

## НАУКА ТА ПРОГРЕС ТРАНСПОРТУ

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### DEVELOPMENT OF SCIENTIFIC SCHOOL OF TRANSPORT MECHANICS: ARTISTIC LEGACY OF YE. P. BLOKHIN

**Purpose.** Development of domestic and global transport science occurred due to the contributions of many scientists and practicing engineers. The purpose of our study is the analysis of scientific documentary legacy of YE. P. Blokhin, Doctor of Technical Sciences, Professor of Dnipropetrovsk National University of Railway Transport named after Academician V. Lazaryan and identifying his place and role in the development of modern railway transport. **Methodology.** Application of problem-chronological, comparative, descriptive historical methods of research, systematization and analysis of scientific papers allowed the authors to submit the actual history of the railway transport development (1950-2013) through the prism of YE. P. Blokhin scientific activity. We identified 6 main periods of his scientific activity. **Findings.** It was found out that the overall intellectual plant of the scientist includes 555 scientific papers (written personally and co-authored) in domestic and foreign publications on key issues of mechanics and operation of railway rolling stock. Artistic legacy of YE. P. Blokhin includes monographs, articles, reports, patents, author certificate, etc. It was found that the epistolary legacy of scientist, archive materials, his personal diaries, reference list of works of his students and followers are almost unexplored. **Originality.** Authors of the work for the first time in the history of science and technology of Ukraine conducted a complex study of the scientific legacy of YE. P. Blokhin in the context of railway transport. It is proved that the ideas, research, scientific works, implemented projects, numerous students and followers of YE. P. Blokhin are important factors, confirming a significant contribution of the scientist to the global engineering and transport science. **Practical value.** The work can be used to create historiographical papers and textbooks, to study the issues of formation and development of the scientific school for transport mechanics and university science of Ukraine in the railway branch, in the course of lectures on the subjects «History of railway transport development» and «Introduction to the profession».

**Keywords:** YE. P. Blokhin; school of transport mechanics; railway transport; Dnipropetrovsk National University of Railway Transport; artistic legacy of scientist

#### Introduction

A year passed since the time when Yevgeniy Petrovich Blokhin prematurely passed away (01.05.1928-27.11.2012). He is a well-known scientist in the field of basic science and applied transportation research, practicing engineer, educator, organizer and just extraordinary, charismatic person. YE. P. Blokhin is a person with a capital P, a man ready to act, bringing to the life of surrounding people true values.

It is written and said a lot on the role of personality in history. After all, the whole history of mankind is a mosaic of personalities, their actions, thoughts, dreams, desires, emotions and passions.

Scientists argue that the individuals "who earlier, better, deeper and more fully aware of the new needs of society development, the need to change the existing conditions and more resolutely fight for it, know how to find and point out the

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forces, ways and means to carry out the tasks the society, people and class should cope with" are doing the fate of mankind [7, p. 641].

G. V. Plekhanov emphasized that the great man stamps his individuality on the events, but it is not his principal meaning. He is great "because he has the features making him the most capable of serving the great social needs of the time, which arose under the influence of general and particular causes" [14, p. 304].

Development of domestic and global transport science at all stages occurred due to the contributions of many scientists and practicing engineers. A lot of memories of both their contemporaries and modern researchers of the history of science and technology of Ukraine are devoted to the great people, outstanding scientists of railway transport science, engineers, educators and public persons [2, 5, 9, 13, 17, 18, 21, 22]. Among them are N. A. Beleyubskiy, D. I. Zhuravskiy, S. D. Kareyshy, V. A. Lazaryan, M. I. Lipin, P. P. Melnikov, V. N. Obratsov, YE. O. Paton, G. P. Perederiy, N. P. Petrov, S. P. Syromyatnikov. At the same time, documentary scientific legacy of such a vivid person in the history of transport and scientific school of transport mechanics as Ye. P. Blokhin is still improperly understood, inadequately appreciated and not brought to the contemporaries in full.

### Purpose

Based on the above mentioned, the purpose of our study is to analyze scientific documentary legacy of YE. P. Blokhin, Doctor of Technical Sciences, Professor of Dnipropetrovsk National University of Railway Transport named after Academician V. Lazaryan and identifying his place and role in the development of modern railway transport.

### Methodology

Application of problem-chronological, comparative, descriptive historical methods of research, systematization and analysis of scientific papers allowed the authors to submit the actual history of the development of railway transport development (1950-2013) through the prism of scientific activity of YE. P. Blokhin. Periodization method made it possible to identify the basic stages and their characteristics in the development of railway transport of USSR and Ukraine, as well as

in the scientific activities of YE. P. Blokhin. Using the analysis of historical situation, this method makes it possible to identify the major milestones of his scientific activity.

YE. P. Blokhin is a Doctor of Technical Sciences, Professor, Member of the Academy of Engineering Sciences of Ukraine and Transport Academy of Ukraine, Corresponding Member of the International Engineering Academy, Honored Worker of Higher School of the Ukrainian SSR, winner of the State Prize of Ukraine in the field of Science and Technology, winner of the Prize named after Academician A. N. Dinnik, Honorary Worker of Transport of Ukraine, Honorary Railwayman of Ukraine [6, p. 83].

Nearly 30 years (1974-2002) YE. P. Blokhin worked as an Academic Vice-Rector and the First Vice-Rector of the Dnipropetrovsk Institute of Railway Transport Engineers, which in 1993 received the status of university. First, as a Head of the Chair of Theoretical Mechanics (1973-1983), and then as a Head of the Chair of Structural Mechanics (1983-2011), Yevgeniy Petrovich also headed a Research Laboratory of the Dynamics and Strength of Railway Rolling Stock – a reputable international scientific research center on the movement mechanics theory of the body and operation of rolling stock.

Professor Yevgeniy Petrovich Blokhin is iconic personality in the domestic and world transport science, so the interest to his research, scientific and practical, engineering-educational and organizational activities is increasing every day. Multidimensionality and large scale of his actions make one again carefully study his artistic legacy.

Scientific papers! The shelves are crammed with books!

The shelves are helpless to retain the pressure of his ideas!

He is absorbed in science and plunged into the torrent of its emotions! [12, p. 36].

The disciple of Academician V. A. Lazaryan, the founder of the School of Railway Transport Mechanics, YE. P. Blokhin devoted most of his scientific works to the key problems of mechanics and rolling stock operation, traction and derailment stability of the vehicles. It is this artistic capital becomes a significant contribution to the global transportation science and served as the starting point for the works of researchers of many schools and directions.

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Using the chronology of works of YE. P. Blokhin for the period of 1954 to 2013 and the stock of scientific and technical library of DNURT, as well as the personal collection of the scientist as the main source of bibliographic information, it was found out that his general intellectual documentary plant includes 555 publications (personally written and co-authored) in domestic and foreign publications. Among them are 4 monographs; 456 articles and reports published in peer-reviewed journals and in proceedings of scientific conferences. In addition, scientific works of YE. P. Blokhin are presented by the following:

- patents and author certificates – 54;
- deposited manuscripts – 17;
- research reports (under scientific supervision of YE. P. Blokhin) – 3;
- proceedings (edited by YE. P. Blokhin) – 11;
- textbooks – 5;
- methodological guidelines – 5.

More than 60 master's and doctoral theses were defended under scientific supervision of YE. P. Blokhin.

Research of any period in the development of railway transport science and technology suggest the study of scientific works of people (scientists, teachers, engineers), which are aimed to solve the problems in the theory of rolling stock, operation of communication routes, construction, energy supply, economics, etc. as an integral component of the study.

Structure analysis of the bibliographic array of works of YE. P. Blokhin, age dynamics of publication activity in his research activities allowed the authors to divide the works (articles in peer-reviewed journals and reports in the proceedings of scientific conferences) of the scientist to the following periods:

- 1954-1969 – 45 publications;
- 1970-1979 – 68 publications;
- 1980-1989 – 94 publications;
- 1990-1999 – 56 publications;
- 2000-2009 – 157 publications;
- 2010-2013 – 36 publications.

Generalization of some scientific research is a series of monographs written by YE. P. Blokhin with national and foreign colleagues and associates «Динамика поезда (нестационарные продольные колебания)» = «Dynamics of trains (transient longitudinal oscillations)», «Расчеты и испытания тяжеловесных поездов» = «Calculations and tests

of heavy trains», «Железные дороги мира в XXI веке» = «Railways in the world of XXI century», «Railway Wheelsets» [23]. These fundamental works in conjunction with scientific articles, reports, deposited manuscripts, patents and author certificates are a kind of scientific chronicles of step-by-step development of railway transport.

Let us study the given chronicles through the prism of six periods in scientific activities of YE. P. Blokhin.

### 50th - 60th of the XX century

It is the years of intensive expansion and development of the USSR railways, increasing the production of electric and diesel locomotives termination of mainline locomotives production, approval of the General Plan of Railway Electrification. As a result, by the beginning of 1970, over 106 sq km of railways (about 80% of their length) had electric and diesel traction, performed more than 95 % of total turnover. Basic performance indicators of rail transport confirm the multiple growth of traffic and turnover. Thus, the turnover in 1950 was equal to 602 billion of ton-kilometers, and in 1970 - 2495; cargo transportations - 834 million tons (1950) and 2896 (1970); passenger turnover - 88 billion of passenger km (1950) and 274 (1970), the passenger transportations – 1.164 million (1950) and 3864 (1970) [1, p. 103].

At the same time - this is the formative years of YE. P. Blokhin as a scientist, a railway engineer, university teacher, characterized by deep scientific erudition and a variety of research interests, extending far beyond the graduate of Mechanical Faculty of Dnipropetrovsk Institute of Railway Transport Engineers (DIIT). In 1958, at the age of 30 Yevgeniy Petrovich defended his Ph.D. thesis "Studies of the impact of the train heterogeneity on dynamic forces arising in the coupling gears during start up" and obtained a rank of Associate Professor.

In those years, the basic research interests of Yevgeniy Petrovich included experimental and theoretical studies of transient processes in trains and in other distributed technical systems. It is he, who was the first to consider the processes in inhomogeneous in mass trains and in inhomogeneous long frame structures.

Enthusiasm and intense rhythm of work of all employees of the Department of Structural Mechanics and Branch Research Laboratory of

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the Dynamics and Strength of Railway Rolling Stock (BRLDSRRS) under the leadership of V. A. Lazaryan had made DIIT an innovator and leader of the technical universities of USSR on the application of computer technology in research work.

Extraordinary performance, energy, non-standard thinking of young scientist Yevgeniy Blokhin, employee of the Department and Laboratory, had been reflected in the period from 1954 to 1970 by 45 scientific publications in journals and proceedings. Among them are the following works: «О влиянии неоднородности поезда на динамические усилия, возникающие в упряжных приборах при трогании с места» = «On the influence of the train heterogeneity on dynamic forces arising in the coupling gears during start up» (1958), «Исследование усилий, возникающих в грузовых поездах, при включении в них восьмиосных полувагонов» = «Study of the efforts arising in freight trains during inclusion of eight-axle open-cars» (1963), «К вопросу о влиянии характеристик связей одномерных механических систем на переходные режимы движения» = «On the influence of the coupling characteristics of one-dimensional mechanical systems on the transitional modes of motion» (1966), «Исследование с помощью ЭВМ процессов торможения поездов» = «Investigation of train braking processes using computer» (1967), «Применение ЭВМ к исследованиям переходных режимов движения при пуске в ход» = «The use of computers in research of transients motion modes when starting-up» (1969), «Экспериментальные исследования продольных усилий в грузовых поездах массой до 10 тыс. тонн при переходных режимах движения» = «Experimental studies of longitudinal forces in freight trains weighing up to 10 000 tons during transient modes of motion» (1970), «Влияние одновременного включения локомотивов на усилия в сдвоенном поезде» = «Influence of non-simultaneous locomotives switching on the efforts in dual train» (1970) and others.

## 1970-1979

Technical reconstruction had made the Soviet Union the world leader in terms of traffic and performance of operational activity. A substantial increase in the transportation volumes in 1970s had led to a further significant increase in congestion of

railway track: from 29.0 million of gross ton-km/km per year in 1970 to 34.6 million of gross ton-km/km per year in 1980. During 1971-1980 the Soviet Union had been building more than 6100 km of new railways.

Scholars and practitioners of rail transport, including the staff of DIIT, participated in the preparation and implementation of a number of all-union and branch programs, ensuring the creation of technical equipment for mechanization of cargo handling, loading-unloading operations, store handling, the use of automation and remote control, the development of more powerful and advanced locomotives and cars. In the late 70s it was started the mass introduction of advanced technological processes and above all of heavy and high-speed train motion.

Development of scientific and technical progress in the Soviet Union was based on the work of a well-developed system of scientific research, design and engineering organizations in the branch. One of them was the aforementioned the Branch Research Laboratory of the Dynamics and Strength of Rolling Stock created in DIIT in 1958 by Academician V. A. Lazaryan. It became a reputable scientific center for the study of longitudinal forces in the train during the processes of motion and braking. In 1972, when he defended his doctoral thesis «Исследования переходных режимов движения поездов с существенно нелинейными междувагонными соединениями» = «Studies of transients modes of train motion with nonlinear coupling cables» and received the degree of Doctor of Technical Sciences, YE. P. Blokhin chaired BRLDSRRS.

Initiated by YE. P. Blokhin and with his direct participation it was developed an original method for assessing the strength of structural elements of cars. Application of computer technology, simulation of complex dynamic processes of longitudinal nature that arise during the train start-up contributed to the development of railway equipment and technology.

Testing of the new railway technology by the order of the Ministry of Communication Routes of the USSR, making recommendations for design organizations of the country, which were included in the rules and regulations of railway construction, the theoretical and practical studies of a number of important dynamic processes occurring in heavy composite trains distributed along the length are

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the workdays and holidays of the staff of scientists under supervision of Professor YE. P. Blokhin.

The intensity of scientific activity of YE. P. Blokhin from 1970 to 1979 indicated, for example, the creation of 3 deposited manuscripts and publication of 68 scientific papers. Among them are: «Интегральная оценка связей в поезде и определение их параметров по результатам натурных испытаний» = «Integral assessment of communications in the train and determination of their parameters according to results of field tests» (1971), «Что показал опыт вождения объединенных поездов» = «What has shown the experience of driving combined trains» (1972), «Продольные колебания нелинейных одномерных систем при возмущениях, распространяющихся вдоль их длины» = «Longitudinal oscillations of one-dimensional nonlinear systems under perturbations propagating along their length» (1973), «Применение электронного моделирования к исследованию динамических процессов в объединенных поездах с автоматически управляемыми вспомогательными локомотивами» = «Application of an electronic simulation to the study of dynamic processes in the combined trains with automatically controlled auxiliary locomotives» (1975), «О новых нормах сопряжения элементов продольного профиля железных дорог» = «On the new standards of elements coupling of the longitudinal profile of railways» (1977), «Об уточнении модели межвагонного пружинно-фрикционного амортизатора удара» = «On the refinement of the model of inter-vehicle friction spring shock absorber» (1979), etc.

## 1980-1989

In the 80 years of the XX century in the USSR the operations on the use of carrying capacity of railways and technical equipment of the transport have been significantly strengthened. Implementation of large-scale activities to develop and implement intensive technologies of transportation process, increasing and improving of the level of use of industrial and scientific-technological potential of the industry have been particularly important in terms of traffic growth and inadequate allocation of funds for the development of the industry. As a result of the success implementation of a set of measures to the 1988 the transportation performance of the USSR railways had reached a record level: loading was

4115.6 million tons, turnover - 3924.8 billion ton-km; transported 4395.9 million of passengers, and passenger traffic has surpassed 400 billion of passenger-km. Productivity of workers employed in transportation had reached 2570 thousand of ton-km and was 1.3 times higher than in 1980. According to the intensity of the use of technology Soviet Railways had no equal in the world. Average traffic density of railways was several times higher than that of roads in the U.S.A. and other developed countries. Performance of freight car was several times higher too. Railways of the country performed more than 52% of freight turnover and about a quarter of passenger turnover of all railways in the world with the extent of about 12% of the world railway network [8, p. 25].

In the context of tasks of advanced engineering science of the time it was performed scientific research of scientists, headed by Professor YE. P. Blokhin (National Branch of the International Academy of Engineering, the Department of Structural Mechanics of DIIT and BRLDSRRS).

The volume of scientific baggage of tireless scientist in this period (1980-1989) - 94 articles/reports, 2 monographs, 26 copyright certificates, 13 deposited manuscripts show a combination of extraordinary health, energy, scientific gift, unique creativity and organizational skills of YE. P. Blokhin. Content of these papers reflects all the nuances of the theoretical and practical developments and solutions of titan activity of Professor Blokhin and his colleagues. Among the articles published in major periodicals are: «Об устройстве сопряжений на переломах продольного профиля пути» = «On the design of couplings on the brake in grade on the track» (1982), «О расчетных схемах элементов вагонов как двумерных механических систем с переменными параметрами» = «On the calculation schemes of car elements as two-dimensional mechanical systems with variable parameters» (1983), «Об опытах с тяжеловесными поездами» = «On the experiments with heavy trains» (1984), «Дифференциальные уравнения пространственных колебаний одномерных механических систем с переменными параметрами» = «Differential equations of one-dimensional spatial oscillations of one-dimensional mechanical systems with variable parameters» (1984), «Моделирование взаимодействия звеньев через дву-

шарнирную связь» = «Modeling the interaction of units through double-hinged connection» (1986), «Целенаправленное движение железнодорожного поезда» = «Purposeful movement of railway train» (1987), «О совершенствовании воздухо-распределителей автотормозов пассажирских вагонов» = «On improving the diffusers of automatic brakes for passenger cars» (1988), «Математическое моделирование обезгруживания вагонных тележек» = «Mathematical modeling of car bogey unloading» (1989), etc.

In the monograph «Динамика поезда (нестационарные продольные колебания)» = «Dynamics of train (transient longitudinal oscillations)» (1982) [4] devoted to V. A. Lazaryan Yevgeniy Petrovich continued and developed initiatives of the teacher in the area of transient motion modes of railway rolling stock. The study describes the mathematical models and algorithms that allow with the accuracy acceptable for engineering practice to determine (with respect to existing and future operating conditions) the forces acting on the cars in the train when starting-up, braking, driving through brake in grade of the track, as well as longitudinal forces arising from the collisions of cars and couplings. The monograph consisting of nine chapters and meant for scientists, university professors, engineers and designers, in a few months becomes a handbook for mechanical transport workers all over the USSR.

4 years later (1986) it was published the next monograph of group of authors «Расчеты и испытания тяжеловесных поездов» = «Calculations and tests of heavy trains» [16], in which YE. P. Blokhin is one of the authors and the editor. The work proposes application program package «Train», created in Dnipropetrovsk Institute of Railway Transport Engineers to determine the dynamic loadings in heavy trains. The publication describes the schemes of electronic models, methodology for conducting experiments and processing the results, as well as used equipment. Using them one can solve the practical problems of calculation and train testing related to the definition of longitudinal forces in the automatic coupler, acceleration of cars and cargo during the transient modes of motion (starting up, various modes of braking, brake release, motion on the track with brake in grade, collision of cars and couplings, including the emergency).

### 1990-1999

The collapse of the USSR, the proclamation of an independent sovereign state of Ukraine (1991) and the reorganization of all sectors of the economy took place against the backdrop of significant adverse changes. Protracted period (1990-2000) of adverse economic situation in the country, decline in industrial and agricultural production, falling of living standard of population had led to decrease in demand for services of transport companies (including the railway transport). It was accompanied by a reduction in freight and passenger traffic.

During this period Ukraine having large transport capacity for the implementation of interstate transit takes a course of integration into the European and global transport systems. This requires the creation and use of international transport corridors, a clear definition of freight and passenger traffic, the development of complex technical and technological documentation, etc. DIIT, despite the difficulties in universities in Ukraine in the 90s of the twentieth century, was able to maintain and strengthen its position in the educational and scientific activities. 16 research laboratories actively worked in the university, significantly expanding the scope of research.

Among them, the staff of the Department of Structural Mechanics and BRLDSRRS supervised by YE. P. Blokhin took a special place solving complex engineering tasks on the high professional and theoretical levels, taking the lead in volumes of contractual works. Their works on the application of the automatic control system of locomotives, suggestions for improvement the brakes of cars and locomotives, the introduction of new norms and standards in the design of railway rolling stock became the most significant and (that is very important) popular. YE. P. Blokhin proposed to his colleagues to develop an original method for estimating the strength of elements of car design. Complex dynamic processes of the longitudinal nature arising at the start of the trains modeled by using computer technology contributed to the development of railway technology. Scientists have conducted studies of the behavior of empty cars in heavy trains, operation compatibility in one train of freight and passenger cars, studies to assess the real efforts that arise in heavy trains, locomotives behavior research at different motion speeds on sections

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with different curvature. All this contributed not only to the development of the theory of body movement mechanics, but also gave specific proposals for operation of rolling stock [15]. Scientific research globality of the school of transport mechanics founded by Academician V. A. Lazaryan, was one of the reasons for the intensive development of international scientific relations with universities, research institutes, enterprises of railway transport in Russia, USA, France, Poland, Iran, Hungary, Lithuania. Among the vivid representatives of the school are: YE. P. Blokhin, S. I. Konashenko, L. A. Manashkin, V. D. Danovitch, M. L. Korotenko, O. M. Savchuk, V. F. Ushkalov, A. N. Pshinko, S. V. Myamlin, V. A. Dzenzerskiy, N. A. Radchenko, S. F. Redko, V. V. Skalozub, V. L. Gorobets, I. G. Barbas, M. YE. Itin, V. N. Zakharov, S. A. Kostritsa, S. G. Kryukov, YE. L. Stambler, G. I. Bogomaz, A. M. Bondarev, V. M. Mikhaylenko, V. A. Tatarinova, I. V. Klimenko, A. I. Palamarenko, L. V. Ursulyak, N. N. Khachapuridze, YE. V. Yuspina, O. L. Yangulova, L. A. Neduzhaya, V. V. Zhishko and many others, worked in DIIT, in the institutes of NAS of Ukraine, academic structures of universities in Ukraine and abroad.

A milestone event in the history of Ukraine is an active participation of Professor YE. P. Blokhin and his team to create the first Ukrainian mainline electric locomotive. This work was highly appreciated by the government – YE. P. Blokhin was awarded by the State Prize of Ukraine in Science and Technology (2002).

Artistic legacy of Yevgeniy Petrovich in this period (1990-1999) was 8 author certificates and patents, 56 published works. They are articles and reports «К обоснованию норм сопряжения элементов продольного профиля пути высокоскоростных магистралей» = «The validation of norms of elements coupling of the longitudinal profile of the track of the mainlines» (1991), «Математическая модель пространственных колебаний магистрального грузового электровоза» = «A mathematical model of spatial oscillations of mainline freight locomotive» (1996), «Тренажер для обучения машинистов безопасным и экономичным способам вождения поездов» = «Simulator for training the drivers safe and economical driving of trains» (1997), «О перевозке жидкостей с повышенной плотностью в цистернах, предназначенных для перевозки свет-

лых нефтепродуктов» = «On the transportation of liquids with a higher density in tanks intended for the transportation of light oil products» (1998), «Динамические качества электровоза ДЭ1» = «Dynamic qualities of electric locomotive DE1» (1999), «Оптимальное проектирование конструкций защиты железнодорожных цистерн от сверх-нормативных продольных загрузок» = «Optimal design of structures protecting the railway tanks from over regulatory longitudinal loadings» (1999) and others.

## 2000-2009

In connection with the transition of Ukrainian economics to market relations all enterprises in the country are adapting to the new economic conditions, including the railway transport. The situation is complicated also by the economic crisis in 2008-2009. Railway transport, as an industry, providing transportation in the sphere of production and directly dependent on it, is the most sensitive to changes in the rapidly changing external environment.

Thus, the decline in traffic volumes by railways in summer of 2008 was a sign of problems as a whole in the industry and in the financial sector of Ukraine. These problems were observed after three months. As a result, for example, in 2008 the railway transported 3 % less of cargo than in 2007, against the background of 3.5% growth as compared to 2006. In 2009 the transportation of goods decreased by 21.5 % as compared to 2008, and the turnover by 23.7% (a decrease in road transport turnover was 9.5%). Even despite the tariff increase, their growth rates did not cover the growth rates of prices for the corresponding resources. In this regard, the income of the Ukrainian railways from ordinary activities in 2009 amounted to 39.4 billion USD, which is only 1.2 % more than in 2008, despite the fact that the rates for cargo transportation in 2009 increased by 13.5% in the average for the country's railways [20, p. 18].

At the same time, transport scientists do not reduce the rate of their own research and developments. As a permanent member of international scientific projects Knorr-Bremse (Germany), Skoda and Dako (Czech Republic), Westinghouse (USA), etc. YE. P. Blokhin at the request of colleagues of the Silesian University of Technology (Poland) becomes a co-author of the

international collective monograph «Railway Wheelsets»(2003), publishing the section «To the issue of wear of wheels and rails» [23].

In the context of Ukraine's integration into European structures it is extremely important to analyze the trends in the field of transport, projected by global community. The team of associates, among which are YE. P. Blokhin, G. N. Kirpa, V. V. Korniyenko, A. N. Pshinko, B. YE. Bodnar, S. V. Myamlin, V. N. Plakhotnik, I. P. Korzhenevich initiated the detailed and systematic study of the European experience with the development of the railways providing analytical predictions for the reform of the railway transport of Ukraine in several directions:

- long freight transportations on international transport corridors;
- high quality passenger service in specialized corridors with increased motion speed;
- regional transport centered around the cities.

Particular attention in the study is paid to the problem of "reconciliation" of transport with the environment. It is proved that under modern conditions the maximum transfer of transport from the roads and airlines to the rails will help to efficiently provide mobility of population with minimal energy and environmental costs.

The results of these studies are presented in the monograph of group of authors «Железные дороги мира в XXI веке» = «Railways of the world in the twenty-first century» (2004) [11], among which a special place belongs to Professor YE. P. Blokhin.

After 5 years, a logical continuation of the theme of trends analysis in the field of transport, projected by global community becomes a textbook of YE. P. Blokhin and A. N. Pshinko «Высокоскоростной наземный транспорт мира» = «High Speed Ground Transport of the World» (2009) [3]. In this textbook the scientists analyze the development of foreign high-speed railways, consider maglev transport systems for high-speed ground transport.

The first decade of the 2000s was the most information-intensive in terms of publication activity of YE. P. Blokhin. Besides the above mentioned works, the scientist is the author of 14 patents and 157 published papers in national and international scientific journals and proceedings. Here are some of them: «К вопросу устойчивости движения легковесных вагонов в со-

ставе грузовых поездов» = «On the stability of motion of lightweight cars in the freight trains» (2000), «Определение параметров плана линии при организации скоростного сообщения Западная Европа-Львов» = «Defining the parameters of organization of line plan of speed communication Western Europe-Lviv» (2000), «Выбор энергетических оптимальных режимов ведения поездов» = «Selection the optimum mode of train driving» (2001), «О модели сопротивления усталости несущих конструкций тягового подвижного состава для оценки их остаточного ресурса» = «On a model of the fatigue resistance of bearing structures of traction rolling stock to assess their residual life» (2002), «Прогнозирование наиболее опасных режимов ходовых испытаний подвижного состава» = «Prediction of the most dangerous modes of rolling stock trials» (2003), «Динамика и прочность электровоза типа ДС3» = «Dynamics and strength of rail bus of type DS3» (2004), «Методические вопросы динамических испытаний рельсового колесного транспорта на вибробезопасность» = «Methodological issues of dynamic testing of rail transport for vibration safety» (2005), «Динамика и прочность рельсового автобуса типа 620М» = «Dynamics and strength of the rail bus type 620m» (2006), «Экспериментальные данные о влиянии конфигурации поверхности катания колес грузовых вагонов на их динамику» = «Experimental data on the effect of the configuration of the rolling surface of car wheels on their dynamics» (2007), «Современные проблемы вождения поездов в условиях оптового рынка электроэнергии» = «Modern problems of driving trains under conditions of wholesale market for electrical energy» (2008), «Определение возможных причин схода цистерн с опасным грузом» = «Identification of possible causes of derailment of tanks with dangerous cargo» (2009), «От материальной точки до нелинейной пространственной многомассовой модели поезда» = «From the material point to nonlinear spatial multimass model of the train» (2009), etc.

#### 2010-2013

Transport Strategy of Ukraine (2010), aimed among other things on the railway reform establishes the development of the railway sector as one of the priorities of the country until 2020. Implementation of this task involves the execution



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of the renovation of rolling stock, improvement of technology of transportation organization and infrastructure modernization.

Railway transport of Ukraine in 2011 sent 430.1 million of passengers (including transportation by commuter train), which is 0.7% more than in 2010. Cargo transportation by railways in comparison with 2010 increased by 8.2%, including the goods shipping - by 8.6%. In 2012, freight transportations by railroads were 97.5% of the total in 2011, including goods shipping 97.3%. In January-October 2013 freight transportations by railroads were 95.4% of January-October 2012, the goods shipping decreased by 1.8% [10].

At the same time, according to experts, today the largest part of the rolling stock of Ukraine is a fleet of freight cars, more than 60% of which is operated on the verge of the period of service and needs urgent update [19].

As a result of research, substantial rehabilitation of infrastructure (including electrification, increasing the radius of curves, relaying of the track, introduction of the turnouts with continuous rolling surface) and the introduction of new technologies, including the development of models of high-speed trains and construction of specialized lines since April 2012 in Ukraine have been introduced high-speed train motion. The first high-speed passenger train was launched in July 2012 on a route "Kyiv-Kharkiv".

DNURT was directly involved in the project. As part of the University Testing Center the staffs of BRLDSRRS under the supervision of YE. P. Blokhin were active participants of acceptance testing of high-speed electric trains of foreign production (firms Hyundai and Skoda), domestic electric train EKr1 (production of Krukov carriage works) with a speed of 160 km/h, as well as high-speed train of the company Tolgo with the speed of 200 km/h.

Scientists continue to participate in activities to harmonize regulations existing in Ukraine, Customs Union and the European Union, on the estimation of the supporting structures strength of the rolling stock. Further studies to assess the changes of physical and mechanical properties of materials during the operation continue too. The efforts in obtaining data on the spatial unevenness of railway track using the responses of modern track recording cars etc. were intensified.

During the period from 2010 to 2013 Yevgeniy Petrovich until the last days of his life actively

working on new research projects registered 6 patents and created 36 publications.

Among his scientific articles are the following: «О роли натурных испытаний при оценке качества подвижного состава железных дорог» = «The role of field tests to assess the quality of railway rolling stock» (2010), «Тележки ZK1 полувагонов, построенных в КНР» = «Bogies ZK1 of open cars built in China» (2012), «Результаты ходовых динамических испытаний дизельного поезда 630М производства АО PESA (Польша)» = «The results of dynamic tests for diesel train 630M of production of AO PESA (Poland)» (2013), «Об эквивалентности критериев безопасности от схода колеса с рельсов при использовании направляющей либо боковой силы» = «On the equivalence of safety criteria of derailment when using the guiding or lateral forces» (2013), etc.

The ability to solve the difficult tasks, to implement the major projects involving groups of performers (domestic and foreign scholars and experts from industry and design bureaus) is specific for scientific and practical activities of YE. P. Blokhin.

Since the 80s of the twentieth century Yevgeniy Petrovich is actively engaged in the work on the creation and organization of the academic structures activities. Thus, on the basis of DIIT it was organized the National Department of the Public International Engineering Academy, which included all the major industrial enterprises and scientific organizations of Dnipropetrovsk region. The National Office, of course, was headed by Doctor of Technical Sciences, Professor Blokhin YE. P. The scientist was also a member of two other academies - the International Academy of Transport and Transport Academy of Ukraine. He took an active part in their development.

Since 1980 YE. P. Blokhin is the permanent chairman and organizer of the All-Union scientific conferences (since 1996 the international ones) «Проблемы механики железнодорожного транспорта» = «Problems of Railway Transport Mechanics», taking place on the basis of DIIT. Conference participants are the scientists and manufacturers from Belarus, Hungary, Germany, Israel, India, Iran, Italy, Kazakhstan, Lithuania, Netherlands, Poland, Russia, USA, Ukraine, Croatia, Sweden, South Africa, France, etc.

The International Scientific-Practical Conference «Развитие школы транспортной механики» =

«Development of school of transport mechanics» (December 2013., DNURT) became the tribute of the world scientific community to YE. P. Blokhin as to the leader of the scientific school of transport mechanics, who left a huge intellectual heritage in the railway sector, hundreds of students and continuers of his work. The Conference was devoted to the 85th anniversary of the scientist.

### Findings

Analysis of documentary scientific legacy of YE. P. Blokhin, its systematization, periodization for the purpose of constructing a logical statement of the facts and ordering of the actual material, suggest the following results:

1. General intellectual plant of scientist is 555 scientific papers (written by him personally and co-authored) in domestic and foreign journals. Most of them (456) – are the papers in a peer-reviewed journals and reports in the proceedings of scientific conferences (domestic and international). In addition YE. B. Blokhin is the author of 4 monographs, 54 patents and copyright certificates, 5-textbooks. 17-deposited manuscripts, under his editorship were published 11 proceedings of scientific papers, etc. At the same time his epistolary heritage, archival materials, personal diaries, etc, remain unexplored.

2. There were identified the following milestones of scientific activity, presented by his scientific papers (articles in peer-reviewed journals and reports at scientific conference proceedings): 1954-1969 - 45 works, 1970-1979 - 68 works, 1980-1989 - 94 works, 1990-1999 - 56 works, 2000-2009 - 157 works, 2010-2013. - 36 works.

3. The memories of his friends, colleagues, students, associates and partners are the important source for reconstructing the image and the artistic legacy of outstanding scientist YE. P. Blokhin (especially his human and professional qualities, relationships with people that are not reflected in official documents). Unfortunately, these publications are still very few. In this regard it should be noted the information publication «Профессор Блохин Евгений Петрович» (Серія «Професори ДІІТ») «Professor Yevgeniy Petrovich Blokhin» (Series «Professors of DIIT»), published in 2013 by alma mater of the scientist - Dnipropetrovsk National University of Railway Transport named after Academician V. Lazaryan.

4. The authors draw attention to the fact that a huge number of domestic and foreign scientists in their publications referenced (in the bibliography) on research and developments of YE. P. Blokhin. This should be a separate area of research of his scientific work.

5. Published and unpublished works of the scientist are aimed to solve some of the critical issues of railway transport development. This, for example, provision of driving the trains of increased length, development and implementation into operation of the traction rolling stock and multiple unit (made by domestic companies), implementation into operation of multiple unit from foreign manufacturers (production companies in Poland, the Czech Republic, South Korea), the development of practical measures, methodologies and current regulatory documentation to continue the service of traction rolling stock and multiple unit; commissioning activities to improve safety performance and sustainability of freight rolling stock; increasing the carrying capacity, etc.

6. Numerous scientific and engineering ideas of YE. P. Blokhin presented in published and unpublished writings, his enthusiasm, passing to all around the scientists, who worked under his supervision, who was with him in joint research and developments, extraordinary diligence and perseverance in the implementation of projects, a large number of disciples and followers allow us to tell about him as about the person, who affected the development of the domestic and global rail transport science.

### Originality

Authors of the paper for the first time in the history of science and technology of Ukraine conducted a complex study of the scientific legacy of YE. P. Blokhin in the context of railway transport development. As a result of the study it was determined the total number of scientific papers (555), their content, as well as identifying the key milestones of scientific activity, presented by his scientific publications. It was proved the necessity of studying his epistolary heritage, archival materials, personal diaries, article bibliographies in the works of his students and followers, etc.

### Practical value

– Taking into account the fact that research of YE. P. Blokhin was conducted in the context of

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engineering science of the 2nd half of the XX-early XXI centuries, and most of his scientific works are devoted to the key problems of the mechanics and operation of railway rolling stock, we believe that the material given in this article can be used:

- to prepare the general works on the history of domestic railway transport and its separate directions (train control, traction and derailment stability of its cars from the track, etc.);

- during preparation of bibliography dedicated to YE. P. Blokhin;

- during creation of a historiographical papers and textbooks;

- in the new research on the history of formation and development of the scientific school of transport mechanics, as well as university science of Ukraine in the railway industry;

- in the course of lectures on subjects "History of the of railway transport development" and "Introduction to the profession".

### Conclusions

Academician of the three Academies, Professor YE. P. Blokhin, as a rule was more deeply and fully aware of the need for change and development of the transport sector than others. He was not only a "generator" of ideas and creative scientific, and practical solutions. He, like a high-speed locomotive, pointed the way and confidently led the scientific and engineering community of transport workers - mechanics.

YE. P. Blokhin was the person that influenced the development of railway transport of Ukraine of the 2nd half of the XX- early XXI centuries. And at the same time, we can confidently assert that there is a lack in personalities of such a scale and the scientists of such level not only in our country but also in the whole world of transport science.

Analysis of the literary scientific heritage of YE. P. Blokhin, the definition of his place and role in the development of modern railway transport allow us to conclude:

1. A wide range of documentary scientific works of YE. P. Blokhin, his quantitative (555 papers), specific (monographs, articles, reports, patents, author certificates, etc.) and qualitative content actually describe more than half a century (1954-2013) in the development of railway transport of Ukraine and the USSR.

2. Intelligent documentary heritage of the scientist reflects one of his most important research

directions in the railway transport science - the development of the theory of body movement mechanics associated with the development, reconstruction and maintenance of railway rolling stock. Ideas, research, scientific works, implemented projects, numerous disciples and followers of YE. P. Blokhin are the important factors, confirming a significant contribution to the global scientific engineering and transport science.

3. Taking into account that the epistolary heritage of YE. P. Blokhin, archival materials, his personal diaries, bibliography in the works of his students and followers, etc. are almost unexplored, the authors have reasonable cause to believe that the historiography of life and work of YE. P. Blokhin is only in the development stage and is waiting for further research.

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## РОЗВИТОК НАУКОВОЇ ШКОЛИ ТРАНСПОРТНОЇ МЕХАНІКИ: ТВОРЧА СПАДЩИНА Є. П. БЛОХІНА

**Мета.** Розвиток вітчизняної й світової транспортної науки на всіх її етапах відбувався завдяки вагомому внеску безлічі вчених та інженерів-практиків. Метою нашого дослідження є аналіз документальної наукової спадщини Є. П. Блохіна, доктора технічних наук, професора Дніпропетровського національного університету залізничного транспорту імені академіка В. Лазаряна; визначення його місця та ролі в розвитку сучасного залізничного транспорту. **Методика.** Застосування проблемно-хронологічних, порівняльних, описових історичних методів дослідження, систематизація та аналіз наукових праць дозволили авторам подати фактичну історію розвитку залізничного транспорту (1950–2013 рр.) через призму наукової діяльності Є. П. Блохіна.

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Було виділено 6 основних періодів наукової діяльності вченого. **Результати.** З'ясовано, що загальний інтелектуальний багаж вченого становить 555 наукових робіт (написаних особисто та в співавторстві) у вітчизняних і зарубіжних виданнях, присвячених ключовим проблемам механіки та експлуатації рухомого складу залізниць. Творчу спадщину Є. П. Блохіна складають монографії, статті, доповіді, патенти, авторські свідоцтва та ін. З'ясовано, що практично невивченими залишаються епістолярна спадщина вченого, архівні матеріали, його особисті щоденники, бібліографічні списки в працях його учнів і послідовників. **Наукова новизна.** Автори даної роботи вперше в історії розвитку науки і техніки України провели комплексне дослідження наукової спадщини Є. П. Блохіна в контексті розвитку залізничного транспорту. Доведено, що ідеї, дослідження, наукові праці, реалізовані проекти, численні учні та послідовники Є. П. Блохіна – вагомими чинниками, що підтверджують значний внесок ученого в розвиток світової інженерної думки й транспортної науки. **Практична значимість.** Дана робота може бути використана при створенні історіографічних праць і навчальних посібників; дослідженні питань становлення та розвитку наукової школи транспортної механіки й університетської науки України в галузі залізничного транспорту, у курсі лекцій із дисциплін «Історія розвитку залізничного транспорту» та «Вступ до спеціальності».

*Ключові слова:* Є. П. Блохін; наукова школа транспортної механіки; залізничний транспорт; Дніпропетровський національний університет залізничного транспорту; творча спадщина вченого

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## РАЗВИТИЕ НАУЧНОЙ ШКОЛЫ ТРАНСПОРТНОЙ МЕХАНИКИ: ТВОРЧЕСКОЕ НАСЛЕДИЕ Е. П. БЛОХИНА

**Цель.** Развитие отечественной и мировой транспортной науки на всех ее этапах происходило благодаря весомому вкладу множества ученых и инженеров-практиков. Целью нашего исследования является анализ документального научного наследия Е. П. Блохина, доктора технических наук, профессора Днепропетровского национального университета железнодорожного транспорта имени академика В. Лазаряна; определение его места и роли в развитии современного железнодорожного транспорта. **Методика.** Применение проблемно-хронологических, сравнительных, описательных исторических методов исследования, систематизация и анализ научных трудов позволили авторам подать фактическую историю развития железнодорожного транспорта (1950–2013 гг.) через призму научной деятельности Е. П. Блохина. Были выделены 6 основных периодов научной деятельности ученого. **Результаты.** Выяснено, что общий интеллектуальный багаж ученого составляет 555 научных работ (написанных лично и в соавторстве) в отечественных и зарубежных изданиях, посвященных ключевым проблемам механики и эксплуатации подвижного состава железных дорог. Творческое наследие Е. П. Блохина составляют монографии, статьи, доклады, патенты, авторские свидетельства и др. Выяснено, что практически неизученными остаются эпистолярное наследие ученого, архивные материалы, его личные дневники, библиографические списки в трудах его учеников и последователей. **Научная новизна.** Авторы данной работы впервые в истории развития науки и техники Украины провели комплексное исследование научного наследия Е. П. Блохина в контексте развития железнодорожного транспорта. Доказано, что идеи, исследования, научные труды, реализованные проекты, многочисленные ученики и последователи Е. П. Блохина – весомые факторы, подтверждающие значительный вклад ученого в развитие мировой инженерной мысли и транспортной науки. **Практическая значимость.** Данная работа может быть использована при создании историографических трудов и учебных пособий; исследовании вопросов становления и развития научной школы транспортной механики и университетской науки Украины в отрасли железнодорожного транспорта, в курсе лекций по дисциплинам «История развития железнодорожного транспорта» и «Введение в специальность».

*Ключевые слова:* Е. П. Блохин; научная школа транспортной механики; железнодорожный транспорт; Днепропетровський національний університет залізничного транспорту; творческое наследие ученого

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