Ways of Development of Computer Technologies to Perspective Nano

[1]E.M. Lavrischeva, Doctor of Phys.–Math.,
Professor MIPT, Chief Scientific Specialist of ISP RAS,
Russia, Moscow
Email: lavryscheva@gmail.com

[2]I.B. Petrov, Doctor of Phys. – Math.,
Professor MIPT, Corresponding Member of RAS,
Head of the Department, Russia, Moscow,
Region Dolgoprudny, Email: petrov@mipt.ru

Abstract—**The ways of development of the first computers to modern computers, which are assembled from transistors, chips, integrated microcircuits on crystals, etc. are considered. New substances, materials, electronic devices, manipulators from new micro Nano elements are created. It is noted that computer technologies provide people communication (mail, video, Skype, etc.), improve the everyday life of each member of the world community. The analysis of the development of computer engineering is given and the technologies of modern supercomputers in the future are determined. A number of operating supercomputers Simulation and Digital Manufacturing in industry, energy, transport, and construction are presented. The ways of development of the Internet, technologies lines of life cycle, ontologies, smart products in the fields of e-science (biology, genetics, physics, medicine, energy, etc.) and industry are discussed.**

Keywords—Nano elements; computer technology; engineering; technology systems; assembling modules; molecules; small computers; internet thing

I. Introduction

Wiener in his work "Cybernetics or Control Communication of Animals and Machines" (1948) considered cybernetics as the management of living organisms, machines and society by means of information transmitted between them through communication channels. Information technology has become a source of vital activity in modern spheres of life. Since the advent of Computer Sciences the subject of study have become all areas of society, education, industry and so on. Revolutionary scientific ideas related to the development of computer technologies for various fields scientifically of knowledge (physics, mathematics, biology, chemistry, genetics, architecture, etc.) and interdisciplinary disciplines began. The main tools of knowledge engineering in the industrial, scientific and managerial sphere of society are information, computer technologies and nanotechnologies. They realize scientific ideas for the needs of society, including the production of new types of products (tangible and intangible). New approaches to computer engineering, supercomputer technologies and their introduction into industry, energy, transport, and communications have emerged. These include: systems modeling - Supercomputers Simulation; Technological lines of the future – Optimization Based Product Development, Digital manufacturing; Intellectual Things - smart computers, cities, organizations and businesses, etc. Their basic elements are technical, technological and software resources of repeated use (microelements, materials, data, processes, assets, reuses, artifacts, etc.). Minimized micro-resources of Nano technologies are created, which help to increase the level of control of living and technical creatures, robots, etc. The main methods for creating new computer products and materials, manipulators of Nano and intellectual resources of the Internet are interdisciplinary and industry-wise technologies and smart industries.

II. Development of Nano Technologies

For the first time the idea of synthesis of atoms in micro atoms with the help of a special software collector was proposed by R. Feynman (1959), as an atom manipulator, on which gravitational forces do not act, but intermolecular van der Waals forces act. He believed that there could be an arbitrary number of such mechanisms represented by manipulators of elements reduced by four or more times the copy of the operator's hand that can tighten small bolts and nuts, drill very small holes, perform work on a scale of 1: 4.1: 8, 1:16. Small elements include microelements for surgical macro devices, micro stimulators, and the like [1]-[4].

R. Feynman believed that millions of miniature plants will be created on which "tiny machines will continuously drill holes, stamp small parts" for small devices, assemble them into macro mechanisms, macro-substances, etc.

This idea led to miniaturization and the recipe of new substances from very small particles of other substances with the properties necessary for a particular application. Such a small particle was called Nano or "dwarf". Nanotechnology is a technology for the production of substances and devices with a predetermined atomic architecture (Drexler).

The atom is 10^{-10} = 1 nanometer (nm), and the bacteria are 10^{-9} nm. Particles from 1 to 100 nanometers are called "nanoparticles". Nanoparticles have the property of sticking them together, which leads to the formation of new agglomerates (in medicine, ceramics, metallurgy, etc.).

One of the most important issues facing nanotechnology is how to get molecules to group themselves in a certain way, to organize them to eventually get a new material or device. For example, proteins synthesize new structures of DNK protein molecules with new specific properties. Research in the field of nanotechnology is being conducted in the USA, Russia, France, Ukraine, etc. Let's consider some of them.

After studying the achievements in the field of nanotechnology, the authors came up with the idea of studying the properties and features of highly effective computer and IT-technologies in terms of ensuring the possibility of reducing various mini and micro elements to Nano elements in relation to e-science (biology, chemistry, physics, medicine, genetics, etc.).

IT-technologies have reached a high level of development, penetrated into all spheres of service of the world community. The emerging Skype-technologies allowed people to communicate and see each other, being in different places on the planet. It is required to develop such technologies that "the train Nano gradually gaining momentum" in the next decade. The nanotechnologies will support life on earth, improve the quality of life and health of people, and promote research of the earth, ocean and atmosphere to create vital new substances from natural and science-intensive particles [5]-[8].

In Russia scientific institutes have formulated for the immediate future 16 priority scientific and technical tasks in biology, medicine, genetics, energy, metallurgy, computer and network problems for studying natural and cosmic phenomena, etc. The solution of each task is determined by the need to create new highly effective super technologies and Nano technologies.

III. Ways of Development of Elements form Nano for Computers

A. History of Development of Nanotechnology Elements in the USSR

The first developments of nanotechnology include:

1) In the 70s of the last century in the Institute of Electric Welding by E. Paton of Ukraine created thin Nano-metal films that were welded by an electron beam in a vacuum. For space, a method for electron-beam melting of metallic aerospace structures was developed (1984) by condensing substances in a vacuum. A new technological method of electron-beam welding was created, which was patented in a number of countries (1984) under the name (EB-PVD) [2], [4].

2) Electron-beam micro processing was used in electronic lithography, as well as for scattering of electron fluxes of substances and energy distribution between different kinds of atoms and mechanisms of chemical reactions. In the Academy of Sciences of the Ukrainian SSR developed: an electroluminescent screen; Integrated circuits with dimensions (0, 3; 0, 5 - 0, 7 microns), which were used by the series "Kiev-70" computer, Dnepr-1, 2, etc.; Ultra-high-frequency transistors (60 Hertz) and integrated circuits for control of ASU technological processes [5]-[9].

3) Long-term studies of computer intelligence and pattern recognition, led to the formation of visual, speech technologies that generate signals of complex physical nature (MNUCIT NANU [5]). A pattern computer with a video image, realizing stereo vision, identification and face image, as well as territories was created. There was an electronic voice keyboard, an intelligent speech interface, and portable voice recorders with voice control, devices with human faces

recognition, and a biometric access control system for "Video Securities", etc. [5]-[7].

4) In the Moscow Palace of Creativity "Intellect" the physicochemical properties of various materials have been studied and the SiO_2 fiber for masking military equipment, engineering structures from optical and radar impacts, as well as for studying plant, mountain and desert areas of the earth have been determined. This fiber is embedded ferromagnetic nanoparticles, providing a reflection coefficient of 15-80 times stronger than a metal plate in the frequency range of A-37 TC. Under the scientific supervision of the specialists of the Moscow State University, the institutes of steel and alloys, the chemical technology institute, electronic engineering, the Nano industry concern, it was created (www.intellect-dt.ru):

- Scanning tunneling microscope "Umka" for studying the surface of materials with the help of atomically resolving an acute needle sliding along these materials.

- Device for sharpening this needle.

- Samples of materials (radio absorbing RPM, hydrophobic, astro-concrete, etc.) [3], [9].

5) Cross-cutting tools (IBM, UNIX, VS.NET, .NET, etc.) many years define the basic framework of the organization creating computer software and information systems. The system functions are implemented in: Function IBMSphere, OS Linux, Cloud Computing (MapReduce, Hadoop, etc.), Big Data (Oracle Designer, Developer, OEPE, Patch, etc.). More than 10 years numerous tools Supercomputers Simulation and Optimization Based Product Development, Digital manufacturing, Multi Stage and MultiTechnology (MultiCAD & MultiCAE), etc. are used to automate various industries [10]-[18].

Tools CAD (Computer-Aided Design) and CAE (Computer-Aided Engineering) are applied in mechanical engineering, aircraft building, instrument making, shipbuilding and other industries. They provide 3D design, issue drawings and means of technological preparation of production programs for CNC routers, 3D printers, etc. MultiTechnology and MultiCAD & MultiCAE address the multidisciplinary and suprasectoral mathematical problems. A new Research Knowledge Management Toolkit for management of engineering knowledge, processes, ontological modeling products, etc. is being developed [10].

B. History of the Development of Elements of the First Computer

At the beginning of the twentieth century, the first von Neumann machines appeared which were originally based on vacuum tubes. But already in 1947 integrated microcircuits (Fig. 1) and transistors have appeared. They simplified and reduced the size of the first computers [3], [9], [10].

The next step was the Intel 8008 microprocessor on a single chip which was contained 100 million transistors. On the plate ($465cm^2$) 31 billion transistors were contained. The prospects of development include materials that produce an electric current (Fig. 2). When you pressurize, four layers of this material stack on top of one another and begin to work.
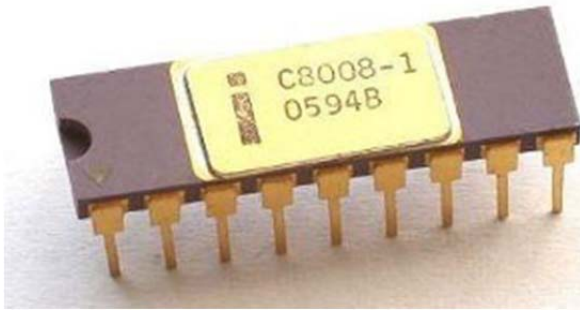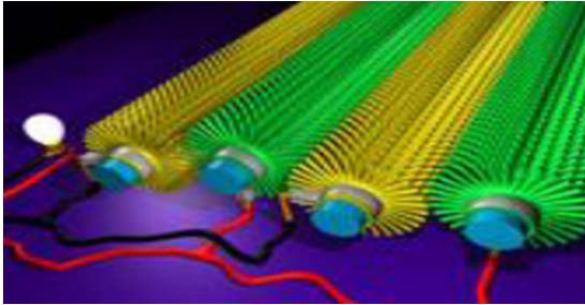
Fig. 1.   Integrated circuit.

Fig. 2.   Electrical current.

It was made the first molecular computer (Nano computer) the size of a few nanometers to work with the smallest atoms close to the thickness of the thread.

The idea of chips developed by scientists in the direction of computer interaction with living cells with a diameter of 1 mm on which are placed 16,384 transistors and hundreds of capacitors. The transistors receive signals that are transmitted to cells through capacitors. The authors drew the chips of technique with living cells. It has a mechanism for combining cells with a chip in American laboratory in Berkeley and at the University of California in conducting genetic studies of the cells of the DNK molecules to create artificial DNK systems. The work of the creating of chip sensors for analysis of environmental pollutants is underway, as well as test new pharmaceuticals, etc.

Thanks to the achievements of microelectronics, notebooks, mobile phones, multi-core telephones, digital cameras, video cameras, etc. began to be created. These elements were widely used in computer and information technologies.

The way to nanotechnology lies in the production of computers from microcode modules of computer type, as well as in the small mini computers from the new functionally related structural microelements. The production of computers goes along the path of automation of production lines for small trace elements, micro modules, small "particles" and means of their "merging" into new small-sized functional structures. The technology of computers has evolved from the creation of large computers to small pocket computers, mobile phones with built-in diodes, triodes, transistors, etc., as well as the manufacture of various devices for different fields of application (medicine, space, aviation, etc.).

Practically were formed the high technology in the type of nanotechnology. New models of computers are being assembled from "miniature" elements like "atoms and molecules" in nanotechnology. Schematic elements of computers are created so tiny that small devices of computer type (desktop, pocket, etc.) are made of them. Computer technologies already work with the smallest elements, "atoms" close in thickness to the threads (transistors, single crystals, etc.). For example, video cards from 3.5 million particles on a single crystal touch cards for correction of the retina of the eye, etc. Such elements can be called "atoms" of computer technology for the manufacture of new types of computers, instruments, industry and technology.

C. Development of Computer Technology along the path of Nano

Since the creation of the first computer under the leadership of Academician S.A. Lebedev and V.M. Glushkov, the technology of designing and manufacturing universal computers has been formed. It was improved in terms of unifying the element base and methods of assembling structural components of electronic, control and engineering calculations and macro-conveyor computers from them. Their main purpose is to provide highly efficient and qualitative calculations of complex mathematical and national economic problems, as well as tasks of managing technological processes of automated enterprises and systems of automated control systems and process control systems [8]-[10].

The development of the elementary computer base is briefly outlined above. At this hour, the process of manufacturing computer systems is close to the automated assembly of small individual elements into larger elements, as on an assembly line, which V.M. Glushkov defined in 1975 by analogy with the Ford conveyor at an automobile plant. A distinctive feature of such a conveyor is technological lines (TL) manufacturing of individual elements and assembly lines of these elements into larger technical structures [9]-[13]. On their basis, different versions of computers are assembled at different corners of our planet.

Analyzing computer technologies it can be said that they developed by the type of nanotechnology, which assures the assembly of new models of computers from small mini-cells like "atoms and molecules". Circuit elements in the 80's became so tiny that they were built into on-board instruments of space and military systems, as well as in the first medical devices of computer type Amosov [5].

Special elements were formed when creating the first "smart" machines of the "MIR 1, 2, 3" series. In the elements implemented a new algebraic language "Analyst" for describing schemes for carrying out analytical transformations and solving numerical problems. The schemes of the programs were very small and were built into the structure of the machines as details [14]-[20]. More advanced schemes of such programs appeared in the new version of the MIR, developed jointly with Germany for the 90th anniversary of Glushkov [7]. This new intelligent engineering machine is capable of solving systems of linear, nonlinear, integral and differential equations, Kashi problems, boundary value problems (I.N. Molchanov et al.) [5], [9].

Significant achievements have been accomplished in the implementation of computer algebra, focused on the creation of mathematical models for technical and computer technologies of information processing 1992-2012 [9], [15]. The idea of smart machines today is reflected in the Internet of smart things, cities, businesses, etc.

D. Technology of Computer-Aided Systems

When implementing the automated process control system (Lisichansk Chemical Plant, Donetsk Mining and Processing Plant, L'viv Television Plant, Agriculture in Bulgaria and TP of the Leipzig-Berlin metallurgical combinate), the Ukrainian Academy of Sciences organized automated data collection and processing in the production process. This period of development of the automated control system industry has gone along the way of improving the objects of data collection and processing [9].

A range of technologies that claim to the industry of computer software systems has appeared. These are: the multitechnology of K. Czarneski and K. Aizenecker with the leitmotif "from manual labor to conveyor assembly"; I. Bey's technology with the automated interaction of multilingual programs; Stream assembly - use case UML factory programs G. Greenfield and G. Lentz; Assembly conveyor EPAM, factory "continues integration" M Fowler and experimental factory by the student programs KNU (http://programsfactory.univ.kiev.ua), etc. [10]-[23], [33], [34].

The common thing that unites them is the assembling lines of various types of programs for the mass application. Composite elements of support of computer technologies are conveyor, macro-conveyor, multiprocessor systems, as well as cluster, grid, super Frameworks, etc. Their elements today are transistors, diodes, capacitors, micro processes, microcircuits, containers, crystals and others, micro and macro elements [3]-[9].

E. Modeling Technology Systems and their Families

Recent years (2005-2016) in technology and engineering systems new methods for modeling software systems (SS) and their families are formed. The methods are focused on (variability) ready (legacy) and newly established systems. One of the first FM (Feature Model) was developed at the Software Engineering Institute (sei.cmu.edu) for Product Line/Product Family (2004) the manufacture of software products (SP) and their families (FSP) of ready resources (artifacts, reuses, assets, etc.) [19], [23]. The definition of CRUs in ISO/IEC FDIS 24765:2009 is "FSP is a group of products or services that have a common managed numerous properties that meet the needs of a particular market segment or activity" [5], [9], [10], [27].

The concept of assembly line systems and families collections based on model FM (K. Czazneski) from ready-made reuses (direction Reusability, 1987, etc.) is formed [25]-[34]. A new method of object-component (OCM) [26] graph modeling the structure of the OM using a logical-mathematical apparatus on four formal levels is defined. At each level of the model is formed, MF (Model Feature) and SP from functional and interfaces objects. Of them are generated

by the options SP collections families FSP. The theory of simulations must cease and the SP and the interaction of the finished FSP (www.ispras.ru/lavrischeva). Models OM and an MF using Model Checking were designed. On these models is carried out management variability and configuration Assembly members of families of FSP and the options of the Model Feature (FM) output product. A method of modeling the changing of MF develops for OS Linux 2.3, Legacy systems and Web-system in a new project of ISP RAS RFFI (2016) [27].

IV. MODERN COMPUTER ENGINEERING: TODAY, TOMORROW

A. Computer Technologies and Engineering

The works [9], [10]-[17] are devoted to the issues of analysis and discussion of computer technology today and tomorrow. In it, the concept of computer-aided design of Simulation-Based Design, based on CAD (Computer-Aided Design), finite element method FEM (Finite Element Method) is fundamental for modern machine building, instrument making, and electronic, automotive, aviation and space industries.

CAE (Computer-Aided Engineering) covers the tasks of creating multidisciplinary and industry-specific systems, the basis of which is formed by mathematical models of physic-mechanical processes, given by non-stationary nonlinear partial differential equations, etc. [10], [28]. Multidisciplinary knowledge includes decision making in various fields of science and technology. They are supported by the developed technologies: Multidisciplinary Simulation-Based Design / Engineering and HPC (High Performance Computing); Supercomputers Multidisciplinary Simulation-Based Design / Engineering; Supercomputers (Smart Mat * Mach) * (Multi3) Simulation and Optimization Based Product Development. They provide high-performance computing on supercomputers, clusters within the framework of hierarchical cyber infrastructures, multimodal and multivariate calculations of mathematical and physical problems, as well as the management of digital manufacturing, smart designs, environments, factories, etc.

The technology of the analysis of the problems of the mechanics of deformation of a rigid body, static, oscillation, stability of dynamics and strength of machines, structures, instruments, equipment, installations and structures is supported by the FEA (Finite Element Analysis) tool, and the solution of the problems of fluid mechanics and gas, computational hydro- aerodynamics using the finite volume method in CFD, MBD (Multi Body Dynamics) and MCAE (Mechanical CAE), etc. [10]-[28]. The CAE tool includes a set of computational engineering programs:

- T-FLEX Analysis, T-FLEX Dynamics, T-FLEX Gear calculations, springs and others.

- PDM-T-FLEX DOC tool is used to solve the problems of design and technological document management and integrated management of engineering data of the enterprise, and architectural and construction design is performed in the AutoCAD environment.

Computing technologies for the solution of problems of continuum mechanics environment (Aero hydro dynamics, plasma dynamics, mechanics of deformable solids), electrodynamics of continuous environment (Maxwell) supported such modern tools as:

- Ansys's 3D (Solid **Continiums Mechanics,** finite element method of, United States);

- Fluid Dynanics (Aerodynamics, Russia);

- Nastran (Engineering calculations, United States);

- Ansys Maxwell Electromagnetism, Maxwell's equations);

- Vision-Flow (Gas dynamics, Russia);

- Tesseral-PRO (Geophysics, Ukraine);

- Logos (Continuum **Mechanics,** Russia);

- Madagascar (Inverse problems of seismic. USA);

- ProCAS (Conductivity, United States);

- Mathlab (Computational Mathematics, USA);

- Mathematics (computational mathematics).

For the numerical solution of these tasks, developed high-precision modern computing tools (methods, algorithms):

- FVM (Finite volume methods);

- FEM (Finite element method);

- GCM (Grid-characteristic method);

- DMG (Discontinued Galerkin method);

- TVD (Total Variation Dinamition);

- ENM (Essential Nonoscilation Mehtod is uniform, Nonoscilation method);

- MMF (Multigrid Method Fedorenko);

- DPM (Difference Potentials Method);

- SPH (Smoothed -Partical Hydrodynamics).

To meet the challenges of design and technological flow and integrated management of engineering data of any enterprise (Organization) uses the PDM tool-T-FLEX DOC for architectural design-AutoCAD.

B. Modern Computer Technology of Russia

The developers of CAD/CAE are ASKON and "Top Systems" [10], [23], [28]:

1) ASKON (1989) is a developer of engineering software and integration in the field of automation design and production activities in engineering and construction. This system is used by more than 7000 industrial enterprises. They make use of the following domestic products:
- KOMPAS-3D system is designed for three-dimensional modeling, based on mathematical-that

integrate with CAD / CAM / CAE packages for design automation.

- LOTSMAN: PLM system is for engineering data management and product Life Cycle and project data management.

- VERTICAL provides computer-aided design of technological processes.

2) ZAO < Top-System >(1992) is an adapted version of the complex T-FLEX conducting design and process workflow of design and production preparation with the help of CAD T-FLEX CAD and drafting and three-dimensional solid and surface modeling. This complex includes:
- PDM T-FLEX DOCs 2010 - the Russian PLM-complex for solving problems of engineering document management and integrated engineering data management enterprise.

- CAE – a set of engineering calculation programs: T-FLEX Analysis T-FLEX Dynamics, T-FLEX Calculations /gears, Springs, etc.

- SARR – T-FLEX (2010) is a complex of technological production preparation and production of quality technical documentation for all types of industrial products.

- SAM – software product line (Project Studio CS) for three-dimensional design of industrial facilities in AutoCAD the layout of the task, calculations and generate specification and drawings, particularly for CNC machines.

- AutoCAD or Autodesk Inventor ensures that design drawings of the products manufactured and ESKD. Technology CS – a specialized product for business use. Electrics Pro and CAD design of electrical equipment in various industries.

C. Prospective Domestic System 3D Modeling

Prospective domestic system includes [9], [10], [28]:

1) GK ROSATOM (2010) include: Russian Academy of Sciences, Ministry of education and science of Russia, St.-Petersburg State University, MIPT, etc.), joint-stock Company < Dry >, NPO < SATURN >, NPO < KAMAZ >, PCF < SIC>, OKB <Chemical Automatics>, etc. Formed Committee 3D modeling kernel.

2) MIPT <Machines>, TSAGI, etc. developed domestic program-mathematical 3D modeling kernel (2012) to create computer engineering products.

3) LEDAS (Novosibirsk) created a domestic license 3D modeling kernel form of geometric elements, their Assembly, animation, as well as the use of computational algorithms, discrete mathematics build arbitrary surfaces and curves.

4) FGUP RFTS-VNIIEF develops supercomputers and Grid technologies by using 3D cores (Para solid from Siemens PLM Software from Assault Systems, ASIS) in priority strategic computer technologies and software according to

"The Russian Presidential Commission on modernization and technological development of the country's economy".

Thus, the powered complexes modeling various industries in Russia on super computers are characterized by the use of foreign funds (approximately 80%) to build a specific domestic systems and complexes, reflecting the automation engineering, medical, architectural industries of the country.

D. Prospective ways of Internet Development

Prospective Internet technologies include [10], [28]:

1) The information objects (IO) that specifies the digital projection of real or abstract objects that use Semantic Web Ontology interoperability interfaces. IO through Web services began more than 10 years ago. Interaction semantics IO is based on RDF and OWL language of ISO 15926 Internet 3.0.

2) The next step of the development of the Internet is Web 4.0, which allows network participants to communicate, using intelligent agents.

3) A new stage in the development of enterprise solutions-cloud (PaaS, SaaS) who spliced with Internet space and used to create Adaptive applications. Cloud services interact through a Web page by using agents.

4) Internet stuff (Internet of Things, Smart IoT) indicates the Smart support competing APPS using distributed micro services such as Hyper cat (mobile communications); GSM-R (for digital roads); industrial Internet (Industrial), covering the new automation concepts-smart energy, smart transportation, smart appliances, smart industry, "the clever house ", "Smart City", "medicine", etc. Apply mathematical models of processes affecting the destruction of highways (San Petersburg, Polytechnic University).

Internet 4.0 provides technological configuration and interoperability with devices handling big data and provides the transformation of Big Data in Smart Data. These lines define the perspective development of Internet/intranet in the coming years. The new platform Source smart city is implemented in "SKB-Abvent" (anfreds.sneps@gmail.com) and Moscow State University named after MGU Lomonosov (dnamiot@gmail.com). The use of the concept of Internet Smart City is represented in the works of foreign and domestic authors [25]-[30]. In [30], ISP RAS jointly with universities in Mexico and Uruguay analyzed large amounts of data in the smart cities environment of Cloud Computing. The main objective is to manage public transport using Smart IoT.

These directions characterize the development of the Internet/Intranet in the coming years.

V. TECHNOLOGIES COMPUTER SCIENCE

Abroad, the computer science (Computer Science - CS) was formed, which includes the theory and technology of creating hardware and application computing systems. The main technological directions of CS are: Computer Engineering (computer engineering or technology), System Engineering (system technology), and Software Engineering (software technology) [17]-[19].

Computer technology is based on the theory, principles and methods of building computers (frameworks, supercomputers, etc.), as well as system support for computers (OS, compilers, loaders, etc.). *System technology* is based on theory, methods and principles of construction, automated information systems, computer systems management (Computer Systems). *Software technology* is a system of methods and disciplines of planning, development of high-quality software, its operation and maintenance on an industrial basis (www.swebok.com).

Information technologies (IT) form the basis of the computer infrastructure of modern corporations, enterprises and government bodies, where various tasks of processing information of a local and global nature are being solved. Their basis is formed by *information systems* (IS) processing of information at enterprises, in management bodies and in business activities, etc. IS operating with electronic documents at all levels of government ranges from a small enterprise right up to the e-government. For example, the IS of document circulation in the sphere of education of Ukraine was made to support and exchange documents in the Academy of Pedagogical Sciences (http://lib.iitta.gov.ua/view/creators).

A. Software Assembly Technology

In the initial period of computer development, the concept of reuse or component ready-made using (CRU) elements (resources) for the development of the software industry based on the created funds of algorithms and programs in all the republics of the USSR was formed. Today they became digital libraries. The thesis of the assembly line for the production of programs from ready-made modules (1975) was formulated by Academician V.M. Glushkov. Based on this thesis, a method for assembling multilingual modules in the APROP system was developed [5]-[9], [19]-[23].

In connection with the 90th anniversary of the birth of Glushkov (2013) in KNU with the participation of students, a factory of programs and artifacts was made (http://programsfactory.univ.kiev.ua). In it, the modules are described in any PL, and the interface is in IDL CORBA. The site presents a technology for assembling heterogeneous modules using an interface, as a mechanism for transferring data between them.

This technology has become a new programming style – assembly since 1982 [6], [19], [21]. The assembly method was used in APROP and creates the TEREM system in the department of Academician Glushkov [5]. It identifies common functional components for the ES OS languages that were used to implement new translators with PL within the MAYAK [20].

B. One of Approaches to Creating New Technologies

The basis of PP production technology including Product Line USA SEI is the product lines. The approach to the development of technological lines (TL) was proposed by Lavrischeva E.M. and approved in the project of the Institute of Cybernetics of the AIS "Jupiter-470" for the navy of the USSR (1982-1991). Within the framework of this project, six TLs were created. Each of them is concretized in the form of visual structures of models of concrete forms, documents, tables and diagrams of concepts, their processes and routes. According to them, about 500 data processing programs were

implemented for different AIS objects. TL is developed by the type of nanotechnology with a technological route at the stage of technological preparation of development (TPR) [23], [31]-[32].

The route consists of a process and operations that correspond to the tasks of the domain, technological modules and a set of information, methodological, mathematical and software. They implement the operations of the process (Fig. 3).
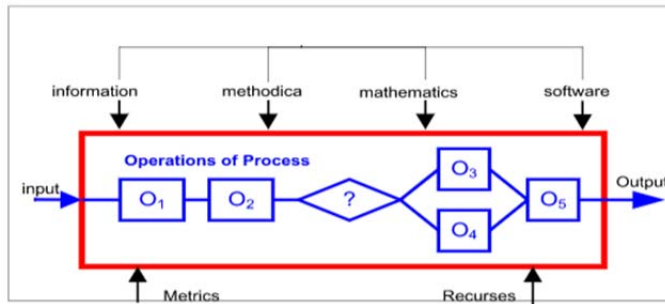

Fig. 3. Pattern of technological line

To perform operations, additional resources (modules, reuses, quality models) and tools (metrics, indicators) are selected to implement specific tasks and functions of application systems. The input of the route is the state of the intermediate element of the process, and the output is the result of the finished product.

All resources are ordered by the TL route into the structure of design decisions for the implementation and modification of individual elements [23]-[32]. The TL route is described in a special language with the used tools, technology module (TM), and workflow management techniques for performing PP building processes, checking the quality of individual technology elements and the final product (Fig. 4).
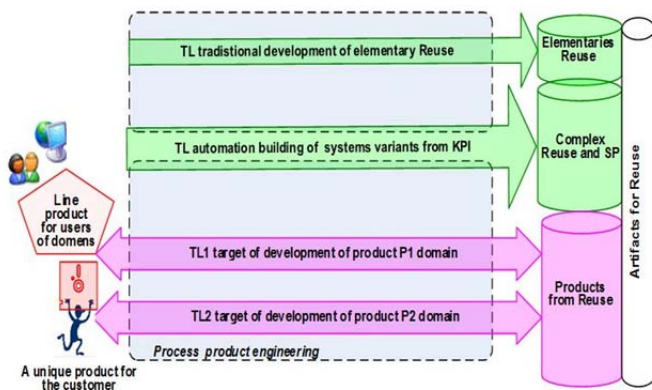

Fig. 4. A set of lines on the factory programs.

Work in this direction was conducted abroad. These include UML, DSL, Work Flow and the new process notation language is BPMN (Business Process Modeling Notation). The method of assembling programs on TL is based on the standard processes of the Life Cycle (LC) of the SS (ISO / IEC 12207- 1996, 2007 and ISO/IEC 3918-99) and special processes to meet the needs of the specifics and tasks of the domains [25]-[30], [37]-[39].

Later, in 2000, there were Product Lines) of SEI USA http://sei.cmu.edu/productlines/frame_report/). Product line and Product family (A family of software Products - FSP) are defined in the dictionary ISO / IEC FDIS 24765: 2009 (E), Systems and Software Engineering Vocabulary – "group products or services that have a common Controlled set of properties that Meet the needs of a certain Market of products". Technology Product Lines is based on the process of the domain engineering model and a process model of the following type.

The engineering domain the development of separate sets of components, reuses and assets and model their assembly to the finished product. The process model is a model of the development "for reuse" and developing with using CRU ("with reuse"). A TL and product line of SP families using CRU as products from finished small elements shortens the time and raises the quality level of individual members of the SS and their families. A set of lines (Fig. 4) form a factory of programs for the production of domains [36].

Today, the standard of notation of processes and operations (actions) of W3C BPMN lines and the method of assembling FSP families from ready-made CRUs and artifacts can be used to describe factory lines. This approach will be developed in industrial nanotechnology in relation to new types of products and substances.

C. Perspective of creating lines of computational mathematics in MIPT

At the Department of Computational Mathematics and Informatics, a portal is being developed to support the interdisciplinary sciences of the Faculty of Applied Mathematics. The discipline "Computational Geometry" will be implemented in the portal, as well as a line of biotechnology for the application of mathematical methods in medicine, biology, physics, and others [14]-[18], [23], [36].

Computational Geometry is a part of computer graphics and algebra. It is used in the practice of calculations, control of machine tools with numerical control, etc. It is also used in robotics (motion planning and image recognition tasks), in geoformation systems (geometric search, route planning), design of microcircuits, etc. The portal will have a line for producing computational tasks Geometry, which is developed and presented in [31]-[32]. In addition, MIPT is developing new methods for analyzing the Arctic Ocean and exploring the depths of the earth and the ocean [14]-[18].

In the program of teaching students of the Department of Informatics and Computational Mathematics and Optimization of Management, the course "Software Engineering" (2000-2014) is included. As part of this course, students learn the theory and methods of creating software and information systems, ISO / IEC 12207 Life Cycle, 9126 Qualities, SWEBOK, etc., as well as new concepts of Nano technologies for scientific disciplines (physics, mathematics, biology and Other). Students prepare abstracts, presentations and programs on specific issues of theory, programming technology and engineering [17], [18].

D. Assembly Line on V.M. Glushkov

"In 20-30 years there will be factories of programs that will work on the principle of an assembly line, as in Ford's automobile industry. The industry of computer programs and systems will be based on TL of conveyor manufacturing of various products: computers, systems (ASU, ASU TP, AS), software and information systems", said V.M. Glushkov in 1975 [15].

Now there are many different factories of AppFab programs from ready-made software resources in many system-wide heterogeneous environments [17], [18], [25]-[32].

On the basis of this idea, an experimental student's factory of programs and artifacts was built at the Taras Shevchenko National University with TL under the guidance of Prof. E.M. Lavrishcheva (2012). The factory is focused on the development and preservation of various artifacts of the fundamental aspects of the theories studied at the university (mathematics, computer science, CS, SE, IS, IT) [23]-[27]. Elements of the TL are represented by the ready resources of CRU and Reuses.

The program factory is an infrastructure of TL and resources (technical, software, human, organizational) for making programs from ready-made CRUs in the following steps (Theory and Practice of Software Factories, K.M. Lavrischeva, 2011, Volume 47, Number 6, Pages 961- 972):

The general sets of elements of any factory of programs are:

- Ready resources (artifacts, CRU, components, services, objects, modules, etc.).
- Specifications of CRU and interface mediator (passport data, call operations, data transfer).
- Method of development and composition of the CRU.
- Technological and product lines for the production of software products.
- CRU and other heterogeneous resources (AppFabric).
- Assembly line or production lines.
- An operating environment to support the collection and integration of SP into families FSP.

The experimental program factory was made by the students of the KNU of Tara's Shevchenko is focused on the development and preservation of various artifacts of the fundamental aspects of the theories studied at the university (mathematics, computer science, physics, CS, SE, IS, IT). Elements of TL are presented in the form of programs, CRUs, as ready resources [19]-[27]. In this factory are realized various artifacts of the fundamental aspects of the studied theories of mathematics, computer science IS, IT, and their presentation in the form of programs, CRU.

In this complex there is a set of simple lines: programming in C# VS.Net, Java, DSL; building artifacts for information and software systems with their preservation in the repository; assembling of software components into complex SP structures; transformation of transmitted data types; metric analysis and quality assessment of substations; teaching theoretical and applied aspects of SE on the e-textbook.

The ready-made CRUs are presented in the standard repository and used as functions for the transformation of the general GDT data types of ISO / IEC 11404 to fundamental FDT; ontologies of the standard ISO/IEC 12207 for the future generation of a specific version of the LC for the automated production of SP; web-service and application system. The site has been contacted by more than 135,000 users from different countries. The site has no analogue and become an important step on the way to the transition to the development of nanotechnology.

E. Ontology of ISO / IEC 12207 Life Cycle (LC)

LC received evolved from the beginning programming, with help of simplified processes for each applied subject (cascade, spiral, iterative and others models) … They formed a separate in collective of various types of software systems.

Result standard ISO / IEC 1996 were set, then in 2007 the second edition of its life cycle, which reflects the overall structure of processes that may be involved in the development of the different PS and objects. The LC processes are given in standard ISO/IEC 12207 at three categories [36]-[39]:

- basic processes for development SP;
- processes support; and
- organization processes.

In the each of processes definite types of activity (actions – activity), tasks, aggregate of results (going out) of activity and decision of tasks design, testing, assembly and others, and also tracing some specific requirements. A list of works for the basic, organizational and support processes is led in standard, but method of their implementation and form of presentation not available.

The LC standard contains description of the ancillary proceeding, that regulate the additional actions from verification of product, management by project and his quality.

The quantitative set of processes, actions and tasks of LC standard tasks led in Table 1.

TABLE I.   PROCESSES, UNDER PROCESSES AND LC ACTIONS

Classes	Process	Action	Task
Basic processes	5	35	135
Support processes	8	25	70
Organizational processes	4	14	27
All	17	74	232

The LC model can be automated with the use of specific languages, which are in class language ontology (OWL, FODA, ODM, Eclipse—DSL, etc.). The models can contain information about the union of processes and actions, including artifacts, which participate in her, and also their dependence between itself. They can also contain information about the configuration structure of the programs of treatment of processes, vehicle and program resources, necessary in case of implementation of the programs of automation of processes and their development. The description of individual processes in the OWL language is passed to Protégé 2.3, which generates the output of the process in XML [37]-[39].

VI.   PERSPECTIVE DIRECTIONS OF COMPUTER TECHNOLOGIES AND NANO TECHNOLOGIES

The development of industrial technology is paid great attention in many countries. New technologies are created software production (SP) and nanotechnology in genetics, biology, etc. leading to new quantum computers[[23]. So in laboratory quantum systems, MIPT, MISIS and MFTT wounds created Russia's first superconducting qubit – a quantum computer, which creates new possibilities for information processing. The qubit consists of several Josephson junctions – two superconductors separated by a thin insulator. Electrons can leak through the dielectric. Quantum bits can perform calculations that are not available to modern computers [40].

VII.   CONCLUSIONS

The technical and software elements of computer equipment and technology are considered from the moment of appearance of the first computers that have passed from lamp elements to microstructures, chips, crystals like atoms and molecules. Computer technology gradually developed for different areas, the elements were improved, decreased in size and approaching the Nano elements. The essence of Nano technology and approaches to the creation of manipulators of control of miniature trace elements in different fields of science (medicine, biology, genetics, etc.) is determined. The first Nano elements appeared in the first computers in the mid-19th century, as well as transistors, electron-beam elements for luminescent screens, and so on. The sizes of such elements have been reduced to nanoparticles with the specified functionality and manufacturability in order to practically use them in the processes of assembly, synthesis of new substances, mechanisms and computers for use in other types of computer devices. The analysis of the development of computer engineering in the world foreign practice, as well as

in Russia and Ukraine, etc. is given. A set of computer technologies for modern supercomputers today and in the future is given. The ways of development of the Internet in the direction of providing an interface for the interaction of information objects in an intelligent network are shown. New technological directions-cloud computing, large data and smart cities, factories, factories, etc. are presented. Computer technology includes the LC for the development of various objects, which is described by means of ontology and is proposed for use in various industries. In the future, new priority computer products appear in e-science (biology, genetics, physics, etc.), in healthcare and industry with the attraction of modern mathematical and physical theories.

REFERENCES

[1] Lavrischeva E. M. From programming techniques to computer nanotechnology programs and systems.-International scientific Congress "Information society in Ukraine -2013".-p. 56 - 60,

[2] Lavrischeva E. From information technology to nanotechnology. - USIM, No. 4, 2014.-p. 47-59.

[3] Lavrischeva E. M. Computer information technologies and nanotechnologies.- 7-th .International Conference "Dependable Systems, Services and Technologies. Dessert 2014. - Ukraine, Kiev, May 16-18, 2014.-p.100-110.

[4] Derkach V.P. Transition from electron tubes to molecular circuits and nanotechnologies. - International Scientific Journal "Science and Science" B 4 (58) b 2007. - p. 58-68.

[5] The book "V. M. Glushkov. Past looking the future. To 90 from the day of birth scientific"–Akademperiodika, 2013.-285 p.

[6] Lavrishcheva E. M., Grishchenko V. N. Connection of modules in different languages OS the IBM.–Moscow, Finances and Statistics, 1982. – 127 p.

[7] Glushkov V.M. Cybernetics, computer science, (ACS). - Works in 3 volumes. -Kyiv, Science. Duma, 1990, 262 C. 267 C, 281 C.

[8] www. crn center for responsible nanotechnology/the meaning of nanotechnology/

[9] International symposium on the contribution of Europeans to the evolution and achievement of Computer Technology. - Computer in Europe. And Future. Proceeding/ October 5-9, 1998. - Kiev, Min of Science and Technology of Ukraine.

[10] Borovkov A. I. Computer engineering. Tutorial // Borovkov A. I., Clemens O. A., Mel'nikova M. P. and others / Engineering Computing. - San-Peterburg.-2012.- Russia, Polit. UN.- 29.-93 p.

[11] Lebedev S.A. The computer BESM 6. Moscow: Fizmatgiz. 1959-1962.

[12] Korolev L .N. Computer structures and their mathematical support .- Moscow: Nauka, 1978.

[13] Lipaev V.V. Fragments of the history of the development of domestic programming for specialized computers in the 50-80s. - Sinteg. - Moscow, 2003.-126 p.

[14] Preparation F., Sheimos M. Computational geometry. Introduction. - M.: The World, 1989.- 478 p.–ISBN.5-03- 001041-6.

[15] Forrest A.R. «Computational geometry», Proc. Royal Society London, 321, series 4, 187–195 (1971).

[16] Lavrischeva K. M. Theory and practice of software factories 2011, Volume 47, Number 6, Pages 961-972.

[17] Golubev V.I., Kvasov I.E., Petrov I.B. Influence of Natural Disasters on Ground Facilities. ISS 2070_0482, Mathematical Models and Computer Simulations, 2012, Vol. 4, No. 2, pp. 129–134.

[18] Bolotskikh Y.V., Vasyukov A.V, Petrov I.B. Modelling of Dynamic Problems in Biomechanics. Math. Model. Nat. Phenom. Vol. 6, No. 7, 2011y., pp. 70-81.

[19] Lavrischeva E. M., Grishchenko V. N. Assembly programming. K.: Nauk.Dumka, 1991.-213 p.

[20] Mishenko N. M. About Assembly programming language processors". – Sonic. Intelligent information and computing systems. – To: Institute of Cybernetics. V. M. Glushkov of USSR, 1990. – p. 45-52.

[21] Lavrischeva Ekaterina. The Operating Computing Complex «Dnepr- 2» SoRuCom-2014, IEEE Springer-2015, http://ieeexplore.ieee.org/xpl/articleDetails.jsp?tp=&arnumber=7032957&filter%3DAND%28p_IS_Number%3A7032916%29

[22] Computer algebra systems of the family ANALYST. Theory. Implementation. Application. - K., NANU IMMS.-2010.-762p.

[23] Lavrischeva E. M. Software Engineering computer systems. Paradigms, technologies, CASE-tools programming.-K.: Nauk.Dumka, 2014.-284 p.

[24] [24] Lavrischeva E., Aronov A., Dzubenko A. Programs factory – a conception of Knowledge Representation of Scientifically Standpoint of Software Engineering. J journal of Computer Science, Canadian Center of Science and Education, ISSN 1913-8989, 2013, p. 21-27.

[25] Lavrischeva K.M., Slabospitska O.O., Koval G.I., Kolesnik A.O. Theoretical Aspect of management Variability in the families of Software Systems. -Vesnik KNU, seria fis.- mat. science. - 2011. - №1. - p. 151-158.

[26] Lavrischeva E.M. Theory of object-components modeling of the programs systems.- . ISP RAS, 2016 p.-52. www.ispras.ru/preprints/ /prep_29_2016.pdf/

[27] Lavrischeva E.M., Petrenko A.K. Modeling system and their families. Trudy ISP RAS, 2016, vol 28. Iss. 6, pp. 180 -190.

[28] Proudakov A.A.and others. Frameworks «AN2», 2016, p - 139.

[29] Lavrischeva EM, Slabospitskaya OA A collection of CASE- Tools for assembling variable systems from ready resources. – Sb. "Information Technology Development Technology -2015" Research Institute of Modeling and Design of Information Systems, RFFI.-p.148-179.

[30] Masrobrio R. Application of cloud computing for large-volume Data analysis // Massobrio R., Nesmachnov S., Chernykh A., Avetisyan A., Radchenko G.-Trudy ISP RAS Volume 28, issue 6, Moscow 2016.-p.121-140.

[31] Lavrischeva E.M. Fundamentals of technological preparation of the development of applied programs SOD.-Preprint 87-5 of the Academy of Sciences of the Ukrainian SSR.-1987.-30 p.

[32] Andon F.I., Lavrischeva E.M., Slabospitskaya O.A. Methodology for constructing production lines for software products and the practice of using them // International Scientific Congress "Information Society in Ukraine" (October 24-25, 2012).-Available at http://www.ict-congress.com.ua/ attachments/article/

[33] Pohl K., Böckle G., van der Linden F. J. Software Product Line Engineering: Foundations, Principles and Techniques. Springer-Verlag, 2005. DOI: 10.1007/3-540-28901-1.

[34] Lotufo R., She S., Berger T., Czarnecki K., Wąsowski A. Evolution of the Linux kernel variability model. Proc. of SPLC'10, LNCS 6287:136

[35] Fedorov I.G. Modeling of e-commerce business processes in notation BPMN 2.0. Standard ISO / IEC 19510: 2013. Moscow, 2015. - Tempus. -274 p.

[36] Lavrischeva E.M. The assembling conveyor of factories programs is the idea of Academician V.M. Glushkov. - In the Book "V.M. Glushkov. The past is directed to the future. "- Akademperiodika, 2013. - p.130-138.

[37] Lavrischeva K.M. The approach to the formal submission of Ontology-life cycle of software systems, Vesnik KNU, A series of phys.and math. sciences, 2013. – №4. – p. 140–149.

[38] Lavrischeva Ekaterina. Ontological Approach to the Formal Specification of the Standard Life Cycle, "Science and Information Conference-2015", July 28-30, London, UK www.conference.thesai.org.- p.965- 972.

[39] Ekaterina M. Lavrischeva. Ontology of Domains. Ontological Description Software Engineering Domain—The Standard Life Cycle, Journal of Software Engineering and Applications, 2015, 8, p.1-15. Published Online July 2015 http://www.scirp.org/journal/jsea

[40] Chain reaction. The Legacy of Nikolay Semenovich – well. For Science, No. 1, p. 10-13G.