articular cavity (cavitas articularis) into two or more sections. Joints by functiondivided into: -axia joint; - biaxial joints; - multiaxial joints. Uniaxial joints in shape include: - cylindrical joints (articulationes cylindricae), in which movements occur around the longitudinal axis (axis longitudinalis); these joints are also called rotating joints (articulationes trochoideae); - block-like joints (ginglymi) and their variety - helical joints (articulationes cochleares). Biaxial joints include: - bifurcated joints (articulationes bicondylares); - elliptical joints (articulationes ellipsoideae) - saddle-shaped joints (articulationes sellares). To the triaxial joints; multiaxial joints include: - flat joints (articulationes planae), which can be immobile joints (amphiarthroses); - spherical joints (articulationes spheroideae); - cup-shaped joints (articulationes cotylicae). The greater the congruence (correspondence) of the joint surfaces, the smaller the amount of movement in such a joint. This is the basic law of the joint system (arthrosyndesmology).

Osteokinematics. Arthrokinematics.

Osteokinematics - the study of bone movements in space. To describe the movements in the joints in anatomy use three main axes: sagittal, frontal and vertical. The sagittal axis is directed from front to back, perpendicular to the frontal plane. Movements: reduction, removal, lateral inclinations. The frontal axis is drawn from left to right or right to left, perpendicular to the sagittal plane. Movements: flexion, extension.

The vertical axis is directed from top to bottom, perpendicular to the horizontal plane. Movements: external and internal rotation, supination, pronation. To describe the movement of bones consider 2 axes: longitudinal (along the bone) and mechanical (as if perpendicular to the articular surface of the bone). They may or may not match. Arthrokinematics - the study of the movement of articular

surfaces. There are three main components (components) of the movement of articular surfaces: torsion, sliding, rolling. Movement in the joint - a combination of 3 components. 4. Additional movements and joint play. Additional movements - passive movements that can be performed in a loose position. These include rotation, sliding, pulling. Stretching is a specific additional movement against the direction of force of the muscles passing through the joint. There are 3 stages of joint extraction: 1. Neutralization of pressure in the joint. 2. Separation of joint surfaces, removal of backlash in a joint bag. 3. Real stretching of soft tissue structures around the joint. If there are no additional movements, then the movement of the bones is impossible. The set of additional movements is called "joint play". Used - for the diagnosis and treatment of hypomobility.

Biomechanics of knee movements.

The main force factors acting on human bones without damage are the internal forces of muscle contraction and ligaments to perform biological functions (flexion, extension, chewing, fixation, etc.) in the process of human life, the force of gravity and inertia in interaction with external environment. Due to the functional efforts of the muscles of human biomechanical systems, the bodies of the limbs are set in motion. By the nature of the change over time, we can distinguish static (eg, slow flexion of the bones of the joints) and cyclic force loads of the human limbs [5]. The mechanical properties of joints are determined by their structure. The menisci of the knee joint are cartilaginous pads that act as shock absorbers in the joint, stabilize the kinematics of the knee joint and increase the congruence of the joint surfaces. At movements of bones in a knee joint menisci are deformed, their form changes. The function of articular cartilage is to reduce friction forces when moving in the joint, as well as to absorb shock loads. Their physical and mechanical characteristics show inhomogeneous, anisotropic, pore-elastic, viscoelastic properties that change over time and depend on tissue load and biological condition, such as hydration (hydration) and age (bone mineralization).

The knee joint is the most loaded and complex joint. The magnitude of the forces acting on the articular surfaces are large and depend on the type of activity and its intensity. The knee joint is able to withstand a load of up to 1 ton, it is "pressed" by its own body weight, and when performing movements (running, jumping, descending stairs) the axial stress increases many times [6]. When walking in the joint, efforts develop 2.67 times more than the weight of the human body, and when walking up the stairs, the force exceeds 3.51 times the body weight. With muscle damage, degradation of the contact surface of the bones of the joints, the effort can reach critical values that increase the localization of deformation and stress gradients of biological tissues (cartilage, bone).

Mechanical properties of structural elements of biomechanical system.

In real conditions, the structural elements of the BS are subjected to various power loads, and their modes vary from static (functional loads) to quasi-static (in the presence of compression plates of medical devices, orthodontic equipment, compression-distraction devices, etc.). Exceptions are shock loads. Bone tissue and materials of artificial origin in the biomechanical system at different rates of deformation behave differently. Under the functional loads of the biomechanical

system, which occur in second time intervals, there are dominant elastic properties. In BSs that exceed the minute time range of the force load, the mechanical characteristics are mainly related to the pronounced viscoelastic properties of the bones and the elastic properties of the medical device materials. The study of the mechanical properties of bone tissue is based on various tests of its homogeneous samples under load. Physico-mechanical characteristics and strength values of bones (cortical, spangiosis) and materials of artificial origin (limits of plasticity and fatigue for metals), which determine the biomechanical state of the structural elements of BS are partially established and published in the works. The material constants that determine the anisotropic elastic properties of bone tissue are most often established experimentally in the local directions of the axes of orthotropy of arbitrary volume for their cortical and spongy layer. According to literature sources Hall et al. (1973), Spears et al. (1993), Abe et al. (1996), known values of 3 modulus of elasticity, 3 modulus of shear, 3 coefficients of transverse deformation of human bone tissue. According to the results of static tensile tests of samples of a certain shape [16], scalar values of the limit of mechanical strength of bone layers are also known. Depending on the problems of the study of the biomechanical system, the viscoelastic properties of bone tissue can be represented by both a simple Maxwell computational model and a more complex Kelvin-Voigt, Ziner.

Mathematical model of stress-strain state and strength of biomechanical system.

The basic three-dimensional Euclidean space with different coordinate systems and classical time was chosen to describe the mechanical processes in the connected bodies. A fixed three-dimensional orthogonal Cartesian coordinate system was used as a basis in the observer's space. The terms "point" and "fraction" were used, meaning a material point, for example, C, and an infinitesimal volume of the material continuum ΩC of connected elements of deformed bodies occupying the region Ω bounded by the boundary surface Γ.

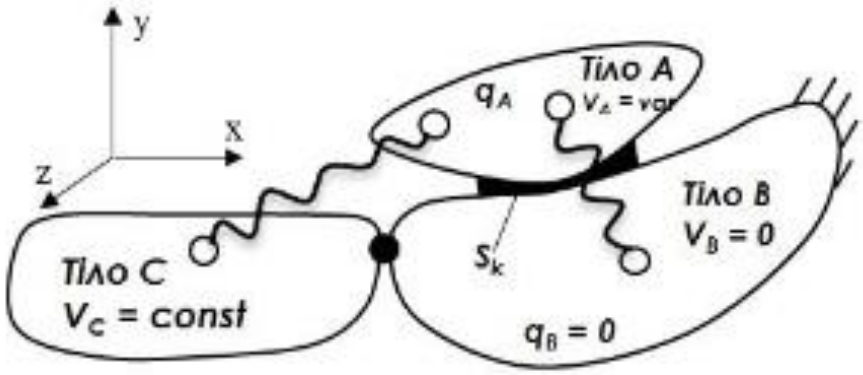


Figure 6.1 Simulation model of the biomechanical system of the human knee joint, as a system of contact moving (body A, C) and immobile (body B) solids (bones) with deformed bodies (cartilage) and having additional rigid connections (muscles)

The absolute position of the "point" of the moving volume of the body in the deformed state was determined by a vector

$$\mathrm{r} = \rho_0 + R + u\left(\overline{X}^i, t\right),$$

where ρ_0 – is the radius vector that determines the time t of the reference Ω_C^r; R – is the radius vector that determines the relative position of an arbitrary "point" of connected bodies in the undeformed state in the reference configuration Ω_C^r; $u\left(\overline{X}^i, t\right)$ - vector of moving the "point" from the reference Ω_C^r to the current Ω_C configuration. The velocity of the deformed medium in the current configuration Ω_C was presented as the geometric sum of three components: the velocities of translational (portable) υ^c and rotational motions ω^c, as well as the deformation velocity at the “point”. The absolute velocity of the particles is determined in the coordinate system with the base Cartesian basis vector.

$$\upsilon = \frac{dr}{dt} = \upsilon^c + \omega^c \times r + \frac{du}{dt}.$$

The spatial velocity gradient υ in the current configuration Ω_C is represented as the sum of symmetric and obliquely symmetric parts

$$\nabla\upsilon = \left(\nabla\upsilon\right)_s + \left(\nabla\upsilon\right)_a = d + \omega.$$

The symmetric part d determines the Euler deformation velocity tensor (“velocity deformation tensor”), and the obliquely symmetric part w is the vortex tensor. Depending on the adopted coordinate system, the Lagrangian (convective) or Euler components of the stress tensor can be attributed to the undeformed state of the medium in the current Ω_C or in the reference Ω_C^r configurations. To describe the rate of change of stresses in the case of small deformations and finite values of rotation of the particles of the medium used the Jowmann-Noll corotation derivative

$$\sigma = \frac{d\sigma}{dt} + \sigma \cdot \omega - \omega \cdot \sigma.$$

The equation of momentum balance of the material continuum, provided that the density of biological materials does not change, was used as

$$p\upsilon = \nabla \cdot \sigma + f$$

where f is the density of mass forces.

For the adopted model of a viscoelastic isotropic material, the volume characteristics were neglected by relaxation, and the values for the shear relaxation function were approximated by a set of exponents with negative degrees. The choice of such an approximation is equivalent to modeling a viscoelastic medium with a generalized Maxwell model.

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