ACADEMICIAN GLUSHKOV'S LEGACY: HUMAN CAPITAL IN THE FIELD OF CYBERNETICS, COMPUTING, AND INFORMATICS AT IGOR SIKORSKY KYIV POLYTECHNIC INSTITUTE

M.Z. ZGUROVSKY

Abstract. The role of academician Viktor Glushkov in the creation of scientific schools in the field of cybernetics, computing, and informatics at the Igor Sikorsky Kyiv Polytechnic Institute, which became a powerful national center for training specialists in this field, is considered. The significant influence of academician Hlushkov's ideas on the formation of generations of scientists, who to this day continue to build a digital society in Ukraine and far beyond its borders, is shown.

Keywords: academician Viktor Glushkov, cybernetics, computing, informatics, digital society.

INTRODUCTION

Cybernetics as a distinct science was formed in the late 1940s. Its formation and development is closely related to the creation of electronic computing machines (ECM) and their expansion in the USA, Great Britain, and the USSR in the late 1940s and early 1950s. In the Soviet Union, a significant impetus for the further development of cybernetics was the creation of a small electronic computing machine (SECM) in Kyiv in 1947–1948 under the supervision of Academician S.O. Lebediev [1].

The government's decision of 1955 to create a new academic institute in 1957 – the Computational Center of the Academy of Sciences of the Ukrainian SSR – was the consequence of this achievement. The activity of this Center, with its subsequent transformation into the Institute of Cybernetics in 1962, became the initial stage of the development of cybernetics, computer science and informatics based on the combination of fundamental and applied research.

Being a leader of a new scientific field, Academician V.M. Glushkov perceived cybernetics as a science of management using computer technology, communication means, and mathematical methods of real-time processing of large arrays of information of arbitrary nature and content. According to Academician V.M. Glushkov, young scientists and specialists of the senior generation had to actively participate in these studies.

That is why, on the initiative of Academician Glushkov, in 1960, the Kyiv Polytechnic Institute (KPI) started training personnel in computing. And in 1969 at Taras Shevchenko Kyiv State University on the initiative of Viktor Glushkov and the dean of the Faculty of Mechanics and Mathematics, prof. I.I. Lyashko, the faculty of cybernetics was opened, which began training specialists in computational mathematics. Later, the training of personnel in computer technology and computational mathematics was started in a few other universities of Ukraine.

KPI'S CONTRIBUTION TO THE TRAINING OF SPECIALISTS IN THE FIELD OF CYBERNETICS, COMPUTER SCIENCE AND INFORMATICS

On March 16, 1960, the first Department of Computer Science (CS) at the KPI was detached from the Department of Automation and Telemechanics (Head of the Department Prof. Y.I. Greben, Dr.Sci. in Engineering). The first Head of the Department of Computer Science was O.G. Ivakhnenko, then the Associate Member of the Academy of Sciences of the Ukrainian SSR.

O.G. Ivakhnenko can truly be called one of the pioneers of Ukrainian cybernetics. In 1959, he published the first monograph on cybernetics in the Soviet Union [2]. Several generations of future specialists in cybernetics and informatics studied the materials of this monograph. O.G. Ivakhnenko was always a generator of ideas, which he generously shared with his students. His scientific school includes 20 doctors and more than 100 candidates of sciences, whom he trained personally. Ivakhnenko's first students were Acad. V.M. Kuntsevich, professors V.I. Ivanenko, V.I. Kostyuk, O.A. Pavlov, Yu.P. Zaichenko and other outstanding scientists who later started their own scientific schools and made a significant contribution to the development of cybernetics.

Some of Ivakhnenko's ideas of the 1960s and 1970s were several decades ahead of the state of science at that time. Thus, the well-known Group method of data handling (GMDH) [3] became the first method of deep learning, which was ahead of classical developments in the field of intelligent data analysis, forecasting, modeling of complex systems, optimization, pattern recognition and artificial intelligence by several decades.

In 1960, the International Congress of the International Federation of Automatic Control (IFAC) was held in Ukraine [4]. O.G. Ivakhnenko, who was one of the organizers of the event, invited the founder of cybernetics, the outstanding American scientist Norbert Wiener to come to Kyiv and take part in the Congress. Norbert Wiener gratefully accepted this invitation, spoke at the IFAC Congress and discussed current problems of cybernetics with O.G. Ivakhnenko in an informal and positive environment.

Professor K.G. Samophalov, Associate Member of the Academy of Sciences of Ukraine, headed the Department of Computer Science at the KPI from 1961 to 1990. Later, Prof. G.M. Lutsky, Dr.Sci. in Engineering, continued his successful activity. Over 50 years of their fruitful work, almost 50 Dr.Sci. and more than 350 PhDs, more than 8.000 specialists have been trained; they have formed several generations of specialists in the field of computer science, cybernetics, and informatics.

A new Department of Engineering Cybernetics of KPI, established in 1969 by Prof. V.I. Kostyuk, Dr.Sci. in Engineering, played a significant role in the fur-

ther training of specialists in this field. Specialists in engineering cybernetics and robotics were trained at this Department. In total, 170 Dr. Sci., 110 PhDs, 6.200 specialists in engineering cybernetics, ACS and robotics were trained at the EC Department.

During the heyday of research in the field of cybernetics, the abovementioned Department of Automation and Telemechanics, headed by Prof. A.A. Krasnoproshyna, Dr.Sci. in Engineering, continued to work actively. Somewhat later, it was renamed the Department of Automation and Control in Engineering Systems (ACES). A scientific school was formed at the department, which conducted research in the field of industrial automation and data transmission; professors Yu.P. Zhurakovsky, G.B. Serdyuk, L.M. Kompanets, Dr.Sci. in Engineering, and other researchers were its members. Later, the ACES Department focused on research in the field of informatics, paying the main attention to the development and operation of information systems and technologies. During the entire period of the Department's existence, three Dr.Sci. and twenty PhDs, and over 5 thousand specialists in industrial automation and information systems and technologies were trained.

On Order of the Ministry of Higher and Secondary Special Education of the Ukrainian SSR No. 278 of October 29, 1985 "On Changes in the Structure of Higher Educational Institutions of the Ministry of Higher Education of the Ukrainian SSR in 1985", the above-mentioned departments were merged into the Faculty of Informatics and Computer Science (FICS). Prof. A.A. Krasnoproshyn, Dr.Sci in Engineering, became the first dean of the Faculty.

Since the early 1970s, the era of practical development of automated control systems (ACS) began, whose ideological foundations were formulated by A.I. Kitov and V.M. Glushkov in 1959–1962 [5]. As a result, in 1973, for the first time in Ukraine, the training of specialists in the specialty of ACS was initiated at the Department of Engineering Cybernetics.

Leading professors of the Department of Engineering Cybernetics: Acad. O.G. Ivakhnenko, Acad. V.I. Skurykhin, Acad. V.M. Kuntsevych, Prof. V.I. Kostyuk, Prof. V.V. Azhogin, Prof. Yu.P. Zaichenko, Prof. O.A. Pavlov, Assoc. Prof. M.K. Pechurin, Assoc. Prof. V.M. Tomashevsky and others participated in the formation of this new and future-oriented specialty.

It is worth noting the significant role of Associate Professor P.I. Akinin in the organization and formation of a new Department of Automated Production Control Systems (APCS), by detaching it from the Department of Engineering Cybernetics in 1978. Subsequently, Professor O.A. Pavlov headed the Department of APCS, later the Department of Automated Data Processing and Control Systems (ADPCS), who made a significant contribution to the development of the ACS specialty over the years. The Associate Professor V.O. Tykhonov was the Deputy Head of the Department; he assured the activity of the Department and development of methodological support of specialty at a high level. At that time, Associate Professors S.F. Telenyk and S.M. Grysha worked fruitfully at the Department and made a significant contribution to the development of the ACS specialty. The department trained 8 Dr.Sci., 50 PhDs, over 6,000 specialists in the ACS sphere.

The establishment of the Branch of the Department of ADPCS at the Cybernetic Center of National Acasdemy of Sciences of Ukraine, where Academicians

of the NAS of Ukraine I.V. Sergienko (Head of the Branch), V.K. Zadiraka, A.O. Chykriy worked, as well as work of Academicians of the NAS of Ukraine N.Z. Shor, A.A. Letichevsky, V.I. Skurikhin at the Department of ADPCS, contributed to highly creative and innovative level of learning [6]. The transfer of the experience of scientific and practical work by prominent scientists of Ukraine, followers of V.M. Glushkov's work, to students, remained in their memory forever and significantly contributed to their professional growth.

The graduation of experts in the ACS sphere lasted for almost 20 years. Over the years, the foundation of the scientific school in the field of engineering cybernetics, ACS and informatics has been created; the leading scientists of the university, in particular, Professors V.I. Kostyuk, K.G. Samofalov, V.V. Azhogin, M.Z. Zgurovsky, O.A. Pavlov, G.M. Lutsky, Yu.P. Zaichenko made a significant contribution to it.

Scientific research in the field of information technologies in KPI became the basis for the development of the latest systems of automation, promising project and technological solutions. Scientists of the Cybernetic Center of the NAS of Ukraine: I.V. Sergienko, Director of the Institute of Cybernetics and Head of the Branch of the Department of Automated Data Processing and Control Systems, Academicians of the NAS of Ukraine I.M. Kovalenko, V.M. Kuntsevych, V.S. Mykhalevych, O.V. Palagin, Associate Member of the NAS of Ukraine B.M. Malynovsky, Prof. V.P. Derkach, Dr.Sci. in Engineering, and others made a significant contribution to the formation of the scientific school in KPI.

In 1990, the Faculty of Applied Mathematics (FAM) was formed at the KPI on the basis of the departments of Applied Mathematics, Mathematical Methods of Systems Analysis and Specialized Computing Systems, by its detaching from the Faculty of Informatics and Computer Science (FICS). Famous scientists M.Z. Zgurovsky, I.M. Kovalenko, K.G. Samofalov, Yu.L. Daletsky, Ye.M. Vavilov, O.A. Molchanov, O.A. Pavlov, V.P. Tarasenko participated in the creation of the FAM and its formation in different years.

The first Dean, the founder of the faculty was I.M. Kovalenko, Academician of the NAS of Ukraine, a well-known specialist in the field of probability and random processes theory. The next deans of the faculty – Prof. O.A. Molchanov and Prof. I.A. Dychka – continued the work of I.M. Kovalenko.

Currently, the FAM includes three Departments: Applied Mathematics; System Programming and Specialized Computer Systems; Computer Systems Software.

The Department of Applied Mathematics (AM) was established in 1973 by its detaching from the Department of Computer Science of the FICS. Prof. Ye.M. Vavilov was the first Head of the Department. Further, for 36 years, Professor O.A. Molchanov, Dr.Sci. in Engineering, was the Head of the Department; nowadays, Professor O.R. Chertov, Dr.Sci. in Engineering, heads the Department.

The Department of AM trains specialists in the specialty 113 Applied Mathematics, Educational Program "Data Science and Mathematical Modeling", which covers the following areas: development of mathematical methods for Data Mining and Big Data; Machine Learning methods; Computer information technologies for knowledge acquisition using Computational Intelligence methods.

The Department of System Programming and Specialized Computer Systems (SPSCS) was established in 1990 by its detaching from the Department of

Computer Science (FICS). Professor V.P. Tarasenko, Dr.Sci. in Engineering, became the first Head of the newly created Department. Nowadays, Professor V.O. Romankevych, Dr.Sci. in Engineering, heads the Department of SPSCS.

The Department of SPSCS trains specialists in the specialty 123 "Computer Engineering", Educational Program: System Programming and Specialized Computer Systems, which covers the areas of designing, development, testing, implementation and operation of computer systems, networks and their components; designing and modernization of specialized computer systems, their object and functional orientation; designing, development, testing, implementation and support of system software.

The Department of Computer Systems Software Support (CSSS) was established in 2009 by its detaching from the Department of System Programming and Specialized Computer Systems. Professor I.A. Dychka, Dr.Sci. in Engineering, became the first Head of the Department. Nowadays, Associate Professor Ye.S. Sulema, Dr.Sci. in Engineering, heads the Department.

The Department of CSSS trains specialists in the specialty 121 "Software Engineering", Educational Program "Software for multimedia and information retrieval systems", which covers the following areas: development and use of object-oriented engineering methods of projecting and designing complex software systems; development, testing, implementation and support of software for intelligent search systems (Information Retrieval, Data Mining, Text Mining); designing software methods for efficient processing, storage and protection of large data, including multimedia data (Multimedia and Mulsemedia).

Since 2010, the FAM is a member of the European Consortium of Mathematics in Industry, ECMI. The faculty trained 11 Dr.Sci., 46 PhDs and over 4,000 specialists in computer engineering, software engineering, data analysis and mathematical modeling.

The FAM graduates hold leading positions in national and foreign IT companies, including scientific subdivisions of Global Logic, Epam, Data Art, Ajax Systems, Samsung, Microsoft, etc.

COOPERATION OF KPI AND NAS OF UKRAINE IN THE SPHERE OF TRAINING SPECIALISTS IN THE FIELD OF CYBERNETIC SECURITY AND SYSTEMS ANALYSIS

One of the bright pages in the history of the KPI scientific school of cybernetics, computer science and informatics is the development of applied mathematics, information and cyber security at the Physical and Technical Institute (PhTI) of KPI [7]. The Institute was founded in 1995 on the initiative of the President of the National Academy of Sciences of Ukraine, Academician B.E. Paton and then Minister of Education of Ukraine, Academician M.Z. Zgurovsky in order to train academic personnel in the field of applied physics and applied mathematics for the National Academy of Sciences of Ukraine. O. M. Novikov, Associate Member of the NAS of Ukraine, is the PhTI Director during all these years.

It was the educational focus on applied mathematics that served as the basis for the establishment of two new departments at the PhTI in 1999–2000, namely,

Information Security (O.M. Novikov, Associate Member of the National Academy of Sciences of Ukraine was the first Head of the Department) and Mathematical Methods of Information Protection (Prof. M.M. Savchuk, Dr.Sci. in Physics and Mathematics was the first Head of the Department), the new specialty "Security of information and communication systems" and the specialization "Mathematical methods of cryptanalysis" within the specialty "Applied Mathematics".

The group of scientists headed by O.M. Novikov, Dr.Sci. in Engineering, trained in the scientific school of Academician M.Z. Zgurovsky, became the basis of the Department of Information Security, and the scientists from the scientific school of cryptography of the Institute of Cybernetics of the National Academy of Sciences of Ukraine, headed by Academician I.M. Kovalenko, formed the basis of the Department of Information Protection. Prof. Ye.A. Machusky, Dr.Sci. in Engineering, Prof. O.Ye. Arkhipov, Dr.Sci. in Engineering, Prof. D.V. Lande, Dr.Sci. in Engineering, prof. M.M. Savchuk, Associate Member of the NAS of Ukraine, Prof. M. Yu. Kuznetsov, Associate Member of the NAS of Ukraine, Prof. A.B. Kachynsky, Dr.Sci. in Engineering, Prof. A.M. Kudin, Dr.Sci. in Engineering, and others made a significant contribution to the development and strengthening of the sphere of information and cyber security in KPI.

The specialty "Informatics" within the framework of the "Applied Mathematics" educational sphere was established in the first years of the PhTI formation, which later gained an impetus within the educational programs "Mathematical methods of cryptographic protection of information", "Mathematical methods of modeling, pattern recognition and computer vision".

In 2021, the Department of Mathematical Modeling and Data Analysis was formed within the PhTI structure (Prof. N.M. Kussul, Dr.Sci. in Engineering is the Head of the Department). The scientists of the Institute of Space Research of the Cybernetic Center of the National Academy of Sciences of Ukraine, scientists and professors of the PhTI participated in the foundation of the Department.

Employers consistently give a high assessment of the qualifications of graduates in applied mathematics, information and cyber security of scientific schools of PhTI. In particular, according to the rating of the "Forbes Ukraine" magazine, PhTI of KPI was recognized as the best faculty of Ukraine in the nomination "STEM disciplines" in 2021.

For more than 20 years of activity, the teams of the Department of Information Security and the Department of Mathematical Methods of Information Protection, and later the Department of Mathematical Modeling and Data Analysis of PhTI, trained more than 2,000 specialists in applied mathematics, information and cybernetic security, 10 PhD and doctoral theses were defended. Teams of scientists received two State Prizes of Ukraine in the field of science and technology and the Prize of the President of Ukraine for young scientists; three PhTI scientists, Prof. M.M. Savchuk, Prof. M.Yu. Kuznetsov and Prof. O.M. Novikov were elected Associate Members of the National Academy of Sciences of Ukraine.

In September 1988, on the initiative of Academician V.S. Mykhalevych, Professors M.Z. Zgurovsky and Yu.L. Daletsky, and with the support of the Minister of Higher and Secondary Special Education V.D. Parkhomenko, the training of system analysts was started in Ukraine. For this purpose, the Department of Mathematical Methods of Systems Analysis (MMSA) was detached from

the Department of Applied Mathematics of the Faculty of Control Systems (FCS) of KPI as a department of targeted personnel training for institutes of the Academy of Sciences of the Ukrainian SSR. The Department trained students in the specialty "Applied Mathematics" with the specialization "Systems Analysis and Control". Prof. M.Z. Zgurovsky, Dr.Sci in Engineering, headed the Department.

The group of Professors of the Department of Applied Mathematics of KPI: Yu.L. Daletsky, Yu.V. Bohdansky, V.G. Bondarenko, S.M. Paramonova, N.D. Tsvyntarna, and scientific group of Professor M.V. Zgurovsky whose members were V.D. Romanenko, O.M. Novikov, O.S. Makarenko, O.M. Selin, P.I. Bidyuk, Yu.M. Selin formed the nucleus of the MMSA Department.

The MMSA Department became the first and basic department in Ukraine for training specialists in the field of systems analysis and made a significant contribution to the development of the new "Systems Analysis" specialty.

For the first time in Ukraine, new specialties "Intelligent decision-making systems", "Decision-making systems and methods", "Social informatics", "Systems analysis", "Computer science" were introduced into the educational process of the MMSA Department, and new educational and professional programs "Systems Analysis and Control", "Systems Analysis of the Financial Market", "Systems and Methods of Artificial Intelligence" were developed and accredited.

Professors P.I. Bidyuk, Yu.L. Daletsky, V.Ya. Danilov, Yu.P. Zaichenko, M.Z. Zgurovsky, P.O. Kasyanov, V.Ya. Melnyk, N.D. Pankratova, V.D. Romanenko actively participated in the organization of the educational process, in the preparation of textbooks and teaching aids.

A series of new textbooks and monographs on systems analysis, data mining, and artificial intelligence by M.Z. Zgurovsky, N.D. Pankratova, and Yu.P. Zaichenko, were prepared and printed, they were used for more than 20 years to train system analysts in Ukraine and abroad.

On the initiative of A.I. Kukhtenko, Academician of the National Academy of Sciences of Ukraine, the Research Institute of Interdisciplinary Studies (RIIDS) was established at KPI in 1990 based on the research sector of the MMSA Department. The main focus of the RIIDS activity was to conduct large-scale exploratory and fundamental research of an interdisciplinary nature in such scientific areas as mathematical, physical, chemical and engineering methods of environmental protection; artificial intelligence systems; theory of fractals and its application in physics, chemistry, materials science; catastrophe theory and bifurcation, synergy and "chaos", and others.

36 Dr.Sci. and 105 PhDs, 4,300 specialists in the field of systems analysis and information technologies were trained at the MMSA Department during 35 years of its activity.

Researchers of the Department P.I. Bidyuk, Yu.P. Zaichenko, M.Z. Zgurovsky, P.O. Kasyanov, N.D. Pankratova, V.D. Romanenko became laureates of the State Prizes of Ukraine in the field of science and technology. M.Z. Zgurovsky and Yu.L. Daletsky were elected Academicians of the National Academy of Sciences of Ukraine for their fundamental developments in the field of science and technology, and V.S. Melnyk and N.D. Pankratova were elected Associate Members of the National Academy of Sciences of Ukraine.

In 1997, by Resolution of the Cabinet of Ministers of Ukraine No. 1351, dated December 2, 1997, the Institute of Applied Systems Analysis (IASA) under

the dual subordination of the Ministry of Education and Science of Ukraine and the National Academy of Aciences of Ukraine, was established on the basis of the MMSA Department of KPI and the departments of "Numerical Optimization Methods" (Head of the department B.M. Pshenychny, Acadelician of the National Academy of Sciences of Ukraine) and "Applied Nonlinear Analysis" (Head of the Department Prof. V.I. Ivanenko, Dr.Sci. in Engineering) of the Institute of Cybernetics of the National Academy of Sciences of Ukraine [8].

The foundation of the Institute of dual subordination resulted from the implementation of the concept of science and education integration. The integration of educational and scientific areas in IASA provided an opportunity to carry out unique research and implement the methodology of training system analysts of a practical orientation. M.Z. Zgurovsky, Academician of the National Academy of Sciences of Ukraine, became the Director of the Institute, and later, its academic adviser. Since 2018, Prof. P.O. Kasyanov, Dr.Sci. in Physics and Mathematics, is the IASA Director.

The main goal of IASA foundation is to carry out innovative educational activities at various levels of higher education and areas of scientific research, to develop the methodology of systems analysis, mathematical methods and software tools for conducting comprehensive analysis, forecasting and solving the state's social, economic, ecological, and technological problems, meeting social, economic and cultural needs of society, achievement of innovative development of the country.

Currently, the IASA educational and scientific structure includes three Departments: Mathematical Methods of Systems Analysis; System Design; Artificial Intelligence, which train highly qualified specialists in the specialties: 124 Systems Analysis and 122 Computer Sciences, and three scientific departments of the National Academy of Sciences of Ukraine: System Mathematics; Mathematical Methods of Systems Analysis; Applied Nonlinear Analysis; they perform fundamental and applied scientific research and participate in the educational process by delivering lectures, conducting practical classes, giving academic advises to graduate students, supervising bachelor's and master's theses. The Institute has subdivisions of pre-university and course training as well.

At the current stage, the Department of Mathematical Methods of Systems Analysis traines system analysts capable to design, create and operate complex man-machine aggregates for analysis, forecasting, control and design of dynamic processes in macroeconomic, technical, technological, security, environmental and financial systems. The MMSA graduates work in the analytical subdivisions of state administration bodies, special services, large companies, data centers, other institutions and enterprises, whose activities are based on modern system analytics.

The Department of System Design trains specialists in the modern theory and practice of building and operating intelligent computing environments (application of service-oriented computing and architectures (SOA and SOC), distributed grid, cloud, fog, and serverless computing in computer processing of big data and automated design; construction of multi-agent systems and infrastructures; use of SOC and SOA in the Internet of Things). Graduates are in demand by scientific centers, IT companies, enterprises involved in the support and maintenance of modern information systems and technological complexes.

The Department of Artificial Intelligence trains specialists in the field of artificial intelligence and intelligent data analysis, computer vision, text and voice information processing, intelligent medical diagnostic systems, and intelligent defense systems.

The Institute of Applied Systems Analysis publishes the international magazine "System Research and Information Technologies" [9], which is included in the register of specialized scientific publications of Ukraine under category "A", the published articles are indexed in the Scopus scientometric database. Staff members of the Institute are members of a number of editorial boards of periodical professional Ukrainian and foreign editions.

The UNESCO International Chair "Higher Technical Education, Applied Systems Analysis and Informatics" [10] operates on the IASA basis, whose main purpose is the implementation of a comprehensive research program in the field of higher technical education, methods of applied systems analysis, advanced information technologies and their application in the educational system, analysis of complex systems of various nature, in particular, socio-economic, ecological, technical and others.

The Institute conducts active international activities. According to the Resolution of the Presidium of the National Academy of Sciences of Ukraine dated 29/04/2015, No. 118 "About the distribution of responsibilities among the members of the Presidium of the National Academy of Sciences of Ukraine", the Scientific Director of IASA M.Z. Zgurovsky, Academician of the National Academy of Sciences, is responsible for the implementation of relations with the Committee on Data for Science and Technology (CODATA), United Nations Industrial Development Organization (UNIDO). He maintains relations with the "International Scientific Council" (ISC) together with the President of the National Academy of Sciences of Ukraine.

For more than a quarter of a century, IASA trained more than 6000 highly qualified system analysts who successfully work in Ukraine and 50 countries around the world. IASA scientific schools trained 2 academicians, 2 associate members of the National Academy of Sciences of Ukraine, more than 50 Dr.Sci. and 130 PhDs.

A powerful scientific base and personnel potential made it possible for KPI in cooperation with the National Academy of Sciences of Ukraine to create the Faculty of Physics and Mathematics (FMF) in 1996 [11]. The faculty was headed by an outstanding scientist, academician of NASU, Hero of Ukraine V.G. Baryakhtar. Since 2007, his case has been continued by Doctor of Technical Sciences, Prof. V.V. Vanin.

At different times, scientists with world-famous names worked here and headed the departments of fundamental training: academicians I.V. Skrypnyk, A.M. Samoilenko, V.I. Loktev, corresponding member of the National Academy of Sciences of Ukraine V.Ya. Valakh, professors A.V. Pavlov, F.P. Yaremchuk, V.V. Buldygin, Yu.I. Horobets, N.O. Virchenko, O.I. Klesov, V.M. Gorshkov, M.M. Kukharchuk, I.V. Beiko and others.

The faculty trains specialists in fundamental and applied problems in various branches of modern mathematics and physics — from the study of aerodynamics and hydrodynamics to the physics of the atomic nucleus and elementary particles using methods of mathematical and computer modeling, analysis and forecasting

of complex processes and natural phenomena to practical applications of modern mathematical methods and tools in the field of economics, finance business and national security.

There are six departments within the FMF: general physics and modeling of physical processes; mathematical analysis and probability theory; general physics; mathematical physics and differential equations; descriptive geometry; engineering and computer graphics.

Over the 27 years of its work, FMF has trained 21 doctors, 53 candidates of science, 2285 specialists in modern areas of mathematics, physics, mathematical and computer modeling and their applications in various fields of science, national economy and national security of Ukraine. Scientists of the faculty have been awarded two state prizes in the field of science and technology.

In 2002, the educational and scientific Institute of Telecommunication Systems (ITS) was established in KPI [12] as a logical result of the development of the Department of Telecommunications, which, since 1993, trained specialists and designed telecommunication networks for large computing complexes and control facilities in ACS systems.

Nowadays, ITS includes three departments: Department of Electronic Communications and Internet of Things (ECIT); Department of Information Technologies in Telecommunications (ITT); and Department of Telecommunications (TC).

Educational and scientific work of the ITS is carried out in cooperation with scientific institutions and companies from Ukraine, USA, Great Britain, France, Germany, China, Poland, etc. Currently, the main ITS partners are the following large companies: Lifecell, ALCATEL-LUCENT, HUAWEI TECHNOLOGIES (China), Kyivstar, Ukrtelecom, Vodafone, Bankomzvyazok, Data Group, NOKIA, etc.

Over the years of its activity, the Institute of Telecommunication Systems has trained 12 Dr.Sci. and 42 PhDs, more than 2.500 specialists in the field of telecommunications; 15 ITS scientists were awarded the title of laureates of state prizes of Ukraine in the field of science and technology; Prof. M. Yu. Ilchenko, Dr.Sci. in Engineering, was elected academician of the National Academy of Sciences of Ukraine.

CONCLUSIONS

1. Academician Viktor Glushkov left an outstanding legacy in the field of training high-quality human capital in the field of cybernetics, computing and information science. Over the past 63 years, the legacy of the KPI has been replenished with three educational and scientific institutes, four faculties, and thirty-one departments. In this area, the KPI has trained more than 61.300 computer engineers, 195 Doctors of Sciense, 1.123 PhD's, four Academicians and seven Corresponding Members of the National Academy of Sciences of Ukraine. 59 KPI scientists were awarded by the title of Laureate of State Prizes of Ukraine in the field of science and technology.

2. Diligent and talented youth who studies and works in many universities, scientific institutions and leading companies of Ukraine and the world, is a follower of Academician Glushkov's achievments. KPI students made a significant contribution to strengthening the image of academician Glushkov's

scientific school at the national and international levels. They won more than 170 awards at Olympiads in mathematics, cyber security, informatics in Ukraine and abroad.

3. Among the significant achievements of students there are 41 awards (including 8 Grand Prix) at the World Mathematical Olympiads (IMC), the World Team Programming Championship (ICPC) according to the ACM version in London, Tokyo, Prague, Warsaw, Bucharest, Munich, Skopje (Macedonia), Blagoevgrad (Bulgaria), etc. Students O. Rybak, A. Mellit, S. Torba, M. Vlasenko, A. Gogoliev, K. Vedensky, B. Nagirnyak, B. Borysyuk, B. Baydenko, O. Slyusarenko, K. Marovetska, K. Matviyiv, V. Mykhaylovsky, Ye. Polishchuk and others were multiple winners of mathematics and informatics Olympiads in different years.

4. Since 2012, a series of victorious performances at the world championships among "white" hackers in the CTF version (capture the flag) of DCUA team supervised by Associate Professor M.I. Ilyin, Ph.D., was added to the bright victories of the students [13]. In 2016, the team won the title of World Champions among "white" hackers among more than 12 thousand participating teams.

5. Currently, students and followers of Academician Glushkov actively build a digital country and its economy, making scientific breakthroughs and training new generations of talented youth, increasing the defense capability of our state.

REFERENCES

1. *Encyclopedia of cybernetics in 2 volumes*, (in Ukrainian); editor: V.M. Glushkov (chief editor); Academy of Sciences of the Ukrainian SSR; Vol. 2. Kyiv: URE ed., 1973, 570 p.
2. A.G. Ivakhnenko, *Engineering cybernetics*, (in Russian). Kyiv: Technika Publ. house, 1959.
3. A.G. Ivakhnenko, "Group method of data handling – a competitor of the stochastic approximation method," *Automatics*, no. 3, pp. 58–72, 1968.
4. *IFAC – International Federation of Automatic Control*, (in Ukrainian). Available: https://www.ifac-control.org/about/history
5. O. Gavva, *Integrated automated control systems: history and development potential*, (in Ukrainian). Available: http://ogas.kiev.ua/perspective/integrovani-avtomatyzovani-systemy-upravlinnya-istoriya-ta-perspektyvy-rozvytku-504
6. *Department of Information Systems and Technologies*, (in Ukrainian). Available: https://ist.kpi.ua/uk/history/
7. *Physical and Technical Institute of Igor Sikorsky KPI*, (in Ukrainian). Available: https://kpi.ua/ipt
8. *Institute of Applied Systems Analysis of the Ministry of Education and Science of Ukraine and the National Academy of Sciences of Ukraine at Igor Sikorsky KPI*, (in Ukrainian). Available: https://kpi.ua/institute/ipsa
9. *Systems Research and Information Technologies (academic journal)*, in Ukrainian. Available: http://iasa.kpi.ua/iasa-journal
10. *UNESCO International Chair "Higher Engineering Education, Applied Systems Analysis and Informatics"*, (in Ukrainian). Available: https://kpi.ua/web_unesco
11. *Physics and mathematics faculty of KPI named after Igor Sikorsky*. Available: https://fmf.kpi.ua/

12. *Institute of Telecommunication Systems of NTUU "Ihor Sikorsky KPI".* Available: https://kpi.ua/en/faculty/its.html/
13. "Ukrainian "white" hackers beat 12,000 teams in the world ranking," (in Ukrainian), *Ukrinform.* Available: https://www.ukrinform.ua/rubric-technology/2164581-ukrainski-bili-hakeri-obijsli-12-tisac-komand-u-svitovomu-rejtingu.html/

INFORMATION ON THE ARTICLE

Michael Z. Zgurovsky, ORCID: 0000-0001-5896-7466, National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", Ukraine, e-mail: zgurovsm@hotmail.com

СПАДЩИНА АКАДЕМІКА ГЛУШКОВА: ЛЮДСЬКИЙ КАПІТАЛ У СФЕРІ КІБЕРНЕТИКИ, ОБЧИСЛЮВАЛЬНОЇ ТЕХНІКИ ТА ІНФОРМАТИКИ В КИЇВСЬКОМУ ПОЛІТЕХНІЧНОМУ ІНСТИТУТІ ІМ. ІГОРЯ СІКОРСЬКОГО / М.З. Згуровський

Анотація. Розглянуто роль академіка Віктора Глушкова у створенні наукових шкіл в галузі кібернетики, обчислювальної техніки та інформатики в Київському політехнічному інституті ім. Ігоря Сікорського, який став потужним національним центром підготовки фахівців у цій сфері. Показано значний вплив ідей академіка Глушкова на формування поколінь учених, які дотепер продовжують розбудовувати цифрове суспільство в Україні та далеко за її межами.

Ключові слова: академік Віктор Глушков, кібернетика, обчислювальна техніка, інформатика, цифрове суспільство.