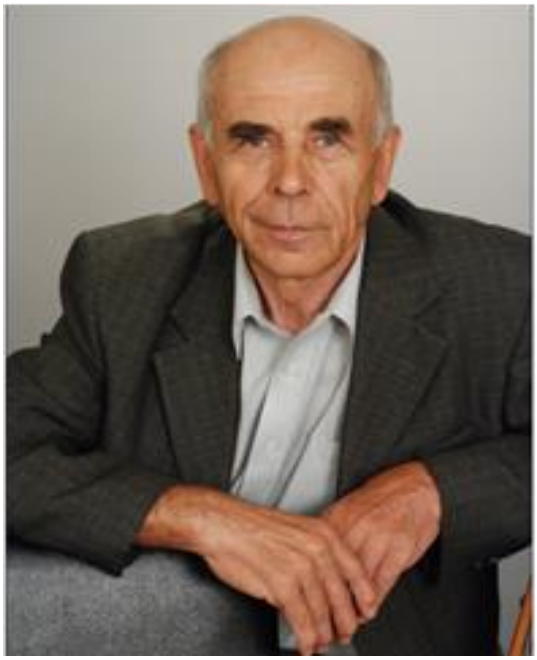
The Creative Heritage of Valentin Pavlovich Tsymbal

Rybenko I.A.



On February 14, 2021, at the age of 87, Professor-Consultant of the Department of Applied Information Technologies and Programming, Doctor of Technical Sciences, Professor and Full Member of the International Academy of Sciences of Higher Education, Honored Scientist of the Russian Federation, Honorary Professor of Kuzbass, Valentin Pavlovich Tsymbal passed away.

Valentin Pavlovich was an outstanding scientist of Russia and the former USSR. He was the pride of our university, he had great authority among colleagues and was deeply respected by the scientific community. Valentin Pavlovich was distinguished by traits such as amazing wise and kind, he had broad erudition, deep decency, spiritual generosity, a positive attitude and inexhaustible optimism. He made an invaluable contribution to the development of metallurgy, became one of the founders of the use of mathematical modeling methods, as well as the theory of self-organization when improving existing and creating new metallurgical processes and units. Most notably, he always believed that the purpose and duty of a scientist is to pass on the baton of knowledge to the next generations.

The scientific concepts and achievements of Valentin Pavlovich and his many students formed the basis for the creation of the scientific school "Mathematical modeling, the creation of applied instrumental systems and new metallurgical processes and units on the principles of self-organization."

Tsymbal Valentin Pavlovich was born in Kazakhstan in the city of Karaganda on August 2, 1933. In 1943, the family of Valentin Pavlovich moved to the city of Temirtau, where in 1951 he graduated from school, after which he entered the Siberian Metallurgical Institute at the metallurgical faculty (specialty "Metallurgy of ferrous metals ") in Novokuznetsk. In 1956, he graduated with honors from the institute, and was assigned to the Kazakh Metallurgical Plant in Temirtau, where his parents lived. At this plant, he worked for 4 years as an assistant foreman, steelmaker, shift supervisor, while receiving a good school of industrial relations and knowledge of real metallurgy. In 1960 he entered graduate school at the newly organized department “Automation of metallurgical production.” In 1963, under the leadership of Professor P.M. Maslovsky, he defended his Ph.D. thesis on "Modeling the process of decarburization of steel in an open-hearth furnace using electronic mathematical machines", and in 1973 - his doctoral thesis on "Research and control of the steelmaking process using mathematical models using examples of conventional and intensive smelting”

In 1996, he was elected a corresponding member of the Siberian branch of the Academy of Sciences of the Higher School, and in 1997 - a full member of the International Academy of Sciences of the Higher School. Also in 1996, he was awarded the honorary title "Honored Scientist of the Russian Federation", and in 2006 - the title "Honorary Professor of Kuzbass." The multifaceted activity of Valentin Pavlovich was deservedly marked with high awards. He was awarded the Order of the Badge of Honor, the medals For Valorous Labor, For Labor Distinction, For Special Contribution to the Development of Kuzbass, III Degree, 70 Years of the Kemerovo Region, For Faith and Goodness, For Service Kuzbass and others. But most importantly, he won the deep respect of his many students and colleagues.

On December 16, 1980 Valentin Pavlovich founded the Department of Mathematical Support and Computers in Metallurgy, which was later renamed the Department of ITM - Information Technologies in Metallurgy. He became the first head of this department and headed it for more than 30 years until 2012. In May 2015, the Department of Information Technologies in Metallurgy, as a result of merging with the Department of Informatics and Management Systems, became the Department of Applied Information Technologies and Programming, where Valentin Pavlovich worked as a professor-consultant.

The main staff of the department teachers in the period 1980-1986 was the following: Doctor of Technical Sciences, Professor V.P. Tsymbal; candidates of technical sciences, associate professors V.N. Buintsev, A.F. Sakun., A.G. Padalko, S.P. Mochalov, N.A. Kalinogorsky,

S.N. Kalashnikov, G.B. Melnik, S.A. Shipilov, and E.I. Livertz.

Since 1986, the teaching staff of the department began to expand at the expense of its graduates: I.A. Rybenko, S. Yu. Krasnoperov, V. I. Kozhemyachenko, L. A. Ermakova, V. Yu. Klimov, M. B. Malinov, M. M. Milovanov, I. A. Kuksov, A. E. Shchendrikov, P. A. Sechenov and others, most of whom defended their Ph.D. theses, and also made a significant contribution to the work of the department and the university

For the first time in the country, the ITM department, headed by Valentin Pavlovich, began training broad-based specialists with fundamental training in the field of metallurgy, information technology, programming, mathematical modeling, research and optimization. Since 1981, the department has been training engineers in the specialization "Mathematical support and use of computers in metallurgy" within the specialty "Metallurgy of ferrous metals," and since 1999 - in the specialty "Information systems and technologies." In 2009, the first enrollment of students was made for a new specialty, "Software for computer technology and automated systems," which then became the direction of training, "Informatics and computer technology." on the initiative of V.P. Tsymbala. For the first time in Kuzbass, a magistracy was opened in the specialty "Metallurgy of ferrous metals." Many graduates of the ITM Department successfully work in various cities of Russia and abroad (USA, Canada, Australia, Germany, Czech Republic, etc.).

The main scientific direction of the department since 1980 was "Mathematical description and optimization of metallurgical processes, the development of automated research and training systems and instrumental systems for modeling," the head of which was Valentin Pavlovich Tsymbal. Within the framework of this direction, more than 30 state budgetary and contractual research projects were carried out, more than 20 objects of equipment and technologies were introduced into production and the educational process. Among them there are 15 training complexes, an automated system for adjusting thermal and technological modes for open-hearth KMK furnaces, a system for optimizing the purge of converter smelting for ZSMK furnaces, and software products for computers in the form of training systems have been created, such as "Converter," "Stalevar of open-hearth furnaces," "Stalevar Chipboard," “Agglomerate,” and others.

Since 1995, a new scientific direction "Models and mechanisms of self-organization" began to develop at the department, and then the scientific school "Mathematical modeling, creation of applied instrumental systems and new metallurgical processes and aggregates based on the principles of self-organization" was created, the head of which was Valentin Pavlovich. Within the framework of the scientific school, a team of scientists and teachers effectively working at the department of PITiP was formed: I.A. Rybenko, V.N. Buintsev, V.I. Kozhemyachenko, S.N. Kalashnikov, L.A. Ermakova, A.A. Olennikov, P.A. Sechenov, as well as graduate students E.A. Martusevich and D.Yu. Belaventseva.

Under the leadership of Valentin Pavlovich, for the first time in the world, scientists of the department, ‘Metallurgy,’ created a concept and a set of models for a fundamentally new metallurgical process and a jet-emulsion-type unit (SEM) based on the principles of synergetics and nonequilibrium thermodynamics. The most important of the proposed and constructively implemented principles and solutions are: the creation of a highly dispersed gas suspension, the organization of the forced motion of a two-phase medium in a closed volume under pressure, which made it possible to create dynamic dissipative structures that play the role of a kind of localized chambers. The central role of the stimulus for the movement of the two-phase medium is played by the reactor-oscillator with gas-dynamic blocking of the channel, which makes it possible to push the two-phase medium through the vertical column reactor and other apparatus of the SR unit. The advantages of the new process and unit of the SR type are: high rates of heat and mass transfer processes (100 - 200 times higher than in the converter); small size and material

consumption of units (10 - 20 times less than in traditional metallurgy); low end-to-end energy consumption (13 - 15 GJ / t); high environmental friendliness and waste-free technologies, the use of various kinds of dusty materials and waste in the charge; manageability, versatility, mobility; the possibility of smelting various metals and implementing a new concept for creating mini-factories and structural changes in metallurgy. The process and the unit are patented in most metal-producing countries in the world.

The new continuous metallurgical process and unit was implemented as a large-scale pilot plant in the second converter shop of the West Siberian Metallurgical Combine. An important role in the implementation of this installation was played by the professor of the ITM department S.P. Mochalov, head of the plant B.N. Kustov and R.S. Aizatulov, chief steelmaker V.V. Sokolov and a whole group of specialists. In total, more than 50 people took part in creating the installation and conducting experiments. From 1992 to 2001, 40 series of experiments were carried out on this installation, which made it possible to confirm the correctness of the theoretical and constructive solutions and to improve the design of the installation. Several new low-energy-intensive technologies were developed and tested experimentally, including: direct recovery of dusty ores and waste (sludge, oiled scale) without agglomeration, production of manganese alloys from poor dust-like ores, separation of titanium-magnetite concentrates into iron and conditioned titanium slag, direct recovery of metals with simultaneous production of synthesis gas (smokeless technology).

Mathematical modeling and research carried out by the scientists of the department showed that the developed process and unit has a certain degree of versatility, it is possible, by changing the blowing mode and the degree of afterburning of the reducing fuel, to process pulverized materials with a wide range of changes in chemical composition, including poor pulverized ores and dressing tails. On the basis of the SES process, a creative team of scientists and plant specialists under the leadership of Valentin Pavlovich developed a number of resource-saving technologies: metal production from cast iron and scale; direct metal reduction from pulverized ferrous materials; obtaining manganese alloys; processing of titanium-magnetite concentrates; direct reduction of iron with associated production of high-calorie synthesis gas and aluminosilicate microspheres.

In addition to the above, the SER-type unit can be used as a gasifier of pulverized coal fractions, but the most economical option is using a mixture of coal and pulverized iron-containing waste. This facilitates the process of maintaining a stable layer of slag-metal emulsion, inside which fuel is burned, and also reduces the consumption of gaseous oxygen due to the use of oxygen from iron oxides. In addition, it becomes possible to use excess temperature, in the case when the priority task is coal gasification with synthesis gas production. Thus, this technology is, in the fullest sense, zero-waste and smoke-free. The project "Technology for processing pulverized coal and metallurgical waste based on the jet-emulsion unit SER" developed within the framework of the scientific school was presented in the program "Russian-German Scientific Dialogue" at the international Congress "Berlin Science Week" in Berlin.

The new process and unit of the NER made it possible to set the task of changing the traditional structure of metallurgical plants, since this eliminates sintering, coke-chemical, and blast-furnace production. Instead of a sequence of large units, the operability and performance change of which is difficult to ensure under changing market conditions, an enterprise of a new structure may consist of a set of independently operating modules.

The creative team of the scientific school under the leadership of Valentin Pavlovich also created a complex of mathematical models and software and instrumental systems in relation to various technological problems: a software and instrumental system that allows calculating the technological parameters of a new continuous metallurgical process in conjunction with the main design parameters of the unit, which creates the basis for automation design of newly created units; a set of mathematical models describing the relationship between flow parameters and physicochemical processes in a jet-emulsion unit, presented as a current equilibrium reactor; instrumental system "Engineering Metallurgy", representing an interconnected system of mathematical models, optimization methods and databases, implemented as a set of programs for solving a wide range of optimization problems of a number of metallurgical technologies; instrumental system for calculating energy technology complexes; a software package that implements a simulation model of a column jet-emulsion reactor; a software and instrumental system that implements a complex of models of the relationship of design and operating parameters to determine the effective operating mode of the gravity separator and the possibility of separating separation products; mathematical model and software implementation of the process of melting spherical particles using NVIDIA CUDA parallel programming technology; software and instrumental system that allows calculating the enthalpy, entropy and heat capacity of both substances and materials in the temperature range; instrumental system for modeling boundary value problems of heat and mass transfer based on the development of software Excel-VBA applications; models of mass transfer processes in dispersed particles; a set of mathematical models and an automated design system for the skull cooling of metallurgical units; mathematical model of the technological process of forming aluminum alloys and the automated information and training system "Aluminshchik"; software product for calculating options for systems for the use of secondary energy; an automated laboratory setup with microprocessor control and a SCADA system for studying the principles of process control with synergistic properties.

Valentin Pavlovich personally and in co-authorship published 9 textbooks and teaching aids, including 3 electronic ones, more than 400 scientific articles in Russian and foreign journals, in materials of scientific conferences, congresses and symposia of various levels, received more than 40 copyright certificates and patents. In 2014, under his editorship, the central publishing house Metallurgizdat published a unique collective monograph summarizing 25 years of work of the creative team to create a new metallurgical process and unit. Now the last work of Valentin Pavlovich is being posthumously prepared for publication - the monograph "Synergetic concept of creating mathematical models of low-power technological processes on the examples of metallurgy" in co-authorship with I.A. Rybenko and P.A. Sechenov.

Valentin Pavlovich was a great scientist and metallurgist, a wonderful person, he made a huge contribution to the development of the department, university, city and our country. He has

passed away, but the memory of him has remained in his deeds, the richest scientific heritage, and numerous students! Bright memories of him will remain in our hearts for many years!