

Lecture 15. New technologies for system design and analysis

The purpose of the lecture: a meaningful introduction to a number of new information technologies most important for system analysis and modeling, to the main trends in the development of new information technologies.

Lecture plan:

Introduction

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Keywords: software, information technology, TV, new information technology, high technology, cost, core, network, hub, router, program, word, works, information, cognitive technology, instrumental technology, applied technology, communication technology, division, applied, cognitive, instrumental, communicative, computer modeling, hypermedia, simulation, mathematical modeling, DB, DBMS, subject area, databases, order relation, rubricator, search, software, interactive services, local modes, DBMS, dbm, database manager, system, interface, query, sorting, database query language, database, data mining, data warehouse, analysis, Data Mining, trend, cluster analysis, taxonomy, identification, knowledge base, ES, access, operations, expert system , email, reverse transform, teleconference, messaging, basic, telecommunications network, user, AC, AWP, human-machine system, intelligent system, efficient management, minimization, information systems, command language, menu, database administrator, network graph, statistics, statistical hypothesis, banking system, technical support, client-server, Unix , consolidation, OLTP, transaction processing, automation, computer, office, computer office, activity, control, programming language, Visual Basic,

VBA, powerpoint, assistant, graph, Chart, equation editor, gallery, recognition system, payment order, working group , identifier, computer, place, information exchange, operating system, Windows, network, mail, server, processor, file system, peer-to-peer, P2P, RFP, communication, assembly, knowledge base, programming, integration, animation, module , hypertext, hypertext, multimedia, multimedia, hypermedia, sound, blaster, CD-ROM, WWW, Web, web, Internet, link, address, transfer, protocol, graphics, site, URL, uniform, resource, locator, browser, HTML, markup, language, ASCII, GIF, JPEG, Grid, queue, architecture, neurotechnology, artificial intelligence, parallelism, self-learning, recognition, diagnostics, forecast accuracy, index, neural network, adequacy, virtual office , virtual corporation, virtual, virtual, corporation, reaction time, object, model, email, mail, decision making, CAD, cycle, view, visual, script, reengineering, performance, class, encapsulation, inheritance, polymorphism, data flows, aggregation , generalization, profit, message recipient, Java, java programming language, Internet, OaK, SUN, component, compilation, compilation, environment-oriented technology, toolkit, frame, TCP / IP, CORBA, OMG, Ada, python, infrastructure, level abstraction, display, transaction management, Object, transaction, service, CASE technologies, architecture, deployment, information, graphics editor, graphical environment, technology, computer notional algebra, transformation of formulas, differentiation, reduce, algebraic, finite, function,, knowledge engineering, precision, ESPRIT, systems analysis.

Contents of the lecture:

Introduction

Review and classification of new information technologies, the most relevant for the analysis and modeling of systems, examples, trends in technology development.

The process of extracting (receiving) information is built on the basis of ordered sequential actions to collect, accumulate, reflect, transform, and update data; such processes in informatics are called information technologies, and their main elements are technical means and devices, for example, in a telegraph - a teletype device, in television - a television set, etc.

New information technologies are information technologies based on new, infological and computer means of obtaining, storing, updating information and knowledge.

High technologies are technologies for a qualitative change in the composition, nature, methods of problems being solved, technologies of evolution, not functioning.

Example. Conventional ("old") computing technology sets the main goal - to find a solution to a problem in an acceptable time and cost. The new technology of using mathematical computer packages sets a new goal - to find a solution quickly, accurately and economically. The high technology of distributed, quantum computing sets a goal - to find a solution to a problem that cannot be solved (difficult to solve) with conventional technologies.

In the narrow sense, new information technology is the use of computers and communication systems for the creation, collection, transmission, storage, processing of information; she is part of the information business.

Any technology is based on scientific and theoretical, engineering and technical, software. By itself, this core does not yet constitute a technology. For this, it must be integrated and supported by networked space-time, organizational-human connections and relationships. There must be a system, a technology relations support network (TSN).

Example. TSN of distance learning system consists of infrastructure - computer networks, protocols of their interaction, etc. A hub (router) is an element of this system, but it is controlled by its software (for example, a switching program), its electrical software. The hub itself is not a technology. The Word program is not a technology in itself (although it is often called a technology for preparing and editing documents), but an element of a technology defined as MS Office - a technology for automated, computerized office work, automation of office work.

Traditional (classical) information technology, as a rule, is built on the basis of well-formalized, structured intellectual procedures. New information technology, as a rule, is built on the basis of poorly formalized and structured intellectual procedures.

Civilization is possible only if there is information, information flows and exchanges in society.

Information makes nations humanity.

At first, information technologies were used, due to their complexity, uniqueness and high cost, only in scientific centers and large industrial companies. As it improved, spread and became cheaper, information technologies penetrated into various industries and began to develop them and develop themselves, which led to the development of the needs of society.

New information technologies are of the following basic types:

- ✓ *cognitive technologies, mainly aimed at obtaining, storing and updating knowledge, making intelligent decisions;*
- ✓ *instrumental technologies, mainly aimed at using as tools, an environment for building other technologies and for servicing them;*
- ✓ *applied technologies aimed mostly at solving problems of a certain problem area (or areas);*
- ✓ *communication technologies, mainly aimed at solving communication problems, communications, communication.*

Note that such a division is very conditional, and the technology can be successfully applied, and cognitive, and instrumental, and communicative.

Example. This is, for example, the technology of computer modeling, hypermedia.

It is possible to divide (also conditional) information technologies according to the scope of use, for example:

- ✓ *information technology in science;*
- ✓ *information technology in education;*
- ✓ *information technology in design and production;*

- ✓ *information technology in management;*
- ✓ *information technology in the service sector;*
- ✓ *information technology in the field of everyday life.*

It is also possible to conditionally divide all new technologies into two groups – technologies of corporate work and technologies of individual work.

Let us consider new information technologies, limiting ourselves to a meaningful simple overview of them, taking into account the fact that the most important information technologies for the analysis and synthesis of systems - mathematical and computer simulation, have already been considered by us above. We only note that mathematical modeling is an "old" information technology, in contrast to computer modeling, which is a new technology.

1 Database technology

Technology of databases (DB) and database management systems (DBMS). DB - rather large sets of structured data of a certain subject area, presented on machine media and having a common and convenient structure, unified organizational, methodological, software, hardware and language means for ensuring the use of data by various user programs. Depending on the method and technology of data presentation, there are hierarchical, network or relational databases, tabular or paged. In any database, an order (order relation) is set on a set of records (record fields), for example, by key fields, the contents of which are numbered, lexicographically ordered. There can be several such fields, and when sorting (selecting, modifying) the data, records are searched for first by one key, then by another, etc., until the required fields match or mismatch. The rest of the fields are not compared. This process is called sorting or searching, comparison by key (s). In addition to searching by key, you can also search by value, iterating over all database records, but this process is more time-consuming and often requires building additional auxiliary index tables to store the values of the records that match the search pattern (if any).

Recently, remote database technology has been spreading. It is based on the collective access of users to information resources concentrated on a single computer, or host computer, in an interactive mode over data transmission networks. Information products here are databases of different subject areas, as well as various directories, rubrics and other data that make it easier for the user to search through the database. Information services are provided due to the presence of a variety of means of searching, processing and issuing information. Information products and software are the main elements of data banks or automated data banks (ADB) - the main organizational form in which modern technologies for the commercial dissemination of information develop. The main features of this technology that determine its advantages and disadvantages are:

- ✓ *providing the user with information services only, and not directly information products, as a result of which he receives (pays for) only really necessary information;*
- ✓ *completeness of information associated with loading large amounts of data on powerful host computers;*

- ✓ *high speed of updating, modifying and moving information;*
- ✓ *developed software that allows not only to find and receive information, but also, if necessary, to carry out its graphic, scientometric and econometric processing.*

Interactive DBA services can be provided in the following modes:

- ✓ *local, when the user is working from a terminal connected to the host computer;*
- ✓ *remote, when the user is working from a terminal physically remote from the host computer over communication networks.*

Example. The library's readers work in the local mode, searching in the ADB, which is located at its computing center, from terminals throughout the library. Remotely, you can work, for example, with the Library of Congress.

DBMS (DBMS – DataBase Management System) is a software system that provides communication (interface) between user programs and data from the database. This communication takes place in a special non-procedural language of logical representations of data and data structures; the data themselves are also described by means of a special data presentation language, while user programs can be written in a programming language. The DBMS should have the means to formulate a query to the DB (search, sorting, etc.) in a language close to natural and understandable for the user, but at the same time formal, implemented in a computer language. These languages are called database query languages and are non-procedural languages.

The main functions of the DBMS:

- ✓ *data management in external memory – providing the necessary external memory structures for storing and manipulating data;*
- ✓ *management of buffer areas of memory – ensuring copying of the necessary part of the database in the area (buffer) of RAM, as well as the use of certain rules for manipulating buffers;*
- ✓ *transaction management, i.e. sequences of operations on the database, considered by the DBMS as one macro operation; each transaction does not change the database, and therefore, various transactions can be performed, i.e. organize multi-user work with the database through the DBMS, including parallel;*
- ✓ *maintaining the reliability of data storage in the database through data redundancy and the log (part of the database that is inaccessible to DBMS users and is carefully copied; records of all database changes are received into it) in order to save data in case of hardware or program failures;*
- ✓ *support for database languages (languages for defining the logical structure of a database, data manipulation languages) or a single integrated language containing the necessary tools for work – from designing a database to providing a basic user interface with a database.*

Example. The traffic police database of all vehicle owners, from which, at the request of the traffic police, you can quickly extract, for example, data on the owner of the car by its state registration number.

2. Data warehouse technologies

Technologies of data warehousing and data mining. A data warehouse is a very large specialized database and software system designed for extracting, correcting (cleaning, editing) and loading data from sources into a database with a multidimensional structure, including means of simplifying access, analysis in order to make a decision. Data Mining - automatic search for hidden ("not lying on the surface") relationships and connections in large databases using mathematical and infological analysis, highlighting trends, clustering (cluster analysis), classification and recognition (taxonomy), scaling etc. Special models and analysis algorithms extract knowledge from large databases (or from other data stores, for example, spreadsheets) that allows you to aggregate, integrate and detail this data and, most importantly, make decisions based on it. This is, in essence, the identification of the dependencies hidden in them.

Example. Data warehouses collect and centralize current information about the state of affairs of the corporation, about its services, customers, suppliers, and provide analytical and reporting tools. By analyzing the financial statements of firms, it is possible to divide them into classes according to financial stability, according to the likelihood of bankruptcy, which will help the creditor bank to implement their lending policy more efficiently. Intelligent analysis of data in geographic information systems can help to detect and visualize areas of the earth's crust with oil, gas, earthquake-prone deposits. In business, such analysis can be carried out to assess customer reliability, identify fraud, interactive marketing, trend analysis, etc. for Business Intelligence.

3. Knowledge base technology

Technology of knowledge bases (KB) and expert systems (ES). Knowledge base is the accumulation, structuring and storage of knowledge, information from various fields by means of a computer in such an organized way that one can have access to this knowledge, expand it, obtain, output new knowledge, etc.

Example. Knowledge base on surgical operations of the abdominal cavity, from which a young and inexperienced surgeon in an emergency surgical situation can extract the necessary information about the operation; the knowledge base itself was developed on the basis of the knowledge of highly professional and experienced surgeons.

ES – the accumulation of experience, knowledge, skills, high-level skills of professional experts, structuring and storage, updating with the help of a computer in order to obtain expert judgments on various problems in this area.

Example. An example of ES "Surgeon" can be an expert system built on the basis of the above KB example. KB and ES are closely related. An example of another ES can be the "Customs" system, which makes it possible to analyze documents on financial transactions, find and issue suspicious facts, investigate their connections and make recommendations to financial inspectors.

4. Email technology

Technology of electronic mail and telecommunication access to information remote from the user, information carrier, interlocutor - a person or a computer. E-mail is a system of sending messages using the sender's computer and receiving them using the recipient's computer. In this case, the sender's message is converted from digital codes, for example, by means of a modem, into codes of electromagnetic waves transmitted through telephone channels, and the addressee's computer performs the reverse transformation. Development of communication networks - virtual local area networks that unite users not according to the territorial principle, but according to professional interests. Teleconference is an exchange of messages (reports) between participants (subscribers) of a conference announced on a special bulletin board in the network, in particular, on an electronic bulletin board. A teleconference is a software-based technology for interactive access to network resources and is intended to discuss any topic. With the help of teleconferencing, you can conduct consulting, training, meeting, office automation, etc. The basic videoconferencing system usually includes: a powerful work multimedia station; a video camera and a special board for compressing video information; microphone and video recorder; means of interface with the network used for the conference. Teleconferences can be conducted both in the mode of exchange of letters by e-mail (mode of postal connection), and in the mode of terminal interactive connection through telecommunication networks. In terminal connection mode, the user can have access (subscription) to the whole teleconferencing system, but, unlike the mail connection mode, it is possible to connect to the announced conference directly on the network using special programs that control the users' work with teleconferences. These programs allow you to perform the following manipulations: find a conference; subscribe to the conference (register); go to the conference; send a response (report); get a response (report); close subscription and others.

Example. Consider medical video conferencing (one of the most compelling and powerful socio-economic examples of teleconferencing). Large hospitals and clinics now have modern medical equipment - tomographs, echocardiographs, etc., as well as sufficiently highly qualified medical personnel, with the help of which, in a video dialogue (conference) mode, doctors from regional (up to district) medical institutions can discuss the results of a patient's diagnosis, diagnosis, methods and treatment strategies. The problem of "bringing these funds and personnel closer" is especially urgent for our country, with its large territory. The main areas of use of medical teleconferences:

- ✓ *primary counseling of preoperative patients and clarification of the preliminary diagnosis, analysis of the examination;*
- ✓ *postoperative consultation and observation of patients;*
- ✓ *urgent consultations of patients in critical situations;*
- ✓ *councils and consultations, exchange of opinions of doctors.*

Medical videoconference technology:

- ✓ *coordination of the time of the video conference (communication session);*
- ✓ *preparation of patient information (files of records from case histories, static data, for example, radiographs, echocardiograms, etc., and dynamic, for example, video recording of operations and analysis results);*

- ✓ *preliminary data transmission by e-mail;*
- ✓ *discussion in the video dialogue mode of information about the patient and the diagnosis;*
- ✓ *making a decision, as well as documenting the results of the discussion.*

At the Scientific Center for Cardiovascular Surgery named after A.N. Bakulev RAMS conducted many scheduled and emergency video consultations. The economic and socio-medical benefits from such videoconferences are 6-10 times higher than from the classical technology of consultations with a visit to the clinic (which is sometimes impossible).

5. Technology of automated systems

Technology (use) of automated systems (AS) and automated workstations (AWS). AS is a man-machine system for the execution of daily, often routine, professionally performed work at the employee's workplace - in order to reduce the time spent, reduce the number of errors and ensure prompt communication with other employees; intelligent systems also have the ability to restructure the technological chain, they are also capable of learning.

Various systemic goals of automation are possible (depending on the type of organization, structure): effective management of flows of material, labor, information, energy resources, increasing social, economic and technical indicators of the system and other systems (for control systems); minimizing the risk of non-fulfillment of plans and maximizing the quality of decisions made, increasing competitiveness, profitability (for production systems); obtaining new knowledge, increasing the prestige in the field of innovation, expanding the scope of the research results, creating know-how, ensuring economic efficiency (for research organizations); minimizing the risk of non-fulfillment of an order or services, increasing competitiveness, increasing the economic efficiency of functioning (for service organizations); increasing the prestige, improving the educational process, the transition to new forms of education, to distance education (for educational organizations).

In recent years, the concept of corporate and distributed systems in the national economy has spread, in which local information systems are widely used. To implement the idea of distributed control, it is necessary to create automated workstations based on professional computers (workstations).

AWP is a subject-oriented instrumental speaker installed directly at the workplace of a specialist and designed to automate professional activities (an employee sitting at this desk). They can be defined as automated systems of a local nature, corresponding to a certain functional purpose. Despite the different nature of the tasks solved with the help of AWP, the principles of creating any AWS should be general:

- ✓ *consistency, firstly, the approach to design and solving problems and, secondly, the ability to work as part of a network, system;*
- ✓ *flexibility, adaptability, adaptability to changing tasks;*
- ✓ *stability, reliability in operation, recoverability in case of failures;*
- ✓ *efficiency (in terms of costs, increasing labor productivity);*

- ✓ *responsiveness - minimum time for each step of the dialogue with the user;*
- ✓ *completeness of functions performed, professional tasks solved;*
- ✓ *interactivity - the ability to intervene in the dialogue, choose the next step of the dialogue, for example, in the form of commands in a special command language, in the form of selecting objects, in the form of a "menu", in a mixed form;*
- ✓ *functionality, user-friendliness, ergonomics and usability, in particular oriented towards the layperson in the field of computer training*
- ✓ *and etc.*

The AWP user interface is often organized using the concept of a desktop on a screen. The screen is divided into three parts (three objects). The first (usually the top) is the menu bar, which is used to access other objects. The second part (usually the bottom part) is called the status bar, and can be used to quickly call up the most used objects or display important current information. The third part (main, middle part of the screen) is called the working surface (table surface), with its help all objects called from the menu or from the status bar are displayed. This form of organizing the dialogue between man and machine is the most convenient, and many programs use it. Workstation software is a part of instrumental software.

Example. The workstation of the assistant secretary should include a text editor, a spreadsheet, translators, an organizer, etc. The workstation of a student-economist should have electronic textbooks on the disciplines studied, training programs and environments, electronic reference books and encyclopedias, translators, an organizer, etc. must be equipped with a DBMS, an electronic logbook of the administrator, etc. The manager's workstation must have means of describing management activities in the form of a network schedule, an execution control system, a document approval system, an electronic signature system, a meeting system, etc. include information and reference databases and materials, tools for its maintenance and support, tools for analyzing statistical data for the rapid preparation of reports, references and reports, in particular, for analyzing time series and testing statistical hypotheses. The automated workplace of a bank employee and banking systems are the most developed systems. They contain software and hardware both for special purposes (for example, for banking settlements and transactions with ATMs) and for ensuring the security of such systems. Banking systems use local area networks, specialized business servers, general-purpose computers, client-server technology and, often, UNIX OS, interconnection of several local networks, inter-network exchange and remote access of bank branches to the resources of the bank's central office for making electronic payments, transactions. Banking systems must have the means to adapt to specific operating conditions. To support the operational work of the bank, the banking system must function in real time OLTP (On-Line Transaction Processing). Their main functions:

- ✓ *automation of all daily intrabank transactions, accounting and preparation of consolidated reports;*
- ✓ *ensuring connections with branches and departments;*
- ✓ *automated interaction with clients ("bank-client" system);*

- ✓ *analysis of the bank's activities and the choice of optimal solutions in this situation;*
- ✓ *automation of retail operations - the use of ATMs and credit cards;*
- ✓ *interbank settlements;*
- ✓ *automation of the bank's activities in the securities market (monitoring of rates, volumes of transactions, etc.);*
- ✓ *prompt information support of the bank's financial and credit policy.*

It should be noted that the automation of an institution, an organization consists not only in providing the workstation employees with a local network, e-mail, etc., but also in creating a new technology for collaboration and management in order to efficiently work for the entire institution. This is a kind of information, economic (corporate) culture of collaboration, use (actualization) of professional knowledge, skills and innovations. At the same time, the knowledge of each employee can be updated by other employees, discussed (voted on) and applied by them.

6. Computer office technology

Technologies of computer (computerized) office teamwork in the office. Computer office - an office that has a high level of computerization, the implementation of AWP, office work systems, so that all professional activities of the office can be successfully automated.

Example. A computer office is, for example, an office where work is carried out using local communication networks and the Microsoft Office integrated software environment, which includes all the main software packages for performing typical and regularly performed operations, office work, in particular, office management, execution control, etc. Microsoft Office has a built-in simple programming language – Visual Basic for Applications (VBA). This language allows you to create new applications or correct and link old ones that run in the Microsoft Office environment, as well as expand the capabilities of the office, its used applications. The standard Microsoft Office core includes:

- ✓ *Microsoft Word text editor (editor functions - typing, naming and saving text, modifying, renaming and moving text or its individual fragments, inserting various formulas, graphs, tables, diagrams, etc.);*
- ✓ *Excel spreadsheet (functions – processing, storage and modification in arbitrary tables of numbers, rows, columns, formulas, according to which numbers, rows and columns are dynamically changed);*
- ✓ *system for presentations (presentation package) PowerPoint (functions - creation and projection on a large screen of electronic presentations, slide shows, bright films for a projector, handouts);*
- ✓ *database management system Access (relational DBMS, accessible to any user and allowing you to quickly and efficiently organize, analyze, move, search, etc. for large amounts of information, without duplicating information in them), for example, according to database creation templates: Address Book - creates a database of the address book type, Library - creates a*

database of the library type, Contacts – creates a database of the contact links type, etc.

More advanced versions of Microsoft Office, in addition to the above standard applications, have the following applications:

- ✓ *Office Assistant - Help Assistant;*
- ✓ *HTML and Web support (Internet Assistants);*
- ✓ *various helper programs (Graph – graphical presentation of data, Organization Chart - the creator of the office staffing table, Equation Editor - the formula editor, WordArt – the creator of logos, headers, ClipArt Gallery - for viewing pictures), etc.*

Microsoft Office includes, and its further modifications will include, the ability to simultaneously display presentations over a local network, use the capabilities of the speech recognition system, visual development environments for various office applications (for example, filling out payment orders), workgroup sites, visualization systems data, scanning and data entry system, etc.

"Working group" technology is a technology of joint work of several computers ("working group") interconnected by common information resources, united to solve a common problem.

Example. Types of working groups: "Directorate", "Accounting", "Office". An organization's computer network can unite several workgroups. Each computer in a workgroup has an identifier, a name in the group, for example, the full name of the person working on it. In the working group "Accounting" there may be a computer (workstation) "Chief accountant" or "Ivanov Sergey Nikolaevich".

A working group can also be temporary - to work on a specific project within a certain period of time.

Example. You can organize a working group "Presentation of the company", which consists of computers of employees of the company, preparing a presentation of their company, or "Annual report" - to prepare the annual financial statements of the company. All of these people may work in different departments, but they make up a temporary team so that it is easy to share information while working on the report.

Information exchange can also take place between working groups. To do this, you do not need to physically move computers: to form a workgroup, you just need to assign a name to all the computers in the group.

Example. The Windows for Workgroups operating system allows computers to be assigned to workgroups during installation. You can then change the composition and structure of a workgroup from the Control Panel by running the Network application. At the same time, all computers on the same network, regardless of their grouping into workgroups, have access to shared printers and shared files, and applications such as Mail (E-mail), Shedule + (Diary) work only within one workgroup. Mail transfer via Mail is only possible within the same workgroup. As a rule, small firms have one working group.

Technology (interaction model) "Client-server" is a technology of interaction between computers in a network, in which each of the computers has its own working purpose. One, more powerful computer (server) on the network owns and

disposes of information and hardware resources (processor, file system, mail service, database, etc.), another, less powerful ("client"), has access to these resources only through the server.

This principle also applies to the interaction of programs and information environments. The program (environment) that performs the provision of the corresponding set of services is the "server", and the program (environment) that uses these services is the "client". The technology of the traditional client-server model is being modernized and improved.

Example. Now they are talking about a fundamentally different concept of interaction between elements of a peer-to-peer (P2P) network, which allows individual computers to work with each other directly.

7. Technologies of using integrated software packages

Technologies for using integrated software packages (PPP) – technologies based on specially organized software complexes for solving various classes of the same type and frequently encountered tasks from various types of subject areas. Modern PPPs have interactive, interactive feedback with the user in the process of setting the problem, solving and analyzing the results. When solving problems, an interface usually used in the subject area is used. The "intelligence" of the PPP is the ability to formulate a problem meaningfully without specifying an algorithm for its solution. The construction of the solution algorithm and the assembly of the target program are performed automatically and hidden from the user. Subject support of PPP – a knowledge base about methods, algorithms for solving a problem and about the problems themselves. Programming is carried out in terms of the subject area, the computer is used already at the stage of setting the problem, solving problems by automatically building a chain of programs, in the course of accumulating knowledge about the problem being solved, i.e. possibly replenishment of the knowledge base of the RFP. Instrumental RFPs are used, which speed up and simplify the RFP creation process and reduce its cost. This method is characterized by high integration: the content of the RFP itself consists of the RFP for various purposes.

Example. As an example of an integrated PPP, we will give the MathCAD package, designed for both complex mathematical calculations and for simple ones (in the mode of an engineering calculator).

8. Technologies of computer graphics and visualization

Technologies of computer graphics and visualization – technologies based on systems of drawing and drawing various graphic objects and images using computers and drawing devices (for example, plotters), as well as their visual, visual presentation. It should be especially noted the means of animation - "animating" images on the screen, i.e. methods and means of creating dynamic images, in other words – computer cartoons.

Example. An example of computer graphics tools is a software package for the image of spatial objects and their dynamic updating - the "3D-Studio" package. This package allows not only to create three-dimensional scenes, but also to use

them in the implementation of computer animation situations (cartoons) using various graphic files of different formats, which makes it possible to use well-known graphic packages when developing cartoons: CorelDraw, PhotoPaint, etc. 3D-Studio has modular structure, consisting of five modules, each of which is assigned tasks of a specific type, solved in a strict sequence. The first module (2D-Shaper) is the main tool for creating and editing flat shapes, as well as supplying other modules with special geometric structures, shapes and paths. For transforming flat figures into three-dimensional wireframe objects, the 3D-Lofter module is available, which includes powerful tools for generating complex spatial shapes and structures. Prepared two-dimensional plans of models are displayed ("extruded") into the third dimension along specially defined trajectories. The 3D-Lofter module is equipped with deformation tools, for example, along the axes, which allows you to create three-dimensional objects of more complex shapes. You can construct a 3D shape from three projections onto coordinate planes.

Modern technologies of 3D graphic modeling allow you to build full three-dimensional objects from their sketches.

Example. The LightWave Modeler software environment allows, using the appropriate graphic primitives, to form a graphic character that can be easily animated at the request (scale, direction, color, etc.) of the user.

9. Hypertext technologies.

Hypertext (Hypertext – "supertext, supratext".) – This technology is based on means of processing large, deeply nested, structured, semantically and conceptually related texts, information that are organized in the form of fragments (text) that refer to the same system objects located at the vertices of a network and usually highlighted in color; they make it possible, in machine implementation, quickly, by pressing several keys, to call and place specified fragments of hypertext in the desired place of the viewed or organized new text, i.e. texts "tied" to highlighted keywords or phrases; hypertext technology allows you to determine and select the option of updating the information of the hypertext depending on the information needs of the user and his capabilities, the level of training, i.e. does not rigidly and in advance define dialogue scenarios. When working with a hypertext system, the user can view documents (pages of text) in the order in which he likes it best, and not sequentially, as is customary when reading books, i.e. hypertext is a non-linear structure. This is achieved by creating a special mechanism for linking different pages of text using hypertext links, i.e. In addition to linear links of ordinary text of the "text-predecessor - text-successor" type, hypertext can have as many other dynamic links associated with the document as a whole or only with its individual fragments; contextual links.

Example. Examples of hypertext include electronic journals.

10. Tools and systems of multimedia

Means and systems of multimedia (multimedia) and hypermedia (hypermedia). Media - "medium or medium". Multimedia, multimedia - actualization of various environments and senses of perception of information:

means of sound, animation - animation, graphical and visual presentation of input and output data of a problem and solution scenarios or even the solution itself.

Example. Examples of multimedia tools are sound cards (Sound Blaster) for generating a wide range of sounds on a computer, active speakers for their transmission, and CD-ROM readers that allow reading large amounts of information, for example, some complex and lengthy music track and then play it using the previous two media.

Hypermedia means – means based on the synthesis of the concept of hypertext and multimedia, i.e. hypertext fragments can be "embedded" with multimedia support, multimedia applications: hypermedia = hypertext + multimedia.

Example. The global hypermedia system is WWW (World Wide Web – "World Wide Web") – a system of navigation, search and access to hypertext and multimedia Internet resources in real time. It can be considered global because, unlike ordinary (local) hypertext, a link to a document in it (carried out by one or more mouse clicks) can lead not only to another document (as in local hypertext), but also to another computer (WWW server), possibly in another hemisphere. The work is carried out using a universal client program, which allows you to combine the client and the server into a single whole. To access a WWW server (information on it), you need to know the server address, for example, the address <http://www.mark-itt.ru> - a server with a list of Russian WWW servers, http (HyperText Transfer Protocol) - a protocol for working with hypertext ... There is an automatic search system for certain keys (queries, sections). Information on the WWW is presented in the form of a hypertext document, including various types of data (text, graphics, video, audio, links to other hypertext documents, etc.). Such documents are called WWW-pages. These pages are viewed using browsers, special programs for navigating the web. Pages are stored on host computers called sites. Each computer has its own unique IP address (Uniform Resource Locator) that tells the browser where the information is and what to do with it. The page is the main element of the WWW. They contain the information that we are looking for on the network, or links to this information. Pages, Hypertext is an easy and quick to use, extremely powerful system of related keywords and phrases (links), allowing you to link to other keywords and phrases on other pages. These links are usually highlighted in a different color, and you just need to click on the highlighted link to go to the information that the link refers to. To create hypertext applications (for example, a personal WWW-page), a special language HTML (HyperText Markup Language) is used, which allows you to create a hypertext document in any text editor in ASCII format, with the connection of graphic files of the two main formats GIF, JPEG.

According to some researchers, the next form of collective coexistence of computers after the Web will be the Grid, which will give users more opportunities to work with remote machines. If the World Wide Web can be compared to an analog telephone network capable of transmitting text, audio and video, the Grid is like a modern electricity system, providing consumers with as much resources as they need. Work is currently underway at CERN to define standards for the Grid. Just like the WWW, the new concept, first of all, will be in demand in research circles.

Scientists using the Grid will gain access to the resources necessary to solve their problems. The Grid architecture is three-layered: the interface, the application layer, and the Grid operating system, which allows users to connect to distributed resources.

11. Neuro-mathematical and neuro-information technologies

Neuro-mathematical and neuro-information technologies and networks. Neurotechnologies – technologies based on models, methods, algorithms, programs that simulate, simulate neural networks and processes for solving artificial intelligence problems; allow you to effectively implement parallelism, self-learning, recognition and classification, adaptability, restructuring, topology.

Example. Personal identification in criminology; selection of control actions in complex systems; geological exploration; diagnostics in seismology. The VNS-736 neural system, for example, allows processing (recognizing) images with a size of 512×512 elements.

Example. One of the most widespread foreign neurosystems is the Brain Maker package. Let it be necessary to solve the problem of forecasting the closing price in today's trading for three-month currency thousand-dollar three-month futures contracts. Let us be satisfied with the accuracy of the forecast, at which the price trend (rise, fall) and the price change are correctly indicated with an accuracy of at least 90% of the last jump. The application of the neural network begins with the preparation of the input data: the dollar rate, inflation index, interbank rate, stock indices, trading volume, number of transactions, maximum and minimum prices, etc. After preliminary network configuration, an iterative learning process begins, as a result of which the neural network adjusts its logical structure for the exact reaction of the market to certain influences. To do this, the Brain Maker package provides a powerful analytical block that allows you to see which parameters have a positive effect on the situation, and which ones have a negative impact. Then the network is trained again and further tested for quality and adequacy, and after successful testing is used for predictions. For ten exchange days, the network has never made a mistake in the sign of the deviation of futures quotes, and nine days out of ten, the deviation of the forecast from the real price was less than 10 rubles. BrainMaker is the program that started the history of using neural networks in Russia. This package implements a classic multilayer neural network at a professional level. This is the only program that has the ability to configure all parameters of neural networks and learning algorithms. Recently, BrainMaker is most often used not as a standalone program, but as an add-on to TradeStation for real-time analysis. NeuroShell, although it is a universal program, but due to the fact that it was the first Russified neural network program with a user-friendly interface, it managed to gain wide acceptance in the Russian market. To solve financial problems, NeuroShell has a market indicators module that allows you to use more than 20 technical analysis indicators when working with a neural network.

Example. The well-known family of Russian programs NeuroScalp is built on a modular basis. The basic module is a classic technical analysis module, which integrates additional modules that implement various methods of analyzing financial

markets. The following additional modules are currently available: "Expert module, Russian stock market" - a module containing ready-made neural networks for three Russian stocks: RAO Gazprom, RAO UES of Russia, NK Lukoil; "Neural Networks Module" - an emulator of classic multilayer neural networks using genetic algorithms; "Kohonen Map Module" - a module that implements Kohonen maps as applied to financial markets; "Module Statistics" - a module for statistical processing of financial information and market analysis. NeuroScalp has a user-friendly interface and implements the necessary set of methods required to implement various user ideas. A demo version of the neural package can be found at <http://www.tora-centre.ru/nscalp>.

12. Virtual reality technology

Technology of virtual reality, virtual reality - technologies of actualization of various hypothetical environments and situations that do not exist in reality and are possible as options for the development of real analogs of systems of the real world; these technologies and systems allow you to control a virtual object, a system by modeling the laws of space, time, interaction, inertia, etc.

The highest form of development of a computer office is a virtual office and a virtual corporation – offices and corporations that do not exist in the usual, classical form ("having a sign, staff, building"), but created imaginatively, distributed - both in space and in time (departments and employees may even be on different continents, communicating at work using computers and communication networks). They are the highest level of business cooperation and radically change the organization of work and the system of information support for employees.

Virtualization of the properties and attributes of a corporation, dynamic (and sometimes virtual!) Allocation of their common fundamental (generic, class) properties, their description and use within a single technology, allows to reduce the gap between the predicted (or simulated) state of the corporation and its real state. The corporation has common interests, appear, actualize, virtualize for the period when they serve a common goal. The success of a virtual corporation (its development, implementation and maintenance) depends on the completeness and quality of information flows between corporation objects. In this case, new employees of a corporation (or employees of a new corporation) deal, first of all, with information models, for example, with models of a warehouse of raw materials, products, managers, suppliers, banks (bank settlements). Thus, virtual computer corporations support a wide range of works and services - from connecting enterprises in resources, production, sales, supply, management, information support, etc., providing basic competence - a set of knowledge and skills for organizing, coordinating and coordinating general organizational, material, information resources of the elements of the corporation, support and development of its infrastructure (architecture, innovations, assets, advertising, etc.) and ending with the provision of corporate functions of the system with lower costs and better quality, reducing bureaucracy and levels of hierarchy in the system, as well as reaction time to changes in the market.

The main characteristics of a virtual corporation: the presence of the main type of business (activity) for all subsystems; concentration of users around this type of activity and general interrelated goals, planning and resource provision, general (integrated) strategies of behavior and resource actualization, general (integrated) technology of resource actualization.

In a virtual corporation, "new workers or employees" will mainly deal with infological models of jobs, tools, raw materials, suppliers, sales markets and services, "new managers" will make quick and smarter decisions on a much wider range of issues, and the "new leadership" will be preoccupied with multi-criteria strategic issues. Consequently, they are required to have a qualitatively new level of professionalism, responsibility and a desire for self-education.

Example. The virtual marketing corporation "Da Vinci" unites a number of mining deposits, production (engineering and construction), transport, investment, ecological systems. All subsystems "Da Vinci" are delivered without modifications for a specific object (like children's designers of collapsible type). One of the scenarios proposed in the project (Venture Management Model) simulates the following situation. The mining company is developing in New Guinea. The hotel built in this area can be expanded to accommodate the growing flow of the company's business clients and tourists. A consortium with a communications and hospitality business is offered a stake in the development of the area and the operation of the hotel. To reduce the overhead costs of expanding the hotel and tourism infrastructure, large construction companies are attracted (on a profit-sharing basis). It should be noted that the criteria for the effectiveness of a business in such a composition are different, and the process of making strategic decisions is associated with conflicting interests of partners, and their dynamically changing picture. For the implementation of this corporation, there are e-mail (multimedia) mail to support decision-making processes by top officials, teleconferencing facilities for functional units and analysts, a geographic information system, a CAD system that interacts with a DBMS through a geo-referenced data structure, a computer record keeping system at all stages. Modern technologies of the "client-server" type and object-oriented ones for Windows NT, Windows-95 (workstations), Unix (server), full versions of MS Office and computer workflow are used. The electronic document management system uses: full-text search, access to project documentation at all stages of the project life cycle, preparation of interactive technical documentation. The document can contain text, for example, an HTML document, illustrations in one or more layers, editorial changes and comments of members of various working groups participating in the project, three-dimensional objects from CAD programs, video and audio files connected to the document.

Example. Virtual reality technologies widely use various simulators for training aircraft pilots, car drivers, ship captains, which allow the student to be placed in appropriate imaginary situations (including emergency), including those that have never existed in reality and do not "fit" into the framework of the laws of classical mechanics, physics; virtual reality effects are often created due to the simultaneous impact on various sensory organs, including the subconscious, sensorimotor systems. Interesting projects for the creation of surgical simulators

using methods and means of virtual reality. An important form of virtual reality (virtual concept) is the market. If earlier the market was understood as a real meeting place of sellers and buyers, now this concept consists of economic, commercial, production and communication relations and systems; they can now meet and implement their functions in computer systems.

13. Cognitive technologies

Cognitive technologies - methods, tools and techniques that provide a visual, hypermedia presentation of the conditions of tasks and / or the subject area, which helps to find either a solution strategy (or the solution itself), or allows you to evaluate and compare solutions, make one or another adequate choice ...

Example. Cognitive graphics, allowing geometrically, figuratively to represent the subject environment and build, based on this, the required graphic object, in particular, the spatial representation of this object. There are both tools and methods of visual programming (program design), in particular, the Visual-C environment. Cognitive methods of choosing decisions in the field of business allow making decisions and determining strategies of behavior based on qualitative data, personal judgments (effectively for eliminating uncertainties). For example, the decision-making model of the Institute of the USA and Canada of the Russian Academy of Sciences, using blocks, submodels such as "Peace", "Value", "Means", "Interest", "Stereotype", "Purpose", "Scenario", "Problem", allows you to change meaningful filling of these blocks, generate new goals and scenarios (using old ones).

14. Technologies of information reengineering

Technologies of information reengineering - methods and means of radical revision, redesign of information networks and processes in order to achieve dramatic, for example, "ordinal" improvements in key indicators of information networks and systems, in particular, in terms of indicators such as "performance-cost", "time-volume of information", "functioning-documentation", "technology-convenience", etc. Reengineering activities change the work (from monoplanar it becomes multifaceted), the role of the employee (from a supervised performer - to making independent decisions), assessment of work efficiency and remuneration (from the assessment of labor costs – to the assessment of the result), the role of the manager (from the controlling function to the training one), and, most importantly, the organizational structure (from hierarchical – to matrix and network).

Example. Reducing the decision-making time and the cycle of preparation and signing of documents, for example, by means of computer records management, communication networks and expert systems that provide access to the decision-maker to all stages, nodes and tools for preparing a decision; shifting emphasis from the problem "How to do?" to the problem "What to do?" Note that the "remote data server and client access" technology, popular in information systems and networks, can be considered reengineering. Reengineering the reporting system, reports, for example, can reduce the reporting cycle from 20-30 operations to 5-10. Simple improvement cannot produce such results.

15. Object-oriented technologies

Object-oriented technologies, object-oriented analysis technologies (technologies for presenting and updating information, information processes, systems as collections of objects and classes using the following concepts: object, instance of a class - everything that can be fully described by some state attributes; class - a set of objects with the same attributes; encapsulation - hiding internal information, the ability to separate objects and classes from the outside world; inheritance - the ability to create new descendant classes from parent classes that preserve the attributes and properties of parents; polymorphism - the ability of objects to choose a presentation method on based on data types of updated messages).

Object-oriented analysis tools: attributes (descriptions of objects, classes); operations (processes applied to object classes); data streams (groups of data elements that implement links between objects); inheritance (aggregation and generalization).

Example. Object-oriented programming environments, for example C ++, Smalltalk; object-oriented engineering, or a set of techniques and methods of business design that most effectively ensure the set goals and profit; object-oriented user interface, using, for example, the concepts of "description class", "language class", "class of operating environments", etc. In object-oriented programming in the APL language environment, for example, procedures are executed in accordance with the logic and instructions of some a program that determines the sequence and content of actions; execution of this program is initiated by a message sent to the specified object by a user, another program, or an object. The recipient of the message decides which program will be executed.

Example. HTML is a static tool. The JavaScript framework is used to "spice up" Web content to make interactive HTML pages. One of the object-oriented systems important for informatics is the Java-system, environments - the Java-interpreting machine, technologies - Java-technology. Let's look at them briefly. All of them are based on the Java programming language, which is oriented towards the Internet and WWW servers. The Java language is derived from the Oak programming language, with a syntax close to that of the C ++ language. Using the Java language, you can develop applications for various platforms: Intel Pentium, Macintosh, Sun, etc. Java programs can be used autonomously (executed in interpretation mode on a specific computer platform) and applets (applets) executed in interpretation mode by the virtual Java machine which is built into almost all modern browsers. Java applets are embedded in HTML documents stored on the WWW server. You can use applets to make your Web server pages dynamic and interactive. All data for processing applets can only get from the Web server. The Java language is object-oriented and has a large library of classes that greatly simplify application development, since the programmer can pay more attention to the functional part of the application, rather than organizing the interface, dynamic arrays, etc. Broadly speaking, Java is a technology that was originally designed to integrate with a completely platform independent Web environment. Java Virtual

Machine is a machine on which Java source programs are interpreted into codes of this machine. This makes the Java environment a powerful and convenient tool for developing client-side components of Web systems. In a Java environment, the user can dynamically load objects from the network, i.e. he does not need expensive work on setting up, administering client Java systems, since to ensure the client's work on the new version, it is enough to download it on the server. There are instrumental environments, for example, Java Studio, that allow you to design applications without programming at all, from ready-made components, establishing connections and relationships between them in accordance with the internal logic of the application. The Just-In-Time compilation is used to improve the performance of Java-based applications in browsers. When the applet is loaded for the first time, its code is translated into a regular executable program, which is saved to disk and launched. As a result, the overall execution speed of the applet increases several times.

16. Environment-oriented technologies

Environment-oriented technologies (interactive technologies for designing, developing, updating information systems, in which the necessary environment and tools are first built, and then they are automatically configured by performing procedures such as: move, insert, delete, indicate, activate, etc. ; ready-made environments, "like cubes", are combined into the necessary structures, and then customized for specific classes of problems or users, and changes in some of them can change and others).

Example. Environment-oriented programming systems, which often use a "window interface", "window environment". They are based on the concepts of "window", "frame", "frame", "picture on the screen", "window menu", etc., each of which is associated with the most suitable tool environment: texts - with a word processor, tables - with an electronic table, graphs - with business graphics environment, etc. To these standard environments can be added also environment developed by the programmer himself, as well as environment libraries. Note that interactive planning allows you to find the optimal structures and a set of resources to achieve the goal.

In recent years, there has been a growing interest in distributed systems - software systems, the components of which operate on different computers in the network, using technologies of different levels in interaction, from the direct use of TCP/IP packets to technologies with a high level of abstraction, such as CORBA. These systems provide the following capabilities that are not feasible using traditional technologies:

- ✓ *scalability, i.e. efficient service of a different number of clients at the same time;*
- ✓ *reliability of the created applications, i.e. resistance not only to user errors, but also to failures in the communication system;*
- ✓ *continuous long-term operation (24x7 mode, i.e. 24 hours within 7 days of the week);*

- ✓ *high level of system security, i.e. protection and tracking, logging of information at all stages of operation;*
- ✓ *high speed of application development and ease of maintenance and modification (an average programmer level is sufficient).*

CORBA technology was created by a non-profit organization - the community of developers and users of OMG software as a universal technology for creating distributed systems using Java, C, Ada, Smalltalk, Delphi, Perl, Python, etc. The client part can be written in any programming language that supports CORBA ...

Since CORBA is a standard framework for the development and use of various platforms, operating systems and applications, all CORBA specifications are completely open. CORBA implements a high level of abstraction - all problems and descriptions of interaction with the operating system or network facilities are carried out at a low level and hidden from the application programmer. A high level of abstraction is achieved by mapping instructions in the specification language to a specific programming language. CORBA can transfer data of various types: structures, unions, etc. A system for describing and checking types is provided. Each language uses its own display of data in the specification language. CORBA supports static and dynamic remote invocation and has advanced server information retrieval. CORBA has a high level of fault tolerance due to greater isolation of clients and servers, automatic persistence of objects, a more powerful and sophisticated transaction management scheme. Transaction management is handled by the so-called CORBA Transaction Management Service (Object Transaction Service). CORBA provides a high level of security. Provides user identification, lists of access rights to resources, an audit system and much more. The integration of CORBA and the Internet is accomplished by using a protocol built on top of TCP / IP, which allows URL names to be used as names for the CORBA Naming Service.

17. CASE technologies

CASE-technologies (Computer-Aided System Engineering – automated design of information systems, or technologies that allow automating the main stages and procedures of the life cycle of information systems: from the analysis of the initial state and goals – to the design of interfaces familiar to the designer, user and basic operating procedures systems; the more steps and procedures are automated, the better and faster the information system is obtained, the wider its applications).

Example. STRADIS technology (STRategic Architecture for the Deployment of Information Systems) defines and supports the main stages of the system life cycle: goals, their priorities, resource requirements, work distribution, composition and content of project documentation, methodology for performing design procedures and programming, testing and management. It includes the following tools for this: a graphical editor (graphical environment), a DBMS, tools for describing scenarios for a dialogue with the system, output documents, etc.

18. Technologies and systems of computer algebra

Technologies and systems of computer algebra, systems of symbolic transformations, analytical calculations (systems that allow automatic transformations of formulas and algebraic expressions, in particular, the reduction of similar terms in algebraic expression, finding the antiderivative of a given analytically function, its differentiation, etc.) ...

Example. The Reduce system for formula transformations, which allows you to both find equivalent algebraic expressions and calculate their numerical values (including complex-valued ones), sum up finite and infinite series (the sum is like a function!), Perform algebraic operations with polynomials, matrices, integrate and differentiate.

19. Fuzzy technologies

Fuzzy technologies (technologies of data processing and knowledge output, decision-making based on the description of systems by the apparatus of fuzzy sets and fuzzy logic).

Example. Medical diagnosis is often based on fuzzy, vaguely clear connections between symptoms and diseases, their fuzzy dependence, therefore, for computerized diagnosis, building an expert system for making a diagnosis, this technology is especially effective, since it allows you to draw fuzzy conclusions, which can then be verified. Fingerprinting problems can also be solved efficiently with fuzzy fingerprint recognition systems.

All new information technologies, in one way or another, use the methods and problems of artificial intelligence, knowledge engineering, often intertwine and integrate.

The problem of artificial intelligence is knowledge, information about this area, which is still objectively incomprehensible, inaccurate, not formalized, not structured, not actualized by available means (and can become such in the process of the system functioning, acquiring knowledge).

Knowledge engineering is a science that studies the problems of identifying, structuring, formalizing and updating knowledge for the development of various types of intelligent systems and technologies.

All new information technologies must ensure purposefulness, information content, adequacy, accuracy, completeness, perceivability and structuredness of messages, as well as flexibility, comfort, timeliness and ease of their actualization in time, space and information.

All information technologies are the basis of many other technologies, as well as a way of updating information, the basis of thinking.

The main trends in the development of new information technologies, regardless of the scope of their use:

- ✓ *the growing role and activity (relevance) of an information resource, i.e. the quality and efficiency of intellectual decisions made in society increasingly depends on the content, accuracy and timeliness of the information received, its spatial and temporal characteristics;*
- ✓ *development of the ability for active technical, software and technological interaction (standardization and compatibility of such interactions), i.e. the*

- emergence of more advanced standards of interaction, more and more often - already at the level of design work, at the level of developing specifications;*
- ✓ *changing the structure of infological and structural interactions, eliminating intermediate links (immediacy), i.e. elimination of stages and functions of intermediaries of information exchange and services, elimination of intermediate functions within companies and between them, wider distribution, easier access, lower prices, etc.;*
 - ✓ *globalization or the use of spatial, temporal and organizational capabilities and the capacity of the information market (almost unlimited);*
 - ✓ *convergence or formation of a market for new information technologies, consisting of the main segments – private consumption (entertainment, household services, etc.), business support (production, sales, marketing, etc.), intellectual professional work (automatic formalization of professional knowledge and etc.).*

Example. In 1990, about 40% of intellectual workers in the United States used new information technologies in their workplaces, in particular, the Microsoft concern invests in new media projects up to 20% of its scientific budget, publishing encyclopedias and reference books on CD, working in parallel with normal television on the network Internet, opening its multimedia magazines on the Internet, for example, Slate (<http://www.slate.com>) and others. The implementation of the Japanese program for creating fifth-generation computers is constrained by the fact that the new software architecture is not yet compatible with the existing centers of artificial intelligence, new protocols cannot be used in old communication systems, and new machine languages are not suitable for old systems, etc. In the banking sector, the role of small banks is decreasing, since the introduction of information technologies requires significant resources. Those with access to public terminals ("electronic kiosks") order goods and receive electronic coupons. An example of a global program is the ESPRIT program (European Strategic Research Program for Information Technology). Examples of hardware-software convergence include printers with copier and fax functions.

Conclusion

Finishing our incomplete review (a complete review, apparently, it is impossible to do) of new information technologies, the most important for system analysis, we note that more and more of their varieties and applications appear, and they become the main factor (toolkit) of globalization, a factor that changes traditional acceptance criteria solutions and opportunities for global business (pricing, costs, location, etc.).

Control questions

See the manual on the organization of students' independent work.