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PHILOSOPHY OF COGNITIVE TECHNOLOGY

Textbook for general educational discipline

"Philosophy and Methodology of Science"

For students, listeners mastering the content of the educational program

of higher education of the II stage

For all specialties full-time and part-time forms of education

E-learning material

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The educational and methodical manual on the philosophy and methodology of science supplements the lecture material with topical issues of the philosophy of digital technologies. The section "Philosophy of Natural Science and Technology" outlines the features of the classical philosophy of technology. In the section "Philosophy, science, man at the beginning of the III millennium" the prospects for the impact of the fourth industrial revolution on the applied use of digital technologies and technological features of the functioning of digital ecosystems are analyzed development of digital technologies and the role of philosophy in the analysis of the ethical aspects of the technological modernization of modern society.

INTRODUCTION

The electronic textbook specifies educational topics in the philosophy and methodology of science related to digital technologies. The dynamics of development of these technologies is high. Previous e-learning publications have dealt with aspects of the philosophy of information, the philosophy of mind, the philosophy of digital technology, industry 4.0, and the new social reality. This electronic textbook contains a course of lectures on the philosophy of cognitive technologies. These technologies have become part of the engineering, economics and creative industries. Immersive technologies are used to solve various problems in the field of architecture and art. They have become part of social and cultural activities and education.

Metaverses have become a new modification of digital ecosystems. As a result, interaction between virtual, augmented and physical realities is being actively created. Digital twins and smart materials play an important role. Philosophy plays an increasing role in the context of new trends, as it requires consideration of new conceptual meanings that business is actively developing. The business of the Republic of Belarus is in the trend of digital transformations. The electronic textbook will be useful for undergraduates and students of the specialty "digital economy". It is important for undergraduates of all specialties to know about new modifications of digital technologies, since these technologies become part of professional competencies.

The electronic textbook systematizes research, design and institutional developments in the field of cognitive technology methodology.

Philosophy of cognitive technologies

Cognitive technologies developed by specialists imitate cognitive processes in the human brain based on mathematical modeling of these processes and endowing strong artificial intelligence with metacognitive abilities associated with self-learning. The main goal of using cognitive technologies based on artificial intelligence is justified by the importance of decision support, big data, risk monitoring, sociotechnical systems design, systems analysis and the field of robotics. In marketing, management and logistics, cognitive technologies are used for an effective dialogue with a potential buyer, based on the knowledge of the features of cognitive processes occurring in his brain.

The result of these studies was behavioral economics. For this purpose, the cognitive mechanisms of acquisition, transformation, representation, storage and reproduction of information in the brain are being studied. Cognitive mechanisms are characteristic of both the conscious and unconscious areas of the human psyche. The fundamental processes that explain cognition are realized unconsciously (universal grammar of N. Chomsky, modalities of perception). The basic assumption of the cognitive sciences is that all thought processes are certain strategies that can be learned through the verbal and non-verbal characteristics of their expression.

Any cognitive strategy available to one person can be learned and reproduced by another person. Philosophical reflection requires such properties of cognitive processes as: temporality; sociality; unity; subjectivity; structured; intentionality. Approaches to the study of these features and trends of the modern cognitive approach, as well as the methodological foundations of cognitive sciences represent a topical issue for philosophical research and reflection. The analysis of knowledge and cognition was a specific object of epistemology as one of the main divisions of philosophy. Since the end of the 19th century, cognitive processes have also been studied by psychology. It was joined by neuropsychology, sociology, cultural studies and cognitive linguistics research in the field of artificial intelligence. As a result, an interdisciplinary direction of cognitive sciences has been formed. It has integrated philosophy, logic, linguistics, psychology, neuroscience and artificial intelligence research.

Cognition is understood as a computational process and as the human subjectivity of mental representations. The theme of categorization sounded in a new way. It is understood as the process of assigning a cognizable object to a certain class, which can be not only the names of material objects, but sensory and perceptual patterns, social stereotypes, standards of behavior. Cognitive structures are studied in their relationship with the language, psychology and corporality of the subject, as well as the basic ways of ordering and classifying (taxonomy) various forms of knowledge at all levels of manifestation of a person's cognitive ability. The infinite variety of reality is covered by a finite number of linguistic forms. This aspect has become one of the central ones in cognitive linguistics, in particular, in prototypical semantics.

The understanding of language as a unity of cognition and communication, expressed through the fundamental process of categorization, plays an important role. The experience of cognitive linguistics, which explores the fundamental operation of categorization as universal in all types of cognition, provides new opportunities for a deeper understanding, including in philosophy, of the nature of categories, as well as for enriching epistemology with evolutionary themes.

This direction, formed in the epistemology of the first half of the XX century. It owes its origin to Darwinism and research in evolutionary biology, human genetics, and cognitive science. The main thesis of evolutionary epistemology boils down to the assumption that people, like other living beings, are a product of living nature, the result of evolutionary processes, and because of this, their cognitive and mental abilities, and even cognition and knowledge, are directed by the mechanisms of organic evolution. If the human brain processes cognitive information, and the processes of information processing by the brain are genetically controlled, then there are mechanisms for the feedback of the work of the cognitive system on the genes that control its functioning.

Consequently, the evolution of man, the evolution of the neural systems of his brain (neuroevolution) continues. This evolution is associated with adaptive value changes in the cognitive system of human populations, with changes in the processes of processing cognitive information. Thanks to the direct participation of genes in the performance of cognitive functions by the human brain, the achievements of cognitive evolution are consolidated in the genome of human populations. Along with psychological and cybernetic models, cognitive researchers operate with neurophysiological, linguistic and synergetic models and approaches.

Conditions for the formulation of a formal ontology have been created. The leading methodology is the informational approach. He considers reality from the point of view of information processes. Man is understood as a thinking system in the world of information. In this context, the development and application of methods of mathematical sciences, experimental and theoretical physics to the study and mathematical modeling of the human brain as a complex dynamic system is being carried out. The study of molecular, cellular and systemic mechanisms of cognitive functions of the brain in normal and pathological conditions is carried out using the methods and tools of modern neuroscience.

Fundamental and applied research is being carried out on the processes and mechanisms of behavior, intelligence, cognitive development, the organization of language systems, learning, memory and other cognitive functions in humans and animals. Developments are being made in the field of human interaction with artificial intelligence systems, new technologies and applications of interfaces between humans and robotic devices, brain-computer, brain-artificial intelligence interfaces. The search and development of promising applications, new mathematical methods and artificial intelligence technologies based on the principles of the brain. There is an application of hardware-software systems for the analysis, storage, processing of large heterogeneous amounts of data, including the fundamental principles of programming theory as applied to artificial intelligence technologies.

Artificial intelligence technologies are being developed and applied to solve the problems of managing autonomous systems, groups of autonomous objects and technological processes. The development of methods for extracting knowledge from large volumes of data of various nature, methods of data analysis, and the study of the fundamental mathematical foundations of such methods are being carried out. Human-machine interfaces are being developed that are used in children's education, rehabilitation and industrial production. Also among the competencies: human-machine interfaces, mathematical methods for processing and analyzing multichannel neurophysiological data of various nature, the dynamics of neural ensembles using models of detailing the activity of biological neurons.

The developments are based on the results of fundamental research in the field of understanding the processes occurring in the human brain during the perception, processing and assimilation of information, decision-making, as well as motor activity. And also on experimental methods for recording and analyzing brain activity, mathematical methods for processing and analyzing multichannel neurophysiological data of various nature, studying the dynamics of neural ensembles using models of detailing the activity of biological neurons. The subject was the physical foundations of self-learning adaptive intelligent systems and their application in biomorphic and anthropomorphic robotics.

As well as physical methods for assessing, training and controlling the cognitive functions of a person, taking into account his personal characteristics. For this purpose, the study of the features of the functioning of the neural network of the brain in the process of processing sensory information and solving cognitive problems using non-invasive methods for recording neural activity is carried out. There is also a simulation of the dynamics of neural ensembles using the methods of time-frequency analysis, the theory of complex networks and machine learning. A study of human biomechanics is being carried out using signals from muscle and neural activity to control anthropomorphic robots and exoskeleton elements.

Cognitive logic

The applied functions of the philosophy of cognitive technologies are related to the subject of logical research. Modern logic is distinguished by mathematization, which played a key role in the development of information technology. There was a proliferation of non-classical logical systems. This is evident in the field of intelligent systems. The concept of algorithm is formalized. The modifications were the quasi-mechanical automaton "Turing machine", "normal algorithm" A.A. Markov, A. Church's lambda calculus. A logical theory of relay-contact circuits has been developed. Experiments of computer modeling of some aspects of intellectual activity have been carried out. These are Logic Theorist, which proves logical-algebraic theorems, and General Problem Solver, which solves intellectual puzzles.

The formation of programming languages in the field of neurophysiology took place, starting with the idea of an artificial neuron by McCulloch-Pitts (the idea of relay-contact circuits) and the creation of a perceptron by F. Rosenblatt as a computer implementation of this idea. Cognitive linguistics has evolved from the logical analysis of natural language and implementations of automatic translation systems to the theory of formal languages and the discussion of upper-level formal ontologies. The possibilities of desirable correlation and mutual heuristics of cognitive science and non-classical logics are revealed. The methodological basis of the analysis is autonomous aspects of the development of logical knowledge: extralogical ones, which involve external stimuli or requests for logical research, and intrological ones, based on internal semiotic and metatheoretical resources for the self-development of logic. The conceptual distinction between the cognitive process of reflection, inference, decision-making and the logical system of premises and conclusions is taken into account.

The logical approach to cognitive research forms the subject matter. It constituted conceptual connectomics (non-standard architectures of formal neural networks, non-classical perceptrons) and cognitive ergonomics (scales of complexity of intellectual tasks; empirical studies of logical thinking).

Intrological aspects of nonclassical logics have a significant potential for cognitive logical research. These logics are characterized by the absence of rigorism: uncertainty, non-formalizability, non-compositionality, non-monotonicity. A special area is formed by Fuzzy logic and multi-valued logics, non-compositional semantics, non-monotonic logics and logics with modifiable reasoning. We can highlight the tolerance for contradictions and incompleteness of information of paraconsistent, paracomplete logics, as well as variations of relevant and connexive logics. There is a predominance of non-deductivity. Logical theories of plausible reasoning: inductive, abductive, procedures for establishing causal connections, putting forward hypotheses, drawing analogies.

Context dependence and intensional semantics of epistemic logics, deontic logics and action logics are taken into account. The mutual heuristic value of cognitive science and logical-semantic research is observed in the empirical studies of aspects of logical thinking implemented jointly by logicians and neurophysiologists. The development of semantic methods of non-classical logics has a serious potential for modeling the fundamental principles of thinking.

Cognitive technology systems

Cognitive systems can support three types of tasks. This is the automation of business processes, obtaining knowledge based on data analysis and interacting with customers and employees. The most common were systems for automating the administrative and financial work of the back office using robotic processing technologies. It is the main environment for automating business processes. In this environment, a robot (a program on a server), like a person, exchanges information with several IT systems at once. Data is transferred from e-mail and call center systems to databases, for example to track a change of address in a customer's file or save a request for additional services.

There is a replacement of lost credit and debit cards with message processing and subsequent updating of customer data in several systems; reconciliation of refusals to pay for services through billing systems with the search for information in various types of documents; "reading" legal and contract documentation to extract solutions using natural language analysis. The applications in question are not programmed to self-learn and improve.

Robots are especially good at projects that link multiple IT systems. Replacing administrative staff was not the main goal. Only a few projects resulted in the release of staff. Robots were given tasks that were previously outsourced. Automation projects will be accompanied by layoffs in offshore outsourcing companies. If a task can be outsourced, then it can be automated.

Cognitive insights use algorithms to identify and interpret patterns in vast amounts of data. This is analytics on steroids. Self-learning systems are used by businesses to predict what a particular customer is likely to buy in the future; real-time detection of credit card and insurance fraud. And also to analyze warranty repair data to identify problems with the safety and quality of cars or other products; automation of personalized targeting of digital advertising; building a more accurate and detailed actuarial model for insurers.

Cognitive decisions based on identified patterns differ from traditional analytics. They are informative and detailed. Cognitive digital technologies are usually trained on some piece of data. They develop the ability to use new data, make predictions, and categorize objects.

Deep machine learning, which tries to mimic the way the human brain works, recognizes images and understands speech with patterns. The program itself can present new data that improves analytics. Thanks to self-learning algorithms, it has become easier to find information that is associated with the same person or company. Companies use cognitive digital technologies to extract terms from contract texts. This allows most of the documents to be audited without proofreading by a human auditor.

Interaction systems are focused on natural language communication using chat bots, intelligent agents and machine learning. These are intelligent agents that serve customers and solve a wide range of problems: from password recovery requests to technical support. Communication takes place in natural language. These are internal sites for answering employee questions about IT, employee benefits, or company policy; products and recommendation systems for retailers tuned to improve the personalization of the offer and communication with the client and increase sales with rich language and visual aids; recommendation systems for physicians in case management: assistance in the development of individual plans that take into account the state of health and previous treatment of the patient.

Firms have become easier to transfer the functions of communication with customers to a computer program. The robot agent is included in communication with people. Avatar Amelia is used for IT support of employees. It is also integrated into customer support. This allows you to cope with the increase in the intensity of communication between the company and customers without additional hiring. Some organizations plan to outsource routine communication to robots, leaving help desks with the more complex tasks of customer issues that require management intervention, unstructured conversations, or alerting customers of a risk before they call and report a problem.

In the course of interaction with employees, the program learns itself. It identifies frequently asked questions, previously resolved issues, and links to documents to help with the answer. This is a sign of belonging to the category of cognitive insights. Smart routing is used to forward complex problems to humans, and natural language interfaces are characteristic of cognitive communication technologies. Experience with cognitive tools is expanding, but companies are facing significant barriers to delivering projects. In this case, methodology and artificial intelligence play an important role.

It is necessary to understand what types of IT are suitable for solving problems, to understand the advantages and disadvantages of each class of software. Expert systems and process automation programs are incapable of learning and improving. Deep learning is suitable for exploring large amounts of labeled data, but it is rarely possible to understand what model it analyzes them from. Operating in black box mode can be a major problem in heavily regulated industries such as financial services, as the regulator often wants to understand why a particular decision has been made. Much depends on specialists who know statistics and understand big data enough to understand how cognitive systems work. The main success factor lies in the desire of employees to learn.

Let's consider actual cognitive technologies. Computer vision refers to the ability of a computer program to recognize objects, scenes, and actions from images. Computer vision technology uses sequences of image processing operations and other techniques to divide image analysis tasks into small, manageable tasks. Some technologies can detect the edges and textures of objects from images. Classification methods can be used to determine if the identified features can represent a class of objects known to the system. Thus, the analysis of medical images is used to improve the prediction, diagnosis and treatment of diseases, Facebook identifies faces to automatically recognize people in photographs. For security and surveillance purposes, it is used to identify suspects, in purchases, for consumers. You can use your smartphone to take a picture of the product and get more buying options.

Machine vision is used in the field of industrial automation. In these applications, computer programs recognize objects such as manufacturing parts in harsh manufacturing environments. The goal is simpler than computer vision, which tends to work in an unrestricted environment. Computer vision startups have raised hundreds of millions of dollars in venture capital.

Machine learning refers to the ability of a computer system to rely on data to improve its performance without following the program's explicit instructions. It automatically detects patterns from the data, and once the patterns are found, they can be used to make predictions. If a machine learning system is provided with a database of credit card transaction information such as transaction time, merchant, location, price, and whether the transaction is legitimate, the system will learn patterns that can be used to predict credit card fraud.

Machine learning has a wide range of applications for activities that generate huge amounts of data. It has the potential to improve performance. In addition to checking for fraud, sales forecasting, inventory management, oil and gas exploration, and healthcare are carried out. Machine learning technology plays an important role in areas of cognitive technology such as computer vision. It can continuously train and improve visual models in massive images to improve the ability to recognize objects. Machine learning has become one of the current areas of research in the field of cognitive technologies. It has raised about one billion US dollars in venture capital.

Natural language processing refers to the human text processing capabilities that a computer program has, specifically to extract meaning from text. It automatically interprets meaning from readable natural style and grammatically correct text. The natural language processing system does not understand how people process text, but it can process text through complex and thoughtful means, such as automatically detecting all the people and places mentioned in a document, identifying the document's main problems.

Natural language processing, like computer vision technology, combines many technologies that help achieve goals. Thus, the creation of a language model to predict the probability distribution of a language expression is the maximum probability that a given string of characters or words will express a certain semantic meaning. The selected elements can be combined with certain elements in the text to identify a piece of text. By identifying the elements, one can distinguish a particular type of text from other text such as spam and regular mail. Machine learning-based classification methods will become the selection criteria used to determine if a message is spam.

Areas of practical application of natural language processing technology include customer analysis. Feedback on products and services, automatic detection of certain values in civil litigation or government investigations, and automatic writing of formal essays such as corporate income and sports.

By combining machine vision, automatic planning and other cognitive technologies into high-performance sensors, actuators and intelligently designed equipment, developers have created a new generation of robots that can work with people. They can handle various tasks in an unknown environment.

In human-machine systems, the focus is on the automatic and accurate transcription of human speech. There are difficulties created by different accents, background noise, and distinguishing between homophones and heteronyms. So, "buy" and "by" sound the same. You also need to have a working speed to keep up with your normal speech speed. Speech recognition systems use some of the same technologies as natural language processing systems, supplemented by other technologies. Such as acoustic models that describe sounds and their likelihood of occurring in certain sequences and languages. The main voice recognition applications include medical dictation, voice recording, computer system voice control, telephone customer service.

In the field of view are database management systems, text search technologies and computer networks. A systematic idea of the methods for solving combinatorial optimization problems has been formed. This is the study of the main types of combinatorial objects and data structures suitable for their representation; mastering the concept of the complexity of the algorithm and the complexity of the classification of tasks; familiarity with the main types of efficient algorithms; mastering enumeration algorithms and methods for reducing enumeration.

Basic structural models of various types of images, algorithms substantiated within the framework of these models, formal accuracy criteria and problems of human-machine interface are considered. A mathematical apparatus for image analysis and processing has been developed. Algorithms for processing, visualization, restoration, analysis, comparison, comparison, normalization and compression of images are applied. A methodology has been developed on the problems, methods, algorithms and tools used in the creation of systems for automatic synthesis and speech recognition.

The means of representing the speech signal are used; tools for creating speech databases and methods for working with databases, as well as approaches to building systems for the synthesis and automatic speech recognition. The conceptual apparatus of the mathematical theory of technical vision is used. These are methods of projective invariant form analysis, as well as models and methods of color analysis that are invariant to lighting conditions (color constancy algorithms).

It is not technology that enters the market, but products. Their success depends on the quality of execution. It is achieved by software systems quality assurance technologies, software optimization methods using the features of computing equipment, including specialized and exotic ones. The main attention is paid to the issues of optimization of the main operations used in the problems of processing and recognition of signals and images.

Cognitive computing

This is a complex of disciplines for the analysis of multiple data, such as: pattern recognition, natural language processing and emotion recognition. These are computer technologies that are focused on reasoning and understanding. It is an ability that can surpass a person's cognitive ability to make decisions in complex situations. AI's cognitive computations are based only on input, not on their own perceptual experience. The lack of experience affects the limitedness and output results.

Cognitive computing can work with huge amounts of data. With the help of analytical tools, this technology simplifies the process of making complex human decisions. It will make it easier for artificial intelligence with cognitive computing capabilities to make strategically important decisions in complex situations. So far, the technology of multitasking large-scale artificial intelligence has not been created, which would solve decision-making problems based on numerous different technologies.

One of the fundamental tasks of cognitive computing is the analysis of feelings in order to understand the context and nuances of the data entered by the user and the full semantic load used by him. AI can recognize the main emotional manifestations of a person by biometrics, gestures, voice tone, and behavior. Cognitive computing is an artificial intelligence technology. Where AI is becoming an integral part of the adoption of other technologies, cognitive computing plays an important role in transforming behavioral processes.

At the same time, AI and cognitive computing will use different approaches to make decisions based on data. Cognitive Computing acts as an adjunct for making more informed decisions. AI and cognitive computing deal with large datasets. After analyzing the data, the AI will suggest the best measures to take to solve the problem. Cognitive computing extracts valuable information to support decision making. As a result, cognitive computing helps a person to make a final decision.

Cognitive Computing technologies provide flexibility, learning, assessment, management with more efficient methods of business development. IBM Watson Cloud Services offers cognitive computing tools in various business areas, embedding them in enterprise applications and programs. This is a call center service with realistic question and answer customer service, using linguistic recognition and human speech perception. By processing unstructured data, providing forecasts, charts and business recommendations, it increases the profitability of the business. Recommendations for the implementation of an effective marketing policy of the enterprise can be issued.

Cognitive technology can provide multi-polar computing for all business development areas, giving an assessment of the profitability of companies. In this context, digital anthropology and cognitive semiotics are in demand. They contain intelligent and cognitive methods for data and image analysis; intellectual and cognitive technologies in the study of weakly structured systems; distributed and multi-agent data and image processing systems; applied systems for intellectual and cognitive analysis of data and images.

There has been an intellectualization of the solution of applied problems in the construction of automated information systems. Intelligent methods and systems in robotics have been developed.

Cognitive systems can be managed with any data arrays, forming assumptions and drawing certain conclusions. Such systems are not hard-coded. They can interact with the environment, including humans, based on their own judgments and conclusions. For cognitive systems to reach their full potential, people need to trust their recommendations, judgments, and conclusions.

Cognitive Technology Trends

Several trends have emerged in the field of cognitive technologies. The first trend is hybrid decision support systems. Their principle of operation is based on the joint iterative solution of a complex problem by a human and artificial intelligence. Human and artificial intelligence can simultaneously show their strengths, which allow you to achieve a better result than separately. Such technologies are needed in situations where the problem being solved is difficult for human perception.

Among the trends are the generative design of sociotechnical systems, composite technologies of automatic machine learning for human understanding, but on non-human logic, metrological cognitive technologies, when strong artificial intelligence talks about the quality of weaker artificial intelligence, and avatar-like technologies. Among them are partner robots for children with the function of monitoring the child's condition.

Among the trends are cognitive platforms. This technology is not without drawbacks. But intelligent systems have the ability to learn and adapt to changing conditions. As a result, the cognitive platform improves performance without requiring manual coding. She has the ability to know. It is important not to confuse the cognitive process of cognition with recognition. Multimedia encyclopedias may provide some knowledge. But knowledge and cognition differ in that cognition is a process, and knowledge is the result of this process. Cognition allows you to solve an arbitrary set of tasks without limiting the intellectual needs of the user with the capabilities of software packages.

Cognitive decision attempts to emulate human thought by engaging in context-sensitive problem solving. A cognitive computer can give advice and even recognize the nuances of problems, which puts it on a level above computer programs that automate the execution of functions. The skills of a conventional AI platform are enough to monitor a patient's heart rate and breathing, control the level of anesthesia, or operate a scalpel during remote surgical intervention. The cognitive assistant can analyze the patient's picture of the disease and prescribe procedures and treatments by analyzing a huge number of medical journals and projecting this knowledge to a specific clinical situation.

Cognitive technology can choose answers from a variety of options, guided not by algorithms, but by logic, rationality, using the techniques of cause-and-effect analysis and experience. To achieve this level of reflection, we need data from the field of neuropsychology. To achieve the ability to make high-level decisions, the intellectual platform will have to go through all the stages of maturation of the human brain. It will take a lot of time to develop such platforms. They have huge computing resources, but have not yet learned how to look for answers without built-in patterns.

In the future, business cognitive technologies will turn enterprises into functional cognitive units that will have the ability to exponentially learn and continuously optimize. Block chain, the Internet of Things and 3D printing will put cognitive companies in a better position. It will be possible to talk about the benefits of cognitive computing when they turn into a practical technology with specific functions. These include predictive support: a huge set of behavioral equipment models that can be used to predict failures in both digital and mechanical systems; interdependent analytics: establishing a relationship between system events to search for both current and potential problems; dynamic search for ways to improve performance; self-healing/offline error correction: automatic recovery of critical infrastructure, applications, and software using a combination of automated tooling, analytics, and end-to-end recovery; management of self-learning systems: providing real-time data; access to relevant information, tools, templates and other resources; "smart" agents: intelligent virtual assets that can detect and respond to internal and external threats and, if necessary, bring the enterprise into an autonomous and controlled state.

While the neurochemical processes that contribute to the process of thinking are not fully understood, therefore, cognitive systems are forced to emulate human intelligence through high-level algorithms. Algorithms can be disassembled into code, analyzed and reassembled, ensuring that cognitive technologies are what they say they are.

Cognitive technologies are achievements in the development of the theory of self-organization, computer information systems, neuroscience and other scientific areas. Cognitive informatics is an interdisciplinary study of cognitive and information sciences. It explores the mechanisms and processes of natural intelligence and their engineering applications using an interdisciplinary approach (artificial intelligence, modern computer science, computer science, artificial intelligence, cybernetics, cognitive science, neuropsychology, medical science, philosophy, formal linguistics and life sciences). Cognitive science distinguishes knowledge representation systems of three main types: rule systems - concepts and procedures encoded in the form of rules of the action condition type. This type is most often used in industrial expert systems; semantic networks - connection by a complex network (genus - species, part - whole, logical and functional connections); structures of relations - knowledge, the most popular is the theory of frames by M. Minsky.

A theory is some kind of information on the basis of which a person makes predictions, and also correlates his behavior. Much attention is paid to the cognitive approach to the understanding of natural language, computer translation, the problems of computerization of society and the theory of artificial intelligence. The cognitive approach can be seen as a springboard to overcome the invisible barriers that often arise between people who speak and think in different languages. After the Second World War, with the rapid development of cybernetics and computer technology, the first thinking machines appeared, trying to solve logical problems, play chess, understand spoken and written speech, translate it into other languages, forced to take a fresh look at the processes of thinking, cognition and understanding.

Cognitive modeling

The experimental study of high-velocity flows is extremely complex and expensive. To reduce the design time and the number of expensive full-scale and bench experiments, specialized computer systems Knowledge Based Engineering and Computer Aided Design are created. Traditionally, modeling uses mathematical models based on the physics of processes and describing the physical processes and phenomena that occur during the operation of an object. In aerohydrodynamics, these phenomena are described by complex differential and integro-differential equations in partial derivatives (for example, boundary value problems for the Euler, Navier-Stokes, Reynolds, Boltzmann equations).

For such equations, as a rule, neither the existence and uniqueness theorems for the solution, nor the nature of the dependence of the solution on the parameters and boundary conditions are known. The numerical methods used have a significant computational complexity, both for the calculations themselves and for the preparation of the initial data describing the option for constructing the object, and the computational grids. This significantly reduces the possibility of using accurate models, especially at the preliminary design stage, where a large number of solutions are considered and the price of an incorrectly chosen solution is high. In the limiting case of a free molecular flow, the collision integral in the Boltzmann equation vanishes, and its general solution is a boundary distribution function that is preserved along the particle trajectories. Determining the boundary conditions on surfaces flown by a rarefied gas is one of the most important problems in the kinetic theory of gases.

The study of gas flows in the transition region between the flows of a continuous medium and a free molecular one is a rather complicated problem. The complexity is due to the fact that the description of these flows goes beyond the scope of ordinary gas dynamics and requires taking into account the molecular structure of the gas, for which it is necessary to solve the Boltzmann equation. When modeling natural conditions of the main Reynolds similarity criterion, it is necessary to maintain a number of other similarity criteria.

Physical and mathematical models based on the cognitive approach are being developed. Such models are built on the basis of scientific and intuitive analysis of the database obtained through theoretical, experimental, numerical studies conducted with various objects of the class under consideration. Models built in this way imitate both data sources based on some initial model, and the models themselves, created on the basis of studying the physics of processes.

Engineering methods based on cognitive approaches have been developed. They enable prediction.

To solve problems of multidisciplinary optimization, it is relevant to study and develop methods based on the use of systems with artificial intelligence. We can conditionally distinguish four main approaches to the construction of intelligent systems (neural networks, fuzzy logic, expert systems and evolutionary algorithms). A distinctive feature of all these approaches is that, unlike standard deterministic methods, they use the ideas of modeling the work of the brain, the mechanism of human decision making. Each of these methods has its own characteristics. An important feature of artificial neural networks is that, due to their design features, they allow us to successfully solve problems with a large number of variables without requiring a large amount of computing resources.

Cognitive architectures

In the development of cognitive technologies, two prerequisites are important - firstly, a sufficient computing base has appeared for the implementation of complex cognitive tasks and, secondly, mathematical methods have been developed for both ascending and descending paradigms of artificial intelligence. Artificial intelligence technologies solve such basic cognitive tasks as pattern recognition, search for hidden patterns, and decision making under uncertainty. Problems such as interpretation of the received data, diagnostics of one's own state, monitoring of the state of the control object, modeling and forecasting the future states of the control object and one's own, planning a response to future states, self-learning and learning with a teacher, control in various modes, decision support are solved in emergency cases. A system of strong artificial intelligence will be able to independently develop and implement a plan for solving a given problem based on the ability to self-learn and with access to the body of human knowledge.

Scientists and engineers working in the field of strong artificial intelligence are currently focused on so-called cognitive architectures. This general presentation of principles and solutions is possible in separate aspects. A large number of cognitive architectures of strong artificial intelligence have been developed and proposed, most of which are based on the study of the properties and functionality of the human brain and central nervous system. The anthropocentric approach provides researchers with a basis for developing strong artificial intelligence systems. Borrowing principles from nature will allow you to find the correct direction of research, which can later be expanded to new principles.

Planes, helicopters and rockets fly through the air differently than birds do. The principles of bionics are suitable for constructing cognitive architectures for artificial intelligent agents of a general level. An important role is played by the description of the principles of the hybrid paradigm of artificial intelligence, the bionic principles for building an artificial intelligent agent of the general level and the description of the updated architecture for artificial intelligence of the general level. Since the founding of artificial intelligence as an interdisciplinary field of research in 1956, two paradigms of artificial intelligence have been formulated: bottom-up and top-down.

The first is focused on modeling the basic elements of the biological substrate that forms the basis of human intelligence - neurons. The second paradigm emphasizes high-level modeling of pure cognitive processes in an attempt to create intelligence. Both paradigms of artificial intelligence have significant problems. If we talk about the ascending paradigm, then the artificial neural networks developed within its framework have a significant drawback. Their decisions are extremely difficult to interpret. And the more serious tasks a trained neural network can solve, the less interpretable are the principles of its operation. The problem boils down to the fact that the rules for approximating an arbitrary function given by a table are built by a neural network in the process of machine learning in a way that is not obvious to human understanding.

The top-down symbolic computing paradigm has a serious problem. It lies in the high complexity of learning systems based on knowledge. Retraining knowledge-based systems to constantly update from knowledge bases is an expensive process. At the same time, universal symbolic systems with the possibility of learning in the process of their functioning have not yet been developed. Such a system could become a strong artificial intelligence system. Decision-making by knowledge-based systems is transparent and easy to interpret. Combining the approaches and methods of the ascending and descending paradigms into a single scheme will solve the problems of both paradigms, leaving only their best sides.

The scheme of operation of an artificial intelligent agent with hybrid architecture is based on a cyclic repetition of the process of perceiving information from the environment, processing it by sensory neural networks, making a decision using a symbolic universal inference machine, and transferring the decision to executive devices for interacting with the environment through a motor neural network. This scheme allows leveling the negative aspects of both paradigms. Recognition of images and situations in the context at the lower level using the methods of the bottom-up paradigm has the ability to quickly retrain for various situations in which an agent built on this architecture can be used. At this level, interpretability is not required, just as it is not required to know how a person recognized an object in the pixels perceived by his retina.

At the decision-making level, through the operation of a symbolic universal inference machine, interpretability appears on the basis of knowledge transferred to a cognitive agent. The main problem of the approach within the framework of the hybrid paradigm is the transition from the architectural view to the implementation. At this level, developing a functioning prototype is not a problem. But its scaling to a universal solution from a practical point of view encounters difficulties. The main one is the complexity of learning a cognitive agent.

To create an artificial intelligent agent of a general level, the hybrid architecture of artificial intelligence lacks an essential characteristic that the human mind has. This is the problem of understanding the situation in which the agent finds himself.

Bionics involves the application of principles, approaches and working solutions found in wildlife to the design and implementation of technical systems. Multisensory integration reflects the ability of an intelligent agent to perceive the environment using a variety of sensor systems of various modalities and build on this basis a holistic description of the surrounding reality, including in a dynamic mode that is, taking into account the short-term and long-term history of observed events.

The mechanism of multisensory integration underlies the formation of personality in the process of growing up and learning. Multi-sensor integration for artificial cognitive agents will solve the problem of symbol binding. Feedback from the decision subsystem to sensors for predicting perception reflects the receipt of a reverse information flow to sensors and pattern recognition mechanisms from the prediction subsystem to optimize the recognition process. This process is based on Bayesian mechanisms for predicting what will be recognized by the sensory system, which is used to reduce the computational load on the sensory and associative areas of the cortex.

This process allows you to keep the recognizable images in dynamics and solve the problem of continuous identification of objects. This is a question of the continuous identity of the observed objects of the surrounding reality, especially in conditions when the observations themselves are interrupted. The personal memory of a cognitive agent reflects the mechanism that determines the processing of the context of the situation in which the cognitive agent is located. The personal memory or life experience of a cognitive agent collects the situations he has been in and how the agent acted in them. This forms the agent's ability to have special meanings for the characters used, which makes its private symbol system flexible for contextual decision making.

Goal setting is considered as an independent setting of goals by an intelligent agent based on its desire to minimize losses and maximize its benefits. The goal-setting mechanism of living agents is often based on the emotional subsystem as an asynchronous signaling. Emotional goal setting is important for the design of artificial intelligent agents that can independently decide which task and how to solve it.

The resolution of internal conflicts reflects a mechanism that allows an intelligent agent to choose a behavior pattern for practicing planned actions in conditions where different patterns lead to different results with different levels of rewards. This problem is solved in the framework of reinforcement learning. For living intelligent agents, this process can have irrational properties, when the chosen course of action is clearly not the best way to respond to the situation. This problem has yet to be explored from the point of view of behavioral psychology and sociology.

Consider examples of architectures that have been developed to solve a variety of problems in the field of artificial intelligence. J. Hawkins proposes a low-level architecture for a general-level cognitive agent. It corresponds to the cortical columns in the human cerebral cortex. The low-level architecture makes it possible to assemble an artificial intelligent agent for solving an arbitrary cognitive task. It can perform symbolic calculations. R. Kurzweil describes a similar architectural solution. It is based on pattern recognition and prediction. An image broadly refers to any situation in which an intelligent agent may find it. The solution uses feedback from the predictive subsystem to the sensory subsystems. In this cognitive architecture, one of the central roles is assigned to probabilistic processes that occur during pattern recognition by the biological brain.

S. Shumsky proposes a cognitive architecture for building an operating system for robots. It combines supervised learning, unsupervised learning, and reinforcement learning. All types of machine learning are used simultaneously to solve various tasks facing an intelligent agent at different levels. Within the framework of cognitive architecture, a description is given of sparse coding, which is used in the cortical columns of the human brain to represent general and contextual knowledge and facts.

P. Anokhin developed the theory of functional systems, within which he gave a description of the cognitive architecture of a living intelligent agent. This is a high-level architecture based on functional systems that provide homeostasis of the body at the basic level of physiology and at the behavioral level. A feature of this architecture is the presence of several feedbacks from the decision-making center to sensory and motor subsystems, as well as the inclusion of goal-setting and satisfaction mechanisms in the architecture. The general process of cognition can be described as follows. Various sensory systems of an intelligent agent receive signals from the environment, as well as predictive signals from a proactive control subsystem. Based on the actually perceived and expected images, recognizable images are formed, which are sent to the reactive control subsystem and to the multisensory integration center.

The reactive control subsystem causes an instantaneous reflex reaction of an intelligent agent in cases where the rule for excitation of such a reaction is present in its structure. If there are no response rules, then attention to the perceived situation is escalated to the proactive control subsystem. If a response rule exists, then it is executed through the action result acceptor. The Multisensory Integration Center builds a complete description of the perceived situation in the intelligent agent environment and sends it to the proactive control subsystem. The proactive control subsystem interacts with the base of general knowledge and personal experience of an intelligent agent, obtaining from them the necessary meaning of the perceived situation and recording new knowledge obtained by the agent as a result of obtaining information from the environment.

This control subsystem uses the cycles of interaction with the mechanisms of emotional goal-setting and conflict resolution to make the final decision about the program of the agent's behavior in the perceived situation. For this, a dynamic model of the environment and the agent itself is used, which is part of the proactive control subsystem.

The final decision is sent for execution to the action result acceptor, and is also transferred to the reactive control subsystem for the subsequent instantaneous reaction of the agent to similar situations. The acceptor of the result of the action receives the decision and implements it through the executive mechanisms of the intelligent agent that act on the environment. In the acceptor, a mode of waiting for the result of the execution of the behavioral program is formed, which is satisfied when the result is received. In this case, reinforcement learning mechanisms should fix the executed program in the base of the agent's personal experience as good.

Internet of Things and Artificial Intelligence

The Internet of Things is represented by a network of electronic devices that communicate with each other. Artificial intelligence is the coordinator of this network. The Internet of Things generates large amounts of data that are designed to be stored and processed in the cloud. Artificial intelligence includes machine learning, neural networks, algorithms, computer vision, syntax recognition, natural language processing, context-sensitive computing, data analysis and interpretation, and automation. The goal of artificial intelligence is to learn how to work like the human brain with a practical economic effect. These effects are motivated by growing requirements for the frequency of business process adaptation to meet market conditions; the need to reduce the load and costs of processes; new requirements for the accuracy of planning activities and forecasting external factors, better work with risks; an increase in the amount of heterogeneous data and the need to increase the speed of decision-making based on them.

And also, the need to improve the quality of work with customers and increase their loyalty; to reduce human involvement in routine tasks and especially to increase labor productivity by automating processes (robotics).

Many solutions are adapted for cross-industrial use. These are filtering and prioritization of received messages/requests/news; digitization of traditional media (translation of handwritten text, audio recordings on traditional disks and cassettes and physical images into digital modification); analysis of unstructured data for the purpose of their classification and indexing.

And also, text analytics, intelligent image recognition in a data stream in order to control information leaks; video identification and smart video surveillance; CRM solutions; virtual assistants and consultant programs: chat bots, question-answer systems, voice technical support programs and hotlines; formation of an electronic dossier of the client.

In retail, there is a formation of customized offers to the client in real time, operational monitoring of media and social networks, determination of the most effective channels of marketing communication and independent formation of marketing messages by AI.

In medicine, there is a generation of scenarios for the disease, treatment and subsequent monitoring of the condition of patients, as well as the development and selection of drugs.

In the investment and financial sector, there is the development of an individual investment portfolio, taking into account the available investment amounts, optimal proportions of risk and return, credit scoring, analysis and investigation of cases of financial fraud.

In telecom companies, AI optimizes the line of tariff plans, uses speech recognition to improve communication with customers. Industrial companies are using AI to predict equipment performance, optimize energy use, increase machine productivity, and eliminate human error. The public sector uses software to protect intellectual property and state secrets, monitors and responds quickly to emergencies.

Multifunctional solutions include: intelligent data search and processing, automated sorters, digital assistants, risk management programs, HR programs (search, selection and talent identification), targeting, navigation and forecasting. There are difficulties: first of all, it is the cost of solutions; the security of data and commercial information is also a big question. With the natural increase in transmission speed and data volumes, this is a particularly acute issue.

Big barriers to the implementation of solutions based on cognitive technologies are the lack of technological resources and the necessary skills among specialists. This problem is partially solved by using ready-made integrated solutions and adapted technologies. Most companies are not aware of the existence of these solution providers on the market, and therefore do not use their capabilities properly.

Due to the fact that cognitive technologies seem incomprehensible and complex, many do not trust either them or specialists. Development of solutions by internal forces and resources seems more efficient for most. Such caution prevents the AI market from reaching its full potential. The integration of efforts and the economy of trust and sharing will help to break this stereotype.

Businesses are looking to invest in AI-powered applications and storage hardware. AI-powered cloud services enable companies to take advantage of AI in end-to-end turnkey solutions.

About half of the companies that work with AI to create new products and added value use cloud-based tools to develop and deliver new solutions to the AI market. System integrators are interested in the development of technology, as it is a powerful driver for their business too. Cloud acceleration creates a support for the development of cognitive technologies, both in small and large businesses. Artificial intelligence as a service enters the market. And if holdings can cope with outsourcing or even insourcing, then startups need a guide that will help attract the attention of the market.

Luddites and job market prospects

The Luddism movement originated in the 18th century. Industrialization devalued the work of specialists. Now even women and children could work. Anyone could be trained to operate the machines, and new workers were paid less. Factories and factories were built. Their owners were rich. Economic inequality grew.

Home workers in textile factories were the first to feel the threat from mechanization. In 1768 they attacked the workshop of J. Hargreaves, the inventor of the spinning machine, and broke his looms. In 1792, Manchester workers burned down the factory with the wool carding machines of the inventor and entrepreneur R. Arkwright. With the advent of machine tools, it was not necessary to study for seven years to weave. This work could now be done for low wages by children.

A huge number of illegal workers began to force out licensed weavers. In 1811 hosiery owners in Manchester began receiving threatening letters from "King Ludd". He demanded that entrepreneurs get rid of machine tools. People who opposed the technological process began to be called Luddites. Some people saw the problem in capitalism. Causing damage to industrial buildings and inventory, they dealt a blow to entrepreneurs.

Workers engaged in sabotage, staged strikes and even killed their employers. The centers of Luddite activity were the counties of Nottinghamshire, Lancashire and Yorkshire. They attacked businesses at night.

From 1811 to 1813 the Luddites destroyed a thousand lathes. The UK government has passed a law to tighten measures against industrial sabotage. More than fifty people were hanged. Some were sent to a labor colony in Australia for

14 years. The result of the Luddites was the creation of trade unions and a growing skepticism towards technology.

The intellectual elite was shocked by this attitude towards the protesters. The brutal suppression of the Luddites triggered a backlash in culture and became one of the factors in the development of romanticism. Romanticism was wary of technology. J. Byron sang the Luddite movement with the hymns "Songs for the Luddites". S. Bronte dedicated the novel "Shirley" to them. The mechanization of labor created more and more unemployment. Working days of 12-14 hours force some to resort to alcohol and drugs.

There are also risks in residential areas. Data collection solves many problems in rapidly urbanizing metropolitan areas. Using sensors, they collect and process information about the state of traffic jams. But there is a factor influencing the abundance of cameras and sensors on the privacy of citizens. The precedent set a conflict related to the smart neighborhood in Toronto. The reason was the disagreement of the developers with the requirement of the developer, who wanted the data to be used by trusted persons. The problem is that such cities can be hacked. This was shown by C. Cerrudo.

The neo-Luddites don't like nuclear weapons and the numbing of youth by digital technology. J. Mander believes that due to the abundance of conflicting news, the human brain gets tired. After such processing, the user can be inspired with anything: from political slogans to advertising unnecessary things. Clip consciousness gave rise to an orientation towards multitasking.

T. Rozzak believes that due to the huge amount of information, people have ceased to understand complex ideas and experience the deep experience necessary for growing up and maturation of the individual.

J. Lanier believes that social networks suppress the mind and willpower and, armed with science, feed advertising to the human brain. It is easy to become a hostage of social networks if you do not realize the power that algorithms have over user behavior.

It is important to minimize the growing disproportion between the capabilities of artificial intelligence and the lack of skills of the human factor. The problem was the lack of qualified personnel to perform various tasks. Employees arriving at the site for the first time include tablets with specialized software installed and connected to cloud services.

They can get comprehensive information about the technical problem that has arisen, about previous work, as well as safety recommendations. By pointing the tablet's camera at the equipment, they receive step-by-step instructions and recommendations on how to perform the work on top of the image of a real object on the screen, including the ability to launch training videos. Each operation performed is confirmed, which allows control centers to control the quality and completeness of the work performed. In this context, the study of the human brain remains relevant.

The human brain and its semantics

Methods such as ultrafast functional magnetic resonance imaging and dynamic causal modeling make it possible in a completely non-invasive mode to restore the picture of cause-and-effect interactions of human brain structures when solving various problems and in the state of waking rest, basic for human consciousness. With the help of these methods, it was possible for the first time to study the interactions of brain mechanisms related to different evolutionary levels of its organization, namely, the most ancient, ancient, new and recent cortex. As a result, new data on the asymmetry of the human brain in normal and pathological conditions were obtained, indicating the importance of interhemispheric asymmetry with the right hemisphere dominance of effective (causal) connections at rest with the normal functioning of the brain and human consciousness. Features of the macro scale organization should be correlated with the molecular mechanisms of neural networks in the human brain.

The results of studying the features of the expression of protein-coding genes in the frontopolar regions of the frontal cortex are topical. These studies revealed right-sided dominance, but this time in terms of the number of genes expressed, which were found to be associated with schizophrenia risk. However, no association was found with major neurodegenerative diseases.

Communicative contact with the patient remains the main test for the preservation of consciousness. At the same time, the importance of objective methods is growing. Arguments are given that indicate that the modeling of consciousness and the corresponding implementation are the most important condition for the further development of work in the field of cognitive technologies and machine intelligence.

Cognitive sciences study the processes of information processing from different angles. The human psyche performs such processing sometimes productively, and sometimes not productively. Classical models describing human cognitive processes were based on a computer metaphor (an analogy of computational processes in a computer and human cognitive processes). Based on this, it was assumed that the human cognitive system consists of three parts: the information input system (perception systems), the output system (motor system), and the central block for processing information.

Contrary to the natural idea that a person perceives the world as it is, the process of cognition is arranged differently. People constantly generate assumptions and beliefs about the world. They change them under the influence of new evidence. There are many stable and specific mechanisms that provide the processes of cognition and interaction with the environment.

Thinking is a complex cognitive process, hidden from external observers. One of the central concepts in cognitive psychology is the concept of representation. It relies on the idea that every event, every object and person we see is presented to us twice: in physical reality and in psychic reality. The representation of something in psychic reality is called a mental representation. Starting with the classical studies of J. Bruner, it is assumed that representations exist in three forms: action, image and sign. Each of these representations has different characteristics.

In a healthy person, the brain functions fully and remains active even during sleep. In the early days of the cognitive sciences, artificial intelligence research was inspired by ideas and insights from the field of cognitive psychology. However, this period has long passed and research in the field of artificial intelligence has long moved away from direct analogies with the mental processes of real people.

Now there is practically no task of assimilation of artificial intelligence to a person or vice versa. Many voice assistants rely on artificial neural networks in their work, which are directly related to the field of artificial intelligence.

An intellectual task refers to tasks for which a person does not have an algorithm. Performing actions according to the algorithm, different people will always get the same result. Their decision process will be the same. When solving an intellectual problem, people use their knowledge, ability to reason and ingenuity, which are different for different individuals.

Formalization of human intellectual abilities

The main successes of cognitive technologies lie in the formalization of human intellectual abilities.

AI will actively fit into automated customer support services, threat and cybernetic attack prevention systems, quality management systems, and diagnostic systems. The struggle for the customer and the highest level of customer satisfaction are directly related to the creation of additional value and profitability of the business. The manufacturing industry can benefit from the use of technology to automate production and, accordingly, reduce its cost.

Nearly half of the cost of rapidly growing cognitive and artificial intelligence technologies will be in software. And also, on cognitive platforms that provide tools and technologies for analysis, organization, access and provision of consulting services based on structured and unstructured information.

Computer cognitive modeling is a relatively new interdisciplinary direction in artificial intelligence. Therefore, it is necessary to use the interdisciplinary knowledge of biologists and psychologists about how a person thinks and solves problems. The interdisciplinary direction sets the task of constructing a model of human cognitive functions. Cognitive modeling aims to build programs that acquire knowledge and use it to create smarter programs. And computer cognitive modeling aims to use these programs in computers and robots.

An interdisciplinary team is needed in order to develop a new direction in artificial intelligence. It includes linguists, psychologists, mathematicians, programmers who write effective programs, and even biologists. Among the tasks that are solved in computer cognitive modeling, those that are not solved by classical methods of artificial intelligence are of the greatest interest. For example, these are tasks such as planning and synthesis of behavior in a team. When you have several intelligent agents that interact with each other (agents can be both software and robots), then there are new effects. It is necessary to solve a problem that one agent cannot solve. He needs to communicate with other agents and say who will solve what tasks.

The role is played by the distribution of roles. The second important problem is related to goal setting. Purposeful behavior has been studied for a long time. A person has a certain goal, and he builds a plan to achieve it using various methods. Man himself invents his goals. He sets a goal for himself and tries to achieve it. Such a number of problems are solved in computer cognitive modeling. One of the interesting ways to solve this problem involves the creation of a representation of knowledge.

L. Vygotsky created a theory that can be used as a basis for creating mathematical formalism and mathematical theory. The most important thing in the representation of knowledge lies in how a person represents actions. There are several levels of action: some automatic operations, actual actions that try to achieve some goal and activities that are guided by some common motive. This activity can be very abstract, or it can be specific. And it is very important that he said that any activity can only be in a team. Any action represents a distributed element, which includes a representation of what a persons has done and what another person will do. A person stores knowledge in a three- or four-component structure, which is called a sign. The sign is used in psychology, linguistics and philosophy.

Psychologists say that a person represents knowledge in the form of a sign and that there are three main components. One of them is an image. It captures how a person sees an object. From a mathematical point of view, this is some recognition function, the calculation of this sign-mediated object from the information flow. The second component reflects the value. It is what the person does with the mediated object. It does it in accordance with how it is customary to do it with an object in culture. These are generalized actions that have some role composition. The third component captures personal meaning. What a person personally does with an object, based on the experience of operating with this object. The idea of knowledge, including the model of this representation of knowledge, is called a sign picture of the world. This is one of the approaches that is used in computer cognitive modeling.

By choosing a special way of representing knowledge, for example, a symbolic picture of the world, it is possible to build models and algorithms of some cognitive functions of behavior planning and behavior plan synthesis on this basis. If it includes changes to some elements of personal meaning. Among other tasks that are solved in computer cognitive modeling, methods from neurophysiology are sometimes used. Any psychological theory boils down to what needs to be understood, and what is the substratum of these cognitive functions and on the basis of what thinking occurs.

A complete theory must include some knowledge if we are to model a machine that thinks. One of the tasks that is solved in computer cognitive modeling involves the construction of a computational model of the neocortex. In the human brain, the upper parts of the brain, called the neocortex. It has a universal structure. It is possible to build a mathematical model of a universal calculator. The combination allows building models of cognitive functions. Each element represents a mathematical model of how some elementary calculation takes place in the cerebral cortex, including the neocortex. The knowledge and models are based on neuroscientists' current understanding of how neural activity propagates from the moment activation occurs in the posterior cortex. Through some departments, including subcortical ones, it comes to the frontal regions, where the realization of cognitive functions takes place, including behavior planning, knowledge presentation and communication in a team. Cognitive psychology, from the very beginning of its history, has described man as a computing machine. But the question remains, what is thinking. Gödel's argument is used against the possibility of creating artificial intelligence. Gödel's theorem on the incompleteness of formal systems implies a fundamental difference between artificial and natural intelligence. A person has the ability to solve problems that are fundamentally insoluble for any artificial intelligent systems. The limitations of artificial intelligence stem from its formal nature.

Neurophysiological localization of consciousness

J. Edelman and J. Tononi consider human consciousness as a process that changes its neurophysiological localization within fractions of a second. With this approach, the task is to find out in what main neurophysiological directions localization changes occur or, in other words, what kind of neuronal activity is essential for the construction and functioning of consciousness. Conventional approaches to understanding consciousness usually focus on how certain areas of the brain or groups of neurons contribute to it.

The application of criteria for neuronal integration and complexity, together with the analysis of extensive neurological data, leads to a verifiable assumption about the dynamic core hypothesis. In order to understand what consciousness is, it is important to single out substratum neuronal processes that are integrated and have such exclusively informational differentiation.

Consciousness can function if the repertoire of differentiated neuronal states is large. If most groups of neurons in the cortex transmit a signal synchronously and the functional differences between them disappear, then consciousness is suppressed and lost. During cognitive activity associated with consciousness, there should be evidence of a large, but quite distinct, association of distributed neuronal groups that interact in a fraction of a second much more strongly among themselves than with the rest of the brain. Studies of brain injuries show that consciousness is destroyed by massive lesions of the cortex, but is preserved with local lesions of the cortex. The only localized brain injury leading to loss of consciousness is usually a lesion of the reticular center in the upper part of the brain stem and hypothalamus or its rostral continuation into the reticular and intralaminar thalamic nuclei. Some explicit-implicit disorders (amnesia) may result from a partial disruption of the connections of the affected area with a more general system of neuronal activity associated with consciousness.

The visual area can be essential to provide visual consciousness with a certain degree of detail. If rapid integration of neuronal activity is achieved at a high cost in terms of number of connections and energy supply, then neuronal groups in higher regions must be privileged members of the dynamic core that is the substratum of consciousness.

Conscious experience and the dynamic neural core

Semantic connections and the order of their strengthening in the semantic field of the term "conscious experience" generally correspond to those of the term "consciousness". The only discrepancy between the terms "consciousness" and "conscious experience" is that the term "dynamic core" is in second place in terms of frequency in the semantic field of the term "consciousness" and one of the last places in the semantic field of the term "conscious experience". Changes in the activity of specific distributed subgroups of neuronal groups that are activated and deactivated in response to a given task are relevant to conscious experience. A group of neurons is directly relevant to conscious experience only if it is part of a distributed functional cluster that achieves a high degree of integration within hundreds of milliseconds. To maintain conscious experience, it is essential that this functional cluster has a high degree of differentiation, which is expressed by a high value of complexity. The dynamic core is a large cluster of neuronal groups that together create, within a few hundred milliseconds, a single neuronal process of a high degree of complexity in order to emphasize both its integration and its constantly changing pattern of activity.

The dynamic core is a functional cluster: the neuronal groups participating in it interact much more with each other than with the rest of the brain. The dynamic core must also have a high degree of complexity. His activity scripts must be selected in less than a second from a very large repertoire.

The dynamic nucleus includes the perceptually classified posterior corticothalamic areas that interact in an input/output fashion with the anterior areas related to concept formation, vital memory, and planning, but it cannot be limited to the thalamocortical system. The term dynamic nucleus does not refer to a unique, unchanging set of brain regions, whether it be the frontal, extrastriate or striatal cortex. The same group of neurons can be part of the dynamic core and be the substratum of conscious experience.

It may not be a part of it and therefore be included in unconscious processes. Participation in the dynamic nucleus depends on rapidly changing functional connections between groups of neurons than on anatomical proximity. The composition of such a nucleus may go beyond traditional anatomical concepts.

The exact composition of the core, relating to particular states of consciousness, can vary greatly among individuals.

The dynamic core is characterized by time-varying neuronal interactions. It is integrated and individual. Its integration should be high, and the exchange of information with what surrounds it should be low, creating a functional barrier between what is part of it and what is not. The dynamic core is able to select, on the basis of internal interactions, in a larger repertoire of different patterns of activity. The choice of one of the integrated states is achieved within hundreds of milliseconds.

Human consciousness is reduced to its own neurophysiological substrate. This is the position of J. Edelman and J. Tononi. The data being analyzed by scientists on the thalamocortical system is important for understanding the development of neuroscience. Distributed neuronal activity in the thalamocortical system is essential for the formation of the content of conscious experience. The key neuronal mechanism supporting conscious experience is the interaction between the posterior thalamocortical regions involved in perceptual categorization and the anterior regions involved in memory, evaluation, and action planning. The activation and deactivation of a distributed neuronal population in the thalamocortical system is a sufficient condition for conscious experience only if the activity of the neuronal groups involved is integrated quickly and efficiently.

Cognitive tasks are accompanied by the emergence of short-term temporal connections between a distributed population of neurons in the thalamocortical system. Neurons in the thalamocortical system are interactive. The emergence of high-frequency synchronous signals in the thalamocortical system critically depends on the dynamics of corticothalamic and corticocortical cycles and the opening of voltaic channels in horizontal corticocortical junctions. The thalamocortical system is represented by groups of neurons localized in the brain based on interaction with each other. It is difficult to establish exactly what kind of neurons interact and where exactly they are located. The activity of neurons with a resolution of up to milliseconds is recorded using such indirect data as the total electromagnetic activity of the brain. The exact localization of active neurons is determined by the water content in the brain tissues and the oxygen content in the blood of the brain with a lower temporal resolution. In the case of an electroencephalographic study, the electromagnetic activity of which neurons is recorded is not exactly known.

Classical traumatic and experimental studies suggest that many structures outside the thalamocortical system are not directly related to conscious experience. Many areas even within the thalamocortical system itself can be damaged or stimulated, but conscious experience is not directly affected. Neurophysiological studies indicate the possibility of a lack of connection between conscious experience and ongoing neuronal activity in some parts of the thalamocortical system. Simulation studies show that only certain interactions in the thalamocortical system are fast and strong enough to result in the formation of a large functional cluster within a few hundred milliseconds. The organization of anatomical connections in some areas of the brain, such as the thalamocortical system, is more efficient in generating coordinated dynamic states than other areas, such as the cerebellum or the basal ganglia.

The activity of neurons processing the rapidly changing fine details of sensory input or motor output is irrelevant to conscious experience. This experience deals with invariant properties of objects that are highly informative and also more stable and easier to manage. The concept of invariant is formulated. Many of the neural processes that provide the highly automatic patterns that make it possible to speak, listen, read, and write quickly and effortlessly do not directly contribute to conscious experience, although they are essential to shaping its content. The processes of consciousness lying at lower levels are less conscious. Processes at higher levels are more conscious. All these processes are only part of a single process of consciousness.

Integral Cognitive Neuroscience

K. Dawson linked the problem of the temporal organization of consciousness with the problem of the connecting link of consciousness. The classical formulation of the problem of the connecting link suggests finding out how neuronal processes can explain the unity of perception of reality, while at any given second there, is an almost infinite number of possible objects of consciousness? The problem of the connecting link of consciousness in this formulation is reduced to the problem of the unity of the perception of reality.

L.S. Vygotsky formulated the concept of semantic perception, which systematizes the essential patterns of the unity of human perception by identifying the role of the meaning of a word for its functioning. L.S. Vygotsky uses the term semantic perception to analyze verbal-perceptual unity and to mediate perceptual processes. Semantic perception is a generalized perception. He explains it using the example of patients with agnosia, who can distinguish individual parts of an object: white, cold, slippery, round, but do not know that it is a watch. In patients, there is a disintegration of a single act of consciousness, in which both what I see and what it is a clock is in one act of consciousness. The unity of perception and generalization leads to the fact that things begin to be seen not only in their situational relation to each other, but also in the generalization that lies behind the word. Semantic, generalized categorical perception is the unity of the visual and semantic field in one act of consciousness.

The problem of the link is related to the problem of time perspective. Time correlates with causal relationships rooted in the integrative linking of the diverse sensory elements of human experience. Time is, through physiological manifestations, the unifying element for the diversity of conscious experience. In order for events to be combined, there must be such brain structures that create an internal model of the external world in relation to time. These structures are the hippocampus, amygdala, hypothalamus, activating reticular formation, and epithalamus.

The higher mental function has a dynamic and chronogenic principle of localization. When solving specific life tasks, a completely different mosaic (pattern) of activation of various parts of both the brain and the central nervous system can be observed.

A particular neurophysiological structure can act as a regulator of several other neurophysiological structures, forming a neurophysiological system. This system is subordinated to cortical neurophysiological structures, and they realize the function of consciousness.

The meaning of the word and speech create a functional barrier that makes it possible to delay and comprehend one's own future action in the inner plane. But the postponement and understanding of one's own future action on the internal plane means a discrepancy between internal and external time. In animals, the flow of internal and external time always coincides. As a result of the delimitation of internal time from external time, a temporal perspective of a person's own actions arises.

Bringing backward temporal perspective (past actions and their results) and forward temporal perspective (future actions and their possible results) into behavior means the dissection and structuring of the external perceptual field by the internal temporal tempo. The simultaneous structure of the perceptual field becomes a successive structure of attention. A person's comparison of his future actions with his past actions allows him to take a different attitude to the present actual situation, serves to overcome situational connectedness. In the process of comprehending actual reality, the combination of a time perspective back, a time perspective forward and the perceived present create imagination. This is due to the development of speech and the meaning of the word.

The key to understanding the development of the higher mental function of logical semantic memory is that the model of any future situation is made up of elements of the past and present sensory field. The development of memory does not proceed through the further expansion and deepening of its natural properties. In the process of its mediation by the meaning of the word, the memory function is restructured.

The function of memory occupies a fundamentally different position in the new organization of the system of functions. Already at preschool age, the developing mental function of semantic memory is included in the process of decision-making, planning of future action, and self-control. Further development of the described psychological processes leads to the emergence of the possibility of building models of various options for their future actions in the internal plan. The construction of such models allows people to predict with a certain degree of probability the consequences of their actions and choose the most optimal tactics of behavior to achieve the desired result.

Human consciousness has its own time, different from the space-time continuum of which it is a part. The temporal characteristic of consciousness is a consequence, not the cause of its organization. A consequence that arises in ontogenesis on the basis of the internalization of the word and the construction of a system of higher mental functions of consciousness or a dynamic semantic system. L.S. Vygotsky proposed a dynamic and chronogenic principle for the organization of higher mental functions of consciousness. According to this principle, at different stages of ontogenesis, different higher mental functions play the role of a system-forming factor in the semantic and systemic structure of consciousness. Before the crisis of three years, the higher mental function of perception acts as the organizing principle of the system of consciousness; before the crisis of seven years, the higher mental function of memory. Then the role of the system-forming factor in the system of consciousness passes to the higher mental function of thinking.

The doctrine of the semantic and systemic structure of consciousness requires a lot of clarification, primarily regarding what is denoted by the term "higher mental functions". The most important transitions between consciousness and neurophysiological structures remain unclear. The main thing is that the impact of the word on neurophysiological structures is almost not taken into account when constructing theoretical generalizations about consciousness. There is a connection between the neurophysiological laws of the functioning of consciousness and the laws of the psychological laws of its functioning. But the solution to the problem of localization remains relevant.

Neuropsychological analysis and synthesis should be built not only from neurophysiological structures and systems to consciousness, but also from consciousness to neurophysiological structures and systems. These two lines of research cannot be separated. The advantages of this approach are manifested in the case of mental disorders associated with the post-traumatic state. Neurophysiological research methods (EEG, MEG, fMRI, biochemical analysis, etc.) can study (albeit very limited) the impact of psychological trauma and severe stress on cortical and subcortical changes in the brain.

Having studied the social essence of the traumatic experience of necessity in metaphorical terms in the first approximation and the neurophysiological changes that occurred as a result of obtaining this type of experience in the brain and the body as a whole, the endocrine system and the cardiac system, it will be possible to try to trace the reverse effect of neurophysiological changes on the psyche and consciousness in dynamics. With this approach, neurophysiological systems and the system of consciousness become elements of a dynamic element of a psychological process unfolding in time.

Cognitive Distortions

These are systematic deviations in the behavior, perception and thinking of people. As well as social, moral and emotional reasons, failures in the processing and analysis of information. Physical limitations and structural features of the human brain. Cognitive biases arise from dysfunctional beliefs embedded in cognitive schemas. People tend to create their own subjective social reality, dependent on their perceptions. Subjective reality can determine their behavior in society. Cognitive distortions can lead to perceptual aberrations, inaccurate judgments, and illogical interpretations.

But cognitive distortions also have a positive function. Some cognitive distortions may contribute to more effective actions of the individual in specific conditions. They allow you to make decisions faster in situations where the speed of decision making is more important than its accuracy. Cognitive distortions are a direct consequence of a person's limited ability to process information or the lack of appropriate mental mechanisms.

Research on cognitive distortions is of great importance because it allows you to highlight the psychological processes that underlie the processes of perception and decision making. The study of cognitive distortions is of great practical importance in the medical field.

Cognitive distortions can occur due to failures in information processing; mental noise; limited brain capacity for information processing; emotional and moral reasons; social influence. The concept of cognitive distortion was introduced by A. Tversky and D. Kahneman in 1972 on the basis of studies of people's numerical literacy. They demonstrated several reproducible patterns of behavior in which human decision making differed from rational choice theory. They explained these discrepancies in judgment and decision making in terms of heuristics. Heuristics are simple in calculation procedures, but sometimes lead to serious and systematic errors.

G. Gigerenzer argue that human thinking should not be considered filled with irrational cognitive distortions. Rationality of thinking should be considered as an adaptive tool. It does not always obey the rules of formal logic. There are various approaches to the classification of cognitive distortions. There are both cognitive distortions that are characteristic of social groups, and those that manifest themselves at the individual level.

Some cognitive biases affect decision making where the desirability of the options is important. Such as illusory correlation, influence the decision about the nature of causal relationships. A special class of cognitive distortions is associated with the properties of memory. It is a misremembering of one's past attitudes and behaviors as being reminiscent of present attitudes and behaviors.

Some cognitive biases reflect the motivation of the subject. It is a desire for positive self-esteem, leading to egocentric distortion in order to avoid unpleasant cognitive dissonance. There is a group of cognitive distortions associated with the features of the brain to perceive, remember and draw conclusions.

Some cognitive distortions reflect the desire of a person to form a positive attitude towards himself. This explains the nature of many patterns and stereotypes of mass consciousness. There are distortions associated with behavior in groups. This is a distortion in favor of one's own group and in the assessment of the homogeneity of members of another group. Some cognitive distortions are associated with the peculiarities of responding to certain stimuli.

Eight cognitive distortions can be generated by the same information generation mechanism. Social institutions in their activities are guided by the thesis that people make rational decisions. Thus, investment companies assume that all investors act rationally. In practice, investors act based on prejudice, heuristic stereotypes, and emotional effects.

Cognitive distortions are manifested in the persistence of superstitions in the public mind. They prevent the spread of a scientific picture of the world that differs from the stereotypes of mass consciousness.

The content and direction of cognitive distortions can be controlled. The concept of correction of cognitive distortions includes procedures for the modification of cognitive distortions in healthy people, and also refers to the field of psychological non-drug therapies to reduce anxiety, depression and various addictions. Cognitive modification is used to reduce psychological stress, depression, anxiety, and various addictions. Methods Psychotherapeutic methods are applied with the help of a computer, both with and without the participation of a psychotherapist. Correction of cognitive distortions that cause problems of an emotional, personal, social nature is the goal of cognitive psychotherapy. The correction of cognitive distortions is based on concepts such as the cognitive model of anxiety, the cognitive model of attention, and other achievements of cognitive neuroscience.

Bounded rationality

A concept that implies that in the process of making a decision, a person experiences a number of problems related to the cognitive limitations of the mind, lack of time and resources. It follows that people's actions are not entirely rational. Decision makers seek to find a satisfactory solution, not an optimal solution. The term "bounded rationality" was introduced by the American economist G. Simon.

The concept of bounded rationality complements the concept of rationality as an optimization. It considers decision-making as a completely rational process of finding the optimal choice, taking into account the available information. The behavior of people can be described on the assumption that they behave like rational beings. Economic models assume that people are rational and never do anything that is contrary to their interests. The concept of bounded rationality questions these assumptions in order to take into account that rational decisions are hardly feasible in practice due to the limited computing resources necessary for their adoption.

G. Simon points out that most people are rational, only in part, and emotionally or irrationally in other situations. Agents of bounded rationality have difficulty formulating and solving complex problems and obtaining, storing, using, and communicating information. The classical model of rationality can be supplemented and brought more into line with reality, while remaining within the framework of strict formalism. It is important to consider the limitation on what kind of utility functions can be; accounting for the cost of collecting and processing information; the possibility of the existence of a vector utility function. Economic agents use heuristic analysis rather than strict application of optimization rules, due to the complexity of the situation and the inability to calculate and take into account the utility of each possible action. The cost of assessing the situation can be very high, while other economic activities may also require similar decisions.

D. Kahneman positions the theory of bounded rationality as a model that allows to overcome the limitations of the widespread model of rational agents.

Cognitive computing.

As long as the scope of computers was limited to calculations, technological control systems, database management systems and other classical applications, von Neumann's programming did not cause any complaints. Enormous engineering forces were directed to overcome its other weakness. When John von Neumann and others proposed their original architecture 30 years ago, the idea seemed elegant, practical, and simplifies a wide range of engineering and programming problems. And although the conditions that existed at the time of its publication have changed radically since then, we identify our ideas about computers with this old concept. In its simplest form, a von Neumann computer consists of three parts: a central processing unit (CPU), a memory, and a channel connecting them, which serves to exchange data between the CPU and memory, and in small portions (only one word at a time). Such a channel not only creates a problem for traffic, but is also an intellectual bottleneck that imposes word-by-word thinking on programmers, preventing them from thinking in higher conceptual categories.

Now that engineers have been able to temporarily overcome this weakness with the help of multi-level caches by complicating the architecture of processors, the limited possibilities of programming come to the fore. Cognitive computer systems can become an alternative to programming. Analysts are talking about the advent of the era of cognitive computing with the ability to think.

Watson was the first to follow the cognitive path, defeating the strongest players on February 14, 2011 in the TV game Jeopardy! From this day on, the era of cognitive computing is being counted.

The term Cognitive Computing is not new. It has been used in cognitive informatics. With increasing volumes of data, it will soon be impossible to synchronously create adequate analytical systems. A palliative solution involves a cognitive approach while maintaining the existing technological basis. We are talking about integrated expert systems. At the macro level, such decisions can be recognized as cognitive. But at the micro level, at the processor level, they are traditional.

The challenge is to overcome one of the weaknesses of modern computers, namely, working with small pieces of data (bits and bytes). The goal is not to replace the human brain or make a machine think like a human. The computer will perform huge amounts of calculations and operate with huge amounts of data. A person will retain intuition, the ability to make judgments, creativity, empathy and moral principles. It should be called systems driven by data flows.

New generation computers differ from previous generation computers in several key ways. Processes and processors are the focus of attention in older computers, and data in new generation computers. Fixed, pre-programmed calculations will give way to analytical approaches.

In computers of the old generation, manual control of systems dominates. The new generation of computers is dominated by automatic systems management. One of the most important differences is in relation to scaling. We are used to two types of scaling - up (Scale Up) and in breadth (Scale Out), and now there is scaling inward (Scale In), the essence of which is the integration into one system (as it was in mainframes) of all the main components, including processors, memory, storage systems and switching.

Cognitive computing refers to everything related to the modeling of brain processes. These are systems with training, data mining, image recognition (photo, video, speech), text processing in natural languages. Cognitive computing is aimed at creating systems that can solve tasks without human intervention. Some of the applications of cognitive computing include speech recognition, sentiment analysis, and face recognition. Unlike computers in the third era, where programming dominates, interaction with cognitive computers is carried out through learning. Machine learning algorithms can extract information from data, process it and contribute to the acquisition of new knowledge.

Projects aimed at creating neuromorphic computers are being implemented. They are at different stages. They serve as stands for brain simulation. In neuromorphic computers, Turing and von Neumann schemes, on which all universal processors are built, are either not implemented at all, or are implemented partially. Therefore, neuromorphic computers are not programmable. They are capable of learning and are analogous to the brain.

As computers in the cognitive era mature, they will become learnable and self-learning systems. Computers will be able to understand data, analyze it, adapt it, and make decisions based on the data. At the same time, they will not replace a person, but will expand his capabilities, taking on the routine work of processing data and leaving the opportunity for a person to draw conclusions and make decisions.

Industries will be ready to adopt cognitive technologies in the coming years. Customer satisfaction will be a key factor in the decision to implement cognitive technologies. The two main benefits of cognitive technologies are improved customer experience and financial results, including increased profitability for businesses and the ability to better measure the ROI of marketing campaigns. Digital platforms use cognitive technologies to gain a comprehensive understanding of their customers. It will enable them to better anticipate customer needs and search for potential buyers, as well as play a greater role in implementing the company's strategy and improving the quality of service.

Cognitive technologies are already in a mature stage and ready to enter the market. Cognitive computing is useful to the organization and is already being used in enterprises. It is important to foresee the issue of introducing cognitive solutions in the Digital Reinvention strategy.

Companies are in the process of reimagining the customer experience, using digital technologies from mobile applications to the Internet of things and virtual reality. Digital customer touch points are a source of structured and unstructured data. With the help of cognitive technologies, enterprises receive information about the personal preferences of customers and the characteristics of their behavior. Shopper insights are the primary way cognitive technologies are used to improve the customer experience. Cognitive technologies have become part of the overall digital rethinking strategy.

Institutional features of the introduction of cognitive technologies

It is important to improve not only information processing skills, but also the business competencies of employees. Analysts are in demand. Cognitive technologies help to cope with the most time-consuming part of the work. Therefore, the marketing and sales departments primarily need people with a comprehensive vision of the company's strategic development and knowledge of its individual areas. These professionals are able to quickly identify potential business impacts based on cognitive insights. They need to have decision-making skill and an understanding of their customers so that the services they provide always live up to the promises of the brand.

Cognitive technologies reflect the opportunity for collaboration and innovation. The implementation of intelligent solutions in the field of marketing and sales requires close cooperation between directors of marketing, sales, information technology, CTOs, directors of data and digital. This will ensure that the necessary technical requirements are met and the cognitive capabilities are aligned with the strategic goals of the company. The cognitive technologies used by marketing and sales professionals can also be customized for customer service, supply chain, product development, HR and training, as well as operational and financial applications. This capability makes it possible to integrate processes for exchanging data and ideas into the activities of traditionally "disparate" departments in organizations.

Marketing and sales leaders fear that the shift to cognitive technology will require them to completely replace the current tools and processes they use to analyze consumer data and create customer experiences. On the contrary, there are many types of cognitive solutions, from improved personalization capabilities to content tagging, that can be implemented in stages to address specific business needs. These tools can be integrated into companies' existing cloud platforms and data management systems. Even small steps will allow enterprises to experience the benefits of cognitive computing and set their development plans for the future.

Cognitive technologies in education

In the field of cognitive activity, cognitive technologies are based on the provisions of cognitive psychology, dealing with the human mind, think and those mental processes and states that are associated with it.

In the studies of intelligence, instead of the concepts of "attention", "memory", "thinking", which characterize the cognitive activity of a person, the term "cognitive" is used. This term describes cognitive activity from the point of view of the processes of information exchange between a person and the environment. The main goal of cognitive psychology involves the intellectual development of individuals in the process of assimilation of systematic scientific content. Cognitive psychology studies how people get information about the world, how this information is represented by a person, how it is stored in memory and transformed into knowledge, and how this knowledge affects attention and behavior. It covers the entire range of psychological processes, from sensation to perception, pattern recognition, attention, learning, memory, concept formation, thinking, imagination, memory, language and emotion, and developmental processes. It covers all areas of behavior.

The first mention of cognitive learning appeared in the writings of E. C. Tolman (1948). E. Loarer and M. Yuto note that the term "cognitive learning" defines one of the areas of research in psychology and one of the currents in pedagogy. The main goal of cognitive learning is to develop the mental abilities and strategies that enable the process of learning and adapting to new situations. The focus of the educational process is not aimed at absorbing information, but at comprehending the internal relations of the subjects under study. It encourages students to dialogue, research thinking and increases the concentration of mental activity. With this approach to learning, conscious and reasonable reasoning is associated with cognitive work and contributes to a highly effective growth of mental activity.

Awareness is a factor that can ensure the transfer of knowledge or a strategy of mental activity from one area to another, and also contributes to the development of volitional control over mental activity. The study of prior knowledge from the point of view of rethinking ensures the study of the content of the transfer, its application in the formation of new educational strategies contributes to the revival of interest in the content of subject education.

The transfer is mediated by the properties of reflective thinking, the effectiveness of the activity of newly rebuilt connections in cognitive structures. The criterion of cognitive development in the learning process is the understanding by the subject of his ability to perform a certain task (the level of development of reflection) and the effectiveness of the strategy that guides the subject in cognitive activity to achieve the goal. Cognitive learning clearly follows the natural psychological mechanisms of information selection used by the individual psyche. Cognitive psychology has given rise to cognitive learning technologies. Cognitive pedagogical technologies are understood as the educational process of the intellectual development of individuals, based on the modular presentation of educational information. Within the framework of the cognitive approach, the student is considered an active and conscious participant in the learning process, and not an object of the teacher's learning activity. The subject-subject relations between students and the teacher are realized, and the learning process has a personal and socially conditioned character.

One of the central concepts of cognitive technology contains cognitive schemas. A person perceives information with the help of cognitive schemes available to him. If these means are absent, then the information is either perceived or partially distorted. Human perception involves an active process of collecting information, carried out with the help of special cognitive schemes that are formed in the process of learning throughout life. Therefore, the experience, knowledge, skills of the perceiver have a critical impact on the completeness of the perception of real objects and events.

The development of educational material is accompanied by the use of certain techniques, methods of cognition or logical operations, which represent a way of transforming information. In order to integrate new information into an already existing knowledge system, it is necessary that there are cognitive circuits in the mind that contribute to each applied procedure. If these schemas are absent, then the way to obtain new information cannot be understood. A distorted, incomplete or erroneous cognitive scheme that exists in the mind of an individual leads to a distorted, partial or erroneous perception of information from the environment, which makes adaptive behavior difficult or impossible. Therefore, learning should be viewed as a process of forming cognitive schemes that are relevant to those types of information that need to be learned to perceive and process in order to adequately respond to the demands of others.

Cognitive technology has a modular structure. Each module acts as a system of classes united by a common didactic goal. The module formation factor is procedural information at the basis of a particular or general method of scientific knowledge. Each module is divided into three blocks of classes, each of which solves a specific didactic task: block of input monitoring; theoretical block; procedural block.

In the input monitoring block, classes are designed to obtain information about the level of cognitive readiness of students to perceive and understand new educational information and perform various cognitive actions and operations. Cognitive readiness determines the success of all further activities for the assimilation of new educational material. To study the current level of cognitive development, a special monitoring system is used, which diagnoses the basic cognitive characteristics of the intellect, which are of a neurophysiological nature; learning skills; subject knowledge and skills; subject knowledge and skills.

In the theoretical block, declarative information is studied. The main task for the teacher is the formation of semantic networks of the studied concepts associated with already known concepts using general logical and specific subject types of communication.

In the procedural block, procedural information is studied. It contains rules and algorithms for performing various types of objective activities, methods for transforming objects used in the studied subject area to obtain the desired results. The assimilation of this information is necessary for mastering general and particular methods that provide adequate perception and cognition for adaptation to the conditions of existence accepted in a given culture.

The result of the educational process is the formation of a cognitive scheme in the mind of the individual. After completing the study of declarative and procedural information, which is part of a group of modules united by a common subject of study, a triad of classes follows: generalizing repetition, thematic final control and correction. Cognitive technologies contribute to the development of a broad outlook of students. They independently strive to search for truth, critically perceive conflicting ideas. They are capable of analyzing and designing their activities, acting independently in conditions of uncertainty, acquiring new knowledge; have a steady desire for self-improvement; strive for creative self-realization. The knowledge and opportunities obtained with this approach contribute to the development of a high level of intelligence, the formation of creative potential, the accumulation of practical experience, the formation of methodical thinking necessary in the new educational conditions.

Specifics of the cognitive economy

The analysis of social prerequisites allows us to conclude that there is a certain regularity in the emergence of the concept of managing knowledge, innovation and intellectual capital of an organization. Gradually, there is a shift in emphasis from material production to innovative technologies, the production of information and knowledge. The term "new economy" is increasingly being transformed into the concept of "cognitive economy".

The main technological and methodological components of the cognitive economy are global network technologies; electronic business; knowledge management; intelligent decision support systems; intellectual analysis of business information; business intelligence systems; change management and business reengineering; consumer-oriented management; cognitive analysis and modeling of situations in the management of weakly structured objects and environments.

The prerequisites for the use of a cognitive approach in management are the complexity of process analysis and management decision-making in such humanistic areas. When implementing strategic management, a methodology and technology is needed that takes into account the conditions of rapid variability of the external environment during the development of a complex socio-economic object, and allows predicting the onset of a problem situation and taking measures to reduce the degree of risk and uncertainty.

The technologies of cognitive analysis and modeling are based on methods of cognitive (cognitive-targeted) structuring of knowledge about an object and its external environment.

Cognitive management is based on problematic knowledge, that is, the information needed to identify and solve problems of social organization. Knowledge reduces uncertainty and reduces the risk of making wrong management decisions. It is necessary to manage social organization on the basis of problematic knowledge about the experience of solving problems or knowledge that can serve as a basis for solving future problems.

Cognitive control is based on the theory of social problems, the development of which was based on the positivist approach to the scientific knowledge of reality by O. Comte; E. Durkheim's doctrine of social facts; general theory of social organizations; methods of system analysis and decision theory.

In accordance with the cognitive approach, the identification and solution of organizational problems is carried out on the basis of internal and external experience in solving similar or similar problems in the past, the experience of specialists (experts), as well as other persons (knowledge carriers) and knowledge contained in constantly accumulated and updated from various sources of problematic knowledge bases.

The problematic knowledge base may contain known precedents of the problems being solved; measures taken to solve problems, some recommendations and other experience; results of scientific research problems.

The creation of a knowledge base within the framework of cognitive management technology can be considered as a process of managing an organization's knowledge using modern information technologies. The problem knowledge base is one of the effective tools for managing knowledge about the problems of the organization and how to solve them.

The process of cognitive management involves the detection of problems. It is carried out on the basis of current information about social norms and constant monitoring of the external and internal environment. Allowing to detect deviations or threats of deviations from social norms; write problem descriptions; problem sorting; study of the problem; preparation of alternative programs for solving the problem; evaluation and selection of the optimal program; program implementation; evaluation of the results of the program implementation; preparation of a report on the results of the program implementation; updating information on the problem being solved.

The preparation of alternative programs for solving a specific problem is carried out with the help of a database of problematic knowledge, which is constantly updated due to new information about similar problems (precedents) and experience in solving them; information about the results of conducted and ongoing studies of the problem; information about the results of solving this problem. The likelihood of making wrong management decisions when a problem occurs is reduced because knowledge reduces uncertainty. This is the essence of cognitive management.

This technology has three advantages. It is based on a constantly updated base of problematic knowledge, containing information about world and domestic experience in solving problems. For this, modern information technologies can be effectively used. It involves constant adjustment of the accumulated information, since new knowledge can supplement, correct, replace the old one. It provides for the study of initiatives, their evaluation and decision-making based on them. The technology of cognitive control is superior in its capabilities to the technology of situational control. It is based on knowledge of various problem situations typical of the managed object. However, problem situations are not exactly the same. New factors are discovered that need to be taken into account, which means that the new solution should be different.

The main difficulty in the practical implementation of cognitive control technology lies in the complexity of formalizing problems and related information to maintain a database of problematic knowledge. But this difficulty can be overcome if there is a transition to problematic thinking. Identification and solution of problems of the organization is carried out on the basis of the internal and external experience of the organization, specialists (experts), as well as other persons (knowledge carriers).

So far, tools for the practical implementation of the cognitive approach in real social organizations have not been developed. Cognitive management tools have been created and have been functioning for a long time. However, they are not adapted to its purposes.

The most promising areas of economics and business, where cognitive and intellectual technologies are most effective, are: production management; production and intra-company planning; marketing and sales management; financial management; risk management; banking; trade; stock market. We are talking about rethinking the entire technology of processing, storing and presenting information to the user from the standpoint of a new information technology.

Cognitive systems can give sound advice on how appropriate it is to perform a specific business task, outline a scenario for its solution, exercise control and suggest how best to prioritize work.

Computer tools for cognitive modeling.

The specificity of the use of cognitive modeling tools lies in their focus on specific conditions for the development of the situation in a particular country, region and city. The key concept in cognitive modeling is a cognitive map, which is a directed graph in which the vertices correspond one-to-one with the factors in terms of which the subject area is described, and the arcs display direct links between the factors. Mutual influences can be positive. An increase/decrease in one factor results in an increase/decrease in another factor.

Mutual influences can be negative. An increase/decrease in one factor leads to a decrease/increase in another factor. To display the degree of influence, a set of linguistic variables and the corresponding set of numerical values from the interval [0, 1] are used: "very weak" - 0.1, "moderate" - 0.3, "significant" - 0.5, "strong" - 0.7 and "very strong" - 0.9 value. Intermediate values are also allowed. To compile a cognitive model of the subject area, it is necessary select a list of significant factors; build a matrix of mutual influences; determine the initial trends in the factors.

Having singled out two subsets of controlling and observable factors in the entire set of factors, we can model the self-development of the situation, that is, answer the question: "What will happen if the current trends in factors change continue?" We can simulate the controlled development of the situation, that is, answer the question: "What will happen if certain control actions are applied? We can look for the necessary controls, that is, answer the question: "What control actions should be applied to get the desired result?".

Work is underway to develop a cognitive approach and its application for the analysis and control of semi-structured systems, a complex software tool for the analysis of cognitive models has been developed, which allows analyzing the self-development of the situation, as well as its development with the application of various control actions. It is planned to create a replenished library of cognitive models of various subject areas.

The results of the developments have been successfully applied to improve the efficiency of management decisions; forecasting the development of housing and communal services; improving the quality of higher education.

Metacognitive thinking

The concept of metacognition was proposed by J. Flavell. The main provision in this concept is the concept of "thinking about one's own thinking". This position is characterized by a number of factors that boil down to the following provisions: what we know, that is, metacognitive knowledge; what we are currently doing, that is, a metacognitive skill; what the current cognitive or emotional state is, that is, the metacognitive experience.

In the concept of J. Flavell, metacognitive thinking is differentiated from other types of thinking. To this end, it is necessary to consider the source of metacognitive thoughts. Metacognitive thoughts do not arise from the immediate external reality of a person. Their source is connected with the mental representations of a person about reality. The term "metacognition" is defined as knowledge and cognition regarding cognitive phenomena.

The concept of "meta-memory" is also introduced in the concept of J. Flavell. This concept includes intelligent structuring and storage, intelligent search and correction, and intelligent control. J. Flavell, relying on the works of J. Piaget, correlates intentional, planned and goal-driven thinking aimed at performing cognitive tasks with the formal operations of J. Piaget, in which the higher levels of thinking control the lower levels. These provisions are also consistent with the works of N.A. Bernstein and A.R. Luria. J. Flavell proves that metacognitive thinking is intentional, planned, goal-oriented and future-oriented mental behavior, in particular, the performance of cognitive tasks. These provisions are leading when considering the problem of metacognitive cognition in learning models aimed at regulating intellectual activity.

A. Brown defines metacognition as knowledge about one's own knowledge. Metacognition is defined as knowledge about cognition. This is a set of activities that include conscious reflection on cognitive actions and abilities; regulation of cognition - a set of activities that require self-regulation mechanisms during learning or problem solving. Of particular interest in understanding metacognitive cognition A. Brown is the idea of regulation and control in the process of learning a number of factors. Among which, particular importance is given to factors determining the process of planning activities: the formation of a plan, anticipation of the result and analysis of possible errors. Also, the process of monitoring activities and checking the results of cognitive activity.

R. Kluve's concept of metacognitive cognition highlights the control and regulation of cognitive processes. By control processes, he understands processes that help identify the task a person is working on and evaluate progress along this path and the ability to foresee the result. The regulation process refers to the procedures for allocating resources to solve the current problem, by forming a certain algorithm of the necessary steps.

S. Tobias and H.T. Everson proposed a hierarchical model of metacognitive abilities: knowledge monitoring; learning assessment; strategy selection and planning. They define knowledge monitoring as the ability of a person to know what he knows and what he does not know. Knowledge monitoring is a prerequisite for other metacognitive skills.

According to J. Flavell's model, a person's ability to manage a variety of cognitive initiatives occurs through actions and interactions between four classes of phenomena: metacognitive knowledge; metacognitive sensation; goals or objectives; actions or strategies. The key for J. Flavell are knowledge of the features of the functioning of the cognitive processor; knowledge of the task, its requirements and how these requirements can be met when conditions change; knowledge of strategies to accomplish this task. Cognitive strategies designed to achieve goals and metacognitive strategies designed to control the progress of cognitive strategies.

Metacognitive knowledge can influence the direction of cognitive initiatives through intentional and conscious memory retrieval or through unconscious and automatic cognitive processes.

Cognitive experience refers to mental structures that provide storage, ordering and transformation of existing and incoming information. Metacognitive experience is understood as mental structures that allow involuntary and arbitrary regulation of intellectual activity. Metacognitive experience involves involuntary intellectual control; arbitrary intelligent control; metacognitive awareness and open cognitive stance. Also intentional experience, which is based on individual intellectual inclinations.

There is a difference between cognitive and metacognitive strategies. The former help the individual achieve a specific cognitive goal, such as understanding a text. The latter are used to control the achievement of the goal, for example, a self-questionnaire for understanding this text. Metacognitive components are activated when cognition fails. This may be a misunderstanding of the text from the first reading. Failure activates metacognitive processes that allow the individual to correct the situation. Consequently, metacognition is responsible for the active control and consistent regulation of cognitive processes, which is of particular relevance when solving complex problems.

Differences between definitions are due to their purpose and assessment of their applicability by researchers with different goals, attitudes and specific experience. Intellectual activity is a behavioral and cognitive activity aimed at overcoming a large number of previously unknown obstacles between fuzzy, dynamically changing goals and conditions. It includes cognitive, emotional, personal and social abilities and knowledge.

The study of individual differences in intelligence, motivation, expert knowledge and skills is carried out using complex realistic scenarios. There is a study of the acquisition and use of knowledge depending on the strictly controlled characteristics of the task. The subjects interact with systems of abstract content based on linear equations and the theory of finite automata.

D. Derner and A.J. Wareing offer a theoretical approach to creating a computer model for solving complex problems that combines rigorous laboratory research and the study of solving economic and political problems in natural conditions. The solution of complex problems tested in computer environments simulating city management is analyzed. The relationship between motivational, emotional and cognitive variables is investigated and hierarchical models for managing intentions, goals, information gathering, hypotheses, decision making, self-control and factors that determine the process of metacognitive cognition are proposed.

In this regard, D. Berry and D.E. Broadbent analyze implicit and explicit learning in order to explain inconsistencies and contradictions between the levels of: a) real control of a complex system and b) verbal description of its work and activities with it. The one who manages the system well describes it worse, and vice versa. It is proved that verbal and non-verbal knowledge are acquired through verbal learning or practical experience and develop relatively independently. O. Huber explores the adoption of multi-step decisions on the material of clearly formulated tasks with a small number of conditions.

These tasks make it possible to rigorously study the influence of various variables (the plot of the task, the presence of feedback, the subjects' locus of control, etc.) on strategies, goal setting, learning, decision outcomes, etc. Applying this approach to complex problems by breaking them down into simpler subproblems helps to bridge the gap between research on complex problem solving and decision making as important problems in metacognitive cognition.

J. F. Beckman and J. Gutke analyze the connection between solving complex problems, intelligence and the ability to learn, which is directly related to metacognitive cognition in learning as the basis for the development of intellectual activity. The low correlation of solving complex problems with intelligence tests is explained by the shortcomings of the theoretical presentation and operationalization of both constructs. Intermediary between them can be learning tests that diagnose the ability to acquire knowledge through feedback. RSH includes a phase of acquiring knowledge about the system and a phase of their application. The indicators of the first phase correlated with the learning tests, and the indicators of the second - with the tests of learning, intelligence and with the indicators of the first phase.

In the studies of J.F. Krems studies the relationship of cognitive flexibility (flexibility) with the solution of diagnostic problems in medicine, technology and programming by experts and beginners. Beginners changed hypotheses less flexibly and were more likely to overestimate the information that supported them. Of particular interest, from the point of view of the use of metacognitive processes, as a means of developing the intellectual activity of a person, is the described computer model of flexible solving problems for abduction (consistent comprehension and integration of incoming data into a single model of the situation, giving the best explanation at the moment).

In the works of U. Funke, systems of vocational selection and vocational training based on RSS are analyzed. Summing up the intermediate result, it should be noted that although a number of works have shown their effectiveness, in general, the data are incomplete and contradictory. The development of criteria for the analysis of professional activity, a taxonomy of RSH scenarios and extensive empirical research are required. It is assumed that methods that combine metacognitive learning and learning through active interaction with scenarios can give the greatest effect.

Of the works devoted to the analysis of methodological problems of RSH, the works of J. Funke stand out. The research of this author reflects the problems associated with the analysis of the possibilities of experimental study of RSH based on group data. A taxonomy of factors influencing RSH is proposed: personal, situational and system factors. The analysis shows that experiments investigating the interaction between these factors are especially promising. The problems of the described approach are the measurement of knowledge and activity indicators, the validity of experiments, the generalizability of results, the analysis of the RSH process, and the development of theory.

In the works of R.Kh. Kluve analyzes the possibilities and limitations of studying RSH on the basis of individual cases. The use of this method is determined by the objectives of the study, for example, testing hypotheses about existence (rather than statistical hypotheses). The activity of each subject is carefully analyzed and compared with its computer (theoretical) model, which generates "synthetic" subjects. The problems of this approach are the explication of data analysis methods, modeling methods, criteria for comparing real activity with a model, the generalization of results, the use of the same data to build a model and to confirm it, which is of particular importance when solving the problem of developing intellectual activity based on metacognitive processes.

Metacognitive cognition is characterized by a number of fundamental factors: what we know, that is, metacognitive knowledge; what we are currently doing, that is, a metacognitive skill; what the current cognitive or emotional state is, that is, the metacognitive experience.

Metacognitive thinking is intentional, planned, goal-driven, and future-oriented mental behavior focused on cognitive tasks. At the same time, three general factors are distinguished in the representation of the model of metacognitive cognition: knowledge of the features of the functioning of the thinking process; knowledge of the task, its requirements and how these requirements can be met when conditions change; knowledge of strategies to accomplish this task (cognitive strategies designed to achieve goals and metacognitive strategies designed to control the progress of cognitive strategies). Metacognitive components tend to be activated when cognition fails. Thus, metacognitions are responsible for active control and consistent regulation of cognitive processes, which is of particular relevance when solving complex problems in new semantically rich situations.

Formal definition of a fuzzy cognitive map

The fuzzy cognitive model is based on the formalization of cause-and-effect relationships that take place between variables and parameters that characterize the system under study. The result of formalization is the representation of the system in the form of a causal network, called a fuzzy cognitive map and having the form:

$G=\langle E,W\rangle$,

where $E = \{e1, e2, \ldots, en\}$ is a set of factors (also called concepts), W is a fuzzy causal relation on the set E. Elements wij W(i ,j = 1, …, n) characterize the direction and degree of intensity (weight) of influence between the concepts ei and ej:

$wij = w(ei, ej)$,

where w is the index of influence intensity (characteristic function of the ratio W), which takes values on the segment [– 1, 1]. Wherein:

a) wij = 0 if the value of ei does not depend on ej (there is no influence);

b) 0 < wij □ 1 with a positive effect of ei on ej (an increase in the value of the concept-cause ei leads to an increase in the value of the concept-effect ej);

c) – 1 □ wij < 1 with a negative effect of ei on ej (an increase in the value of ei leads to a decrease in the value of ej).

To perform the analysis of the constructed fuzzy cognitive map, in addition to directly specified cause-and-effect relationships, it is necessary to take into account all the indirect mutual influences of factors on each other available in the system. This allows us to perform a transitive closure operation that transforms the initial matrix of the intensity of mutual influences W into a transitively closed matrix Z, the elements of which are the pairs, where characterizes the strength of the positive influence, and - the strength of the negative influence of the i-th concept on the j-th. Based on the Z matrix, the following system indicators of a fuzzy cognitive map can be calculated.

The study of the development of problem-oriented systems remains a rather urgent task, especially at the stage of observation in order to scientifically predict the development of such systems. The task is complemented by an increased requirement to take into account the human factor in the development of models for studying behavior and determining sound management decisions. A problem-oriented system is understood as a complex of various subsystems in a hierarchical representation, uniting a sufficiently large number of mutually connected and interacting objects of various nature within the problem area.

Any problem-oriented system, in particular, a socio-economic system (SES), is a self-organizing object that develops under the influence of many changing factors, both internal and external. By its nature, the structure of such a system is hierarchical, dynamic, and reflects the evolution of the system in time and space. The presence of cause and effect relationships the need to take into account the human factor, hierarchy justify the use of a cognitive approach.

Methodological foundations of fuzzy cognitive modeling

Clear and fuzzy cognitive maps (models) have gained popularity. Fuzzy cognitive models are the basis for describing problem-oriented dynamic modeling systems in finance, politics and business. Such tasks as are solved: financial and political analyzes and forecasts; making strategic decisions based on cognitive maps in a clear and fuzzy environment; situational modeling of world politics and design of man-machine systems.

Cognitive modeling allows you to explore the evolution of the situation, which includes such components as: self-development, modeling of external influences, modeling of the purposeful development of the situation and controlled development in the presence of weakly structured situations. The traditional cognitive model is based on the concept of a cognitive map in the form of a signed directed graph (digraph) G=<V,E>, in which: V is a set of concepts (vertices), , i=1, 2,…, k are elements of the system under study ; and E is a set of arcs, arcs , i,j=1, 2, …,N reflect the relationship between concepts.

Such a device allows you to work with data of both qualitative and quantitative types. The degree of use of quantitative data can increase depending on the ability to quantify the interacting factors in the iterative simulation cycle. The purpose of cognitive modeling is to generate and test hypotheses about the functional structure of the observed situation until a functional structure is obtained that can explain the behavior of the observed situation.

Adequately built structural diagram of cause-and-effect relationships allows you to understand and analyze the behavior of the system. For systems whose problems are poorly structured, a cognitive approach is applicable. The description of such a system, taking into account its uncertainty, is possible. Let us describe the methodology for modeling problem-oriented systems, which, unlike the known ones, is built on the basis of multilayer fuzzy cognitive maps. This makes it possible to develop managerial decisions for the sustainable and economically safe development of such a system.

The analysis of the control object includes sections related to the analysis of the subject area, as a result of which subsystems, internal, external and subordination links should be identified. Management problems in the system and its subsystems are also identified. A stratified description of the system structure is carried out. The system management levels are represented by a model in the form of a pyramid, the selection of pyramid segments; definition of control echelons, strata and layers of the segment.

A set-theoretic representation of the selected layers is made. Definition of input, output and control information flows. The construction of a situational model of system control is implemented. Predicting the transitions of the system from the current state to the desired one. Modeling of fuzzy control action. The process of modeling the subsystems of the system is implemented by means of multilayer fuzzy cognitive maps.

The model is built in the form of a multilayer fuzzy cognitive map for each of the subsystems. An analysis of its structural and dynamic properties is carried out. Alternative control decisions are being developed under conditions of uncertainty for each of the problems. The transition to clear cognitive maps of individual elements of subsystems is being implemented. Next, an experiment is carried out with modeling the subsystems of the system with clear cognitive maps. It involves three steps. Building a model of system subsystems in the form of a clear cognitive map. Analysis of the structural and dynamic properties of the system on a clear cognitive map. Development of strategies and modeling of the corresponding scenarios for the development of the system.

Further, verification and development of recommendations for making informed management decisions are carried out. As a result of completing all stages, the decision maker will receive a set of strategies for the sustainable development of the system.

At almost every stage, the researcher is faced with the problem of making various kinds of decisions. A logical-mathematical approach is proposed using elements of artificial intelligence to the problem of decision making. The central link of the scheme is a set of such blocks as "generation of alternatives", "setting preferences" and "logical-mathematical models". The development is based on a set-theoretic approach together with a dynamic model. A complex of models is used to fill the block "logical-mathematical models", based on the cognitive approach, the theory of hierarchical structures, graph models and fuzzy sets.

To represent simple subsystems of the model at one level of the hierarchy, a clear cognitive map is used based on the mathematical apparatus of directed graphs. Multilayer cognitive maps are built on the principle of hierarchical structures using echelons and a stratified description. Fuzzy hierarchical cognitive maps are described by the apparatus of fuzzy digraphs. Statistical trend models are needed to match the scenarios identified in the course of impulse modeling. Multivariate statistical methods, such as factor analysis, reveal the degree of significance between factors.

The resulting correlation coefficients are used to assign weights over arcs in a fuzzy graph. Cluster analysis can be used to identify layers of a hierarchical structure. Impulse modeling on a graph model is used to identify promising areas for investing in a particular industry. Such a complex of models is built taking into account the laws of behavior of complex hierarchical structures. It is clear, easy to understand, meets the requirements of system completeness and scalability. This reflects the stage of formalization of the development and evaluation of the decision being made.

The use of fuzzy cognitive modeling technology, in contrast, allows you to be proactive and not bring potentially dangerous situations to threatening and conflict. Build models in the interest of analyzing and forecasting the development of technical, socio-economic and political systems. The proposed methodology for fuzzy cognitive modeling of hierarchical problem-oriented systems is based on the principle of combining formalized modeling methods and expert procedures in order to increase the level of validity and collegiality of managerial decisions due to the fundamental impossibility of complete formalization of decision-making procedures, systems of preferences and human values.

Smart materials

Over a long historical period, materials were used by man rather than created. Tools were made, and shelters were built from available materials. At the same time, the fundamental nature of the materials did not change. As civilization developed, the need arose, and then the ability to create materials that would satisfy certain requirements. This is how bronze, steel, dyed fabric and ceramics appeared. For each of these materials, the raw materials were assembled and processed in such a way that a new material with a specific set of required properties was obtained.

The development of the physical sciences in the twentieth century provided an extensive theoretical basis for explaining the properties of existing natural materials and creating new artificial materials. The creation of powerful computers made it possible to transform this base into various methodologies for the practical design and production of new materials. A distinctive feature of humanity was its desire to control environmental conditions in order to make life more comfortable. For almost all of history, humanity itself has been a key element in this governance.

As more and more complex mechanisms and structures were created, the need to control non-biological mechanisms, depending on the state of the environment in an automatic mode, became obvious. One example of an early environmental control system was the sea anchor, which was used to keep sailing ships at one point on the waves with lowered sails in stormy weather. Up until the nineteenth century, basic machines and the control systems associated with them were of limited complexity. When large and powerful machines rapidly developed during the Industrial Revolution, mechanical adaptive controls began to be created at the same time. A simple example of such control is an exhaust valve to prevent steam engines from reaching pressure limits and bursting.

The field of adaptive control has expanded with the invention of the computer. Complex models of mechanical systems can now be used to define and implement control laws. An example is continuum mechanics, which focuses on smart materials and structures.

In the second half of the twentieth century, scientists began to look for ways to create electronic devices that could solve problems in ways similar to those used by humans. It seemed that such devices should have artificial intelligence. The digital computer invented at that time was initially ill-suited for this type of research. The algorithms of early computers mirrored their internal fixed architectures and used linear serial data processing. The algorithms were programmed using the computer's basic operating instructions in machine language. They were aimed at processing large arrays of numerical data.

In order to use the computer as a tool for the implementation of artificial intelligence, high-level symbolic languages were developed and new architectures of parallel computers and algorithms with neurological capabilities were created. The result was computer-based systems that used recursive non-linear techniques to adapt and reconfigure themselves based on environmental changes from inputs.

The main idea of technological evolution leading to the emergence of smart designs is related to the concept of adaptation. One of the main characteristics of such structures is that they adapt to changing conditions. Adaptive materials, adaptive computing and adaptive control systems represent full-fledged areas within the framework of smart design research. Smart structures should include elements made of certain materials that provide the ability to change the properties of the entire structure under the influence of external fields of various physical nature (electric, magnetic and temperature); evaluate data on the state of the object and decide on the action by means of computational methods developed in the framework of research on such structures; – determine and perform the correct action based on knowledge or relevant control laws.

Adaptability does not only occur at the highest level of structural organization, it can also be present at the levels of the base material from which structural elements are made. The research on smart materials and designs includes so many technically different areas that it has become almost typical for one area to have a complete misunderstanding of the terminology and current state of affairs in other areas. Various terms are fixed: intelligent, intelligent, adaptive, active, sensitive, metamorphic structures, materials and systems. If we strictly follow the dictionary definitions, then intellectual, reasonable and adaptive are adjectives of different meanings.

Intelligence implies the ability to think abstractly and apply experience to new situations. Intelligence means the ability to gather knowledge and use it in the right way. Sensitivity means the ability to collect information and be aware that it is being collected. But this does not imply the ability to learn from this information and make decisions. Intellectuality and reasonableness describe mental activity; and adaptive, active and metamorphic are responsible for physical activity. The difference between these terms lies in the type of activity.

Activity means that physical activity is taking place. Adaptability implies that the results of the activity are only changes to the existing configuration. Metamorphic means major transformations. As for the terms material and structure, they differ only in scale. The system emphasizes the collectivity of components working together towards a common goal. Its individual components may have goals that differ from the collective goal. The terms intelligent, intelligent, and adaptive are used to describe the same level of functionality. And none of them say how the term is implemented in detail. For example, sensitivity simply means awareness, but not awareness through vision systems, tactile sensors, and other sensor technology.

It is generally accepted that intelligent, intelligent, adaptive, active sensitive and metamorphic materials and structures represent completely different systems and have different attributes. Smart materials and smart designs can be described as systems that change their properties depending on the changes in the environment that they capture. Nature is the main source of inspiration for engineers, which implies an approach to the creation of technological devices in which the idea and basic elements of the device are borrowed from wildlife.

By analogy with biological objects, smart systems contain sensitive elements that act like a nervous system; actuators like muscles; real-time data processing devices acting as control centers for the system. Of interest are sensitive (passive) structures that have a structurally integrated system of micro-sensitive elements to determine the state of the object and the environment in which it operates. As well as responsive smart structures that have a nervous system and a closed power system of automatic control to change the properties of the structure of its rigidity, shape, position, orientation and speed. Intelligent systems are capable of self-learning when adapting.

Smart materials represent a new design philosophy. It combines the actions of sensors, actuators, and control circuitry into one system that can change its response in a convenient way depending on changes in the environment. Such intelligent designs have a number of significant advantages over traditional designs. H. Petroski in his book "To Engineer Is Human" notes that when designing, an experienced designer always considers the worst case. As a result, the project has a large margin of safety due to numerous reinforcements, redundant element duplication subsystems and increased mass. This approach requires more natural resources than necessary. It consumes more energy to maintain the performance of the structure. More effort is spent on predicting the circumstances under which the constructed object will be used correctly or incorrectly.

Attempts to foresee the worst case come up against the impossibility to foresee all possible circumstances. Design engineers are looking to use new concepts to reduce the weight and cost of a structure, to do more with less. The resulting design is a model of efficient use of materials. An engineer always believes that he is doing something without mistakes. But the truth is that every new design can lead to a new trial. Explaining what went wrong and pointing out changes that worked is much easier than looking for bugs in a project that has yet to be implemented. It is necessary not only to determine the mysteries of the design, but also to test your solution, checking all the possible ways in which the destruction of the structure is possible.

The engineer has a finite amount of time and resources to complete the project. Therefore, it is important that he understands and tests all possible hypotheses about what types of loads, stresses and temperatures will be encountered in operation. Smart materials systems can avoid many of these problems. Created for a specific purpose, they change their behavior under specific circumstances. An overloaded ladder, using electrical energy, would be able to warn a person and increase its rigidity. The reaction of the ladder can be based on actual experience with its operation, taking into account the destruction and aging.

Having determined its current state, the stairs, even with minimal load, would signal risks. You can coat bridges with smart paints that will report wind load or traffic, or buildings that allow you to observe the integrity of a structure subjected to loads, or even repair small cracks by shearing the surrounding material. It is possible to manufacture special clean rooms with an active coating that can collect dust and dirt in certain places. You can build walls that feel vibrations and actively absorb noise.

Structurally, smart-systems materials and designs include built-in or surface-mounted sensors; built-in or surface-mounted actuators (actuators); schemes of control elements for the implementation of the control system, allowing to process data from sensors to make an appropriate decision. Sensors and actuators in designs copy nature. According to the five senses (sight, hearing, smell, taste and touch), visual optical, acoustic ultrasonic, electrical, chemical and thermal magnetic sensors have been developed.

The responses from the primary sensors are converted into signals that are transmitted to the information processing center and the control unit for further processing. In addition to processing information, the center has a great role as a processor to make a decision based on the input data. To implement the concept of smart structures in the simplest form, composite materials are suitable. Sensors or actuators can be embedded in them during their manufacture.

Sensors or mart-structure sensors, which have only sensors in their composition, are called passive. Embedding sensors inside during the manufacture of a composite material makes it possible to observe the internal state of the material. The successful development of passive smart structures depends on the development and tuning of suitable sensors; principles of operation of sensors and methods of signal processing; choosing a suitable production scheme that allows you to integrate sensors without much difficulty.

The attention of researchers is focused on two types of materials that are convenient for embedding in intelligent systems as sensors or sensors, these are optical fibers and piezoelectric materials. Sensors based on fiber optics can measure magnetic fields, deformations, vibrations and acceleration. They fit well into the composite fabrication process; able to withstand deformations comparable to the size of the composite itself; are small in size, light in weight and easy to manufacture; are immune to electromagnetic interference and outperform other sensors in harsh environments.

Fiber optic sensors can also be easily integrated with other equipment for remote control and allow monitoring the structure of the composite during all stages of its existence: manufacturing, testing and operation; resistant to aggressive environment and insensitive to electrical and magnetic noise; have a wide response bandwidth. Fiber optic sensors have proven themselves well both when fully embedded in the material, and when externally fixed. The embedding of optical fiber entails the need to make changes to the manufacturing process of composite materials in order to place the sensors exactly in the required places and to be sure that the signals from them can be input and output through the conductors.

In order to be usable, a fiber sensor must cause minimal deviations from a predetermined distribution of reinforcing fibers in the composite material; if possible, do not reduce the mechanical properties of the composite; prevent excessive signal attenuation and not be destroyed during the embedding process. Otherwise it will not be possible to carry out the necessary measurements. Have suitable means for input and output of laser light into the system via conductors. The widespread use of piezoelectrics as sensors provided their advantages. This is a wide frequency band; – the possibility of using very thin layers of piezoelectric material when they are fixed on the surface or embedded inside the composite; lack of delay of the regulatory action; mechanical simplicity.

Piezoelectric polymers, such as vinylidene fluoride, are used as sensors instead of piezoceramics, which can be fixed on surfaces of any type and any, even strongly curved, geometry. Such sensors are able to replicate the capabilities of human skin by detecting geometric features such as edges and corners, temperature, or distinguishing between different materials. Thus, the sensitivity of the strips is high enough to distinguish between type in books for the blind and grades of sandpaper.

Actuators are needed to make reactive smart structures. These are actuators that are capable of causing deformation of the structure, based on information received from sensors that describes the physical condition. Historically, with the advent of rubbers and solvents, self-sealing materials began to appear. One of the earliest patents (1896) belongs to Mercier, who developed a material that heals a wall puncture on its own.

The technology of self-sealing liquid containers has been developed with the advent of various modern systems in which an uncontrolled leakage of liquid can be extremely dangerous and lead to the impossibility of operation or destruction of the system itself. These are space suits, cars and planes. A well-designed system can handle a wide range of operating conditions, typical faults, and has the ability to provide early warning of critical or threatened damage. However, this kind of approach has a number of disadvantages. The applied sensor system relies on the predictability of results, which in itself is a limiting factor in everything but space technology.

The implemented approach of self-healing with the help of thermoplastic materials is limited in practical application, since the structure is temporarily weakened when working to restore the integrity of the material. In addition such geometry of structural elements is required so that the material can easily enter the damaged areas. There is a lack of development of damage detection algorithms. Pre-existing corruption can compromise baseline values for the monitoring system, reducing the efficiency of corruption detection algorithms.

Time dependence of damage detection algorithms; slow-growing damage such as fatigue remains undetected for the time being, as the methods used are based on a fairly rapid deviation of the tracked structural state curve due to damage. This is analogous to the distinction between acute and chronic illness or pain in biological systems.

Another unresolved issue is scalability. On a large scale, the amount of information coming from a network of sensors can become so unwieldy that special control over the structure's self-healing is required. Biological systems have managed to cope with this problem by adding levels of system hierarchy through intermediate filtering nodes and delegating various functions, each of which can be applied to engineering systems.

The use of smart materials is expanding. They can be found even in household applications. For the new generation of ski jumps, tennis racquets, snowboards, golf clubs and baseball bats, vibration damping becomes important, as this not only increases comfort in use, allows you to achieve better results, but also prevents breakages. Head Intelligence was the first company in the world to produce piezo-fiber tennis rackets. The secret of such rackets lies in piezoelectric fibers that can convert the mechanical energy of the ball into an electrical impulse. Fibers generate electricity at any of their slightest bending or deformation. Due to this spark, which jumps along the rim in less than a thousandth of a second, the racket acquires additional rigidity at the moment of impact. Hence the new reserve of its power and the complete absence of vibration. These technologies have been tested in alpine skiing and snowboarding.

Research is being carried out to optimize the dynamic behavior of smart structures and their dissipative properties. The objects of research are structures, which include elements made of piezo materials connected to external electrical circuits. The aim of the work is to create effective methods of mathematical modeling that allow finding the best placement of the piezoelectric element on the structure, which ensures the generation of the largest signal when it is deformed. The parameters of the elements and the type of external electrical circuit (series, parallel, or their combination) are studied, which provide the maximum damping properties of an electro elastic body with external electrical circuits at given resonant frequencies.

Self-learning hardware and software will produce their own hardware and software. Mechanical loads, electric or magnetic fields, temperature, light, humidity, chemical properties of the environment will be taken into account. Changing the properties of a smart material is reversible and can be repeated many times. These are self-healing materials that can independently heal the defects that arise in them. Alloys with a memory effect after deformation restore their original shape when heated. Self-lubricating materials reduce friction and wear. They are applied as coatings with hardness to reduce wear or low surface energy to reduce adhesion and friction. Self-lubricating materials are developed as composites with metal, polymer or ceramic fillers and a matrix that provides structural provides structural integrity. For this purpose, the use of graphite is widespread. Self-cleaning materials repel water, organic liquids and other contaminants. Piezo electrics generate electricity when a mechanic load is applied. When an electrical voltage is applied, the material can bend, expand, or contract. Photomechanical materials change shape when exposed to light.

The properties of magnetorheological fluids change when a magnetic field is applied. In the absence of a magnetic field, such liquids are a suspension of randomly located magnetic micro particles (most often iron) in a liquid (various oils). In a magnetic field, the particles line up in chains along the lines of force, thereby sharply increasing the viscosity in the direction perpendicular to the direction of the field. Magnetostrictive materials change shape in a magnetic field. There is also the opposite effect. Electro strictive materials are similar to magnetostrictive materials, with the only difference being that an electric field is applied. Electrochromic materials change their optical properties under electrical influences. Liquid crystal displays are an example of such materials.

Pyroelectrics generate electricity when the temperature changes and vice versa. Commercially successful smart materials include nitinol (shape memory alloy), Terfenol-D (magnetostrictive material) and lead titanate zirconate (piezoelectric). Smart materials are the basis of many applications, including sensors and actuators or artificial muscles, in particular, electro active polymers.

Shape memory polymers are materials in which a large deformation can be induced and restored by changes in temperature or changes in stress (pseudo elasticity). The shape memory effect occurs due to the martensitic phase transition and induced elasticity at higher temperatures. Electro active polymers change volume when subjected to a voltage or an electric field. Smart inorganic polymers exhibit tunable and responsive properties. PH-sensitive polymers change in volume as the pH of the environment changes. Thermo sensitive polymers undergo changes as the temperature changes. Halo chromic materials (paints) may change color, indicating corrosion of the metal underneath. Polymorph can be molded by hot water dipping.

Healing materials have an inherent ability to repair damage caused by normal use, thereby extending the life of the material. Smart self-healing coatings heal without human intervention.

Agile software development methodology

Agile is an agile software development methodology. They share Agile as a family of flexible approaches and Agile as a philosophy and value system. Among the most popular approaches are Scrum and Kanban. An important question is why Agile values are needed, what is behind them. Where can they be applied and what is the place of Agile in the overall picture of process, product and business management. The term "methodology" is applied to Agile by analogy with previous approaches to the organization of software development: RAD, RUP, XP and other approaches.

Agile is made up of four values and twelve principles. And the description of the RUP methodology, for example, takes up dozens of pages. This is a lot of tricks and algorithms of actions. RUP (Rational Unified Process) includes a breakdown of the development lifecycle into four phases, recommended workload ratios for nine streams in each phase, and specific tools for each stream. OpenUP, as the latest methodology - the heir to RUP, is shorter and more flexible, but still far from Agile brevity. Agile does not provide algorithms, methods and techniques. At the same time, the flexible approaches included in Agile often prescribe specific techniques. For example, XP (extreme programming) agile methodology includes techniques such as pair programming and the planning game, which indicate very specific algorithms of actions. And even the flexible Scrum framework, which is not a process, technique, or method, mandates the use of multiple roles, activities, and artifacts.

Each element of Scrum is essential for its successful use. Unlike software development methodologies, methods, and frameworks, Agile is based not on specific processes or even elements of processes, but on values. Following these values increases the speed of development and the business effect of the products being developed. At the same time, the cost of development can increase, so Agile is not always needed. Since 2012 Agile has been used in software development. The Agile values were born in 2001 in the Agile Manifesto as a result of a generalization of many development methodologies of the time by their authors. Values reflect what is common, which determines the priorities in the work, regardless of the specific process and subject of work.

Each of the four Agile values is formulated as “X is more important than Y”, where X is: people; working product; cooperation with the customer; readiness for change. For people to work more efficiently, processes and tools should not limit them. In Agile, neither the process nor the software tool dictates what people should do. Moreover, they themselves decide how to change the processes / tools of their work.

To speed up the development process, people should also interact directly without intermediaries in the form of documents or other people actively communicate with each other in person, and not in writing. In modern business, communication is often forced to move online. But then it should be video communication with interactive online whiteboards, and not just letters and chats. For customers to be happy, they need a working product. Therefore, product developers should focus on making the product usable as soon as possible, rather than listing, charting, requirements, and reporting to the customer.

In order to meet tight deadlines with a minimum of costs, it is often not worth binding yourself with documentation. Maintaining documentation in a state adequate to the product often slows down development and requires unreasonably high costs. In order to get a product that is really valuable for the customer, it is worth abandoning unnecessary details in the contract between the contractor and the customer (as well as in the requirements of the internal customer to the internal product developer). Being rigidly set at the start, contract details make it difficult to take into account new data and priorities that appear only during development.

In order for the business value of the product to grow rapidly, the customer and the developer must communicate closely in the course of work. In this case, all emerging changes and problems are promptly processed by both parties. And in order for such cooperation between the contractor and the customer to become possible, it is necessary to build their trust in each other. In order not to postpone the risks of projects to the last stages of development, when it will be too late to reduce the scope of work, shift the deadline or strengthen the team, Agile offers not only iterative work, but also a willingness to change at all stages. In order for the most valuable thing to be done first, the current vision of business value and product positioning must be transparent to developers, and their work process must allow significant changes to previous plans.

Developers must be ready to add unplanned new features to the product if they become valuable in a changed situation. As for the willingness to change on the part of the representatives of the customer (client), in such a situation they can sacrifice something planned, but less valuable, for the sake of new opportunities. The willingness of the customer to quickly sacrifice some part of the planned action is also needed in a situation where the performers encountered unforeseen problems during development. How the Agile value system helps developers make new products faster and with greater business impact.

Through more effective interaction with the customer and with each other, which is not limited to a rigid contract or a rigid internal process; due to a quick reaction to changes, and from both sides; by focusing on a working product, rather than supporting things like documentation. Agile is often referred to as a philosophy. There is also the term "agile mindset", which means a person's understanding of Agile values. Changing the mindset of leaders and executives from a traditional mindset to an agile mindset is the hardest thing to do. This is the most difficult thing to do in order to implement any kind of Agile approach in a team or company.

The Agile mindset is most often implemented through the Scrum framework. If Agile thinking is not inherent in people, Scrum leads to higher development costs, since more time needs to be devoted to communication and feedback. New roles are required, resources are needed for training and for increasing the interchangeability of employees. At the same time, without a concrete approach like Scrum Agile will remain just a beautiful philosophy that most people will not be able to turn into a guide for everyday work. Therefore, Agile and Scrum are usually studied together. Historically, Agile also includes the Kanban method. Therefore, the most universal international certificate for Agile ICAgile Certified Professional includes not only Scrum, but also Kanban.

In addition to values, the Agile Manifesto has twelve principles and six features that refine and complement values. Let's uncover the signs. With an Agile approach, not only the business and the product manager are focused on the needs of the client, but the entire team. That is, each of the developers understands who the customers are, what they need and what problems the new product solves. This helps to find more adequate solutions.

The rules and processes by which agile teams work must be kept simple so that people can focus on the customer and the product being created. It is supposed to work in short cycles (iterations) of the order of a week or a month. During this time, the developers produce some useful result for the client.

Developers demonstrate the product to the customer, get feedback on the product and information about changes in the customer's plans, then refine it, add something useful, and so on through the cycle. The feedback loop works to improve the development process itself: to get rid of waste, delays and other obstacles that hinder productivity. Ideally, people make their own decisions and are responsible for them. When a team or even an individual employee wants and has the right to solve some problem without waiting for outside actions, this significantly speeds up the processes of activity.

Agile methods help to set up processes in such a way that employees see the demand for their work by clients, appreciate the trust and opportunities provided to them for self-development. People with this intrinsic motivation are more efficient at work, especially if it is a complex creative job. Features are common to many agile approaches if they are applied correctly. Agile management practices include the Scrum framework and the Kanban method.

In Scrum, work is done in sprints, short iterations of the same length. The work is carried out by a small team of up to 10 people. It includes the developers, the Product Owner, who is responsible for the success of the product, and the Scrum Master, who is responsible for the effectiveness and correct application of Scrum. The team independently decides who, what, when and how to do it. Team members jointly plan the sprint, jointly demonstrate the results to stakeholders, and jointly look for ways to solve problems, both with the product and with the work process. During the sprint, developers have daily and verbal discussions about obstacles, short-term plans, and the division of work among themselves. Kanban is a method of improving the quality of service.

It is a set of principles and practices that make a service or product develop faster and better meet consumer expectations. Kanban differs from Scrum in many ways. It has a wider scope. These are not only new products, but also operational activities. Unlike Scrum, it is implemented gradually without a one-time change in current processes and more simply without changes in the organizational structure.

It is aimed not only at acceleration, but also at the uniformity of processes; has metrics that are very different from Scrum, which do not require an assessment of the complexity of tasks, for example, the time it takes to complete a task in the system; differs by the lack of focus on team self-organization and the lack of a direct connection between Kanban practices and Agile values. Kanban has its own values, many of which align with the Agile values, such as customer focus, collaboration, and transparency.

Visualization of the process is widely used, including with the help of Kanban boards. This is a physical or electronic board with stickers indicating different tasks. Unlike the three-column Scrum board, it is customary in Kanban to visualize each stage of the process on the board, as well as divide each column into two parts - “in progress” and “ready for the next stage”.

Scrum and Kanban are not the only approaches included in Agile. But most of the other flexibilities that are being actively developed now deal with problems of a different level. We are talking about the problems of large organizations that are forced to compete with startups both in terms of the speed of bringing new products to the market and the speed of decision-making. Such organizations are helped, in particular, by the SAFe (Scaled Agile Framework) and LeSS (Large-Scale Scrum) approaches, as well as the Scrum of Scrums practice. These are the most popular Agile scaling approaches.

Agile is used in various industries: in banks and insurance companies, in retail networks and telecoms, in energy and in industry. The formulations of many of the Agile principles apply only to software development, but most of them are applicable outside of IT. Agile is not just about software development. Agile is especially effective in creative work or in conditions of uncertainty. Otherwise, the overhead of Agile processes can outweigh the business benefits of Agile, especially if these processes are poorly tuned.

Agile is useful in a situation where the first version of the product needs to be released to the market as quickly as possible, otherwise the competition may be lost. The situation where Agile values will be most effective: an innovative product with unpredictable properties in advance and with non-standard means (new technologies) for its development.

Smart cities

Agglomerations and cities have begun to develop smart cities. The word "smart" suggests that the views of the designers and developers include awareness and citizenship independence. These are cities that combine six areas: governance, people, technology mobility, economy, environment and lifestyle. The concept of "smart city" covers the activities of well-informed and independent citizens. It is a complex relationship that involves several players, as well as a behavior in which three main factors can be distinguished: technological, institutional and human. The purpose of the research is to identify the most important of them, which would be the most necessary for the survival of smart cities. Most studies show that citizens are the most important players. Several studies have shown that municipalities are equally important players. Researchers emphasize the importance of all stakeholders in smart cities.

With regard to the specifics of human-centered smart city concepts, two preliminary remarks can be made. There is an evolution of ideas from technological determinism to socio-oriented justification. The research methodology includes identifying the features of expert opinion on the basic principles of scientific approaches used in social practices in the form of the principles of the "smart city" concept. The foundations of the holistic approach in understanding the "smart city" as an integral adaptive system, the "smart city" and its main actors-players are explored.

A system of participatory methodologies is used to analyze the problems of digital citizenship and a "smart city" of equal opportunities. A smart city appeared as a balanced system of knowledge and practices, including the involvement of the population in socially responsible research; participatory research in urban communities; development of a model of a "smart city" focused on people. What BIM-centric software is currently doing, with real-time rendering connected to a geospatial context, responsive to business model processes and mobile-driven interfaces, is a testament to the extent to which industry the offer can interpret the user's need.

Each innovation had its followers, who, tied to the model, transformed different industries. The management of physical documents has changed. Computer-aided design systems sent drafting tables and a thousand artifacts to warehouses that did not fit in drawers. Email has become the default digital means of formal communication. All of them were guided by standards from the point of view of the provider. These transformations were aimed at increasing the value of geographic and alphanumeric information. The model on which these transformations were carried out was the global connection; i.e. http protocol. New initiatives have taken information, connection conditions and turned them into new cultural practices that Uber, Airbnb, Udemy and Netflix are cultivating.

Standards will play their best role in striking a balance between creative proposition and end user requirements. In order for http/TCIP to become the standard communication protocol that remains in place to this day with advances in technology and society, it had to go through a process of governance and renewal. The user never knew the IP address, no need to type www anymore, and the search engine has replaced the need to type http. The new protocol goes beyond connecting computers and phones. Current cloud services, instead of storing pages and data, are part of the daily lives of citizens, governments, and businesses. This is one of the reasons for the death of the original protocol based on IP addresses, since now it is necessary to connect devices coming from the washing machine, which should send a message about the completion of the spin of the clothes. Real-time monitoring should report your state of fatigue and the need for maintenance.

From a business perspective, the new standard should look a lot like a digital representation of physical assets; like a printer, apartment, house, bridge. But more than simulation, it is expected to add value to operations; so it allows you to make more informed decisions and therefore better results. From the city's point of view, the new protocol should be able to create ecosystems of many connected models and assets to add value by using this data for the public good.

In terms of performance, the new protocol should be able to standardize the lifecycle. Simplified what happens to all things like road, lot, vehicle; intangible assets such as equity investments, strategic plan, Gantt chart. The new standard should simplify the fact that they are all born, grow give results and die or transform. The convergence of smart infrastructure, modern construction methods and the digital economy opens up more and more opportunities to improve the quality of life of city citizens.

Having interconnected models should simplify middlemen by being able to automate checks that are self-service for the end user. This is a sale of real estate, a mortgage, a loan request, a business license, the exploitation of natural resources, or an urban plan update. Options relate to aspects such as scope and approaches; but if they have the same domain model, they should be able to interact. Digital transformation needs to include the entire built environment as a whole to ensure better use, operation, maintenance, planning and delivery of national and local assets, systems and services. A project is underway to create a structure that guarantees effective information management throughout the built environment, including secure data exchange.

Thinking in interconnected global contexts involves connecting systems that do not necessarily have geographic modeling. Management has found itself in a new phase of context expansion where no one will take away the role it held and continue to carry out the BIM methodology, but something higher will absorb or unify it. It is preferable to have a standard for infrastructure and one for land, and link them at the point where the exchange of information adds value.

In the context of digital twins, BIM can continue to be the methodology that defines standards for infrastructure modeling. Who manages to group the key participants of this philosophy, understanding the importance of the public good, the economy, society and the environment will have great advantages.

Digital twins

The concept of digital twins appeared in relation to the modeling of complex industrial objects and systems. But, recently, it is also often used in relation to copying various objects of wildlife, including people. Digital twins of subjects, unlike digital twins of inanimate objects, can be used for more than just models. They themselves are able to actively act, including interacting with each other. This opens up new possibilities for using such entities to solve a wide range of different problems.

In the case of inanimate nature, we have the following main way to use the digital twin. The owner of a physical twin - a device, a product, a process - raises certain questions about its current state and forecasts. These questions are addressed to the system that performs the role of decision support. The digital twin functions as part of a decision support system, performing simulation tasks.

Simulation modeling in the variant of a numerical experiment is the main task of a digital twin in the modern classical sense. Additional features of the digital twin, such as feedback or its variability during the life cycle, do not change the designated main task. When transferring the concept of a digital twin to the field of wildlife objects, the above use case can also be transferred. In many respects, a living object can be approached with the same task of determining and predicting a state and considered as a special physical object. This is how the problem of using a digital twin to predict the risks of health disorders in a patient is solved.

A special case may be the digital copying of some person or, more generally, a subject. In this case, since the person is endowed with consciousness, she can set the task of creating her own digital twin and formulate questions to him on her own. These questions can be similar to predictive questions about physical health. In this case, a fundamentally different possibility arises, connected with the fact that human consciousness has a different nature than the physical, even the living world. Human consciousness operates both in the world of physical reality and in the world of virtual reality.

In the virtual space, the digital twin can be used not to identify states and make predictions, but to utilitarianly replace the physical twin, performing various activities for it, for example, communication interactions. Something similar is practiced in cyberspace. His world is filled with bots of varying complexity, imitating consciousness. If a person has the opportunity to create his own digital twin as a kind of assistant bot, a kind of cyber assistant, then he uses it with the greater benefit, the more accurate a digital copy he is.

Digital twins created by subjects in their likeness and used as their virtual assistants will be called personal digital twins. Personal software agents, known as digital twins, will serve as personal assistants. A personal software agent is a digital simulation of a person, their values, interests and goals. The digital twin will be able to track calls, decide what should come first on the to-do list, and compose simple emails. If a personal assistant scanned letters, blogs and media posts, then the twin agent imitates the essence of the person immediately after launch. He can interact with other people's helpers, rationalizing everyone's life. But we need to be careful not to completely load ourselves into our digital assistants. If his interaction with the owner's social circle becomes too effective, he will appropriate the owner's social connections and become autonomous. As a result, if not the physical, then the social existence of the original will cease. Regardless of the positive or negative connotation, the idea of a digital twin of personality is considered in the context of the digitalization of business and production. This concept is connected with such key categories as dynamics, procedurality and modeling.

Modeling becomes a source of cultural fears. The generalized definition of a digital twin as a process represents it as a constantly changing digital profile containing historical (memory) and current data about an object. Other definitions are based on the idea of modeling a system based on simulation rules in order to predict the production of the human body. The ideas of procedurality and modeling are combined in the definition of a digital twin as a digital dynamic model corresponding to a physical object, which allows simulating all the features of its behavior.

The potential danger of a digital twin is associated with the possibility of modeling an object or process and with the threat of losing control over the model, which is equivalent to controlling the object of modeling. In real practice, the construction of digital twins of a person has received a rather limited distribution. In most cases, this is an external task in relation to the individual, when the modeling of the desires, goals, preferences the individual is performed by external players and without her participation and consent. This is how targeted advertising is organized. The idea of creating a digital twin as a personalized tool for expanding the capabilities of the subject is closest to the work on creating personal software assistants and virtual digital assistants.

The task of building programs to support the work of human activity with machine complexes was set already in the 80s of the twentieth century under the name of personal software assistants. The development of this idea led to the widespread use of smartphone programs under the name of virtual digital assistants, which began to take into account the context of work, for example, geolocation. Known research work aimed at developing the functionality of learning and self-learning in the TSC.

All this can be seen as a movement towards a personal digital twin. The main efforts in creating virtual digital assistants have focused more on endowing it with artificial intelligence and creating a voice interface.

For progress in this direction, several important aspects must be taken into account. First, the virtual digital assistant will evolve towards acquiring the traits of a personal digital twin. Immersion in the context of the subject, which began with tracking his geolocation and taking into account the time of interaction, will develop. An immersion in the content context of the subject will follow: his work and contacts.

The complication of tasks will require modeling the behavior of the owner, the study of his behavior patterns for a deeper construction of the digital twin of the subject. Secondly, the natural habitat of digital twins is cyberspace.

The implementation of virtual digital assistants as mobile applications for a smartphone is determined mainly by the commercial environment and is interdependent with their weak personalization. A personal digital twin can no longer be considered as a replicated program associated with a specific device. It will be unique to the subject, of particular value, and used regardless of the specific device. This does not exclude the possibility of a digital twin to control various devices, including the subject's smartphone, with the help of subagents. Thirdly, realizing the activity of the subjects, digital twins may be faced with the need to establish contacts with the user's counterparties. Such contacts will coincide with social groups and networks of subjects. In cases where counterparties have their own digital twins, direct contact will be established between them as well.

As a result, networks of digital twins can be formed in the form of multi-agent systems of intelligent software agents. Such networks will be isomorphic to real social networks. Just as real social networks consist not only of people, but also of collective subjects, digital twin networks can also include digital twins of collective subjects. The structures of interacting digital twins will be called sociomorphic.

Sociomorphic multi-agent systems that allow combining the autonomy of nodes with collective work can be applied to solve a wide range of tasks related to collective activity. A certain functional analogue of sociomorphic multi-agent systems are social network services. Such systems are very complex to build and extremely resource-intensive. This could be a serious obstacle to study, since practical verification of the validity of the results could be difficult to implement. However, sociomorphic multi-agent systems are distributed in their organization and therefore can be built as open and heterogeneous.

Sociomorphic multi-agent systems built on open formats and protocols can be freely expanded by simply adding new agents. This means that a system can start as a small cluster of simple agents and gradually evolve to a large scale system. With such an expansion, unlike closed centralized systems, which include social network services, there will be no problems with scaling.

Appeal to the topic of constructing sociomorphic multi-agent systems consisting of digital twins involves the choice of tasks in which the effectiveness of such systems can be best manifested. And the features of construction and development have been verified in a practical way. A practical application of sociomorphic multi-agent networks of digital twins will be competition with network services in supporting real social networks. One of the important functions of digital twins will be participation in the communications of the owner. Modern digital twins are able to interact to some extent with the owner's contacts through social networking services. However, in cases where PDCs are available on both sides of communication, mediation in the form of a social network service becomes unnecessary, since digital twins, having a cybernetic nature, can organize interaction.

It is possible to imagine the support of communication in some social network based solely on the interaction of digital twins of the subjects of such a network. It seems that all the possibilities of social networking services used by community members can be simply and efficiently implemented in a multi-agent system of digital twins. Certain problems may arise in that part of the functions of a social network service where general information about the community of service users is integrated and analyzed. However, this is primarily a means of monetizing the service by its owners, and individual members of the community are not directly interested in this functionality.

Social network services have a certain attractiveness, so that in order to transfer social network communication to the basis of multi-agent systems of digital twins, serious arguments and the interest of the participants in these networks are needed. It will work in favor of standard social networking services that they already have established multi-million user communities and a well-established business model.

It should be taken into account that existing social networking services have a number of disadvantages and limitations. Support for social networks based on multi-agent systems does not have these shortcomings. It can be attractive to be able to choose and expand the functionality of an agent, since the openness of the system, combined with extensible protocols, allows agents with different extensions of basic capabilities to function in one multi-agent system.

Sociomorphic networks of digital twins can also be useful for the actual task of knowledge management. The main practical task is to build knowledge management systems that ensure the accumulation, systematization, preservation and reuse of the organization's intellectual, knowledge capital.

At the same time, effective solutions suitable for mass application have not yet been found. The creation of really working systems is available in practice only by industrial giants with practically unlimited financial possibilities. Such solutions are unique and poorly replicated in practice. The solution to the problem can be an appeal to the perspective approach of knowledge ecosystems, in which knowledge management is seen as an activity that takes place in a certain ecosystem formed by actors, each of which works with knowledge and manages it within their needs and capabilities, and knowledge sharing ensures the effectiveness of everything. process.

At the system level, knowledge ecosystems can be built on the basis of multi-agent systems of digital twins of knowledge subjects. Helping their prototypes in knowledge management will be one of the tasks of personal digital twins. By organizing into sociomorphic multi-agent systems, digital twins can exchange knowledge, synergistically reinforcing each other. In this approach, an organization's knowledge resource is created as an aggregation of relevant knowledge of all employees, departments, cooperating organizations obtained in the interaction of digital twins of all these persons.

Such a knowledge management process is more natural in relation to real practice. The task of building individual educational trajectories has been known for a long time and is considered one of the urgent problems of modern education. The search for solutions is mainly focused on loading the learning tool with some artificial intelligence, which determines the level of training and abilities of the student, with subsequent consideration of these data to select the level of complexity and nature (verbal, auditory and visual) of educational materials, the pace of their presentation.

There are a number of restrictions. First, the personalization of education is being replaced by the personalization of learning. Out of the focus of consideration is the goal-setting of the student and the set of competencies already mastered by him. In the case when digital twins of students and agents of educational services are included in the interaction in some sociomorphic system, personalization of both education and training is possible. The digital twin, owning the target settings, the competence map of the subject of education and the cognitive portrait (style) of the person, is able to form an actual educational program. Secondly, in interaction with artificial intelligence of learning tools and systems, to determine an individual learning trajectory based on a significantly larger amount of knowledge about a person than in implemented solutions.

A significant part of the activities of most subjects is implemented in cyberspace. A large proportion of contacts occur not with subjects, but with cybernetic systems, or with their direct participation in the interaction. Cybernetic systems, realizing the goals and objectives of their owners, collect and accumulate information about subjects, including for building their digital twins.

The ultimate goal of such activities is the monetization of this information. This situation causes reasonable concern, since the security of personal space in such interaction is under threat, and in a number of cases a person cannot compete with cybernetic systems. An effective alternative to the direct interaction of the subject with cyberspace can be the inclusion in the interaction of the personal digital twin of the subject, which, as an intermediate cybernetic system, will screen the interaction of the subject with cyberspace.

The digital twin could recognize and shield various attacks and manipulations from cybernetic systems during interaction with cybernetic space. The issues of creating personal digital twins and organizing them into sociomorphic multi-agent systems are an interesting and relevant area of research, and may have direct practical value in the field of social engineering. A feature of these studies will be the ability to build effective interaction between representatives of various specialties. Designing a model of a personal digital twin and determining ways to organize such twins into sociomorphic networks will require competencies in a wide range of humanities, including philosophy.

Implementation of competencies in the field of computer science and information technology, primarily in the areas of artificial intelligence and personal software assistants, distributed, open, multi-agent systems, knowledge management systems and decision support. Based on this methodology, specialists are actively involved in the development, validation and deployment of digital twins of industrial expert systems that provide automated intelligent monitoring of process equipment, early detection of defects and forecasting of technical condition. Virtual and physical production systems flexibly interact with each other. At the heart of this world is an ideal copy of the physical world in a digital version, its digital counterpart. It can allow you to interact virtually with other participants in the process, receive information from sensors, quickly simulate conditions, clearly understand the consequences of scenarios, predict results and issue commands for execution in the real physical world.

Pairing technology has become the basis for the development of digital twins. The concept of a digital twin was proposed in 1994. And the term "digital twin" was introduced in 2001 by M. Greaves from the University of Michigan at a presentation of the university to industry representatives. M. Greaves defined this concept in the context of product life cycle management. The idea was to create digital records of mass-produced parts and raw materials to better manage recalls and claims tracking requirements; predict and detect defects associated with quality trends earlier; improve the overall quality of the product.

Since the advent of the Internet of Things, the concept of digital twins has evolved significantly. This term refers to virtual clones of real assets.

They analyze data and create reports, new data and commands to correct the operation of real assets and ensure correct decisions are made. Collecting information from the sensors of connected devices in real time allows you to enrich them with business and contextual data, constantly analyze new useful information.

Digital twins can be divided into three types: product twins, production twins, and performance twins. To conduct virtual testing, the digital twin uses information collected from sensors. Using data provided by IoT technologies (e.g. temperature, humidity), you can show the system performance and health status of the digital twin, and then use this information to predict the behavior of physical equipment. With such data, the digital twin can track the history of behavior and reflect the events and experiences of its physical twin (twin) during its life cycle. Digital twins in production allow you to improve the processes of planning, modeling and optimizing the production process.

They represent virtual models of production assets that are used to predict behavior and optimize system performance. They can be used to predict unit performance, eliminate limiting factors, and ensure that products are produced to meet customer expectations.

Computer engineering analysis

The success of companies is largely determined by the ability to effectively balance the innovativeness of developments, their cost and the quality of the finished product. At the forefront are the tasks of optimizing operational benefits: reducing the size of the product, its weight and energy consumption. And engineers who develop products for mission-critical applications or extreme environments must keep safety and reliability in mind. However, given the demands for ever-shorter R&D times and increasing product complexity, maintaining this balance can sometimes become a difficult task.

As a result, computer-aided engineering analysis allows designers to visualize every aspect of performance, evaluate product strengths and weaknesses, and find design solutions that combine innovation, reliability, time to market, and profitability. Numerical modeling involves the study of physical phenomena, processes or systems of objects by constructing, applying and studying their mathematical models using numerical methods and with the support of high-performance computing. It allows you to make design decisions that can optimize any product performance and ensure business profitability while controlling costs. With the help of numerical simulation, you can simulate the operation of smart devices from the chip level and recreate the conditions that it will be subjected to in the real world. And all this without the huge time and financial investments required for physical testing.

The term CAD refers to a wide range of computer-aided tools that help engineers, designers and architects create the geometry of designed products, structures and structures. Computer-Aided Engineering involves the use of special software for computer engineering analysis of the behavior of designed products and evaluation of their characteristics. Traditionally, the areas of analysis include the analysis of the stress-strain state of parts and assemblies, the calculation of the temperature state of products, the analysis of electromagnetic compatibility, and pressure losses during the flow of liquid and gas.

Computer-Aided Manufacturing refers to software whose main purpose is to create programs for the control of numerically controlled machine tools. The initial data is the geometric model of the product developed in the computer-aided design system. The main trend in the industry is the integration of CAD/CAM/CAE/PDM/PLM platforms into a single engineering interaction. This trend requires transformations, both in the organization and in the culture of production.

The process of designing new products, even based on existing prototypes, has never been an easy task. To achieve the desired performance and reliability, it is necessary to change and refine the design of the product many times, studying a wide variety of physical processes from heat and mass transfer to assessing the stress-strain state of the structure and calculating durability. Despite the fact that design tasks are so diverse, often design goals can conflict with each other, deadlines are constantly being reduced, and budgets, on the contrary, remain unchanged. Model-Based Systems Design helps overcome these difficulties. The methodology is to use simulation early and throughout the design cycle and subsequent stages of the product life cycle, up to its disposal.

This allows you to make more accurate decisions, explore more design options, and plan maintenance more efficiently. In the early stages of design, this means comparing the performance of different design options. Later in the design process, analytics is used to refine the design and optimize its geometry. At the final stages of design, a check is made whether all the necessary requirements are met or not. Models of a virtual system can be of different levels of complexity: from simplified to full-scale models.

Lightweight models reflect simplified structure, such as simplified geometry, and simplified physics, such as reduced order models. This reduces the computational load, especially at the preliminary design stages. Such lightweight models allow you to simulate complex systems and systems of systems and obtain the necessary data with minimal computational costs. A unified modeling language greatly simplifies communication and collaboration both inside and outside the project team. These models can be shared within the organization and with the supplier network, thereby helping them better understand the system being built.

The implementation and development of the methodology creates the foundation and the necessary infrastructure for the transition from document-based project management to a model-based paradigm, which ultimately leads to the creation of cyber-physical systems, digital twins and smart digital enterprises.

The nature of the design, planning and modeling of products in enterprises will change. Once a product is created in a virtual environment, data about it will be seamlessly transferred to production, where, with the help of semi-autonomous robots, people will use additive and subtractive manufacturing methods to automatically transform the virtual model into physical objects. Engineers will use simulation in conjunction with digital twin technologies. This is incomparable to the traditional design process, which had to rely only on knowledge of ideal and possible worst-case operating conditions. With new technologies, actual system performance data can be compared with data from the digital twin and corrective decisions can be made based on this.

By augmenting the digital twin with data from the physical media, engineers will improve system models and use the results of the analysis generated by the digital twin to improve the performance of the physical system in the real world. An important function of the simulation will be the estimation of the expected life of the product, because the digital twin can track its susceptibility to failures depending on the wear and tear of the physical twin. With the help of simulation, the digital twin can estimate the remaining life of the product, schedule maintenance in advance. State of the art maintenance will be used to estimate how long the physical system will be able to function normally. Digital twin technology will become central to Model-Based Systems Engineering as it can allow model-based design to span the entire lifecycle of a system or product.

Digital avatars

The idea to use digital avatars in life and the technology for their creation appeared thanks to science fiction films. Virtual characters first appeared in 2009's Avatar. Director J. Cameron had to delay the release of the film for ten years until the right technology was available. In 2006, Weta Digital, a New Zealand studio founded by The Lord of the Rings director P. Jackson, began working on 3D characters and other visual effects. It was real rocket science. For Avatar, the team created facial motion retargeting technology to transfer human facial expressions to 3D characters and light stage motion capture equipment. Technology author M. Sagar joined the University of Auckland. For several years he has been developing digital androids.

These are 3D models with artificial intelligence. They communicated with people through a webcam and a microphone. In 2016, M. Sagar launched the startup Soul Machines and began to offer androids to businesses. The first Soul Machines avatar in 2017 was BabyX. This is a 3D model of M. Sagar's one and a half year old daughter. With BabyX you can interact like with a real child: attract attention, show pictures in books and ask to read words. Thanks to artificial intelligence, the avatar learns and responds to stimuli. M. Sagar designed BabyX so that her emotions work like human ones: like the release of neurotransmitters in the brain. Soul Machines offers HumanOS and Digital DNA Studio avatar products for companies. Personalities with artificial intelligence are used as virtual assistants, company employees and digital copies of celebrities. Two types of avatars are used: realistic digital characters controlled by people, and fully automated, interacting with a person thanks to neural networks.

The creation of an avatar begins with the development of a realistic 3D model. Previously, faces and bodies were made by hand, but now there are many automated CAD programs for modeling graphics. For example, based on subsurface scattering technology, realistic skin is obtained. 3D models are made movable using CGI computer animation. They shoot a prototype actor, then to transfer his facial expressions and gestures to the avatar. For example, M. Sagar's Light stage equipment captures movements, focusing on the reflections of light rays. Artificial intelligence is used to improve 3D models. Neural networks make avatars realistic. Machine learning also helps the character to synthesize speech, enables him to understand human speech and develop emotional intelligence based on behavioral and speech models of people. While working on the screen or in virtual reality devices, the avatar is controlled by engines, as in computer games.

Virtual workplaces and digital workers are transforming the professional environment. Company employees will have avatars. Instead of watching each other in Zoom, employees will fully participate in meetings using virtual and augmented reality technologies. This is not only about 3D models of people, but also about the possibilities of joint work of avatars. In the virtual space between team members there will be images of projects and tools for working with them. XCOM Labs, Apple and Google are already developing office avatars. The development of this area depends on the emergence of more compact and powerful VR devices, as well as on the speed of implementation of 5G and 6G communication standards.

With the help of artificial intelligence, companies create a full-fledged replacement for people. Banks use avatars for specific positions. Avatar works as a consultant and provides clients with analytics of the global economy and individual markets. With its help, the bank wants to study how convenient it is for users to receive different services from virtual personalities. There are no risks with avatars. Companies can fully control the communication of virtual representatives.

Video chatbots look and communicate like real people. They know how to hold a conversation, learn and show emotions. In the future, they can be teachers, concierges, financial and medical consultants. Neons will be able to become friends, employees and companions who are constantly learning and keeping memories. Home assistants with realistic images are already being created. Technology is becoming more and more accessible. Companies are working to ensure that avatars can help in offices and apartments.

The digital identity of a person will soon become a very valuable commodity, since we are talking about data collected about a person. All this data is collected by organizations and services. Any application, the user agreement that an individual signs, creates his mini-digital avatar. For example, if the phone is on Android, then the Google Now service is installed by default, which collects various statistical data about the user. Such data can be used in various fields of activity. Digital avatars can be used in all social areas from finance to medicine. Some companies go even further and use the acquired processing skills in areas such as agriculture and mining.

But first of all, marketers need avatar data. They want as accurate information as possible about a person's behavior and preferences. This allows us to offer customers interesting products and services. Any client can get a really personalized offer and full visibility of the company's participation in his life, understanding that he is important to the company. This data can be used to create full-fledged copies of a person. Avatars are actively filled with biometric information. This is a voice, and facial features, and even movements.

Innovative companies create robots that are loaded with all the collected personal data about a particular person. This robot is a carrier of artificial intelligence. He begins not only to have information about a person, but also to look and speak like him. And even think. As a result, the avatar becomes an improved version of the person himself, his double. A technology for creating a 3D model of the human body has been developed. This system is used as a virtual fitting room, which in 30 seconds creates a three-dimensional copy of a person in a special terminal in shopping centers, and then can be downloaded to a smartphone and used regularly.

The main problem with avatar technology is the loss of privacy. Avatar makes it impossible to hide from marketers. In this situation, the protection of personal data becomes a top priority.

Metaverse

The word "metaverse" was updated by N. Stevenson in the novel "Avalanche" in 1992. The writer called this word the virtual world where avatars of real people live. A similar concept was then found in other science fiction novels, for example, Ready Player One by E. Kline. The metaverse refers to a world in which virtual objects that do not exist in reality merge with physical things and events within a single ecosystem. The concept of the metaverse is closely related to the technologies of virtual and augmented reality, as well as artificial intelligence. The Metaverse reflects the evolution of the global network.

Instead of traditional online shopping, when the user sees a list of products on the screen, he can move to the space of virtual trading floors, allowing you to carefully and in detail examine the goods before buying. This is an opportunity to transfer digital objects and people into the physical world with the help of holograms. They will move, feel and look like real people, the physical and digital world will become one. Familiar activities that are implemented in two-dimensional space, such as viewing images and videos on the screen, will become three-dimensional.

This is an immersive Internet where people have the same opportunities as in the real world: free movement, ownership and exchange of goods and assets. This is a place where users can spend time interacting with each other in any virtual place created. It is a hybrid of real and virtual space. It will allow people to play games, work, shop, play sports and communicate while at home. People from different parts of the physical world will be able to meet in the same virtual place, for example, on the shore of a digital beach, where they can watch the sunset. We can identify the main features of the metaverse. It never resets, pauses, or ends. It works in real time and does not depend on external factors, although developers can create and schedule events in the metaverse.

There is no limit on the size of the audience and the number of concurrent users. Everyone can connect to the metaverse at any time and participate on an equal footing with everyone else. Individuals and companies can be rewarded with the equivalent of money for work that brings value recognized by others, spend it and invest it.

The Metaverse unites the physical and digital worlds, open and closed platforms, private and public networks. It is a single digital whole. This is the compatibility of data, objects, assets, content transferred between digital worlds. The Metaverse is filled with content and experiences created by its own users: individuals, groups, or commercial enterprises.

Let us characterize the main tendencies in the sphere of metauniverses. 3D technologies, AR and VR devices, and sound systems play a big role in the virtual gaming industry. Against the background of the development of the metaverse, these technologies demonstrate exponential growth, which underlines their value and relevance to the modern market. As the realm of the metaverses develops, so does the ability to control and manipulate them. The increase in the number of applications and tools for managing and configuring virtual worlds is an integral factor for the development of the entire industry.

Trends in the development of the metaverse indicate that avatars are becoming more and more advanced. The corporation focuses on improving avatars that fit into the business environment. The development of tracking technologies will become one of the top priorities in the coming years. The force that can completely change the way businesses do business and how consumers perceive, interact and analyze the built world is 3D digital twin technology. This technology creates a complete 3D virtual and spatially accurate model of any building or space. This means that enterprises will be able to create exact copies of physical objects, which will then function as separate divisions.

Consumers can use digital twin technology to virtually try on clothes and experience new stores before they open. They can also visualize and see if new furniture will fit before making a home purchase without leaving home. Non-fungible tokens are actual digital objects. NFTs are tied to the blockchain as a unique entity. NFTs are used in a wide variety of crypto projects.

The immersive and versatile aspects of the metaverse require cloud computing to process, store and analyze the data generated by the platforms. A metaverse platform will not succeed if it cannot provide a flawless user experience or if it is difficult to scale. Virtual art galleries are among the widespread trends in the metaverse. Virtual art galleries are a new kind of immersive space where artists and digital creators can showcase their NFT exhibitions to collectors. Art aficionados can experience sensational virtual environments and even trade their favorite pieces.

The Metaverse collects a huge amount of data, which it will extract and use almost instantly. While the metaverse is based on a distributed technology such as blockchain, it is necessary to ensure that the data received in one part of the metaverse is reflected in the user experience in another. Consequently, studying the next generation of data engineering is becoming a key area of education in the world of the metaverse. The omnidirectional motion system and five-sense technical equipment allow users to enter the virtual world for sports, entertainment, education and work.

Metaverses work on desktop computers, but the user experience with a VR helmet and on a computer is very different. The computer screen does not provide the depth of immersion that the user of a VR headset has. Existing metaverses offer a rather primitive visualization, often based on ready-made libraries. Computer versions of the metaverses are not very attractive to users. Metaverses appear regularly. But the growth of the market is constrained by a fairly high threshold for entering the metaverse for brands. This is the cost of land, the commission for the placement of one digital item, the design, rendering and development of the space itself and the objects of the store, gallery, and the construction of logic in it.

Metaverses open up new, almost unlimited business opportunities. This includes the opportunity to work with new cross-border payment instruments, business diversification through the sale of digital goods, and almost complete independence from the country of origin of the brand and the localization of the production of goods. One of the problems of the metaverses is the creation of virtual avatars based on the personal data of people, as well as the use of cybernetic sex with tactile sensations by these avatars.

Using augmented reality to feel tactile impulses is also reimagining the experience of cybersex, and there is a threat in the possibilities of cybernetic sex with minors and the formation of various deviations. The problem of avatar identification makes identity and personal data vulnerable to copying, erasing and manipulation. The dominance of digital currencies in the metaverses will lead to the violation of state borders due to the inability of the legislation to regulate the chain of sale. There is a risk of creating shops with banned substances in virtual spaces. The value of land in the metaverse will be determined by what owners do with the property, such as designing a popular attraction, a museum, not by location.

With the increase in the amount of time that users spend on the Internet, a new model of consumption of digital content is being formed and an ecosystem of virtual life is emerging. People are willing to invest heavily in internet property, including digital real estate, digital fashion, and premium cars. The Internet is beginning to be used for therapeutic purposes, the concept of metamedicine has appeared. Doctors prescribe video games to treat cognitive dysfunction.

Games for global business are becoming new marketing platforms on which hypotheses are tested and models are worked out. Large companies tend to create their own in-game brand representation. Despite the explosive growth of the digital industry, the popularity of games and the skyrocketing advertising budgets in the Metaverse, many key issues remain unresolved. Thus, the digital world opens up wide opportunities for distortion of ideas about reality, manipulation and disinformation. It is impossible to remove these questions by the methods used in the real world in the new nascent universe.

The Metaverse will have a significant cultural impact on society and human behavior in the real world. In the metaverse, we should expect a decrease in the importance of morality and ethics due to the use of a virtual avatar, which people do not fully relate to themselves. The most susceptible to the deforming effects of the digital environment are children whose consciousness is still being formed. It is not yet clear how the laws will work in the metaverse. How will it be possible to demand the implementation of national legislation in a virtual world in which there are no borders. These mechanisms have not yet been developed. In the metaverse, existing principles of currency regulation will be violated, as purchases in the digital environment will eventually use digital tools much more often than national payment systems. User activity will generate significant amounts of personal, biometric, financial and emotional data. When using cyberspace, more and more questions arise about the protection of personal data and digital payments, counteracting manipulations with the preferences and actions of citizens.

Radio systems in a virtual environment obey physical laws. The virtual world will be larger than the real world in terms of the economy. More different things, buildings, houses, cars, clothes and bags will be created for virtual worlds than for the real world. Because the physical worlds must obey the laws of conservation of mass and energy, but this does not apply to the virtual world.

A feature of the metaverse will be the ability to feel the physical presence of another person through digital spaces. Portal and Oculus can teleport an individual into a room with another person, regardless of physical distance, or into new virtual worlds and experiences. To fully see the metaverse, you need to build a connective tissue between these spaces to remove the limitations of physics and move between them as easily as moving from one room to another.

The Metaverse is called a three-dimensional model of the Internet: a hybrid of a computer game and a social network. Instead of photos, each user has a 3D avatar. Flat browser pages have replaced bulky interfaces. The Metaverse offers users a virtual version of life. Study, go to concerts, get married, buy real estate, earn and spend cryptocurrency. We need unlimited cloud storage, high data transfer speeds and the latest graphics engines.

The computing power of users' home devices will have to increase 1000 times to process a quadrillion operations per second. So far, only supercomputers can do this. In the metaverses, one cannot do without a helmet of virtual and augmented reality. For complete immersion, you will need a tactile suit, it allows you to feel touch and even temperature.

A startup from Belarus has developed a Teslasuit. It has a built-in motion capture system of 68 electrodes. They were written in the new programming language VRML. The gadget is able to maintain eye contact with other digital avatars and convey user emotions using facial expression trackers. People take on the appearance of holograms and interact with digital objects against the backdrop of the interiors of their own homes. You can attend lectures of the world's best universities, arrange training in a safe environment.

The development of virtual spaces will lead to a change in the labor market due to the emergence of new professions. It is also a new opportunity for the world of entertainment. The Metaverses have created an alternative way to make money. You can buy a virtual land and build an NFT art salon or a virtual clothing store for avatars out of pixels.

Ethical cons include insults, harassment, and other examples of toxic behavior. The metaverses can become the environment for cybernetic criminals. The risks of theft of cryptocurrency and personal and biometric information of users are high. The law does not yet regulate the operation of digital worlds. The developers suggest that some of the functions will fall on the shoulders of artificial intelligence. Despite the current difficulties, corporations believe that the metaverse is not just a marketing product, but a real chance to take technology and the world as a whole to a new level. The COVID-19 pandemic has created an enormous public demand for cybernetic interaction of large masses of people. Due to the ongoing negative returns on many traditional instruments, record amounts of free capital have entered the venture capital markets in recent years to finance the most fantastic projects. Traditional social networks have begun to experience serious criticism and are forced to change. Gaming technologies have developed to such heights that they began to provide other functions, for example, holding concerts in an online format.

The most important part of the metaverse will not be 3D visualization, but an element of a decentralized economy powered by blockchain technologies. It is these technologies that will be the foundation of Web 3.0. They allow users to securely fix property rights in the virtual and then physical worlds, as well as automatically make transactions through smart contracts. Blockchain technologies, in addition, are the basis for cryptocurrencies and crypto assets, so all these digital entities will also be important components of the metaverses.

The gaming industry has been and remains the vanguard of the application of elements of the metaverse. Gaming, like the Internet, has gone through a three-stage evolution from the “pay-to-play” concept (monetization of games through the sale of them) to the “free-to-play” concept (the games themselves are almost free, but are monetized through the creation of an in-game economy of digital assets) and then to the current play-to-earn concept. This is a brand new paradigm where players dynamically participate in the digital economy, can carry artifacts and avatars between games, collect virtual collectibles, create their own games, control their experience, and more. Active presence in games allows you to earn, and a lot. It's very similar to the metaverse. The development of the metaverses will most likely rely on current gaming technologies

Table of contents. These technologies will be adapted and systematically scaled to all types of human activities that can be digitized. Communication through social networks and videoconferences will go to the metaworlds.

Investors have focused on Metaverse hardware vendors and infrastructure operators. The hardware will be based on powerful GPUs and will require very reliable and fast data transmission, as the amount of traffic generated and transmitted will be gigantic.

Investing in the metaverse carries risks. Many of them are difficult to configure. The sheer amount of computing required to run such platforms would require a corresponding amount of power. A wave of criticism will rise against the metaverses for non-compliance with carbon neutrality. If this issue remains unresolved, large investors may lose interest, for example, due to reputational or political risks.

Risks of cultural degradation

The Internet can provoke a colossal decline in written culture, which will be replaced by an audiovisual culture. Although it was written culture that for centuries was one of the main tools for transferring experience from one generation to another. It created a kind of reservoir of a large human community, which is now under threat. Reformatting or changing the relationship between audiovisual and written signs will occur. The transition from narrative literature to narrative video genre has also been accelerated by streaming platforms. TV series are used like books.

Almost everything goes through accounts and photos. This is a function of memory about oneself, but it occurs in a different form and on other media. The transition to audio-visual content is not related to the Internet, but to the advent of cinema. The Internet has simply made film accessible to everyone. If earlier cinema was the work of specialists, now everyone can take up the production of a film. That is, there was an extreme democratization of the film as a media.

Written language has its own domains and it is not yet seen that they can be absorbed by the Internet. The Internet functions as a narcissistic mirror. It does not reflect the world, but exclusively the individual.

The Internet shows what the individual wants to see. And reality often shows what they do not want to see. The same can be said about communication. This is what social networking algorithms are built on. Formally, there is access to the entire space of the Internet, but de facto the individual uses it only by the community, which always leads to an abbreviated and symbolic language. From this arise memes that are understandable only to those who are part of a particular group.

The Internet environment is characterized by a short memory. She quickly raises the wave of popularity on one thing, and then just as quickly replaces it with something else. The mechanisms of transmission of traditions are becoming less stable and more and more ephemeral. Historical and cultural memory is becoming less stable. There is a certain nervousness in relation to this instability. Trying to keep everything on the cloud is problematic. First, it is very expensive. Secondly, it is harmful to the environment. A large-scale compensatory process of museumification of non-electronic media has begun in order to somehow compensate for this fear of a complete dementia of cultural memory.

Transactions and digital communication modifications

In 2008, the article "Bitcoin: A Peer-to-Peer Electronic Cash System" by S. Nakamoto was published, whose identity has not yet been established. From that moment, the use of blockchain technology and Bitcoin cryptocurrency began. The evolution of cryptocurrencies has begun. Thus, Ethereum favorably differs from Bitcoin in the presence of smart contracts that allow transactions to be concluded between parties without the participation of third parties.

The presence of this feature significantly spurred the development of the cryptocurrency industry. An ICO for the sale of tokens has begun. Smart contracts have overcome the process of standardization. The ERC20 standard has appeared. In 2018, thanks to the game Cryptokitties, the ERC721 standard, known as NFT, joined it.

The ERC20 token plays the role of identical tokens, for example, on the subway. Each is identical to the others. In ERC721, on the contrary, each token is unique and contains a link to an asset. As a result, the NFT acts as both a digital certificate of ownership and real ownership. Each of the NFTs exists in a single copy, and all information about their author, transactions and buyers is stored in the blockchain block chain. Like any blockchain project, NFT is not tied to any one server, and by buying it, an individual declares his right to a digital object for the whole world.

NFTs have become a real mainstream in 2021. Certificates confirm ownership of a digital painting, music, book, or collectible sports cards. It contains a link to a digital property object. The object is stored on some kind of hosting, which can lead to the removal of ownership. Therefore, in order to preserve access to digital property and protect it from deletion, new solutions are required, other than storing information on a hosting.

The emergence of IPFS technology became important. It is a content-addressable, peer-to-peer hypermedia communication protocol. The nodes of the IPFS network form a distributed file system, so that hosting is no longer required to store information. Simplified, the network itself is able to store information that is in demand, and obliterate information that no one needs.

The symbiosis of technologies implements a full-fledged decentralized environment in which users have personal secure digital assets, which was not the case before. Due to centralized decisions, development companies dictated rules that could be changed unilaterally. In many ways, for these reasons, early attempts to create a digital universe turned out to be a failure. In 2003, one of these was released, Second life. It is called the progenitor of the metaverses. Companies continue to make money from advertising.

Virtual and augmented reality in the metaverse

Some applications of the metaverse are created solely with the help of virtual reality in the mind. However, this is not the only thing that makes the overall experience of people. They can feel like they are really there even without expensive equipment. People go to a concert or a fashion show and it's an unforgettable experience for them. In fact, they really felt immersed and shared this feeling with their friends.

Although some people use VR (Virtual Reality) or AR (Augmented Reality) technologies to make the environment more real, these technologies are not suitable for all users of online spaces. This is especially true for young children and people with certain neurodiverse conditions. Also, some people just don't like wearing a headset.

The difference between some early metaverse platforms and Roblox is the ability to take an avatar with you in various situations. It is important that these places remain safe and civilized so that the community has a positive experience. Children and teenagers can use other spaces of the metaverse with different rules and standards. Parents and guardians should ensure that these other places are suitable for children.

Immersive technologies

Immersive (immersive - “creating the effect of presence, immersion”) is usually defined as immersion in certain, artificially formed conditions. It includes augmented reality, virtual reality, mixed reality and artificial intelligence. Immersive is defined as immersion in certain, artificially formed conditions. Personal and professional use of technology includes entertainment, Industry 4.0 applications, medical research, education, and a range of other uses. Reliable, ultra-fast networks (including 5G) and edge computing needed to realize the full potential.

Immersive technologies allow you to create a virtual world for the user or make a mix of the virtual world and reality. This effect can be achieved using specialized devices (for example, virtual reality helmets). At the next stage of technology development, it is expected that there will be a possibility of complete immersion in the virtual world to a level where it will no longer be possible to distinguish visualization from reality.

With the help of special equipment, such as glasses, we add non-existent, virtual elements to reality. For augmented reality, in addition to glasses, indicators on the windshield of the car, special helmets and smartphones are used. Augmented reality glasses are not yet common gadgets.

Simulation centers successfully operate in many cities to train medical personnel, where skills in surgery, resuscitation and intensive care, obstetrics and gynecology, nursing and patient care are practiced in virtual reality. Virtual reality is being introduced and used for the rehabilitation of patients, for the recovery of patients who have suffered traumatic brain and spinal injuries, as well as strokes. Promising areas are also the fight against phobias, fears and other psychological ailments.

Technologies in retail are aimed at providing the client with the opportunity to try on the product on himself or in his interior. The IKEA Place app allows you to place furniture in the space of the room using your smartphone. Immersive technologies help to navigate the motivate consumers to purchase through digital visualization. Virtual prototyping in construction and architecture allows you to check the ergonomics of buildings, check their reliability, as well as conduct a collective discussion of projects and demonstrate them.

The hybrid work format is gradually becoming the new norm. However, in such conditions, it can be difficult for newcomers to join the team. To fix this, companies are using immersive learning through virtual and augmented reality headsets and the metaverse. The virtual reality platform allows you to create an avatar, walk around the virtual space, and even hear the voices of other colleagues. Everything happens in real time, just like in the office.

Culture plays an important role in onboarding, and newcomers don't need to be physically present at work to experience the values and build a sense of camaraderie. Virtual reality is becoming an important element of business engagement and learning. Repetitive, measurable task-based learning can be done safely and at any time. This can eliminate the need to stop work to conduct production preparation. The concept of augmented reality covers the whole range of real and virtual environments, such as virtual, augmented and mixed reality. The resilience of the pandemic has forced businesses to look for new ways to adapt and train staff. Augmented reality technologies have become the most optimal solution for many.

Immersive learning is especially useful when physical simulations are needed. This makes it possible to learn by doing without fear of making a mistake. These technologies will help to get and soft skills. For example, through a role-play simulation that mimics the same levels of stress an employee experiences in real life. A no-code platform that allows organizations to create their own simulations and virtual people helps standardize and scale soft skills training and remote onboarding. Hints and questions can be added to simulations to test employees' knowledge and generate objective performance data to help them improve.

Augmented Reality is a technology that augments existing reality with virtual images, animations, visual effects and titles. Virtual reality involves a mask or helmet with or without sensors. Putting on a mask, a person is immersed in a fictional or recreated environment. This technology is most widespread in games. The user puts on a helmet and enters the virtual space with which he interacts. Mixed reality is similar to augmented reality, but instead of embedding images and text on top of reality, it creates virtual objects and elements that seem to be already in the room, each in its place. Immersive reality will lead to the abandonment of physical and touch keyboards, replacing them with virtual keyboards with holograms hovering before the eyes. It will change how companies communicate with customers, how colleagues communicate with each other while working remotely, and add a new dimension to social media, creating new marketing opportunities and supporting communication within the organization. A sustainable process in immersive reality will be made possible by further advances in on-screen displays, overcoming barriers such as vergence versus adaptability conflict, advances in foveal imaging, tactile technologies, and 5G and 6G technologies.

The conflict between vergence and adaptability hinders the development of augmented reality, making the user experience unsatisfactory. As long as it exists, the adoption of augmented reality will be slow. Foveal imaging defines how augmented reality uses small screens such as glasses or contact lenses, where screen resolution imposes technological limitations. Foveal imaging seeks to overcome this problem by providing higher screen resolution in the region of the image where the brain is focused.

Both augmented and virtual reality require the use of tactile technology. Bringing physical sensations and a sense of touch into an immersive reality. However, with primitive tactile technology, the user experience of immersive technology will be disappointing, and its business benefits will be limited.

5G and 6G technologies will be important for immersive reality. First, they will make new applications viable, such as remote control of machinery, especially outdoors, such as in agriculture or construction. Secondly, the immersive reality potential provided by these technologies will stimulate a new startup ecosystem to become successful enterprises. This new immersive reality ecosystem will create new business benefits, driving the spread and supporting the evolution of immersive reality.

With advances in immersive reality technologies and their convergence, the business benefits will come suddenly. But businesses need to learn how to apply immersive reality before that happens or they risk ruining their business.

Immersive spaces

With the development of multimedia technologies, immersive spaces are gaining popularity, immersing the visitor, the viewer into the world of images or historical panoramas, natural landscapes or paintings by great masters. Immersive spaces are characterized by the connection of the virtual and real worlds, the involvement of several channels of perception at once. These are omnichannel, video, sound and tactile-interactive action.

For full immersion, the video projection area must exceed the viewing angle of the human eye. This can be a total projection on all surfaces of walls, floors, ceilings and a panoramic projection on a concave screen. The viewer wants to be an active participant in the events, which means that he needs to be given the opportunity to choose the trajectory, plots and implement various scenarios. This is done using interactive sensors.

Experiential art refers to movement in art. Artists create immersive, interactive and large-scale works. The rapid development of technology has prompted artists to experiment with new mediums and redefine the boundaries of familiar perception. Artists need support and a place where they can share their work with a wide audience. Artists always have very specific intentions about how visitors should navigate through their installations. Traditional galleries focus on presenting objects, not experiences, so can greatly limit artists working in large-scale, immersive environments, and often only allow short-term presentations. The organization of space determines our epistemological and sensory attitudes.

The Renaissance artist was able to create a three-dimensional reality thanks to linear perspective: the space of the image where it is used exists in almost the same dimension as the reality in which the viewer is physically present. Following the invention of perspective, the next stage on the path to the transparency of the medium and the immersive of perception were experiments with the camera ob scura, and then with photography. An important step here is the leveling of the role of the artist-photographer in this practice due to the automatism inherent in photography. The photographic image appears due to mechanics and chemistry. It seems that all the work is done by light and a chemical reaction, and a person simply presses a button.

The next important stage in the history of immediation and immersion is associated with the desire to get rid of the fixed point of view, which is always characteristic of the image. This static, fixedness really disappears in the cinema, although the point of view still remains associated with a certain position of the operator. The goal of experiments with virtual reality is to get rid of this flaw. Illusory reality should be perceived from the same position as the physical one. To achieve this effect, for example, a virtual reality helmet uses motion sensors that monitor the position of the body in space.

The virtual environment should be sensory similar to the real one. Virtual reality enthusiasts strive not only to show a realistic picture of the plausibility of the image, but to convey the experience. Immersive is becoming one of the main requirements for a virtual environment. The phenomenon of immersive in the context of changing relations with the media can also be considered on the example of more familiar technical systems.

For example, in the case of digital photography, we have almost immediate access to the image, to its potential variability. The image becomes malleable, mobile, and its boundaries blur. Any individual can edit photos thanks to the available tools built into the smartphone. Special skills are not needed for this, just using ready-made filter solutions.

The image is becoming more and more mobile. It can be instantly transferred to another device, arbitrarily remote, or projected onto any surface, almost losing visually fixed boundaries. An active position in relation to the image, a kind of intervention, which is provided by the available means of editing or even modeling images that are indistinguishable from photographic ones, can be seen as blurring the boundaries between the real and virtual worlds, in which people are increasingly immersed.

The way photography provides access to the world is changing. Computer technologies are more and more sealed immersed in the space of digital images. A carefully thought-out interface provides a high degree of immersion, participating in the creation of a comfortable environment, within which interaction with algorithms seems direct. In order to get closer to immediacy, to achieve new degrees of immersive, the medium uses the resources of other media, increasing the number of channels of interaction. An example of this phenomenon is the many windows and tabs on the Internet. The presence of the medium, heterogeneity and provides access to the most diverse combinations of images and sounds. This new way to achieve a more natural interaction with the representation shifts the focus from creating an object that is very similar to reality to the naturalization of the very process of accessing it.

The interface no longer needs to erase itself. The main thing is to ensure the naturalness of the interaction. The interface is interactive, it responds to commands and user actions. Therefore, an even greater immersive effect is achieved. The Internet is not visual. Visual media does not exist primarily because there is no purely visual perception. The media are mixed and multimodal. Immersive as an immersive experience is associated more with the perception of polysensory space than with purely visual perception.

Thus, the perception of cinema can be considered as multisensory. The effect of a breakthrough in a two-dimensional image, immersion in the cinema space is created not only thanks to visual means. An important role is played by the auditory channel of perception. Music promotes immersion. In cinemas, the body is gradually involved in the creation and living of an illusory reality.

Digital manipulation of immersive environments

New media, having a great suggestive potential, in comparison with the previous one, are able to create illusory realities that are less and less distinguishable from the prototype and can be used as a tool of manipulation, ideological suggestion. Such conclusions can be reached if we think about the process of creating immersive environments. The interfaces through which individuals interact with digital algorithms are developed by experts in the field of UX design. It depends on their work whether the immersion in the virtual environment will take place, how, being inside it, the individual will move from one step to another, whether he will be able to achieve his goals and how quickly. The goal of UX design is to provide a comfortable interaction with virtual reality, based on the simulation of the experience of the individual. This design is aimed at immersive. The more time people spend on the sites of online stores, social media the more profit the site owners will receive. As a result, immersive is associated with profit maximization and manipulation.

New media, not yet becoming familiar, have a stronger effect on the emotional sphere, which confirms fears about the power of images. Due to the fact that immersive perception is associated to a greater extent with the emotional sphere, the power of the impact of the image increases, while the possibility of critical distancing decreases.

The intensification of presence associated with the concept of immersive can be associated with the factor of aesthetic, which should be understood not only and not so much as an economic strategy associated with manipulation, but also as a changed way of perception. There is an increase in the role of internal orientation, the focus of the individual's intellectual and physical efforts on the intensification of sensations, the experience of being in the world. The area of subjective experiences ceases to be an accompanying factor in the context of various relations with the outside world, both social and physical, and sensory experience becomes the most important factor in social interaction.

Immersive media is associated with these trends. They are aimed at intensifying the presence in space and time. Interest in the effect of presence, immersion and participation extends not only to areas related to the development of technology. Increasingly, you can hear about immersive theater, immersing the viewer in the reality of the performance, or even immersive journalism.

There is a connection between the effect of immersive, which is becoming more and more in demand in modern culture, with the growing importance of aesthetic perception in a broad, non-artistic sense, which entails structural changes in society. Aesthetic connected not with the expansion of the space of manipulations, but with the horizon of the life possibilities of the individual. It contains an emancipatory potential.

It is quite difficult to unambiguously assess the significance of the immersive effect for modern culture. Virtualization processes, as a result of which images from the space of technical visual culture are mixed with images of the surrounding world itself, require an active study of the impact of the immersive phenomenon on a person. Studies of this effect, which are also related to the analysis of the role of technology, devices and media, are relevant.

Immersive interface in virtual environments

The interface characterizes the properties and technology of human-machine communication, which ensures human activity in a technical or social system. It is the way a task is performed by a product. The actions taken and what the response represents is the interface. The interface provides the conditions that give rise to a professional and learning environment.

There are two forms of interface. These are external technical and internal psychophysiological interfaces. Classical front-end systems include controls, systems for presenting and displaying information, elements of ergonomics and workplace design. The functional and practical states of the human operator, the quality of his professional activity largely depend on their physical and information-dynamic qualities.

The psychophysiological interface characterizes the state of the body and psyche of the operator, his readiness to perform certain algorithms of a professional and educational task. The internal interface is being improved under the influence of various forms of professional training. Learning is a procedure that creates the ideal form of an interface in a human-machine system.

The main problems that arise in the design of a physical interface are related to the need to coordinate the physiological, anthropological and biomechanical characteristics of a person with mechanical controls and optical systems. These are quite complex tasks leading to the creation of machines containing complex mechanics and optics, which increase the cost of the system and limit the operator's capabilities.

The way out of this situation is the use of computer modeling technologies for the interface, presented as a virtual interactive environment that connects the operator with the technical system. These interface systems can be called immersive or immersive interfaces. In them, the operator is immersed in a machine-generated three-dimensional environment formed by virtual reality technologies, displaying an artificial world, the activity in which leads to solving professional problems in the real world. In the design and properties of tools modeled in the artificial world, the life experience of the subject is used to the maximum.

There is an opportunity to gain practical experience and learn. A person in contact with the physical world has such tools for selecting important aspects of the physical environment that are difficult, and sometimes impossible, to foresee in a virtual environment. This is the main problem that arises in the design of ergotic systems of this class. The development of virtual reality technologies allows creating virtual environments with a high degree of interactivity.

Interactivity, reflecting the interaction of the subject with the world, is a key concept that characterizes the effectiveness and capabilities of the human-machine interface. The higher the interactivity of the system, the greater the number of parameters of the simulated world can be changed by the subject in the course of his life and the more management experience can be gained in the process of activity. In virtual reality, it is possible to influence almost all elements of the simulated world and to do this in a natural way. At the same time, the world responds to influences with its changes available to the operator's sensory systems.

The main advantage of the immersive interface lies in the reduction of interactions to forms that are understandable to human sensory and executive systems, to its direct actions with elements of the simulated environment without intermediate operations, including logical and linguistic constructs. The immersive interface takes into account the experience of developers, which is assimilated into the elements of the interface environment. An immersive interface immerses a person in an artificial world, which in turn can be connected with the real physical world, displaying its main properties in its subject, spatial and temporal content.

Manipulation in the environment of an immersive interface is natural, unlike that implemented in the classical forms of a partial interface. In them, for example, when solving the problem of pointing a controlled object at a target in space, the operator is forced to use the controls in the form of handwheels to simultaneously combine the coordinates of the object and the target with the right and left hands, solving the problem of compensatory tracking. This is a rather complex sensorimotor task. In the immersive interface, it is enough to take a virtual model of an object in the virtual space and transfer it to the target contour, thereby targeting it.

The transformation of the real world into the world of virtual reality and the properties of the real world into the properties of the virtual world are carried out without the participation of a person, which makes it possible to free him from complex operations of spatio-temporal transformations. The artificial world can be adjusted using the state translator to the dynamic properties of the operator, freeing it from the need to work in time pressure. Other forms of psychological and psycho-physiological restrictions are also removed. Examples of immersive interfaces in game activity are computer representations of elements of a simulated virtual environment that provide interactivity between the player and the content of the game world. For example, these are animated characters ("avatars") that help navigate in the environment, with which you can conduct dialogues, artifacts and objects with a specific functional purpose.

Industry 5.0

An industrial society 4.0 has been formed on the basis of digital technologies and its economic basis, based on the use of information technology, process automation, and the use of artificial intelligence. There was an integration of local and cloud systems. Converged development environments and autonomous production began to dominate. Since the launch of Industry 4.0 in 2011, just over ten years have passed and society 4.0 took place. The pandemic has contributed to this. It accelerated the introduction of technology into production. In practice, remote connection, design digital twins, a combination of physical and digital assets are used.

As part of the process of digital modernization of the economy and society, the Industry 4.0 project of the German government and the Industry 5.0 project of the Japanese government began to coexist. In the Industry 4.0 project, a large role is given to the convergence of technological processes based on human-machine and machine-machine interfaces. In this context, data centers, cyber-physical systems and the Internet of things play a big role.

Industry 5.0 is focused on improving customer service; personalization of products and services; digital logistics; interactive technologies; return of workers to production. This strategy will be facilitated by the evolution of cloud, digital wireless data technologies and software; integrated management and converged integrated development environments; native operations management, including digital services; autonomous systems and a workforce with enhanced capabilities.

In a converged environment, control, safety and traffic functions are integrated. This is relevant in the context of the development of intelligent robotics. And it blurs the boundaries between control components and updates the security aspect. The efficiency of operational management becomes higher if artificial intelligence is included in the architecture of the sociotechnical system. Decision making is based on the collection and processing of large amounts of data. A sociotechnical system can be autonomous thanks to the functions of artificial intelligence. They are used to convert machine vibrations into data, for process simulations, and for predictive control. It creates the ability to manage all elements of the architecture of the sociotechnical system.

The transition from automated systems to autonomous systems will increase the efficiency of decision making, expanding human capabilities. Artificial intelligence allows you to simplify the design in the new generation, replacing one of the specialists in joint development.

Autonomization of the system allows you to rethink the fundamental principles of control systems. There is no need for a complete retooling when it is possible to supplement existing systems with new technologies.

It's not just about technological innovations that provide opportunities in terms of features or profitability. They should also be accessible to users and implemented with user experience in mind. In the digital world, innovation goes beyond technology and features. Industry 5.0 blurs the boundaries between different types of industrial workers.

Industry 5.0 should not be seen as a chronological continuation or alternative to the current Industry 4.0 paradigm. Industry 5.0 complements and expands the hallmarks of Industry 4.0. These factors are not only economic or technological in nature, but also contain important environmental and social aspects. Six categories are defined, each of which reveals the potential in combination with others, as part of technological structures. It is an individualized interaction between man and machine; bioinformation technologies and intellectual materials; digital twins and modeling; technologies for data transmission, storage and analysis; artificial intelligence; energy efficiency, renewable energy, storage and autonomy technologies.

In its ten years of existence, Industry 4.0 has paid less attention to the underlying principles of social justice and sustainability, and has paid more attention to digitalization and artificial intelligence-based technologies to increase the efficiency and flexibility of production.

The concept of Industry 5.0 provides a different focus and emphasizes the importance of research and innovation to support industry. The strategy for building a super-intellectual society (Society 5.0) was developed by the Japanese government with the participation of big business. The goal is to transform the economy through the use of digital technologies such as Big Data, the Internet of things and artificial intelligence. In 2016, the Japanese government identified the main problems that hinder the sustainable development of both the Japanese and the global economy, negatively affecting society.

Among them are the reduction and aging of the working population, the decline in the global competitiveness of production, the need to upgrade infrastructure, environmental problems, lack of natural resources, issues of counteracting natural disasters and terrorism. These challenges set the task not so much to transform the industrial sector as to create a universal concept that would go beyond industry problems and meet social needs and demands.

With the help of technology, physical, administrative and social barriers are removed for human self-realization and technology development. The shortage of labor force will be compensated by the elderly, who will receive additional opportunities with the help of new technologies. Suitable solutions for this purpose would be robotics (for example, for lifting heavy objects), as well as devices that improve vision and hearing.

Technology is a key element in the implementation of autonomous transport and intelligent transport systems. These are autonomous driving technologies, developments in the field of satellite navigation systems, high-precision 3D maps based on signals from the CLAS centimeter-level differential correction system. and transmitted by QZSS quasi-anti-aircraft satellites. Developments in this area are not limited to intelligent transport systems. They are used in the implementation of smart land use and integrated construction.

The cognitive components include personalized services. For example, in medicine, these are health databases and real-time monitoring. Technologies that will allow you to quickly and remotely carry out diagnostics. Autonomous driving is not an end in itself as a technology, but it will provide mobility. It will allow people who, for health reasons, can no longer drive a car to live in a comfortable environment. Also, autonomous vehicles solve the problem of transport accessibility in remote regions.

Autonomous driving is being tested in many countries. Japan is testing an autonomous bus that will run in remote areas. Elderly people live there. The bus will make it easier for them to access infrastructure such as shops or clinics. Such a bus is necessary for regions where public transport is either not provided or is not economically feasible. A technology that could only be used for profit is being rethought in terms of social benefits.

Although the concept was written for Japan, it and its elements can be adapted for any state, since everyone has the same problems. This is an increase in the average age of the population, wear and tear and obsolescence of industrial and social infrastructure, a decline in the competitiveness of production and environmental problems.

People will use customized solutions based on big data, the technologies of artificial intelligence and the Internet of things will work in full force, the social structure will become as intelligent as possible, focused on unlocking the potential of every citizen. We are talking about a gradual evolutionary development, in which the transition to "Society 5.0" will be as painless as possible.

The Japanese government, when developing Society 5.0, identified the obstacles that would have to be faced in the implementation of this strategy, and called them walls. This is the wall of ministries and departments, the legislative system, technology, human resources and the wall of acceptance by society. Among the five walls, the legislative wall is the most important. People are afraid of change. And "Society 5.0" is just a strategy of change based on the penetration of digital technologies into all spheres of human existence. The need for such changes is well understood by business, but the public considers this strategy one of many government initiatives.

Population aging causes shortages of workers and a severe shortage of workers, not jobs. The Society 5.0 strategy is not aimed at reducing the number of employees employed in production. Its task is to enable industrial companies to solve current problems of business scaling, improving product quality indicators, and improving energy efficiency. But do it with the same number of people as you have, given that it will naturally decrease. Technologies such as IoT and IoE will help create new areas of application of human talents, knowledge and skills, and thus new employment opportunities.

Other jobs must be created for people. They should be provided with new opportunities to realize their potential and employment. This requires retraining and education. People should not feel abandoned and lost. To some extent, this is a paternalistic model. In practice, it works like this. In Japan, a large company cannot fire a person just like that. She must find a way to give the person a new position. If its level does not match, the company invests in a retraining program. The main goal is to create an ecosystem based on a digital platform.

The platform allows you to combine the expertise of each participant so that it is easy for the end customer to operate and develop an existing production system, regardless of which equipment supplier he works with or will work with. As part of the "Society 5.0" strategy, ensuring public cyber security is at the level of cooperation between companies.

This is a global challenge for all business, and each of the companies working with digital technologies is making a contribution. The technology for identifying cyber attacks for critical infrastructure facilities has been announced. On the e-F@ctory platform, cloud computing has been completely abandoned, eliminating all the vulnerabilities associated with it. The developments are based on the understanding that digital solutions cannot be fully implemented without technologies that ensure cyber security.

The e-Factory platform for industrial enterprises is one of the key elements of Society 5.0. It is used to create digital manufacturing and optimize manufacturing processes. Its key element is the technology of peripheral computing, which allows you to analyze and select the necessary data, converting them into the information necessary for making optimal management decisions. This platform is used by manufacturers of automobiles and their components, representatives of the food industry, light industry and assembly industries.

The strength of the platforms lies in the fact that it adapts to the needs of users and adjusts to the priorities that the company sets for itself. This is a reduction in energy costs and an increase in productivity. Much depends on the volume of investments and the priorities of the company's management. The advantage of digital manufacturing solutions is that, firstly, they can be used on the basis of the current production infrastructure, and secondly, it is possible to upgrade production lines in parts or in stages.

It is necessary to develop cyclical processes that allow reusing, redirecting and recycling natural resources, reducing waste and environmental impact. Sustainability means reducing energy consumption and greenhouse gas emissions to avoid depletion and degradation of natural resources, to meet the needs of today's generations without compromising the needs of future generations.

Artificial intelligence and additive manufacturing can play a big role by optimizing resource efficiency and minimizing waste. Resilience refers to the need to increase the resilience of industrial production, better safeguard against failures and ensure that it can protect and maintain critical infrastructure during times of crisis.

Geopolitical shifts and natural crises such as the Covid-19 pandemic highlight the fragility of the current approach to globalized manufacturing. It should be balanced by developing sufficiently resilient strategic value chains, adaptable manufacturing facilities and flexible business processes, especially in cases where value chains serve basic human needs such as health or safety.

The new role of the industry worker in Industry 5.0 is changing significantly. The employee is not seen as a value, but as an investment position for the company, allowing the company and the employee to develop. This means that the employer is interested in investing in the skills, abilities and well-being of its employees in order to achieve their goals. This approach is very different from simply balancing labor costs with financial returns. Human capital is more respected and valued. In an industrial context, this means that the technology used in production is adapted to the needs and diversity of industrial workers, rather than constantly adapting to ever-evolving technologies. The worker should have more opportunities and the work environment should become more inclusive.

The digitization of manufacturing processes makes teleworking possible, allowing people living in remote regions to enter the labor market, as well as increasing the sustainability of production itself. The Covid-19 crisis, during which the functioning of many businesses was jeopardized due to physical distancing measures, demonstrated the potential of digitized remote operations, but at the same time, the dangers, given the growth of cyber attacks on facilities that ensure the functioning of remote work.

When designing digital workplaces, mental health and well-being must be considered on an equal footing. While there are new risks associated with digital work practices, digital technologies can be used to better control and manage the risks and impacts of the new work environment on workers' mental health and well-being, such as the risk of burnout due to o verwork.

Digital solutions and wear ables can open up new channels to alert workers and their GPs to critical health conditions, both physical and mental, and to support workers in adopting a healthy lifestyle in the workplace. With the help of new technologies and digital solutions, companies can promote the development of mental health and a culture of well-being as an integral part of their corporate culture. This is likely to bring economic benefits and savings through increased productivity and the prevention of long-term illness.

Skill needs are evolving as fast as technology. This applies to both expert level and general digital skill requirements. Technology can be made more understandable and user-friendly so that workers do not need special skills to use it. Training can be developed at the same time as this technology, thereby ensuring that the existing skill set better matches the skill requirements of the industry. Only four skills are digital skills. These are digital literacy, artificial intelligence and data analytics, working with new technologies, cyber security and data awareness.

REFERENSES

1. Aaron Parrott, Lane Warshaw. Industry 4.0 and the digital twin technology. Manufacturing meets its match. - Deloitte Insigts. URL: https://www2.deloitte.com/us/en/insights/focus/industry-4-0/dig

2. Akhras G. (2000). Smart materials and smart systems for the future // Canadian Military Journal. – № 3. – P. 25–32.

3. Alonso R.G., Castro S.L.D. (2016). Technology helps, people make: A smart city governance framework grounded in deliberative democracy // Smarter as the New Urban Agenda / Eds. J.R. Gil-Garcia, Th.A. Pardo, T. Nam. – Springer. – P. 333–347.

4. Alternative Logics: do Sciences need them? / ed. P. Weingartner. Berlin: Heidelberg; N. Y.: Springer-Verlag, 2004. 368p.

5. Asundi A.K. Smart structures research at NTU (College of Engineering Nanyang Technological University, Singapore) – 9 p. http://www3.ntu.edu.sg/mae/Research/programmes/Sensors/sensors/fos/smartin.pdf.

6. Axelrod, Robert M., Structure of decision: The Cognitive Maps of Political Elites / R.M. Axelrod - Princeton, NJ, Princeton Un. Pr., 1976, − 404p.

7. Balcerak, P. (2018). Role of Logic in Cognitive Science // Studia Humana. 2018. Vol.7, iss.1. P. 21–30.

8. Berntzen, L., Johannessen, M.R. The role of citizen participation in municipal smart city projects: Lessons learned from Norway // Smarter as the New Urban Agenda / Ed. by J. Gil-Garcia. – Springer, 2016. – P. 299–314.

9. Bibel, W., Kurfess, F., Aspetsberger, K., Hintenaus, P., Schumann, J. (1986) Parallel Inference Machines // In book: Future Parallel Computers, An Advanced Course, Pisa, Italy, June 1986. – Chapter: 5. – Publisher: Springer Verlag, Berlin, Lecture Notes in Computer Science 272. – P. 115–118.

10. Bionics: Nature as a Model. – PRO FUTURA Verlag GmbH, München, Umweltstiftung WWF Deutschland, 1993. – 223 p.

11. Castelnovo, W. Co-production makes cities smarter: Citizens' participation in smart city initiatives // Coproduction in the Public Sector / Eds. M. Fugini, E. Bracci, M. Sicilia. – Springer, 2016. – P. 97–117.

12. Dawson, K.A. Temporal organization of the brain: Neurocognitive mechanisms and clinical implications // Brain and Cognition, 2004. Vol. 54. P. 75–94.

13. De Oliveira, A.D. The Human Smart Cities manifesto: a global perspective // Human smart cities / Eds. G. Concilio, F. Rizzo. – Springer, 2016. – P. 197–202.

14. Dushkin, R. V., Andronov, M. G. The Hybrid Design for Artificial Intelligence Systems // In book: Arai K., Kapoor S., Bhatia R. (eds) Proceedings of the 2020 Intelligent Systems Conference (IntelliSys), Volume 1 (1250). – Springer, Cham, 2020. — P. 164-170.

15. Yates, S., Walker, A., Kerri, V. M. (2020) Artificial Intelligence, 2020.

16. Flasiński, M. (2016) Symbolic Artificial Intelligence // In book: Introduction to Artificial Intelligence, July 2016. – DOI: 10.1007/978-3-319-40022-8_2.

17. Gauld, R., Goldfinch, S., Horsburgh, S. Do they want it? Do they use it? The «Demand-Side» of e-Government in Australia and New Zealand // Government Information Quarterly. – 2010. – № 27 (2). – P. 177–186.

18. Georgakopoulos, T. (2019) Semantic Maps // In book: Oxford Bibliographies in LinguisticsPublisher: New York: Oxford University Press, January 2019. — DOI: 10.1093/obo/9780199772810-0229.

19. Ghallab M., Ingrand F. (2020) Robotics and Artificial Intelligence // In book: A Guided Tour of Artificial Intelligence Research. — May 2020. — DOI: 10.1007/978-3-030-06170-8_12.

20. Grazier, Kevin R., Cass, Stephen. Hollyweird Science: The Next Generation. Springer, 2017. 436 p.

21. Grieves, M., Virtually Intelligent Product Systems: Digital and Physical Twins, in Complex Systems Engineering: Theory and Practice, S. Flumerfelt, et al., Editors. 2019, American Institute of Aeronautics and Astronautics. p. 175-200.

22. Grohmann, B., Maucher, C., Jänker, P. Actuation concepts for morfing helicopter rotor blades // 25th International Congress of the Aeronautical sciences. – Canada, 2006. – 10 p.

23. Harnad, S. (1990) The Symbol Grounding Problem. – Physica, 1990. – D 42: p. 335-346.

24. Hawkins, J., Blakeslee S. (2005) On Intelligence. – New York, NY: Owl Books. – ISBN 978-0-8050-7853-4.

25. Hofstadter, D.R., & FARG. Fluid Concepts and Creative Analogies: Computer Models of the Fundamental Mechanisms of Thought. N. Y.: Basic Books, 1995. 528p.

26. Hollands, R.G. Will the real smart city please stand up? // City. – 2008. – № 12 (3). – P. 303–320.

27. Hurley, D.A., Huston D.R. Coordinated sensing and active repair for self-healing // Smart Mater. Struct. – 2011. – Vol. 20. – № 2. – 7 p. DOI:10.1088/0964-1726/20/2/025010.

28. Kordon, A. (2020) Problem Knowledge Acquisition // In book: Applying Data Science, How to Create Value with Artificial Intelligence, September 2020. — DOI: 10.1007/978-3-030-36375-8_7.

29. Kosko, B. Fuzzy Cognitive Maps // Intern. Journal of Man-Machine Studies, – 1986. – vol. 24. – pp. 65 – 75.

30. Kranowitz, C. S., Silver L. B. (2006) The Out-of-Sync Child. – Penguin Books, 2006. – 352 p.

31. Kurzweil, R. (2012) How to Create a Mind: The Secret of Human Thought Revealed. – New York: Viking Books. – ISBN 978-0-670-0252.

32. Lee H.-J., Saravanos D. (1996). Layerwise finite elements for smart piezoceramic composite plates in thermal environments // NASA TM-106990 AIAA-96-1277. – 48 p.

33. Lipov A. N. (2010) At the origins of modern bionics. Bio-morphological formation in an artificial environment. — Polygnosis. № 1-2. 2010. – Ch. 1-2, pp. 126-136.

34. Liu Zh., Lin Y., Sun M. (2020) Representation Learning and NLP // In book: Representation Learning for Natural Language Processing, July 2020. – DOI: 10.1007/978-981-15-5573-2_1.

35. Loiko, A.I. (2020). Electronic Texbuok for the educational Discipline « Philosophy» of the compulsory Module «Philosophy». Minsk: BNTU. 228p.

36. Loyko, A.I. (2019). Information technologies in the paradigm of cognitive sciences / VII Международная научно-техническая интернет-конференция "Информационные технологии в образовании, науке и производстве", 16-17 ноября 2019 года, Минск, Беларусь [Электронный ресурс] / Белорусский национальный технический университет ; сост. Е. В. Кондратёнок. – Минск: БНТУ, 2019.

37. Loiko, A.I. (2020) Interdisciplinary structure analysis systems in the field of artificial intelligence technologies / Системный анализ и прикладная информатика № 1 pp. 40-44

38. Loiko A.I. (2020) Interdisciplinary projections of the social and cultural theory of L. Vygotski / A.I. Loiko // Современные тенденции кросс-культурных коммуникаций. – Краснодар: Изд. КубГТУ. pp. 318-324.

39. Loiko, A. (2022). New Industria. Digital Ecosistems and Smart Society – Chisinau: LAP. ISBN 978-613-9-45361-0

40. Loiko, A. (2022). Nova industria. Ecossistemas digitais e Sociedade Inteligente. – Chisinau: Scientia Scripts ISBN 978-620-4-63894-2.

41. Loiko, A. (2022). Nuova industria. Ecosistemi digitali e societa intelligente. – Chisinau: Scientia Scripts ISBN 978-620-4-63893-5

42. Loiko, A. (2022). Nouvelle industrie. Ecosystemes numeriques et societe intelligente. – Chisinau: Scientia Scripts ISBN 978-620-4-63892-8

43. Loiko, A. (2022). Neue Industrien. Digitale Okosysteme und intelligente Gesellshaft. – Chisinau: Scientia Scripts ISBN 978-620-4-63890-4

44. Loiko, A. (2022). Nueva industria. Ecosistemas digitales y sociedad inteligente. – Chisinau: Scientia Scripts ISBN 978-620-4-63891-1

45. Loiko, A.I. (2022). Philosophy of Digital Technology. – Minsk: BNTU.

46. Loiko, A.I. (2021). Philosophy of information. Minsk: BNTU. 324p.

47. Loiko, A.I. (2022). Philosophy of Mind. – Minsk: BNTU. 207p.

48. Loiko, A.I. (2021). New Format of Dialogue Platforms based on Translateral Thinking / Вестник Удмуртского университета. Социология. Политология. Международныеотношения – Т.5. – Выпуск 3 – pp.374-380.

49. Loiko, A.I. (2012). Philosophy and science methodology. – Minsk: BNTU.

50. Loiko A.I. (2022). Technologies of Digital Ecosictems // Вестник Самарского государственного технического университета. Серия: Философия – Т.4 – P.49-56

51. Luria, A.R. (1976) Cognitive development: Its cultural and social foundations. Cambridge, MA: Harvard Univ. Press.

52. Matsuzaki Y. (1997). Smart structures research in Japan. (Review article) // Smart Mater. Struct. – № 6. – P. R1–R10.

53. Matveenko V.P., Yurlov M.A., Yurlova N.A. (2015). Optimization of the damping properties electro-viscoelastic objects with external electric circuits // Mechanics of Advanced Materials/ eds. V.V. Silberschmidt and V.P. Matveenko. – Engineering Materials, Springer. – P. 79–100.

54. Mehrabian A.R., Yousefi-Koma A. (2011). A novel technique for optimal placement of piezoelectric actuators on smart structures // Journal of the Franklin Institute. – Vol. 348. – pp. 12–23.

55. Mercier P. (1896). Material for protecting vessels, receptacles, &c. / US Patent Specification. – 561905. – 3 p.

56. Nader M., Irschik H., v. Garßen H.-G. (2006). Aktive Schwingungskompensation im Leichtbau mit piezoelektrischen Materialien // Internationales Forum Mechatronik. – Linz.

57. Nam T., Pardo T. (2011). Conceptualizing smart city with dimensions of technology, people, and institutions // ACM International Conference Proceeding Series. – 2011. – P. 282–291.

58. Ng G.-W., Leung W. (2020) Strong Artificial Intelligence and Consciousness // Journal of Artificial Intelligence and Consciousness. 07. — P. 63-72. — DOI: 10.1142/S2705078520300042.

59. Nesterov, F.S., Loiko, A.I. (2022).Problem of "Consciousness-Body" in analytical philosophy of Mind // Евразийские ценности: народное единство и историческая память. – Минск: БНТУ, 226-253

60. New Materials for Next-Generation Commercial Transports / Report Committee on New Materials for Advanced Civil Aircraft, Commission on Engineering and Technical Systems, National Research Council 1996, 98 p.

61. Nuffer, J., Bein, T. (2006). Application of piezoelectric materials in transportation industry // Global Symposium on Innovative Solutions for the Advancement of the Transport Industry. – 4–6 October, San Sebastian, Spain. – 11 p.

62. Osipov, G. S. (2015) Signs-Based vs. Symbolic Models // Advances in Artificial Intelligence and Soft Computing. 2015.

63. Ouellette, J. (1996). How Smart are Smart Materials? // The Industrial Physicist. – P. 10–13.

64. Paskaleva, K.A. (2009). Enabling the smart city: the progress of city e-governance in Europe // International Journal of Innovation and Regional Development – № 1 (4). – P. 405–422.

65. Petroski, H. (1985). To Engineer is Human: The Role of Failure in Successful Design. – New York: St. Martin's Press. – 247 p.

66. Priest, G. (2008). An Introduction to Non-Classical Logic. – Cambridge: Cambridge Univ. Press. 264p.

67. Qualitative health monitoring of a steel bridge joint via piezoelectric actuator/sensor patches / J.W. Ayres, F. Lalande, C.A. Rogers, Z. Chaudhry // SPIE Nondestructive Evaluation Techniques for Aging Infrastructure & Manufacturing – 1996. – 3–5 December, Scottsdale. – 8 p.

68. Quantitative health monitoring of bolted joints using a piezoceramic actuator–sensor / S. Ritdumrongkul, M. Abe, Y. Fujino, T. Miyashita // Smart Mater. Struct. – 2004. – № 13. – P. 20–29.

69. Recent advances in Eurocopter’s passive and active vibration control / P. Konstanzer, B. Enenkl, P.-A. Aubourg, P. Cranga // 64th Annual Forum of the American Helicopter Society. – Canada, Montreal. – April 29–May 1, 2008.

70. Ripley B. D. (2007) Pattern Recognition and Neural Networks. – Cambridge University Press. – ISBN 978-0-521-71770-0.

71. Russell S. J., Norvig P. (2003) Artificial Intelligence: A Modern Approach (2nd ed.), Upper Saddle River, New Jersey: Prentice-Hall. — ISBN 0-13-790395-2.

72. Saddik, A. El. "Digital Twins: The Convergence of Multimedia Technologies". IEEE MultiMedia. 25 (2): 87–92. doi:10.1109/MMUL.2018.023121167.

73. Searle J. (1980) Minds, brains, and programs // Behavioral and brain sciences. — 1980. — Vol. 3, № 3 (September). — P. 417. — DOI:10.1017/S0140525X00005756.

74. Schulz M.J., Pai P.F., Inman D.J. (1999). Health monitoring and active control of composite structures using piezoceramic patches // Composites: Part B. – Vol. 30. – P. 713–725.

75. Sodano H.A. (2003). Macro-Fiber Composites for Sensing, Actuation and Power Generation // PhD Thesis. – Blacksburg, Virginia. – 151 p.

76. Spillman W.B., Jr., Sirkis J.S., Gardiner P.T. (1996). Smart materials and structures: what are they? // Smart Mater. Struct. – 1996. – № 5. – P. 247–254.

77. Sundas A., Bhatia A., Saggi M., Ashta J. (2020) Reinforcement Learning // In book: Machine Learning and Big Data: Concepts, Algorithms, Tools, and Applications. — John Wiley & sons, July 2020.

78. Tahmasebi H. (2012) A hybrid neural networks-fuzzy logic-genetic algorithm for grade estimationю — Computers & Geosciences. 42: p. 18-27. — Bibcode:2012CG.42.18T. — DOI: 10.1016/j.cageo.2012.02.004.

79. Tononi G., Edelman G.M. (1998). Consciousness and complexity. Science, 1998. Vol. 282. P. 1846–1851.

80. Vovk, S.P., Ginis, L.A. (2012). Modelling and forecasting of transitions between levels of hierarchies in Difficult formalized systems // European Researcher. − Vol. (20), №5-1, − pp. 541 – 545.

81. Wavelet-based active sensing for delamination detection in composite structures / H. Sohn, G. Park, J.R. Wait, N.P. Limback, C.R. Farrar // Smart Mater. Struct. – 2004. – № 13. – P. 153–160.

82. Wadhawan V.K. (2005). Smart Structures and Materials // Resonance. – № 11. – P. 27–41.

83. Wolenski J. (2016). Logic in the Light of Cognitive Science // Studies in Logic, Grammar and Rhetoric. Vol. 48 (61). P. 87–101.

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