New Challenges for Socio-Cyber-Physical Systems Management

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Abstract The convergence of biological and technical objects and systems in modern production, everyday life and cultural practices leads to the need for the formation and management of the socio-technical landscapes of civilization. There arise problems of optimal mutual coexistence of various components of the information society, which are being built at the present stage in the form of various socio-cyber-physical systems. Penetrating generally in all spheres of society, they undoubtedly create new points for the growth of society, but, at the same time, provoke new risks and threats for the adequate management of the modern socio-technical landscape.

Keywords: socio-technical landscape, hybrid systems, socio-cyber-physical systems, risks, digital distance education.

Introduction. At this stage of development, mankind is forced to use more advanced and faster means of analyzing beingness to predict its actions in the umwelt and implement appropriate responses. For this purpose, it creates its own intellectual ‘exoskeleton’, surrounds itself with assistants (both physical and intellectual ones), creating ‘accelerators and amplifiers’ of intelligent-digital ‘communication’ and intelligent management of both the surrounding world and its own role in it from the point of view a human being [1]. Recently, the more well-known term ‘exocortex’ has been introduced; one of the concepts of this term is specified in M.V. Sukharev’s phrase: “Knowledge is a cognitive constructor that includes elements (concepts) and rules of interaction between them, and society is a cognitive hybrid system of human beings and artificial means of helping thinking (exocortex)” [2].
The development of the information society has been initiated, in which new technologies of information processing are being created in various social strata and communications, thereby causing digital expansion of umwelt and its inner being [3; 4] (“armament”, “protection”, “nutrition”, “lifecycle”, “communications”, “genetic and semiotic memory” and other society’s determinants and predictors involved in the formation of the anthropological key [5; 6], NBIC-technologies [7; 8]). There arises a new anthropogenic environment of the evolving planetary Society – digital reality [9; 10; 11]. Not only biological and biophysical components, but also biomechanical, computer, biotechnical, cyber-physical objects, subjects and systems (such objects are also called hybrid ones [12]) are the elements (and links between them) of the structure of the Digital Information Society (DIS).
Currently, new, cyber-physical technologies are intensively developing [13], including the subject areas of artificial intelligence, drones and robotics, augmented and virtual realities. In fact, we are talking about the transition from the chaotic, synergistic formation of DIS to the

comprehensible, predicative and controlled under conditions of “certain uncertainties”, which are modelled using a specific philosophy [14] and mathematical apparatus [15].

Cyber-Physical Systems and Pholosophical View

Let us define Cyber-Physical Systems (CPS), including both objects and subjects of control, modelling, forecasting and management, as systems including various natural objects, artificial subsystems and process controllers that make it possible to represent such formation as a whole. The “progenitors” of such systems that support the functioning of BTS and TBS (technical and biotechnical systems in which the biological part is controlled by the technical one) are real-time systems, wireless computer sensor networks, distributed computing networks, and expert interactive systems (which were later called SMART systems). Currently, the German academy Acatech is carrying out the development of national cyber-physical platforms, the system-forming pillars of which are network structures: the Internet of People, the Internet of Things, the Internet of Services – see Figure 1 [16].

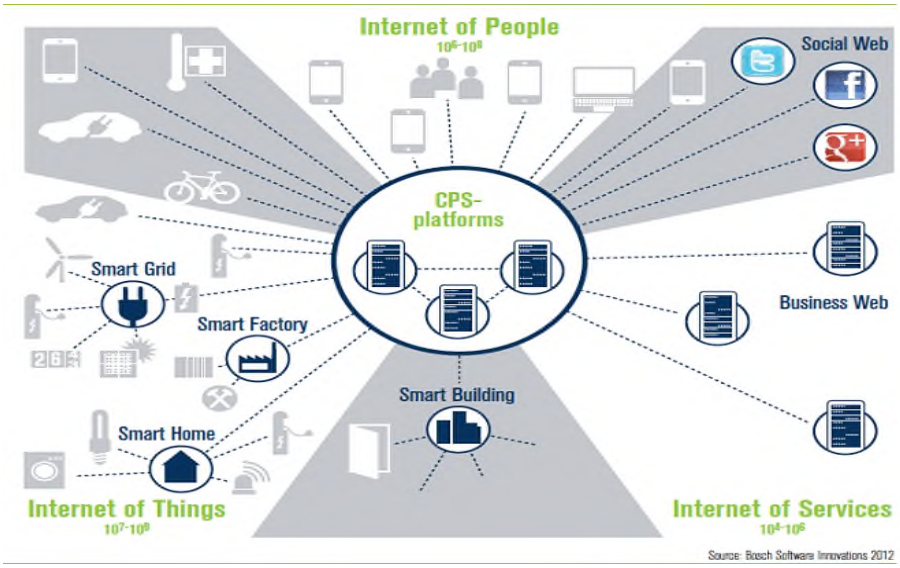

Figure 1. The platform of building Cyber-physical systems (according to Acatech scientists)

The scientists of the German Academy reasonably prove that the prospects for the emergence and development of cyber-physical systems, due to the needs of the new technological order and Industry 4.0, affect the interests of the planetary Society and should be considered in a general socio-cultural aspect. It can be reasonably assumed that the creation and development of full-fledged CPS systems will lead to significant transformations of social practices and society as a whole both in the field of interaction with the physical world and with the spiritual area, radically changing ethical relations (of course, without changing the strategic target function of Societies, about which we have already mentioned) [17; 18]. N.A. Yastreb and M.D. Kent note that there comes a time when people are no longer able to cope with the amount of information required for making decisions, and some part of the actions must be transferred to the CPS, taking a human out of the control loop. However, ‘transferring’ a human from a biological and physical object or subject to a cyberphysical one, on the contrary, increases his influence in the control loop, multiplying his analytical abilities.

Context analysis of various information sources and our own research allowed us to identify the following basic principles that should be specified in the methodologies for constructing networks of cyber-physical objects and subjects, and which should be taken into account when organizing the control process:

1. The universality of the communication interface;
2. Acceptable redundancy of information transmission and processing;
3. Biofeedback;
4. Rhythmic cascading functioning of the components;
5. Taking into account uncertainty in synergetic evolution;
6. Blurred boundaries of the functioning of cyber-physical objects and subjects, the biological is inseparable from the technological [19];
7. Taking into account the characteristics of an anthropological nature (when designing communication interfaces in cyber-physical social systems of various sizes and hierarchies) at the current time and in the predicative future;
8. Three principles of functioning of cyber systems similar to the Isaac Asimov’s Three Laws of Robotics;
9. Cyber-physical objects and subjects have the properties of autopoiesis (self-healing) and self-destruction, if this improves the operation of the system as a whole, contributes to the achievement of a certain, specified value of the objective function at acceptable costs and losses;

10. In various taxa of the socio-technical landscape (STL) [20], cyber-physical systems function specifically and coherently; technologies for constructing hybrid, cyber-physical networks are specific in terms of functionality, but universal in terms of assembly meta-methodology.

Taking these principles into account, there arise problems in the convergent development of cyber-physical systems in various STL taxa (both in time and in space). In his work, V.V. Chekletsov (2016) emphasizes that the anthropological and socio-philosophical significance <...> of technologies lies in the formation of new forms of inter-subject, subject-object and inter-object communications [21]. As a result of the synergistic or controlled combination of cyber-physical subjects and objects into a certain system, there arise problems in creating new specific communications, interfaces, and synchronizing the operation of the elements with the external environment.

S.A. Kudzh and V.Ya. Tsvetkov, describing the evolution of technical systems, note the connection of cyber-physical control with network-centric one and matrix and hierarchical technologies as prototypes [22]. A similar approach was used in the construction of a string model of control in the sociotechnical landscape by M. V. Artemenko [23].

We have proposed the concept of an 'anthropological key' [24], thanks to which in this case, it becomes possible to formalize the process of network assembly. Since in assessing anthropological and social transformations and risks arising both at the assembly stage and in the process of functioning, there arises a problem of measuring (assessing) human-dimensional and poorly formalized parameters, it is possible to use expert assessment for the metric of such components of the anthropological key as: soma, energy, reaction, empathy, communicativeness of realities (genuine, virtual, augmented), etc. This helps creating expert systems that allow processing fuzzy knowledge using fuzzy inference tools. Obviously, the process of interfacing is carried out in such a way that the components of the anthropological key satisfy human beings and maximally realize the target function of the cyberphysical society.

Cyber-physical assemblies in education

It is in the ancient times when the thinkers noted the necessity to constantly improve the preparation of the new generation (as the major elements of the future society) for the existing and predictable state of society and communications within it and with the environment [25].

We have analyzed the processes of the network assembly of digital technologies that support education in secondary schools in Russia during the crisis caused by the COVID-19 pandemic in 2020, called distance education [26].

So, before the COVID-19 pandemic, within the framework of the strategy for the development of digital education in Russia and implementation of the Decree of the President of the Russian Federation on the Development of Artificial Intelligence in the Russian Federation dated 10.10.2019 N 490 (together with the National Strategy for the Development of Artificial Intelligence over the Period Extending up to the Year 2030) schools got new digital equipment for almost all secondary school subjects. At the same time, retraining of teachers was being carried out. Students of secondary schools use gadgets extensively, but not for educational purposes. Schools, in fact, lack a cyber-physical network (despite the presence of relevant entities), since there is no target function and experts for its implementation. Introduction of a compulsory computer version of the Unified State Exam in Informatics (and partly the Basic State Exam), students' project activities, various extra-curricular specialized communities (camps, Sirius, quantoriums, schools of innovators, correspondence schools and associations, social networks on the Internet, etc.), the abilities of students work in social networks and exchange educational information in them contribute to the initiation of the process of cyber entities network assembly in secondary schools. However, when teaching methods that are not actively aimed at using computer technology and social networks predominate; they do not provide for the convergence of various disciplines taught using digital platforms. This is due to the fact that full-time education of a large number of students is a natural form of acquiring knowledge and skills according to the 'person-to-person' scheme through direct audio and video communication.

With a quick, almost instantaneous transition to distant communication, the natural form partially transits to an artificial one, which is not sufficiently prepared in terms of methodology. The usual communications used in training are being broken. Since the methodological basis of such an 'age of changes' is poorly prepared, the process of the emergence of a new educational environment (a certain network) turns to be of a synergistic nature. In conditions of poor methodological elaboration, government institutions for managing the educational process are trying to take control of the chaotic situation by issuing various, often contradictory, orders and resolutions. This leads to the strengthening of all the components of the quality of the educational process: those who know how to learn improve their knowledge by intensifying and extending the use of computer technologies, access to a variety of information resources; those who do not have a target attitude towards learning begin to lag behind in learning process at first, and then drop out of schools. In such situations, parents begin to blame teachers; in feedbacks appears negativism, sometimes leading to their breakup. Let us note that the problems of the emergence of aggression in socio-cyber-physical systems have been considered, modelled and predicted in [27].

Thus, on the "Educational Process – Digital Technologies" socio-technical landscape the process of synergistic assembly of cyber-physical subjects and objects begins; the participants of this process are the actors of the

educational process (people+smartphones+computers), communications, educational digital technologies, automatic and automated technologies for quality control of acquired knowledge and skills, schoolchildren's computing hardware, computer and communication resources of a particular school.

There are more than enough digital educational tools for organizing and carrying out distant educational process. However, due to their mass use most of them function unsatisfactorily under heavy excessive loads. Obviously, equipping schools with good computers and virtual laboratories, and providing educational participants with communication tools and relevant competencies will lead to the need to develop "virtual classrooms" imitating most of the processes taking place during real lessons. Of course, this will not replace the development of students in society, but will bring them as close as possible to that during the forced "separate education". The younger the schoolchild is, the greater the need for acquiring knowledge in society, in a team of approximately the same age type.

Meanwhile, the implementation of the Digital School Project has certain threats and risks for society associated with the ongoing processes [28]. Since they significantly affect the "network assembly", we will consider them in more detail:

1. School education "modernization" is being implemented in the interests of large IT businesses (Cisco, Samsung, IBM, Microsoft, Huawei, Sberbank, etc.) that consider Russian educational institutions as a market for their products.
2. The risk of "breaking/eliminating the traditional model of the educational system" [29] is clearly visible; the school system is being "scrapped"; the gap between "digital" schoolchildren and "non-digital" teachers is growing; non-system education and many alternative forms of education are being established; there appear teachers who have no special education; international certification and transformation of the Unified State Exam is being carried out. The state loses its strategic influence on the school, retaining only economic and administrative functions.
3. The segmentation and stratification of the educational system can arise as well as an increase in the gap between the "elite" and "lagging" educational institutions.
4. Higher education promotes the elitism of attendance education, work on a local order, state support for fundamental education "which is going to be not for everyone".
5. During the general network assembly of society a "history file" is being created; it is bound with a single citizen's "end-to-end identifier", which is a descriptor to information in the Unified System of Identification and Authentication (USIA, Russian – ESIA) and the Unified Biometric System (EBM), which can lead to an invasion of private space identity and breach of confidentiality.
6. Strengthening the gaming principle in all spheres of life (gamification), when "game" and "team" will become the dominant forms of education, as a further development and convergence of technologies and methodologies of game theory and simulation. The danger here lies in escape of a particular person from augmented reality to virtual one, which will allow the environment to absorb human consciousness through the digital reality umwelt, which means, that ultimately, this will contribute to the disappearance of society, the emergence of a number of people living in the same territory, who are easily controlled.

The specified ideas, which are serious risks for an adequate network assembly of cyber entities in the education system, are reflected in The Future of Education: Global Agenda report prepared for strategic planning and decision-making in Russia and developing countries [30]. It is too early to talk about the end of the process of assembling a new educational network consisting of cyber-physical objects and subjects with a different ratio of cybernetic, biological (human), personal and social shares [31]. However, the analysis of the feasibility of the demands of education for digital technologies allows us to assume in which direction both structural changes in the network and the cyber-physical essence of its constituent elements will develop.

Conclusion

The development of society during the formation of the information society and the transition of civilization to the post-industrial era, the processes of intensification and extension of the demands and implementation of Industry 4.0 to new technologies and communications in the system of society, existing and functioning on certain spatio-temporal socio-technical landscapes have led to the expansion of information and digital technologies, the exponential growth of their share both in the umwelt and in the internal processes of society and its individual elements and structures. There arose the problem of transforming the methodologies for constructing (assembling) certain network structures of hybrid subjects and objects of cyber-physical reality for the optimal adaptation of society to the emerging new challenges of the umwelt.

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