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NEW PRODUCTS AND NEEDS IN THE ERA OF CYBER-PHYSICAL SYSTEMS

Abstract: The article reveals the periodization of the evolution of the main scientific and industrial discoveries in the field of digitalization, artificial intelligence, cyberphysics, as well as the prospects for the evolution of needs and product markets in connection with the development of cyber-physical systems. For cyber-physical systems, there is already an extensive knowledge base formed by various technical disciplines, including information systems, engineering, computer science, and mechanotronics. Neurotechnological companies aim to create a holistic brain interface capable of linking biological and artificial intelligence more closely. The neural interface is able to absolutely determine consumer behavior in accordance with the project. He will be able to set, set consumer behavior in a range in accordance with management goals – from absolutely rational to irrational. The range of applications of cyber-physical systems includes transport, logistics, medical devices, energy, security systems, asset and resource management, distributed robotics, military systems and many others. The products of the future are a computer program that simulates the work of the mind; physical media for storing information; means of extracting and transferring information located in the brain to a computer; quantum computers; controlling machines with the power of thought; exchange of information between people without additional "physical" control interfaces.
Keywords: cyber-physical goods, consumer behavior, ethics, digitalization, neurointerface.

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网络物理技术时代的新商品和新需求

摘要：本文揭示了数字化、人工智能和网络物理领域的主要科学和工业发现的演变周期，以及网络物理系统发展所带来的需求和商品市场的演变前景。在多个技术学科已经形成了有关网络物理系统的庞大的知识库，包括信息系统、工程学、计算机科学和机电一体化等学科。神经技术公司的目标是创建能够将生物智能和人工智能更紧密地联系在一起的完善的大脑接口。神经接口能够按照设计完全决定消费者的行为。它将能够根据管理目标设置和控制消费者行为的范围：从绝对理性到非理性。网络物理技术的应用范围包括运输工具、物流、医疗设备、能源、安全系统、资产和资源管理、分布式机器人、军事系统等。模拟思维工作的计算机程序、存储信息的物理介质、提取大脑信息并将其传输到计算机的工具、量子计算机、通过思维操控的机器、无需额外的"物理"控制界面的人与人之间的信息交流服务等将成为未来商品。
关键词：网络物理商品、消费者行为、伦理、数字化、神经接口。

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The Internet, social networks, cloud services and e-commerce are important components of a modern person's life. Cyber-physical systems combine two aspects of people's lives – the real "analog" world and cyberspace.

The creation of cyberphysical systems was led by the evolution and synthesis of discoveries in physiology, neurobiology, psychology, addictionology, computer science, electronics, communications, cybernetics, and captology. The periodization of this process can be represented by the following main substantive milestones and time stages:

1. Achievements of physiology.

Principles of higher nervous activity by I. Pavlov (1904), author of the behavioral concepts of reinforcement, unconditioned and conditioned reflexes.

Theory of functional systems by P. Anokhin (1935), the harbinger of cybernetics (author of the term «reverse afferentation or communication»).

2. Development of computer science, the emergence of cybernetics for the purposes of the military-industrial complex.

1915-1918 an American entrepreneur created the first unmanned aerial vehicle E. Sperry.

1936-1940 A. Turing's computer was created, the first computer, the doctrine of the architecture of computers (J. von Neumann), information theory (K. Shannon).

1940-1942 the work of N. Wiener and D. Bigelow on the creation of an air defense device that predicts the flight of an aircraft.

3. Research on the brain and artificial intelligence.

1949 creation of a "homeostat" – the first "thinking machine" closest to an artificial brain (W. Ashby).

1956-1957 – the first programs in the field of artificial intelligence (G. Simon and A. Newell).

1949 Nobel Prize in Medicine and Physiology was awarded to E. Moniz for lobotomy.

1950 – testing of the first neural interface device (Stimoceiver) (J. Delgado).

4. Development of data transmission networks and computers for military-political purposes.

In the early 50s. – in the military-industrial complex of the USSR, communication lines (networks) were widely used, connecting central computers with remote terminals (RTE).

1962 – the first computer video game, Spacewar. S. Brand compared it to taking psychedelics.

1959-1960s. – development of the use of cybernetics in management and economics (E. Beer, V. Glushkov).

1967 – F. Emery (Tavistock Institute) predicted the use of "teenage swarm synergy" at rock concerts to destroy nation states by the end of the 90s. But the methods were used already in 1968 in the European "color revolutions" ("Prague Spring", "Paris Revolution").

5. Distribution of data networks and computerization to the mass consumer sector.

Mid-1960s – in the USSR, automated air and railway ticket offices "Sirena" and "Express" (an analogue of social networks) were developed and launched in 1972.

1969-1971 The first American networks (ARPANET and TYMNET) were created by order of the American military agency DARPA.

At the end of the 1970s S. Jobs and S. Wozniak brought personal computers and telephone devices to the market.

In the early 1980s P. Benioff proposed a quantum mechanical model of the Turing machine.

1984 Apple introduced the Macintosh, the first computer with a graphical user interface.

1985 The WELL online community was opened.

1996 Captology (B.J. Fogg) appears, studying computers as technologies of persuasion.

2003-2004 The rise of social media (LinkedIn, Facebook).

6. Development of neurocomputer interface.

2019-2023 Elon Musk and Neuralink presented the technology of an implantable neural interface ("brain-computer"), received permission for clinical trials on humans.

Digitalization, artificial intelligence, cyber-physical systems have changed the model of production, consumption, management.

The concept of Industry 4.0 is based on cyber-physical systems connecting the material and virtual worlds via the Internet. Cyber-physical systems are used in industry in the following areas: autonomous robots, drones, digital twins, integration systems, Internet of things, gamification, cybersecurity, online planning and analysis, cloud technologies, adaptive manufacturing, augmented reality, energy-efficient technologies, big data, alternative energy, unmanned transport.

Cyber-physical systems (CPS) are a complex concept. To date, they have not received an unambiguous and generally accepted definition, because systems are at the intersection of several spheres at once and, depending on the implementation, are capable of affecting a variety of aspects of people's lives. According to E.A. Lee and S.A. Seshia in 2006 Helen Gill from the US National Science Foundation defined the term CPS as "the integration of computation and physical processes (Lee et al., 2017). Embedded computers and networks monitor and control physical processes, usually with feedback loops in which physical processes influence computation and vice versa."

CPS combine and integrate several technology approaches, including big data analytics and artificial intelligence, improving the monitoring and control of production processes in real time. CPS are used both in industry and in many other areas of application, therefore they are general-purpose technologies [Bresnahan, 2010].

In our opinion, cyber-physical systems can be defined as integrated engineering systems that are built on the basis of seamless integration of physical components and software that interact with one another and with the external environment using modern technologies.

The cyber-physical era differs from the digital era in that it includes not only the world of digital technology, but also the physical world.

Cyber-physical systems are a key enabler of the new era of Internet communications and real-time economic relations between all participants in the value chain, such as devices, systems, organizations and people. The future of CPS will lead to the next generation of a wide range of new specific products, needs and ways to meet them. The mechanisms of supply and demand for CPS will have significant differences from models based on the laws of classical theory.

In order to study future models of consumer behavior, interdisciplinary knowledge will be required, based on: neuroscience, cognitive psychology, epistemology, philosophy, linguistics, anthropology, artificial intelligence, electromagnetism, field theory, particle physics, information theory, cosmology. Logical possibilities for solving problems are higher at the intersection of disciplines.

The theory of information and computational sciences, which appeared in the middle of the 20th century. thanks to A. Turing (who created a mechanical device capable of carrying out any computational process, 1936), J. von Neumann (author of the doctrine of the architecture of computers, 1944), K. Shannon (formulated the theory of information, 1948), allows us to take a fresh look at the product, use value, utility.

Experts in consumer behavior and psychologists sensed the incredible potential of the discoveries of information and communication theory and applied them in their field. With the discovery and development of information theory, it is obvious that the property of a product is information about it and the information itself can be a product in its pure form. The properties of a commodity body are its physical and informational characteristics. Therefore, in the era of computers and telecommunications, we can say that use value has become the embodiment of not only physical, but also informational existence.

A product is (or can be) a physical carrier of information, stores it, and processes it. The physical state of an object, substance, product that is a carrier of information affects the quality of transmission, reproduction, safety, and duration of existence of information. Stone (rock paintings), clay (clay tablets), papyrus, paper, ice, air (communication through smoke, using special pyrotechnic devices) are historically known formats for figurative representation of information. Great many people consider information to be the same basic entity as matter, energy or consciousness. The reality through which information passes can be divided into spheres: physical and mental. Matter is a physical substance as opposed to a mental, spiritual substance. Speaking about the types of matter that serve as the material basis for presenting information, it is obvious that they change and evolve. At the present stage, the accumulation of bits of information is carried out in individual atoms, electrons, photons. In the early 1980s P. Benioff proposed a quantum mechanical model of the Turing machine, so the creation of quantum computers seems to be a matter of time.

Information moves from physical reality to the mental reality of a person. Consumer behavior consists of a unique configuration of traits and attributes that make a person one of a kind (personality), unlike all other people. According to C.L. Delgado “information goes hand in hand with the concepts of personality and consciousness” [Delgado, 2022, p. 155], “the human personality is a mask, a product of information processed by the brain”, “the entire content of the mind is information” [Delgado, 2022, p. 166].

According to R. Penrose, the behavior of the human mind does not fit into the laws of any of the currently known areas of physics[1]. “Despite decades of combined efforts by neurophysiologists, philosophers and psychologists, the question of how our brain makes us conscious and how sensations, feelings and subjectivity awaken has not received an answer: we have no idea” [Noé, 2010, p. 13]. C.L. Delgado identifies the following models of the mind: materialism, neural doctrine, computational focus, neural network approach, quantum paradigm [Delgado, 2022, p. 122-128]. Materialism states that the brain consists of matter (two types of quarks and one type of electron); the neural doctrine explains how information moves through the nervous system (received, encoded, transmitted and stored); in accordance with the computational approach, knowledge is presented in the mind in an analytical format (in the form of judgments) or in an analog format (using mental pictures); the quantum paradigm shows that the brain uses the prin-

[1] Discover interview: Roger Penrose says Physics is Wrong from String Theory to Quantum Mechanics. Discover Magazine. October. 2009. 06.

ciples of classical physics and quantum mechanisms for computational operations. To a certain extent, this also explains the wide range of economic models of human behavior.

Until now, digital (or computer) behavioral design is used as a tool, a technology for creating digital goods of a new generation, which makes it possible to form consumer habits and manipulate people's behavior. There are various models for describing this process, for example, the "hook" of Eyal and R. Hoover [Eyal et al., 2013], represented by a four-stage process of trigger, action, variable reward and investment. Digital behavioral design is based primarily on psychology.

Developers of neural interfaces are aimed at creating a holistic brain interface capable of more closely connecting biological and artificial intelligence [Skokov, 2022]. The neurocomputer interface, as a system for exchanging information directly between the brain and an electronic device, is based on neurobiology. A neurocomputer interface opens up an order of magnitude greater possibilities for influencing human behavior compared to digital behavioral design. Behavioral design transforms, influences, influences behavior, brings it closer to a specific project. The neural interface is capable of absolutely determining consumer behavior in accordance with the design. He will be able to set and establish consumer behavior in the full range depending on management goals: absolutely rational, rational, limitedly rational, and even irrational, which is absent in the mainstream of economic science.

The areas of application of cyber-physical systems are as follows:

– transport systems, logistics, manufacturing (including agriculture), medical devices (including for elderly and disabled people);
– production and distribution of electricity, energy saving;
– heating, ventilation and air conditioning systems;
– physical safety, assistance and rescue;
– traffic and safety management;
– asset management and distributed robotics;
– resource management (land, water, etc.);
– control and measuring instruments;
– military systems.

The goods of the future are: a computer program that simulates the work of the mind; a physical medium for storing information (including the human brain after death); means of extracting and transferring information located in the brain to a computer; quantum computers; controlling machines with the power of thought; exchange of information between people without additional "physical" control interfaces

CPS becomes a key driver of the innovation potential of industries large and small, driving economic growth and supporting meaningful jobs for citizens. In Russia, research into the problems of creating and monetizing cyber-physical systems is not carried out intensively enough, as a result of which all the latest initiatives in the field of digitalization of the economy, which looked like breakthroughs, in fact have not yet led to the emergence of competitive goods and business models of monetization. The economic and institutional aspects, which are of utmost importance, have not actually been studied, therefore the categorization of cyber-physical goods acquires economic, legal, and socio-psychological significance. It is necessary to build an economic theory of cyber-physical systems and a model of public and state regulation of the markets for goods and services generated by them based on specifying their essence, structure, functions, specifics of supply and demand, analysis of the evolution of concepts, assessment of effects and risks, development experience institutions and mechanisms of regulation and self-regulation.

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