УДК 001; 004.5

Oleksandr Yu. Burov
Dr.Sc. (Eng.), Leading researcher
Institute of Information Technologies and Learning Tools of NAES of Ukraine, Kyiv, Ukraine
ayb@iitlt.gov.ua

EDUCATIONAL NETWORKING: HUMAN VIEW TO CYBER DEFENSE

Abstract. Networks play more and more important role for human life and activity, both in critical occupations (aviation, power industry, military missions etc.), and in everyday life (home computers, education, leisure). Interaction between human and other elements of human-machine system have changed, because they coincide in the information habitat. Human-system integration has reached new level of defense needs. The paper will introduce features of information society in respect of a human and corresponding changes in HF/E: (1) information becomes a tool, goal, mean and environment of a human activity, (2) it becomes a part of the human nature and this makes him/her unprotected, (3) human psycho-physiological status becomes not only a basis of effective performance, but an object of control and support, and means of a human security and safety should be a part of information habitat, (4) networking environment becomes an independent actor in a human activity. Accompanying cyber-security challenges and tasks are discussed, as well as types of networking threats and Human View regarding the cyber security challenges.

Key words: cyber defense; human factors/ergonomics; human view.

1. INTRODUCTION

At present, changes of the school education worldwide aim the transition from classroom to a mixed system in which the share of individual and project-oriented work constantly grows [1; 2]. This is important both in terms of the ability of students to learning, and the ability to search and perform research activities to obtain practical results [3; 4]. As Joseph S. Renzulli has highlighted at the 18th World Conference 2009, it is necessary to reexamine the purpose and role of gifted education in a rapidly changing world and in an education system, because today's children and teens were born into a digital world [5]. That world gave all children much more opportunities to realize their abilities. Experts of psychological and educational spheres noted the need to form a human 21 century's professionally important skill: information literacy, ingenious analytical thinking, fast information searching and processing, innovative way of thinking, effective communication, working in projects and teams, problem solving, ability to take responsibility, high productivity, life competence [6].

Statement of the problem. Using the concept of context-based cognition it is assumed that learner's individual construction of knowledge should take place within a certain context, which is similar to the context in which this knowledge should be applied in the future [7]. At the same time, it is known that human cognitive opportunities can vary from day to day depending on his/her functional state and fitness-for-work [8; 9]. As a result, such changes can impact a human ability to adapt in a particular learning environment, to perceive and to conceive new information, to use it, to get knowledge and skills and to prevent its inefficiency.

Besides, nowadays it is known that human's work with computer over a long period has a negative impact on his/her health and mental efficiency. It is especially important for children and young people whose organism is more sensitive and unstable comparing to adult one. In addition, humans in the open network, first of all, young humans, need special attention to be safe and resilient to external impact. Events around Ukraine and other "hot

points" demonstrated clearly over last two years that networks including social ones became the means of a significant influence on a human behavior, way of decision making, changes in life values and priorities.

Analysis of recent research and publications. It is recognized that we live in the information age [10] and the digital space is increasingly affecting all areas of our life ("e-World": e-Work, e-Learning, e-Health, e-Commerce etc.) including education as a system of training and formation of intellectual capital [6]. Over last years, more and more attention is paid to the quality of education [11], as well assistance and network means [12; 13]. These changes need to take into account new challenges in human factors (ergonomics) view to anthropocentric systems. However ergonomic features of a person interacting with ICT have not yet become a component of the overall quality of education system [14] due to lack of general understanding of network technologies as a means of human activity [15].We strongly believe that complexity and variability are two outstanding features of the information age [16]. This primarily refers to new technologies that accompany our activity in all spheres of our life and work - information and communication technologies - as well as directly affect not only our present but also the future [17].

Special attention is paid currently to cyber-defense, because very effective information and psychological operations by Russia in Ukraine cyber-space over last 5 (or even 10) years have clearly demonstrated needs to build national defense information system [18; 19], first of all, beginning from education. This needs to take into account new tasks and solutions proposed by human factors/ergonomics discipline [20; 21].

The article's goal is to analyze safety challenges of education process subjects when using network learning/teaching tools and means.

2. RESEARCH METHODS

Comparative analysis of goals and components of human-technical systems in technological ways, as well as of human-technical-environmental (HTE) system; classification of threats for a human from networks. "Human-in-networking-education-loop" is analyzed in three aspects: new features of education in digital space, human factors/ergonomics, and cyber-threats (human and networks).

3. RESULTS

As it is highlighted in [18], priorities of education in the 21stcentury should be built to form key competences for lifelong learning that are "a combination of knowledge, skills and attitudes appropriate to the context. They are particularly necessary for personal fulfillment and development, social inclusion, active citizenship and employment". Eight key competences are:

- communication in the mother tongue;
- communication in foreign languages;
- mathematical competence and basic competences in science and technology;
- digital competence;
- learning to learn;
- social and civic competences;
- sense of initiative and entrepreneurship ;
- cultural awareness and expression.

The emphasis in general is on high productivity, ingenious analytical thinking, quick search and information processing, innovative and critical thinking, effective communication,

team work, problem solving, ability to take responsibility and life competence.

Implementation of this approach needs:

- flexibility of education programs – a student can choose courses, teachers, time of active work, etc.;
- individualization of education process – re-allocate time and education resources in dependence on a student's individual psycho physiological possibilities to make this process more intensive and to give equal opportunities for all people including people with disabilities.

These advanced proposals can help a student to make a decision as to what type of learning activity in a particular day is preferable depending on his/her functional state to:

- take lectures,
- carry out applied tasks,
- work in interactive mode with computer/network/e-clouds,
- work in interactive mode with other subjects of learning process,
- work in library,
- work in Internet,
- perform individual tasks,
- delay an active form of teaching for another time,
- control his/her workload as well as mental and physical health.

Although further work in this direction is required to gain a more complete understanding of such a tool's use, it is clear that this could give a student an opportunity to intensify time by means of re-allocating his/her efforts and to optimize time use. Another aspect of the same problem is an adaptive automation of human-computer interaction in accordance with a student functional state, motivation, abilities and other resources at a time. To achieve a positive result on this way it is necessary to consider at least two significant factors in the transition to the use of networks - the changing role of human factors/ergonomics and cyber-security.

3.1. Human Factors/Ergonomics in the digital world: human life, learning and activity

As a "meta"-discipline, Human Factors/Ergonomics (HF/E) deals with different sides of a human life and activity. But its goal and tasks have changed over 60 years of existence, as well.

At present, we are based on the definition: "Ergonomics (or human factors) is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance"[19]. "Other elements of a system" are means of labour and tools as well as subject environment. The human factors/ergonomics object is a system "human-tool-environment" (HTE) and the ergonomics subjects are ergonomic properties including interactions among all 3 system elements, where "interaction" is a core (main feature) of the discipline, because it is activity of the system (Fig. 1).

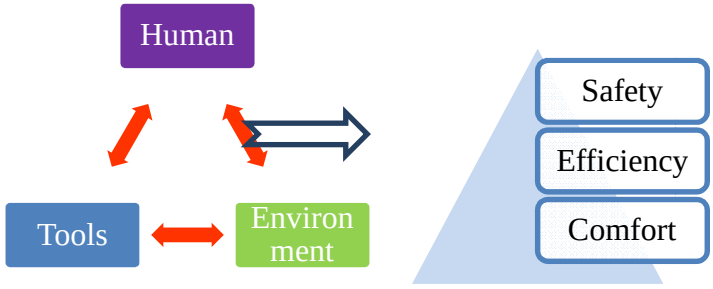

Fig 1: HF/E, its object and subject

Thus HFE is a systems-oriented discipline that is changing with modifications in the system. Main goal of human factors'/ergonomists' activity is design and evaluation of tasks, jobs, products, environment and systems in order to make them compatible with the needs, abilities and limitations of people.

It was a natural goal in a "hard" system (relatively fixed in time and space) when working means and tools were *material objects* in comparison with a human (with his/her physical and psychic parameters) and general environment (including natural, social, informational and organizational) that were quite flexible [14]. It was typical understanding over previous ages of work (by J. M. Christensen [20]: manual labor age, machine age, energy age, new age - machines for mental work. At present we are already living in information age (information society) that gives rise to "*soft*" systems which all 3 elements are flexible (Fig.2b).

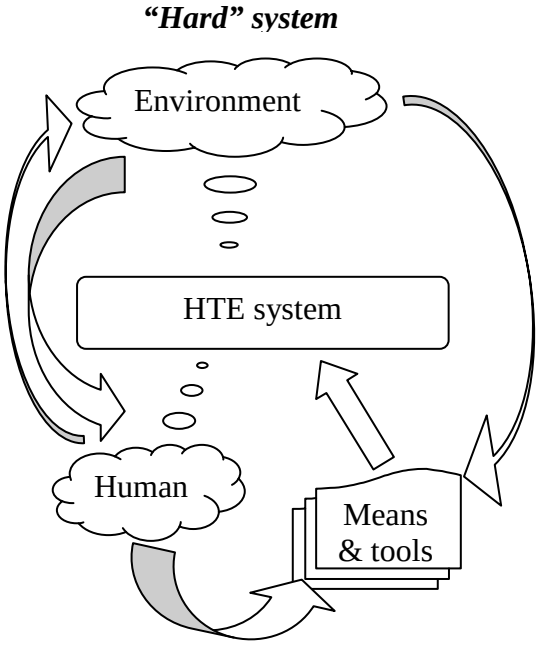

Fig. 2a: Ergonomics objects in industrial age (after [14])

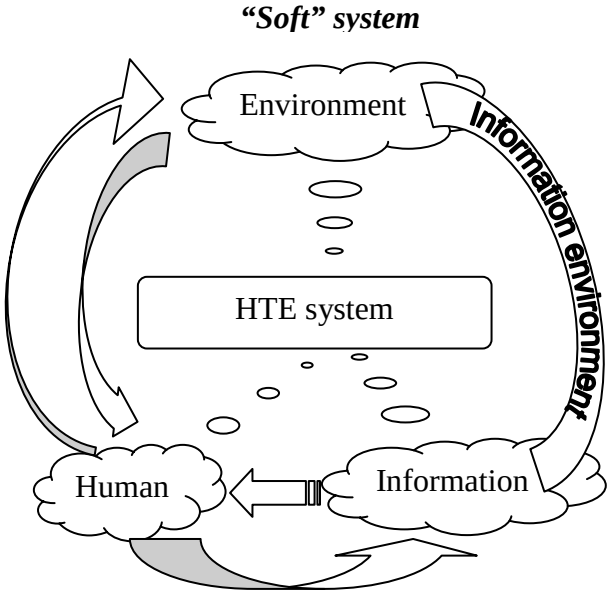

Fig. 2b: Ergonomics objects in digital age

Our life conditions have changed:

- Current work/education/life challenges comply with modern possibilities and tendencies to use electronic forms of activity.
- Human cognitive opportunities play more and more significant role in general human performance, they influence HTE safety and efficiency because of their variation from day to day depending on his/her functional state and fitness-for-work.
- Such changes can impact human ability to :
  - ✓ adapt in a particular activity environment,
  - ✓ perceive and to conceive new information,
  - ✓ use information,
  - ✓ get knowledge and skills,
  - ✓ prevent its inefficiency.

Changes in HF/E object

As follows from figure new links within ergonomics object result in changes in the human factors/ergonomics object structure. Hence, the subject, methodology and methods of human factors/ergonomic science have to change as well, because human activity has changed in all aspects. Working (or rather, activity) means and tools have been transformed into information that became not simply an information, but means, tools, environment and a goal of activity at the same time. A human has started to act mainly:

- to get information,
- to change information,
- to create new information and knowledge as a product (internal – while learning, external – while working),
- by means of information,
- in information environment.

Changes in a human activity

Activity is a main substance of our everyday life. But its scopes become relative, not clearly defined because of :

- changes in our goals and needs (earning, cognition, leisure),
- tools and facilities (electronic equipment in workplace, in office, at home),
- workplace design and construction (more ergonomic and comfortable),
- location (outsourcing job),
- increasing of mental component work (in contrast with physical one),
- day time span of the same or similar type of activity (work in office with computer can be continued at home with computer again, but as learning or leisure at the similar table).

Respective types of work could be described as:

1. Learning
2. Training and retraining
3. Job duties
4. Professional functions
5. Creative activity
6. Professional training/re-training
7. Raising the level of the skill
8. Home (family) work
9. Social activity.

Types (3)-(4) usually are associated with “work”, but (5) can be a part of regular work as well. Lifespan education becomes not a slogan, but demand of our time and often needs even more continuous efforts than regular work. Nevertheless, in information age all these activities could be considered as e-work, if they are carried out in digital environment.

HF/E results (criteria) in digital life

The main task of ergonomics is “to design in order to optimize human well-being and overall system performance”, i.e. human *efficiency + safety + comfort*.

When a human works and produces industrial (agriculture etc.) goods his/her efficiency can be described as:

Efficiency = quality goods production + minimal workload efforts + minimal time loses.

Safety = his/her safety (labour protection) + goods safety + environment safety.

Comfort = optimal conditions (striking distance + microclimate + lack of time pressure) + work satisfaction.

In digital environment:

Efficiency = quality of information goods and services production + minimal mental

workload efforts + minimal time loses.

Safety = his/her safety + information product safety + information environment safety.

Comfort = optimal conditions (human friendly interface + reliable information) + positive motivation + work satisfaction.

In this case, both a human and information environment takes on new significance. It is especially important because of his/her personal safety and safety of his/her activity results. Being open when working in information environment, a human becomes not only a subject, but an object (target) of activity from other participants of information space. A human openness is a result of activity goals: to use information as a tool, a human has to "touch" it, to contact with it. At this moment he/she becomes open for information and vulnerable from it.

New safety problem in digital world

At present, mankind has faced a new safety problem in information society. It was possible for traditional activity to standardize a duration of working time, dozes and levels of affecting factors, efforts etc., to protect a human by personal and common protective equipment, to make tasks, jobs, products, environments and systems compatible with the needs, abilities and limitations of people, to adapt and to adjust tools to a human physical possibilities. But in the information environment the questions could be set as:

1. What should be protective means?
2. What should they protect from?
3. What threats could come from the digital world?
4. In what way is it possible to protect a human from information that is a goal, mean, tool and condition of activity, a part of a human at the same time?

It would be possible to answer these questions, if we recognize a new role of HF/E in digital world.

New HF/E component in digital world

Material object, nature, information, social environment, organization of activity and communication have changed and obtained new features in digital world, especially in networks (social, education/training etc.). In both activities, physical and mental, human parameters of activity are affected by internal and external factors (Fig.3).

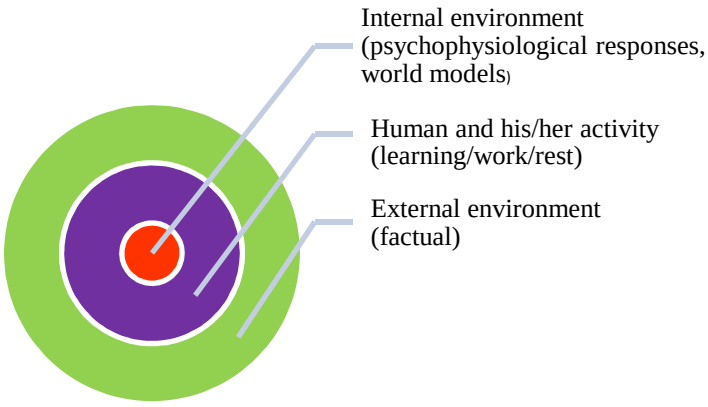

Fig. 3: Place of a human and information in information society

We strongly believe that psychophysiology is not only a basis of the human working effective activity, but a goal of activity (of information habitat impact) of the human himself. Because his/her tool becomes a part of his nature, first of all his brain, and this makes him unprotected, psycho physiological features and limitations have to be protected in education

and training process, work and leisure (it is more and more deal with information surroundings).

1. External environment

Material objects: ergonomic design of workplace, facilities, clothes, classroom (micro- and midi-ergonomics).

Nature: conditions in workplace.

Information: general and specific awareness concerning opportunities and benefits of learning, process and content of subject studied related issues.

Social environment: country, school, out-of-school, home, friends, colleagues, business partners.

Organization of learning/teaching activity: task planning and allocation in space and time.

Communication: opportunity to ask questions, coaching, sharing ideas etc.

2. Internal environment

- Physiological: health level, general and current conditions, fitness-for-work.
- Psychological: motivation (to learn, to work, to communicate), activity satisfaction, life satisfaction, self-recognition etc.

3. Human activity

Working: workplace condition, job organization, facilities, professional awareness, inter-personal relations and communication.

Learning: workplace condition at work and at home, access to information needed, working (learning) process organization, task planning and allocation, out-of-school activity, self-evaluation, achievements recognition and success.

Means & Tools: workplace organization and design, facilities, IT, communication technologies, teaching aids, curriculum, clouds.

3.2. Virtual life and activity: benefits and draw-backs

New features of life in digital world have both benefits and draw-backs and some risks for a human in such an environment, because information space and especially networks become independent factors, even more: independent actors of activity. E.g., in cloud technology, social networks etc. where information allocated there becomes distributed, not-controlled and lives independently from the person that gave birth to it. Such information begins to live its own life. The network begins to be “owner” of that information and can impact a human (humans) life. Wikileaks and other similar scandals can be examples of this. Such information exists beyond time and space since it was created.

Thus a human has to balance benefits, disadvantages and risks when exposing themselves to information space.

Benefits of digital world for a human

- Extended information and tool resources with faster access.
- Opportunity to communicate with a great number of colleagues and experts worldwide, including on-line.
- Quick information exchange.
- Opportunity for long-distance “brain-storming”.
- Equal access for people with disabilities.
- Higher opportunity to control own functional state.
- Better time self-management.
- More direct time-on-job, less disturbances.
- Individual adjustment in the workplace (physical, psychic, informational).
- Individual adjustment of the secondary (out-of-workplace) environment.

Draw-backs

- A human “openness” for external impact through information flow.
- Not everyday communication face-to-face with other people (lack of “live” communication).
- “Artificial” environment of communication.
- Lower social-psychological life.
- Uncontrolled and invisible threats from information.

Potential risks

- A human vulnerability from information.
- Lack of protection means from digital environment as a risk factor.
- Static posture, hypodynamia and accompanying diseases.
- Dependence on gadgets and channels of communication.
- Syndrome of “operator diseases”, in general.
- Loss of interest in team communication.

As it was stated [14], not so far ago a human place and role in networks could be described as a terminal element (node) linked to other elements with its specific interface (having human and technical parameters). Currently, when a human life and activity has more virtual nature, information environment (network) becomes an independent factor, because process of a human presence as well as results of his/her activity lose their localization in space and in time, as well as could be affected at any time and anywhere. Even more, those results could «live» inside the network «infinitely», because technical resources holding them are distributed, flexible and supported continuously.

Recommendations for improving a human psycho physiological security have been developed and described [21]. The further development of ergonomics criteria could be developed taking into account the new human activity nature and a multiaspect ergonomic analysis [22; 23].

Networking threats

Active usage of networks, especially by children and youth, is accompanied by increase of different kind of threats coming from networks. Particularly acute this problem becomes with development and use of social networks. Most active hidden threats (for children) emanating from the computer network, could be stacked in the following classification scheme [24]:

- Viruses attacks.
- Cyber-crime (spamming, carding, phishing, botnets etc.).
- Threats from network-surfing (cyber-bulling, “adult” content, illegal content, on-line violence, disclosure of private information, pay services etc.).

The authors [24] recommend considering the interaction between schoolchildren and students with computer network as the system "Human-technique-environment". In this system, computer network serves as a machine that allows us to consider the impact of the network on a human as a threat coming from the machine. Accordingly, the concept of "network effect" can be revealed through the concept of "operator error and reducing the quality of operator activity', 'impact of computer games" and "Internet addiction".

Threats coming from networks can be classified into the following types: active and passive, overt and hidden, current and deferred.

Using ergonomic approach and methodology, it is possible to evaluate active hidden dangers as a hierarchical set of indicators:

- one integrated (complex) index - the level of danger as a result of a computer network; index is a dimensionless quantity and is on the upper level assessment system;

- three group indicators - levels of hazards caused by virus attacks, cyber-crime or internet surfing; indicators are dimensionless quantities and are at average levels of the system assessments;
- set of individual indicators of the group of one or set of threats; indicators are also dimensionless quantities and are on the lower level of grading system.

3.3 Directions of cyber-security (CS)

From educational domain context, target groups of CS could be classified as follows:

- Students as operators
- Educators
- Children/Youth (in general)
- Population (in general, as social environment for children).

In general, it is reasonable to classify CS challenges into four groups (by their means):

- Technical (T)
- Informational (I)
- Organizational (O)
- Psychological (P).

Informational means could be classified depending on tasks to be solved by users:

- Defend/Secure/Protective Means
- Awareness
- Content
- Learning to use
- Safety
- Resilience
- Avoidance
- Replacement of a human or change the type of a particular activity.

Organizational means (creation, dissemination and control):

- Data Bases
- Mass-Media
- Social Networks
- Education and Training
- Textbooks/Historiography.

Psychological means could be grouped in dependence on inter- and intra-individual level:

- National
- Social
- Group
- Individual
- Cultural
- Cognitive/Intellectual
- Habits.

Human factors and CS

At present our lives are being built more and more around digital networks, with social media as a new social environment [25]. Interventions to these networks pose a real threat to the education security and to the society [26]. In order to keep abreast with the rapidly changing threat landscape and maintain a robust cyber defense, civilian and military organizations at the national and international levels try to adopt their new enhanced policy

accounting new challenges appeared over last two years. It is recognized that cyber defense is a part of the core task of government and collective defense, international law applies in cyberspace and intensifies military cooperation with industry.

The top priority is the protection of the communications systems owned and operated by them. Cyberspace is, and will continue to be a very important part of the battlefield of ideas and civilizations. Lesson learned from Ukraine-Russia conflict allows to argue that most future operations will at least start in cyberspace and operations will most probably be conducted within it during the duration of the conflict, increasing the importance of its control.

While technical/technological solutions are being developed in response to cyber-attacks, there is increasing awareness that the role of human performance and decision making in cyber security is critical to increase the effectiveness of responses to developing threats. Especially it is significant from viewpoint of future manpower, because young people are especially sensitive to external influence and are the most active part of "network population".

The human factor may be the weakest link of a system, but at the same time may also be a powerful resource to detect and mitigate developing threats. Several areas of most critical and urgent needs and the knowledge gaps to address in cyber research agendas of NATO and the nations can be defined as: Psycho-social, Cultural, Conceptual and Organizational dimensions of cyber security.

In this context, the human view regards CS could be a fruitful approach to define tasks, resources and ways of solution the above mentioned challenges.

Human View (constraint)

If a system requires a human interface, then the system must be designed to accommodate the human as a passive and as an active element, creating sub-system for safety both for and from a human.

Human View (functions)

Provide a justification for the allocation of tasks and functions between the humans and machines depending on a human current status and capability.

Human View (role)

Describes the roles that have been defined for the human interacting with the system and their possible changes over mission time (f.e., from simple executor to leader and/or commander) accounting his/her competencies, ability for tasks generation, leadership etc.

Human View (human network)

Team performance impacts, re-allocation, dependencies and communication.

These views should be a basis ergonomically grounded for design and creation of new and safety educational tools.

4. CONCLUSIONS AND OUTLOOK

1. Digital life and activity gives new opportunities for people and new problems in different domains including education.
2. New opportunity of eWorldraises new challenges for ergonomics/human factors as scientific and practical discipline.
3. A human has to balance benefits, disadvantages and risks when in the information space.
4. Threats coming from networks can be classified into the following types: active and passive, overt and hidden, current and deferred.
5. Active hidden threats can be assessed as a hierarchical set of indices: one integrated (complex) index; three group indices; set of individual indicators of the group of one

or set of threats.

6. Cyber Security challenges can be classified into four groups (by their means): technical, informational, organizational and psychological.
7. When designing educational networks, it is proposed to take into Human View regards the cyber security challenges as: constraint, functions, role and human network.

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Text of the article was accepted by Editorial Team 22.04.2016.

ОСВІТНІ МЕРЕЖІ: ПОГЛЯД З БОКУ ЛЮДСЬКОГО ЧИННИКА НА КІБЕР-БЕЗПЕКУ

Буров Олександр Юрійович
доктор технічних наук
Інститут інформаційних технологій і засобів навчання НАПН України, м. Київ, Україна
ayb@iitlt.gov.ua

Анотація. Мережі грають все більш важливу роль в житті і діяльності людини, як в критичних професіях (авіація, енергетика, військова справа тощо), так і в повсякденному житті (домашні комп'ютери, освіта, відпочинок). Взаємодія між людиною та іншими елементами системи людина-машина змінилася, тому що засоби діяльності та середовище співпадають в інформаційному середовищі. Інтеграція систем людина-техніка-середовище досягла нового рівня потреб безпеки. У статті дається аналіз особливостей інформаційного суспільства в ставленні людини і відповідних змінах у сфері людського чинника/ергономіки: (1) інформація стає інструментом, метою, змістом і навколишнім середовищем людської діяльності, (2) вона стає частиною людської природи і це робить людину незахищеною, (3) психо-фізіологічний стан людини стає не тільки основою ефективної роботи, а об'єктом управління і підтримки, а витрати зусиль на безпеку людини повинні бути частиною інформаційного середовища, (4) мережне середовище стає самостійним актором в людській діяльності. Обговорюються проблеми і завдання кібер-безпеки, що виникають по відношенню до людини, яка живе і працює в інформаційному світі, а також види небезпек, що виникають у мережах, і людський вимір проблем кібер-безпеки.

Ключові слова: кібер-безпека;людський чинник/ергономіка;людський вимір.

ОБРАЗОВАТЕЛЬНЫЕ СЕТИ: ВЗГЛЯД СО СТОРОНЫ ЧЕЛОВЕЧЕСКОГО ФАКТОРА НА КИБЕР-БЕЗОПАСНОСТЬ

Буров Александр Юрьевич
доктор технических наук
Институт информационных технологий и средств обучения НАПН Украины, г. Киев, Украина
ayb@iitlt.gov.ua

Аннотация. Сети играют все более важную роль в жизни и деятельности человека, как в критических профессиях (авиация, энергетика, военное дело и т.д.), так и в повседневной

жизни (домашние компьютеры, образование, отдых). Взаимодействие между человеком и другими элементами системы человек-машина изменилась, так как средства и среда совпадают в информационной среде. Интеграция систем «человек-техника-среда» достигла нового уровня безопасности. В статье дается анализ особенностей информационного общества в отношении человека и соответствующих изменениях в сфере человеческого фактора/эргономики: (1) информация становится инструментом, целью, содержанием и окружающей средой человеческой деятельности, (2) она становится частью человеческой природы и это делает человека незащищенным, (3) психофизиологическое состояние человека становится не только основой эффективной работы, а объектом управления и поддержки, а затраты усилий на безопасность человека должны быть частью информационной среды, (4) сетевая среда становится самостоятельным актером в человеческой деятельности. Обсуждаются проблемы и задачи кибер-безопасности, возникающие по отношению к человеку, живущему и работающему в информационном мире, а также виды опасностей, возникающих в сетях, и человеческое измерение проблем кибер-безопасности.

Ключевые слова: кибер-безопасность; человеческий фактор/эргономика; человеческое измерение.

Conflict of interest. The author has declared no conflict of interest.