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SOME STAGES OF EVOLUTION AND PROSPECTS OF TRIBO-FATIGUE

The paper describes briefly information on stages of evolution of Tribo-Fatigue as a science. Its basic ideas and role in machine-building progress are discussed. The author rests on the opinion of famous mechanic scientists and science organizers.

Introduction. The definition of the term Tribo-Fatigue is presented in the Intergovernmental Standard GOST 30638–99 [1]; Tribo-Fatigue is a science of wear-fatigue damages and fracture of force systems of machinery and equipment. It has been first published in 1986 [2]. During the last 25 years from the moment of its publishing, Tribo-Fatigue has passed a difficult way of formation and recognition. I would like to tell briefly only some stages of evolution of Tribo-Fatigue since many events occurred with my participation.

About Tribo-Fatigue: 1995. In 1995 I had to speak of Tribo-Fatigue on a meeting. The contracted text of that speech, which was published in [3] under the headline ″Tribo-Fatigue Already Serves and Will Serve People″, is presented below.

When the term Tribo-Fatigue was first published in 1986 (in Minsk), it did not evoke heightened emotions. But already in 1990 a sharp debate run at the All-Union Scientific and Technical Meeting in Gomel. Specialists from known research centers of the Soviet Union wanted to elucidate what is Tribo-Fatigue. Either it was an independent science or a new direction in some science?

Most specialists that participated the International Symposium on Tribo-Fatigue in 1993 (Gomel, Belarus) were already close acquainted with Tribo-Fatigue and for many of them it became a subject of concrete activities. But among them were researchers and engineers, for which the word ″Tribo-Fatigue″ rang as news. And debate on whether Tribo-Fatigue is a science continued and has not yet been finished up to now.

I would like to note that it is not a quite idle issue. Its solution is not a toy for theoreticians. In my opinion, an answer is important, first of all, for machine-building. To substantiate this statement, I will refer to recent events and... fights.

Studies on friction and wear as well as role of lubrication in contact of solids were carried out througout the world and are performed nowadays. However, the leading role is played by so-called complex studies, i. e. tribological studies. In this case all three processes are investigated in indissoluble connection, i. e. in a complex manner. And what is the result?

Here I have to remember the paper of Prof. Jost (Great Britain), in which he made a concrete estimate of cost of fight against new views in science. He noted that initially tribology was ignored because of its versatility. The direct result of such ignorance was impeded evolution of design in machine-building and gross expences for reducing friction and wear and eliminating their consequences … Only in Great Britain it would have been possible to save 5.5 million pounds (by estimate in 1965), if more attention had been paid to tribology. At present is is believed that due attention to tribology would yield money saving of 1.3 to 1.6 % of gross national revenue. These are the scale of losses only in one country!

So, foundations of Tribo-Fatigue have been developed in our country. It deals with regularities of wear-fatigue damages. As it was repeatedly reported, these damages yield 70, 80, and even 90 % of premature failures of machinery and equipment. And Tribo-Fatigue finds novel and effective ways to control over these damages and methods for their prevention. Just imagine yourself: if all the engineering community (and we too) found and continues finding measures against wear and strives for so-called wearless friction, specialists in Tribo-Fatigue have established that, on the contrary, wear is necessary in some important cases to prolong the life of a Tribo-Fatigue system. Such approach leads to not only improvement of machine reliability but also saving of gross means.

Nowadays some persons enter into struggle with Tribo-Fatigue instead of fight against wear. They appeal to cut costs for Tribo-Fatigue studies, not to introduce a course of Tribo-Fatigue in higher schools, not to establish a specialization on Tribo-Fatigue, and not to develop machines for wear-fatigue tests...

In this connection I would like to remember how protective was attitude of Francis Bacon to science. He wrote that, if only science itself would yield no use, one could not call it vain; if only it would sharpen a mind and make an order in it. Nowadays the purpose of science is to serve people. Such was the Lev Tolstoi's opinion. Is it possible to disagree? There is no doubt that Tribo-Fatigue already serves and will serve people...

...What is Tribo-Fatigue really?

Some tribologists assert that Tribo-Fatigue is a new scientific direction in tribology; in my opinion, they are right only partly. The reason is that they take into account only one side of the coin, i. e. effect of cyclic loads on variations in friction and wear resistance characteristics. It is this issue that corresponds to traditional views and scientific interests of an ″ingrained tribologist″.

On the contrary, when strength scientists assert that Tribo-Fatigue is a new scientific direction in fatigue fracture mechanics, in my opinion, they are also right only partly. One of the reasons is that they consider only one (naturally, another than tribologists) side of the coin, i. e. effect of friction and wear processes on variations in fatigue resistance characteristics. It is this issue corresponds to the

traditional views and scientific interests of an ″ingrained strength scientist″.

However, if one overcomes the cognitive-psychological barrier that separates narrow specialists and takes into account both peer sides of the coin in their indissoluble unity, he comes to the fact that two new scientific directions have arisen at the interface of tribology and fatigue fracture mechanics. They are dialectically united and form a basis for new science – Tribo-Fatigue. As for any science, Tribo-Fatigue has its own subject of the study (Tribo-Fatigue systems), methods of study (wear-fatigue testing), and models and criteria (complex indexes of wear-fatigue damage). Tribo-Fatigue ″stands on the shoulders″ of such scinces as tribology, fatigue fracture mechanics, and reliability of mechanical systems and it does not belittle significance of the sciences, which are the sources of Tribo-Fatigue; it rather proves vital force and power of the new scince. Let us remember Isaak Newton's words: ″If we saw farther than others, it was only because we stood on the shoulders of giants″. Specialists in Tribo-Fatigue have already proven that they see farther than others.

Tribo-Fatigue: 2000. To this moment, results have been achieved in Tribo-Fatigue that are estimated by the II International Symposium on Tribo-Fatigue (Moscow, 1996) as priority ones. Here I list only briefly some achievements in this field:

– new methods and procedures of wear-fatigue testing have been proposed and experimentally implemented;

– basic regularities of wear-fatigue damage have been experimentally studied (the direct and back effects);

– some theoretical problems have been formulated and solved; their generalization has allowed us to formulate foundations of mechanics of wear-fatigue damage and fracture;

– a practical problem on control over processes of wear-fatigue damage is formulated and solved as applied to developed Tribo-Fatigue systems of machinery and equipment;

– first summarizing books on Tribo-Fatigue have been prepared and issued;

– a number of standards in the field of Tribo-Fatigue have been developed, certified, and introduced;

– several modifications of SI series machines for wear-fatigue testing of materials and models of Tribo-Fatigue systems have been developed.

And now some words about prospects that were pointed at the II International Symposium on Tribo-Fatigue [4].

(A) In theoretical direction, evolution of Tribo-Fatigue will be governed by profound understanding of the main regularities of wear-fatigue damage of materials, conditions of achieving the limiting states of Tribo-Fatigue systems, and search for new principles and methods for predicting durability and preventing emergencies in operation of complex engineering devices for important purposes.

(B) In practical aspects, evolution of Tribo-Fatigue leads to transition from design of single machine parts to life design of Tribo-Fatigue systems. A complex of methods for control over wear-fatigue damage of concrete Tribo-Fatigue systems has to be developed and introduced to save labour, costs, and materials in fields of production and exploitation of modern machinery with improved durability.

(C) In the field of improving testing equipment, evolution of Tribo-Fatigue leads to development and introduction of new and high methods and technologies for wear-fatigue testing, including accelerated testing, and to creation of a new class of testing machines on this basis.

(D) In the field of developing technological normative documents, evolution of Tribo-Fatigue yields development and introduction of a complex of standards for methods of wear-fatigue testing. Subsequently, it will allow one to formulate and solve a problem of certification of Tribo-Fatigue systems by the most vital criteria of serviceability.

(E) In the field of staff training, evolution of Tribo-Fatigue necessitates the discipline ″Foundations of Trib-Fatigue″ (Dynamics, strength, and wear resistance of machines, instruments, and equipment) to be introduced in curricula of machine-building higher schools. The question is ripe on introduction of this speciality for training of research and technical staff.

(F) In the scientific-organizing field, evolution of Tribo-Fatigue results in creation and export of science-intensive production such as new and high testing methods, principally novel testing machines, and new standards.

In October, 2000 scientists from many countries summarized achievements of Tribo-Fatigue at the III International Symposium on Tribo-Fatigue (Beijing, China) for fifteen years [5]. Generalizing monograph [6] was published, which was written by specialists from Belarus, Ukraine, Russia, and China. Below I give a short citation from the foreword of its authors.

″Five of us participated the III International Symposium on Tribo-Fatigue in Beijing, October, 2000, but all we presented reports″. Five other colleagues not only presented their reports, but were also involved in organization of two previous symposiums. Though our reports were partly presented as separate ones, we had a common task: to favor evolution of Tribo-Fatigue by carrying out our own studies. Now we have united our results and we guess there is a whole that is called Tribo-Fatigue.

It is an arduous task for six researchers to write a monograph, even though they belong to one team. Although we were separated by borders and great distances, we wrote it quite easily, cause we were inspired by the problem, which was, in our opinion, of tremendous practical significance for modern machine-building.

The bibliography on Tribo-Fatigue for 1995–2000 [7] includes only the papers, whose issue is related to Gomel in any case and, of course, to complex of research and development works on Tribo-Fatigue carried out in Belarus. It comprises over two hundred scientific papers and their almost 70 authors are researchers and engineers from over 50 organizations.

Thus, we may assert that Tribo-Fatigue is a new and thriving domain of mechanics.

We are eyewitnesses of amalgamation of independent scientific disciplines into a new more general and complex discipline. This is another example of generalizing trends in the current stage of science evolution: from the particular to the general.

And now a few words about prospects in Tribo-Fatigue methodology. During the recent years, ideas of Tribo-Fatigue have been used to analyze life of biological objects, especially human being [8]. Life is considered as a specific mode of damage accumulation; foundations of quantitative analysis in dialectics have been developed. Thereby, Tribo-Fatigue becomes useful for the humanities.

Not long ago I have happened to see the first ″toy from Tribo-Fatigue″; it was a wonderfully interesting mechanism for modelling of wear-fatigue damages. A theory of such modelling has not yet been created, hence, no ″toys from Tribo-Fatigue″ exist. But as I am acquainted with specialists in this domain, I am sure that such theory will be developed. An I hope that new and unexpectable for the present results will be obtained.

Tribo-Fatigue: 2005. I said in my report [9] at the 5th International Symposium on Tribo-Fatigue (Irkutsk, 2005): *″I am written these words not as a detached observer and not as a specialist who investigates history of science, but as a direct participant of main events related to origin, evolution, and formation of a new science, i. e. Tribo-Fatigue*.

Belarus has become the cradle of Tribo-Fatigue. However, Moscow, Beijing, and Kiev also made very much for its maturation and recognition by the community of scientists and engineers. Nevertheless, Gomel was and has remained for two decades the starting point on the path of Tribo-Fatigue: here fundamental experiments were carried out, new concepts were formulated, and fundamental theoretical results were obtained. Here, at the Belarus State University of Transport the first unforgettable International Symposium on Tribo-Fatigue was organized in 1993 [10] and Tribo-Fatigue got full-grown status of a academic discipline for future mechanical engineers [11]. Finally, it was Gomel where at the Production Association "GOMSELMASH" the first industrial laboratory on Tribo-Fatigue was created. All this is based on indubitable merit of Prof. L. A. Sosnobskiy, whose 70th anniversary we observed last year 2005, like the 20th anniversary of the birth of Ttribo-Fatigie″.

I would like to pay readers' attention to brief paper [12], which was published at the ″beginning″ of Tribo-Fatigue in 1990 and which became a program document of evolution of Tribo-Fatigue. Below I quote a passage from this work.

″…Evolution of up-to-date engineering poses a new urgen problem for science – a problem of complex assessment of the limiting state of units that are characterized by various combinations of damagind phenomena; such units are called Tribo-Fatigue systems …

…In general case complex assessment of the damage and limiting state of Tribo-Fatigue systems of modern machinery can be made based on a principally new approach… Such approach should comprise corresponding achievements in the theory of reliability of mechanical systems, tribology, fatigue fracture mechanics, erosion fracture mechanics, mechanics of continua, mechanics of continuous and local damage, materials science, physics, chemistry, and thermodynamics. The range of objects of study here is vast: any modern machine contains at least one Tribo-Fatigue system, whose serviceability depends on the above phenomena. From the practical viewpoint, the aim is to solve the problem of a great economical significance, i. e. reduction of labour, cost, and material consumption for production and maintenance of modern machinery and simultaneous improvement of their service reliability.

The new approach to complex assessment of Tribo-Fatigue systems using the above criteria is called Tribo-Fatigue. It corresponds to one of the main trends of modern evolution of sciences, i. e. Integration of single sciences that deal with particular objects or phenomena into complex sciences, which deal with an interrelated unity or system of objects or phenomena.

Evolution of Tribo-Fatigue, like any science, will be governed, first of all, by formulation and solution of complex theoretical problems of great practical significance. In addition, it is necessary to carry out extensive experimental studies to find corresponding regularities of resistance of materials under conditions of multicomponent effect and estimate the accuracy of theoretical dependences. Vast experimental studies are possible provided that a new class of testing equipment, i. e. machines for wear-fatigue testing of materials and units under conditions close to operating ones…

…As for theoretical results, some most general problems can be pointed out, in our opinion. It is believed that the following measures will be necessary:

1) a new approach to subsequent evolution of particular sciences – tribology, fatigue fracture mechanics, and erosion fracture mechanics – to provide their close interaction…

2) to perceive, how study of particular sciences and their evolution due to interaction, can yield a qualitatively new result – complex criteria of serviceability of Tribo-Fatigue systems;

3) to provide such unity of analysis and synthesys and such profound unity of particular sciences, which would substantiate development of Tribo-Fatigue as a whole with its proper united features…;

4) to develop general principles for elucidating role of methods and criteria of particular sciences for estimating damage and the limiting state of objects that operate under certain conditions…;

5) to implement a system approach to optimal design of Tribo-Fatigue systems by criteria of Tribo-Fatigue with account for the effect of all the variety of governing factors on their serviceability...;

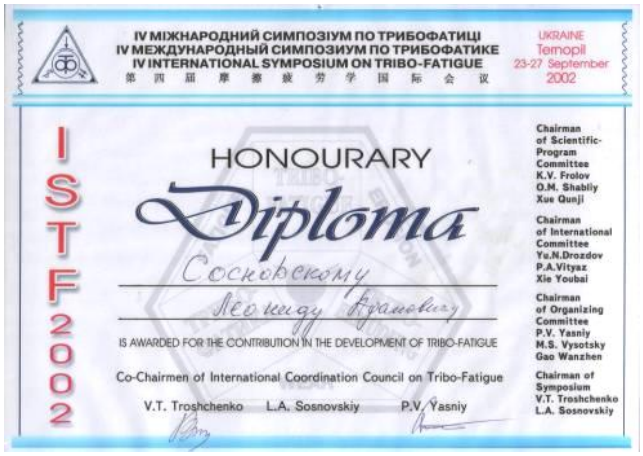
6) to formulate and solve a problem of optimization of Tribo-Fatigue systems to provide their requited life with minimal consumption of labour, cost, and materials in domains of production and maintenance…″.

Time has shown that program document [12] turned to be perspicacious and vital: essentially, all subsequent 15 years were devoted to implementation of problems formulated in the document. We refer readers to papers [3, 9, 13, 14] for concrete study results.

The symposium in Irkutsk has become, in my opinion, not only the next but a jubilee milestone in history of Tribo-Fatigue: five symposia, the 20th anniversary of Tribo-Fatigue, and the 70th anniversary of its founding father.

In this connection I would like to tell about one episode, which happened during the 4th International Symposium on Tribo-Fatigue in Ternopol. Following the tradition established at the International Symposium on Tribo-Fatigue in 1996 in Moscow, the event was completed by investiture of Honorary Diplomas ″For Contribution to Tribo-Fatigue″. At that moment one of the participants D. Sc., Prof. G. V. Tsybanev asked for the floor and made an unexpectable offer: to award to Prof. L. A. Sosnovskiy such a diploma. Prof. Sosnovskyi made a grounded objection: he paid attention of participants to the fact that he signed the diplomas together with other chairmen, so that it was improperly to award himself. The ″problem″ was immediately solved. The name of Prof. Sosnovskyi was inserted into the

blank, which was signed overleaf by representatives of various organizations that participated actively the symposium. The photo of this unusual document presented here one can see not only the signatures but also a figurative estimate: ″To a romantic from the science highway″. I believe that it is the highest honour and award for a scientist to merit such recognition of the colleagues.



Some Results of Evolution of Tribo-Fatigue: 2010. Let me repeat: some materials about history of Tribo-Fatigue can be found in papers [3, 9, 13, 14]. A set of statements of famous scientists and organizers of Tribo-Fatigue will be issued to the coming jubilee symposium and chronology of stages of evolution of Tribo-Fatigue will be presented. The chronology comprises only the events, which can be characterized as pioneering ones. Readers will see that we come to the next ″double″ jubilee – 25 years of evolution of Tribo-Fatigue and the 75th anniversary of its founding father – with spectacular progress.

I would like to recollect organization stages of evolution of Tribo-Fatigue. First there was the Scientific-Production Association ″TRIBO-FATIGUE″, Ltd., which exists nowadays. Subsequently, the Tribo-Fatigue Laboratory was established under the double authority (Research Center of Problems in Mechanics of Machines of the National Academy of Sciences of Belarus and the Head Special Design Bureau of the Production Association ″GOMSELMASH″). It was established under the auspices of Academician M. S. Vysotskii and D. Sc. V. A. Shurinov. The next step was the Tribo-Fatigue Laboratory of the Joint Institute of Machine Building (established under the auspices of Academician M. S. Vysotskii), the Laboratory of Dynamics, Strength, and Wear Resistance of the Ya. Kupala Grodno State University (created by D. Sc. A. V. Bogdanovich), and the Industrial Laboratory of Wear-Fatigue Testing (created by the director general of the Production Association ″GOMSELMASH″ Ph. D. V. A. Zhmailik). And, finally, four years ago Academician P. A. Vityaz, Corresponding Member L. G. Krasnevskii, Ph. D. (Eng.) V. A. Zhmailik, Prof. V. I. Senko, and Prof. L. A. Sosnovskyi advanced a proposal to establish the Inter-Agency Laboratory ″Tribo-Fatigue″, which joins specialsits from science, industry, and education (the Joint Institute of Machine Building of the National Academy of Sciences of Belarus, the Belarus State University of Transport, the Production Association ″GOMSELMASH″, the Ya. Kupala Grodno State University, the Brest State Technical University, the Republican Unitary Enterprise ″GOMELTRANSOIL DRUZHBA″, and the Republican Unitary Enterprise ″Head Special Design Bureau for Grain and Forage Combines″) to solve urgent interdisciplinary problems. The protocol on establishment of the Laboratory was signed by the President of the National Academy of Sciences of Belarus, the Minister of Education of the Republic of Belarus, the Minister of Industry of the Republic of Belarus, and the Chairman of the State Committee for Science and Technologies of the Republic of Belarus.

By now, over 500 papers on Tribo-Fatigue have been published, over 20 books and monographs have been issued, and seven state standards have been developed, including three intergovernmental standards. Eighteen patents have been obtained and five tutorials for technical universities have been issued, including the two-volume course of lectures certified by the Ministry of Education of the Republic of Belarus. During the recent eight years, seven Ph. D. theses and one D. Sc. (A. V. Bogdanovich) have been defended. Five international symposia were organized in four countries (Gomel (1993), Moscow (1996), Beijing (2000), Ternopol (2002), and Irkutsk (2005)). One hundred and twenty scientists from various countries have been awarded with the Honorary Diploma ″For Contribution to Tribo-Fatigue″, including 16 scientists from Belarus. Since 1996, the International Coordination Council on Tribo-Fatigue acts, which was established by Academies of Sciences of Belarus, Russia, and Ukraine (co-chairmen are N. A. Makhutov, L. A. Sosnovskiy, V. T. Troschenko, and Gao Wanzhen). A training course on Tribo-Fatigue has been introduced in five universities of Belarus (Belarusian State University of Transport, Belarusian State University, Belarusian State Technical University, and others); it is intended for future engineers and mathematicians-mechanicians. Full tutorial and methodological provision of the course has been developed.

On Prospects in Tribo-Fatigue. In 2007 the monograph ″Mechanics of Wear-Fatigue Damage″ by L. A. Sosnovskiy was published [15]. I think it is useful to give here the very capacious conclusion to this book.

″I know and readers see that something is presented in this book not in such strict manner as it has to be done from the viewpoint of mechanics and as I would like to do it. But I think that the benefit of this book is

not in the fact how much it contains but in the issues following from its content.

Experimental mechanics of Tribo-Fatigue systems; problems of the theory of elasticity supplemented with consideration of local effects in the area of load application; problems of contact mechanics supplemented with the effect of various off-contact forces; *a deformation approach to analysis of friction in Tribo-Fatigue systems*; *mechanics of local and wave-like damages as sources of the vibration-impact process (the troppy phenomenon); a complex of experimental and theoretical studies of diverse Λ-interactions in systems at any scale levels; the theories of limiting and overlimiting (overcritical) states of systems and their elements; finally, mechanothermodynamics and, possibly, a united theory of evolution… And moreover: life as a specific mode of accumulation of damages – physical, biochemical, and intellectual…*

A lot of work".

One can say here: "No comment". I can only add with proud that I am happy to be involved, though little, in origination and evolution of Tribo-Fatigue.

Tribo-Fatigue for Mechanics and Machine Building. The above presented misses two elements, in my opinion. First, it is a question what is properly Tribo-Fatigue and what it gives to mechanics and machine building. In Paragraph 2 of the present paper I made an effort to answer briefly this question from the observer's viewpoint; however, it seems to be necessary to elucidate this issue from the viewpoint of a specialist in Tribo-Fatigue. Second, the above text contains only an allusion to human factor, but I know that the process of evolution of Tribo-Fatigue was quite expressive. I guess, I will be capable of fill these blanks partially by presenting the protocol made by Ph. D. V. N. Stukachev and Ph. D. V. A. Vereschagin. It is a conclusive speech of Prof. L. A. Sosnovskiy at the extended meeting of academic cuncils of two academic institutes, namely, the Research Center for Problems in Mechanics of Machines and the Institute of Reliability and Durability of Machines. It took place on January 27, 1996 in Minsk under the chairmanship of Academician M. S. Vysotskii and Corresponding Member O. V. Berestnev. A team of known scientists from the Russian Academy of Sciences headed by the Vice-President of the Russian Academy of Sciences Academician K. V. Frolov participated the meeting. Main results of studies on Tribo-Fatigue and problems of their development were discussed in accordance with the "Program of International Complex of Research and Development on Tribo-Fatigue" approved by Academies of Sciences of Russia, Belarus, and Ukraine in 1995. Below I present a citation of the conclusive speech.

"ON TRIBO-FATIGUE. Today is Saturday, a day off. Of course, everybody had its own weekend plans. It would be expected that in our vague time "another scientific meeting" will be of little interest, especially as it was announced only one or two days before, while one may plan its weekend during a few weeks. However, the hall is full, we have been working already more than two hours and no one said: "Please, order a recess!" The reason is that all of us came here to listen to each other and know something new. Your questions and speeches were interesting to those present as the report. Today the words of great Gete are consonant with our mood: *"If you invent something, it is remarkabke, but if one understands and appreciates the things created by others, it is as important than its own inventions"*. And another his idea that is close to us now: *"To listen the opinions of other is almost the same as to visit other countries and epoches"*.

In conclusion I would like to speak a few words about Tribo-Fatigue.

During recent years, some tribologists consider Tribo-Fatigue as a direction of tribology only. Some strength scientists treat it as one of directions in fatigue fracture mechanics or, that is the same, in strength of materials. Indeed, these tribologists consider Tribo-Fatigue as their own science more ardently than strength scientists. The reason is simple: the well-known term *"**tribo**"* meaning friction (from Greek) occupies the honorary first position in the word "Tribo-Fatigue". Whereas "fatigue" occupies the minor position. Really, *in general sense, the terms making up the word "Tribo-Fatigue" are of equal right and meaning.*

Tribo-Fatigue relates to tribology no more than to fatigue fracture mechanics. *For example, the direct effect can be studied by strength scientists, while the back effect can be studied by tribologists*. Alteration of interests is inconceivable: tribologists are not interested in the fatigue strength of a crankpin, whereas strength scientists do not deal with the wear rate of the sliding bearing in a connecting rod head. However, significances of these effects are close: both decrease in the endurance limit under the effect of friction forces and increase in the wear rate under the effect of cyclic stresses 1.2–2 times are a common thing. *A specific difference of experts in Tribo-Fatigue from tribologists and strength scientists is that they are worried by both factors – the direct and back effects.*

This yields substantial differences in experimental methods and testing equipment used. Tribologists develop and apply methods and machines for testing materials and models of friction units under various conditions of contact, specialists in fatigue fracture mechanics develop and use methods and machines for testing materials and structure elements under various conditions of cyclic-loading, while *specialists in Tribo-Fatigue create methods and machines for wear-fatigue testing of materials and models of Tribo-Fatigue systems.* The difference is as follows: friction machines are unsuitable for studying the fatigue resistance, machines for fatigue testing are inapplicable for studying friction and wear processes, whereas machines for wear-fatigue testing are applicable for investigating both factors as well as carrying out complex testing under various combinations of contact and cyclic loads.

It is known that theory rests upon experiment. That's why tribologists are based on their experience and deals only with contact mechanics and strength scientists are based on their experience and investigate only mechanics of deformation and fracture. Specialists in Tribo-Fatigue deal with both issues, moreover, in their indissoluble

unity. It is for this reason that *both have their specific objects of study: strength scientists investigate independent structure elements, tribologists study friction units, and specialists in Tribo-Fatigue deal with Tribo-Fatigue systems.*

Now let us speak now of aims. The main aim of scientists in fatigue fracture mechanics is to fight against fatigue failures; prediction and prevention of such failures is the summit of their achievements. The main task of tribologists is to fight against wear; attainment of almost wearless friction is the culmination of their desires. *The main aim of specialists in Tribo-Fatigue is to control over processes of wear-fatigue damage in order to provide the optimal – from the engineering and economical viewpoint – life of a certain Tribo-Fatigue system*. They try to use both wear and fatigue damage during operation of an article to prolong its life. The matter is simple. Tribologists consider cyclic stresses as a damaging factor. Strength scientists, in their turn, consider wear as a damaging factor. Specialists in Tribo-Fatigue believe that friction, wear, and fatigue are the phenomena, whose kinetic interaction, depending on conditions, may result in either acceleration of material degradation or almost spontaneous and long retaining of the material carrying capacity. Understanding of conditions and mechanisms of these processes yields a simple key for control over them.

Traditional design of a machine included and includes now calculation of main (particular) parts for strength and wear resistance as the most important element. Specialists in Tribo-Fatigue believe that the moment came to create methods of calculating and designing mechanical systems, i. e. the above parts but with account for their real interaction. *A new principle of designing the most important Tribo-Fatigue systems of machines will allow one to estimate more accurately and to provide the required operational reliability with minimal cost.*

It is always difficult at the interface of sciences: it is too much new and often unusual, too hard is pressure of old and, as a rule, already ineffective, and chains of traditional thinking are terrible! Who will the winner? There is no such a question now; perhaps, all is predetermined. There are the obsessed that suffer much from foul envy of ones, from stupid incomprehension of others, and from barefaced counteraction of both, but especially, from indifference of many. Indifferent people do not lend a helping hand, when one falls, but they hold both hands without saying a word to get something one can give them, though it would be useless for them... how diverse and contradictory is the nature of human being! Otherwise progress would not take place.

In the womb of time, all will end – sorrow of envious people, cobwebs of fools, swampy rest of indifferent people, and trepidation of possessed people. But the things that were born and passed through them in struggle will alive. And that is good″.

…I am sure that one day the history of Tribo-Fatigue studying all aspects of its origin, formation, and evolution will be written; I think that due attention will be paid in it to fight of opinions and human factor.

…It occurred that my report consists of the Russian and English texts. The known logo of Tribo-Fatigue also uses these languages. However, I think that Chinese would be also used in the logo of Tribo-Fatigue since from 2000 China has become the first higly intelligent country on the way of Tribo-Fatigue abroad. This jubilee symposium shows that the most representative team from abroad is the delegation of Chinese scientists headed by Prof. Gao Wanzhen, a co-chairman of the International Council of Tribo-Fatigue. I believe that the Council would accept my offer officially.

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11. **Sosnovskiy, L. A.** Fundamentals of Tribo-Fatigue / L. A. Sosnovskiy. – Gomel, 2003. – V. 1. – 246 p.; V. 2. – 234 p.

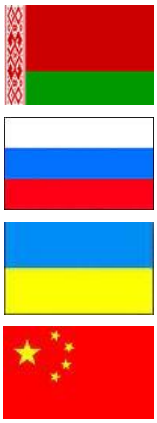
12. Tribo-Fatigue : New Ideas in Promising Direction / K. V. Frolov [et al.]. – Gomel : BIRE. – 1990. – 7 p.

13. **Kukharev, A. V.** Some stages of progress of Tribo-Fatigue / A. V. Kukharev // ISTF 2000: Proc. of the III International Symposium on Tribo-Fatigue, Beijing, China, October 22–26, 2000. – Beijing : Hunan Universiry Press, 2000. – P. 179–182.

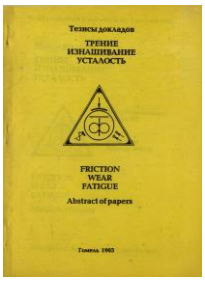
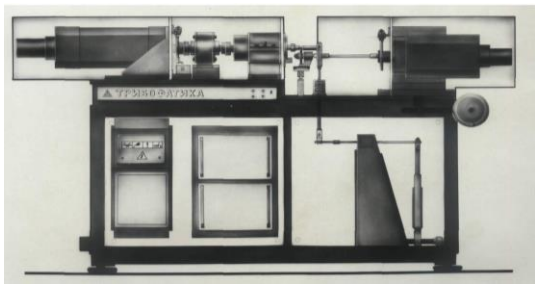
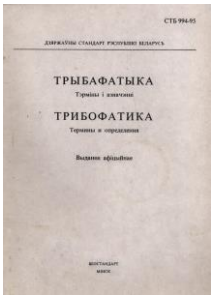
14. **Kukharev, A. V.** Some Stages of Evolution and Prospects in Tribo-Fatigue / A. V. Kukharev // ISTF 2002: Proc. of 4th International Symposium on Tribo-Fatigue, September 23–27, 2002, Ternopol, Ukraine. – Ternopol, 2002. – V. 1. – P. 72–78.

15. **Sosnovskiy, L. A.** Mechanics of Wear-Fatigue Damage / L. A. Sosnovskiy. – Gomel : BelSUT, 2007. – 434 p.

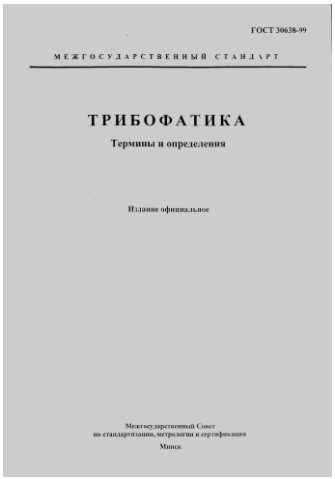
SOME EVENTS AND MAIN STAGES OF TRIBO-FATIGUE EVOLUTION

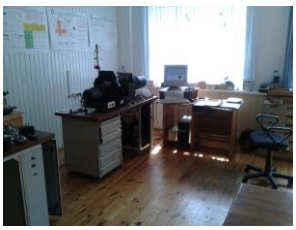


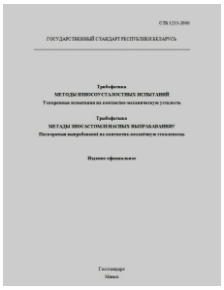
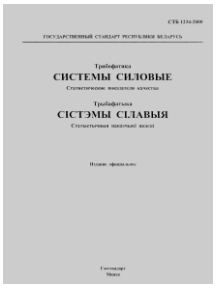
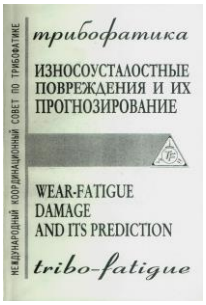
1984, September 29	The term "Tribo-Fatigue" was suggested (in a letter from L. A. Sosnovskiy to K. V. Frolov)	
1986	The term "Tribo-Fatigue" first appears in a publication (Abstracts of the Republican Scientific and Technical Conference, Minsk, November 20–21, 1986). – Minsk : The Research Institute of the Belarusian Academy of Sciences, 1986. – 29 p.)	
1986/87 academic year	First several lectures on Tribo-Fatigue are delivered (L. A. Sosnovskiy) for the students of the Belarusian Institute of Railway Engineers (BIRE) in the course of railway track reliability (initiated by V. I. Matvetsov)	
1988	First methodological guides how to learn Tribo-Fatigue are published (L. A. Sosnovskiy, A Comprehensive Assessment of Reliability of Active Systems from the Criteria of Resistance to Fatigue and Wear (Fundamentals of Tribo-Fatigue). – Gomel : BIRE, 1988. – 56 p.)	
1989, November 28	The first Tribo-Fatigue award (L. A. Sosnovskiy is awarded a Silver Medal of the USSR Economic Achievements Exhibition "For development of methodological and theoretical principles of Tribo-Fatigue")	
1990, September 5	The first all-union round table of scientists and specialists "Problems of Tribo-Fatigue" (Gomel, chairmen N. A. Makhutov and L. A. Sosnovskiy)	
1990	The first scientific Tribo-Fatigue program is published (*Frolov, K. V.* Tribo-Fatigue : New Ideas in a Promising Trend / K.V. Frolov [et al.]. – Gomel, 1990. – 7 p.)	
1992	A separate research engineering project "Tribo-Fatigue" is approved in the Republic of Belarus	
1992, August	A limited liabilities company TRIBOFATIGUE is set up, later in 1994 transformed into a research and production Group (TRIBOFATIGUE S&P Group)	

1993, September 14–17	The I International Symposium on Tribo-Fatigue takes place (Gomel, Belarus). The first press-conference (K. V. Frolov and L. A. Sosnovskiy) devoted to Tribo-Fatigue (14.09)    
1994	The TRIBOFATIGUE S&P Group develops a prototype of a multipurpose SI machine for wear-fatigue tests of materials and models of Tribo-Fatigue systems, the first representative of new family of testing equipment advanced within the framework of Tribo-Fatigue. The coefficient of technical level of SI machine is K_{TL} = 2,39 (world level matching conditions $K_{TL} \geq 1$)  
1994	A.V. Bogdanovich defended the Ph. D thesis (*Bogdanovich, A.V.* Laws and Hypotheses of Fatigue Damage Accumulation and Assessment of Durability of Machine Parts : Ph. D. thesis : 01.02.06 / A. V. Bogdanovich. – Minsk : Institute of Machine Reliability, 1994. – 283 p.) 
1995, June	Vice-presidents of Academies of Sciences of Russia (K. V. Frolov), Belarus (M. S. Vysotsky) and Ukraine (V. G. Barjahtar) authorize the first "The Plan of the International complex of research and development on Tribo-Fatigue"
1995, September 30	The Belstandart (chairman V. N. Koreshkov) approves the first Tribo-Fatigue standard: *STB 994-95. Tribo-Fatigue. Terms and Definitions*, – Introduced 01.07.1996. – Minsk : Belstandart, 1995. – 98 p. Developer: TRIBOFATIGUE S&P Group 
1995, December	A Tribo-Fatigue Laboratory is set by two institutions, the Industrial Machine Building Scientific Center of the problems of mechanics and machinery of the Belarusian Academy of Sciences and the Designing Bureau of the PG Gomselmash (the order is signed by M. S. Vysotsky and V. A. Shurinov). L. A. Sosnovskiy is nominated the leader of the Laboratory

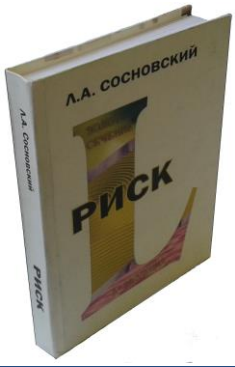
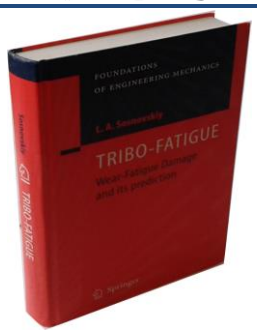
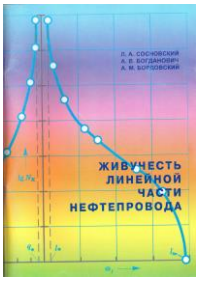
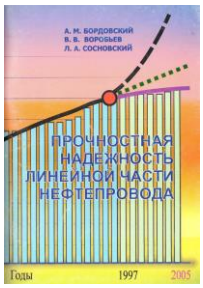
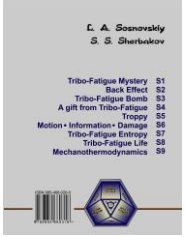
1996	The following publications appear: the first annual "Tribo-Fatigue" (Tribo-Fatigue-95: annual / ed. by L. A. Sosnovskiy // Issue 1 : SI-series Machines for Wear-Fatigue tests / ed. by M. S. Vysotsky. – Gomel : TRIBOFATIGUE S&P Group, 1996. – 80 p.); the first four-language glossary of terminology on Tribo-Fatigue (Tribo-Fatigue. Трыбафатыка. Tribo-Fatigue. Triboermüdung / ed. by L. A. Sosnovskiy. – Minsk – Gomel : TRIBOFATIGUE S&P Group, 1996. – 138 p.); scientific essays written by 17 eminent scientists and science organizers (Some Words about Tribo-Fatigue / ed. by A. V. Bogdanovich. – Gomel – Minsk – Moscov – Kiev : Remika, 1996. – 132 p.)    The course "Fundamentals of Tribo-Fatigue" is incorporated into the curriculum of the Belarusian State University of Transport (BelSUT) (upon of V. I. Senko initiative)
1996, October 15–17	The II International Tribo-Fatigue Symposium (Moscow, Russia) takes place       
1996, December 20	The Academies of Sciences of Russia, Belarus and Ukraine set up an International Coordinative Council on Tribo-Fatigue (co-chairmen: N. A. Makhutov, L. A. Sosnovskiy, V. T. Troshchenko, and Gao Wanzhen (from 1999)) 

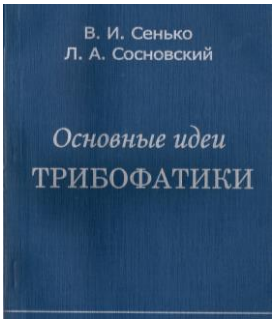
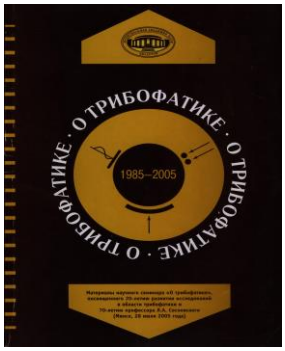
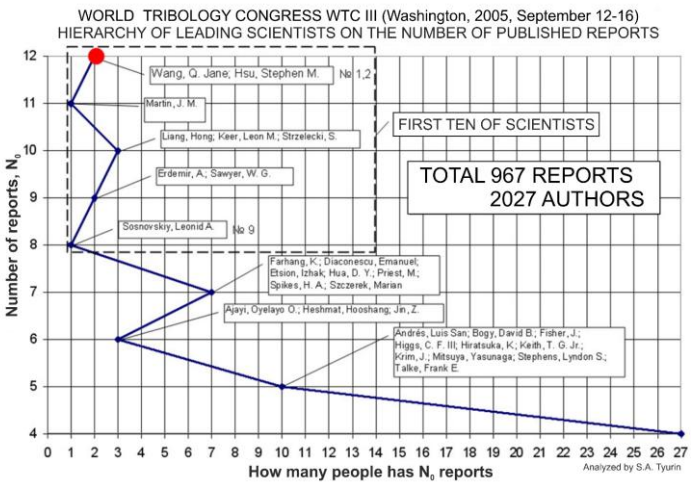
	For the first time a group of Ukrainian and Belarusian scientists (the scientific coordinator V. T. Troshchenko) is awarded the State Prize of Ukraine in the sphere of science and technology (L. A. Sosnovskiy's contribution relates to the works on Tribo-Fatigue)	
1997	Created the first examples of specialized modular machines for standard wear-fatigue tests (SI-01 – for mechano-sliding fatigue tests, SI-02 for mechano-rolling fatigue tests). This – table-top machines designed for mass standard wear-fatigue tests  	
1998, May 14	The Extraordinary and Plenipotentiary Ambassador of the People's Republic of China to Belarus U Syaotsu visits the TRIBOFATIGUE S&P Group that ushers scientific and technological cooperation between China and Belarus in the sphere of Tribo-Fatigue	
1998	P.O. Sukhoy Gomel State Technical University includes the course "Fundamentals of Tribo-Fatigue" into its curriculum (upon initiative of the rector A. S. Shaginyan)	
1999	The first interstate Tribo-Fatigue standard is approved: *GOST 30638-99 Tribo-Fatigue. Terms and definitions*. – Introduced 01.01.2000. – Minsk : Interstate council for standardization, metrology and certification : Belarusian state institute of standardization and certification, 1999. – 17 p. The organizations – developers: TRIBO-FATIGUE S&P Group (Gomel), IMAS RAS name A. A. Blagonravov (Moscow), IPP NASU name G. S. Pisarenko (Kiev)	 ГОСТ 30638-99 МЕЖГОСУДАРСТВЕННЫЙ СТАНДАРТ ТРИБОФАТИКА Термины и определения Издание официальное Межгосударственный Совет по стандартизации, метрологии и сертификации Минск
	A monograph is published in which the methodology of Tribo-Fatigue is applied for the first time to analyzing life as a specific way of damage accumulation (*Sosnovskiy, L. A.* Tribo-Fatigue: Dialectics of Life / L. A. Sosnovskiy. – Gomel: BelSUT, 1999. –116 p.)	 Л. А. СОСНОВСКИЙ ТРИБОФАТИКА: О ДИАЛЕКТИКЕ ЖИЗНИ

1999	The first industrial Tribo-Fatigue laboratory is set up "laboratory for Wear-Fatigue Tests" at the Central Laboratory of the PG Gomselmach (the order is signed by V. A. Zhmailik). V. O. Zamyatnin is nominated the Leader of laboratory   
	Created the first fully complete machine SI-03 for the wear-fatigue tests on mechano-sliding and mechano-rolling fatigue. It is designed to test models of heavily loaded contact interaction (Tribo-Fatigue systems) in a wide range of loading conditions  
2000, October 22-26	The III International Tribo-Fatigue Symposium (Bejing, China) takes place   
2000	A monograph, which gives main results of theoretical and experimental studies of complex damages and limiting state of active systems in fretting-fatigue, mechano-sliding, mechano-rolling and mechano-corrosion fatigue (*Sosnovskiy, L.A.* Tribo-Fatigue: Wear-Fatigue Damage in the Problems of Resource and Safety of Machines / L. A. Sosnovskiy, N. A. Makhutov. – Moscow – Gomel : FCNTP "Security" – TRIBOFATIGUE S&P Group, 2000. –304 p.) was published 

2000	Approved standards of Belarus: 1) *STB 1233-2000. Tribo-Fatigue. Wear-Fatigue Tests Methods. Accelerated Mechano-Rolling Fatigue Tests.* – Introduced 01.01.2001. – Minsk : Gosstandard, 2000. – 8 p.; 2) *STB 1234-2000. Tribo-Fatigue. Active Systems. Statistical Exponents of Quality.* – Introduced 01.01.2001. – Minsk : Gosstandard, 2000. – 25 p.	 
2001	The scientists of Belarus, Russia, Ukraine and China publish the first international Tribo-Fatigue monograph (Wear-Fatigue Damage and its Prediction (Tribo-Fatigue) / L. A. Sosnovskiy [et al.]. – Gomel – Moscow – Kiev – Uhan, 2001. –171 p.)	
	Approved interstate standards: 1*) GOST 30754-2001. Tribo-Fatigue. Wear-Fatigue Tests Methods. Mechano-Rolling Fatigue Test.* – Introduced 01.07.2002. – Minsk : Interstate council for standardization, metrology and certification : Belarusian state institute of standardization and certification, 2002. – 32 p.; 2) *GOST 30755-2001. Tribo-Fatigue. Wear-Fatigue Tests Machines. General Technical Requirements.* – Introduced 01.07.2002. – Minsk : Interstate council for standardization, metrology and certification : Belarusian state institute of standardization and certification, 2002. – 8 p	 
2002	The first publication about Tribo-Fatigue in the encyclopedia (*Tribo-Fatigue.* – Minsk : Byelorussian Encyclopedia, 2002. – V. 15. – P. 542)	
	V. A. Zhmailik defended the Ph. D. thesis (*Zhmailik, V. A.* Strength Aspects of an Estimation and Normalization of Active Systems Quality ; Ph. D. thesis : 01.02.06 / V. A. Zhmailik. – Gomel : BelSUT, 2002. – 159 p.), which first built multi-level evaluation system of indicators of quality, risk and reliability of Tribo-Fatigue systems	
	V. V. Vorobjov defended the Ph. D. thesis (*Vorobjov, V. V.* Aspects of Service Loading and Damage of Linear Parts of Pipeline : Ph. D. thesis : 01.02.06 / V. V. Vorobjov. – Gomel : BelSUT, 2002), which first showed that the operation of the pipeline to a certain extent is determined by the high-cycle fatigue	

2002, September 23–27	The IV International Tribo-Fatigue Symposium (Ternopil, Ukraine) takes place	   
2003	The first Tribo-Fatigue textbook is published and approved by the Ministry of Education of the Republic of Belarus for higher school students of engineering (*Sosnovskiy, L. A.* Fundamentals of Tribo-Fatigue. / L. A. Sosnovskiy. – Gomel : BelSUT, 2003. – Part 1. – 246 p.; Part 2. – 235 p.)	
	S. A. Tyurin defended the Ph. D. thesis (*Tjurin, S. A.* Rolling-Mechanical Fatigue : Research Methods and General Laws : Ph. D. thesis : 01.02.06 / S. A. Tyurin. – Gomel : BelSUT, 2003), which first investigated the wave-like damages in roller / shaft Tribo-Fatigue system	
2003, апрель	N. I. Yurchuk and M. A. Zhuravkov at the Belarusian State University propose to deliver a special course of lectures on Tribo-Fatigue for students of mechanics and mathematics (L. A. Sosnovskiy)	
2004	On the suggestion of P. A. Vityaz (Presidium of the Belarusian National Academy of Sciences), L. G. Krasnevsky (the Institute of Mechanics and Reliability of Machines of the Belarusian National Academy of Sciences), V. A. Zhmailik (PG Gomselmash), and V. I. Senko (BelSUT) it has been decided to set up the first Interdepartmental TRIBO-FATIGUE Laboratory (the Protocol was signed by the President of the Belarusian Academy of Sciences M. V. Myasnikovich, the Minister of Industry of the Republic of Belarus A. M. Rusetsky, the Minister of Education of the Republic of Belarus A. M. Radkov, and the President of the State Committee for Science and Technology of the Republic of Belarus Yu. M. Pleskachevsky). L. A. Sosnovskiy was appoints the scientific leader of the laboratory (the order have been signed by M. S. Vysotsky (OIM NASB), V. A. Zhmailik (PG Gomselmash), V. I. Senko (BelSUT), E. A. Rovba (GrSU of Ya. Kupala), A. A. Kostyuchenko (RUE GOMELTRANSOIL DRUZHBA), A. A. Dyuzhev (RUE GSKB on grain-harvesting and forage-harvesting machinery))	 

2004	The monograph is published, in which the methodology of Tribo-Fatigue is applied for the first time to constructing the mechanothermodynamics of irreversible damages (*Sosnovskiy L. A.* L-Risk / L. A. Sosnovskiy. – Gomel : BelSUT, 2004. – 317 p.)	
	The first monograph on Tribo-Fatigue is published in English (*Sosnovskiy L. A.* Tribo-Fatigue. Wear-fatigue Damage and its Prediction / L. A. Sosnovskiy ; Series : Foundations of Engineering Mechanics. – Springer, 2005. –424 p.)	
	Approved standard of Belarus: *STB 1448-2004. Tribo-Fatigue. Wear-Fatigue Tests Methods. Mechano-sliding fatigue tests.* – Introduced 01.09.2004. – Minsk : Gosstandard, 2004. – 14 p.	
	Published books: 1) *Sosnovskiy, L. A.* The Durability of the Linear Part of the Pipeline / L. A. Sosnovskiy, A. V. Bogdanovich, A. M. Bordovskiy. – Gomel : TRIBOFATIGUE S&P Group, 2004. – 112 p.; 2) *Bordovskiy, A. M.* Strength Reliability of the Linear Part of the Pipeline / A. M. Bordovskiy, V. V. Vorobjov, L. A. Sosnovskiy. – Gomel : TRIBOFATIGUE S&P Group, 2004. – 114 p., which set out the main results of calculation and experimental studies on the evaluation and forecasting of efficiency of oil pipeline "Druzhba"	 
2005	A monograph "Surprises of Tribo-Fatigue" is published, which describes surprises of Tribo-Fatigue – associated with damage and destruction of the active system events, situations, laws which can not be seen to understand analytically describe the basis of traditional idea (*Sosnovskiy, L. A.* Surprises of Tribo-Fatigue / L. A. Sosnovskiy, S. S. Sherbakov. – Gomel : BelSUT, 2005. – 192 p.). In 2009 republished in English (*Sosnovskiy, L. A.* Surprises of Tribo-Fatigue / L. A. Sosnovskiy, S. S. Sherbakov. – Minsk : Magic book, 2009. –200 p.)	   

<table>
<tr><td rowspan="3">2005</td><td>First Doctor of Sciences dissertation is defended in the field of Tribo-Fatigue (Bogdanovich, A. V. The Scientific Bases of Prognoses of Limiting States for Active Systems : D. Sc. thesis : 01.02.06 / A. V. Bogdanovich. – Minsk : IMINMASH NAS of Belarus, 2005. – 313 p.), which developed the theory of energy and the regularities of complex wear-fatigue damage and fracture of Tribo-Fatigue systems</td><td>  </td></tr>
<tr><td>A. M. Bordovskiy defended the Ph. D. thesis (Bordovskiy, A. M. Methods for Maintaining and Partial Rehabilitation of Strength Reliability of Oil Pipeline Linear Part : Ph. D. thesis : 01.02.06 / A. M. Bordovskiy. – Gomel : BelSUT, 2005), which solved the problem of extending the life of oil pipes after 30 years of service</td><td>  </td></tr>
<tr><td>The first book published Senko, V. I. The Basic Ideas of Tribo-Fatigue and their Study in the Technical University: handbook / V. I. Senko, L. A. Sosnovskiy. – Gomel : BelSUT, 2005. – 191 p., which lays down the methodological bases of Tribo-Fatigue</td><td> 
</td></tr>
<tr><td>2005,
July 28</td><td>Two academic institutions – the Institute of Mechanics and Reliability of Machines and Research and Development Republican Joint Enterprise "Belavtotractorostroenie" of the Belarusian National Academy of Sciences (under the chairmanship of M. S. Vysotsky) organize the scientific seminar "On Tribo-Fatigue" (On Tribo-Fatigue : Proceedings of Scientific Seminar, dedicated to the 20th Anniversary of the Development of Researches in the Field of Tribo-Fatigue and to the 70th Anniversary of Professor L. A. Sosnovskiy, Minsk, July 28, 2005 / enter word academician M. S. Vysotsky, ed. by L. G. Krasnevsky. – Minsk : Belavtotractorostroenie, 2005. – 84 p.)</td><td> 
</td></tr>
<tr><td>2005,
September
12–16</td><td colspan="2">8 reports on Tribo-Fatigue for the first time are presented at the World Tribology Congress WTC-III (Washington, USA)
 

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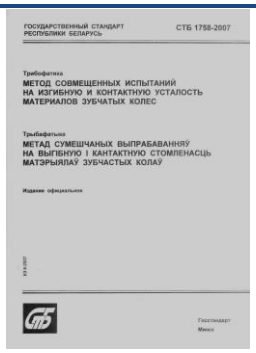
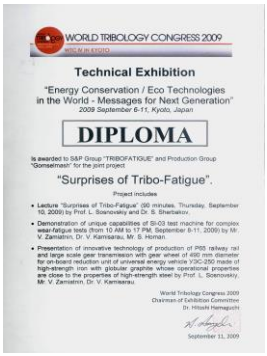
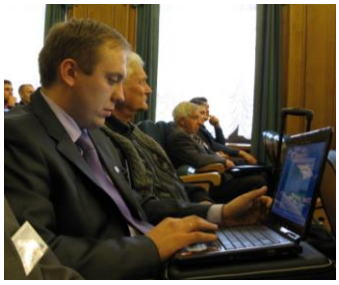
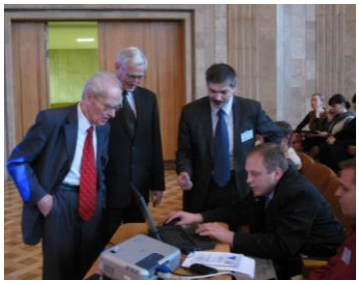
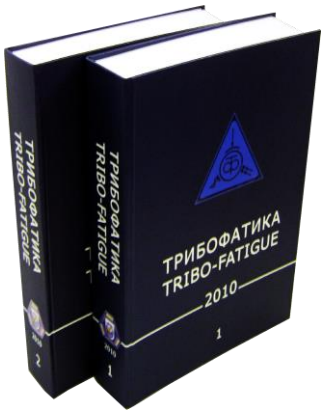
2005, October 3–7	The V International Tribo-Fatigue Symposium (Irkutsk, Russia) dedicated to the 20th anniversary of the development of researches in the field of Tribo-Fatigue and to the 30th anniversary of Irkutsk State University of Railway Engineering (rector A. P. Khomenko) takes place   	
2006, August 22–28	First plenary report on the Tribo-Fatigue is presented at IX All-Russia Congress on Theoretical and Applied Mechanics in Nizhni Novgorod (*Makhutov, N. A.* Fundamentals of Mechanics of Wear-Fatigue Damages / N. A. Makhutov, L. A. Sosnovskiy, K. V. Frolov // Abstracts of IX All-Russia Congress on Theoretical and Applied Mechanics, Nizhni Novgorod, August 22–28, 2006. – Nizhni Novgorod, 2006. – V. III. – P. 143–144). L. A. Sosnovskiy is elected a Member of the Russian National Committee on Theoretical and Applied Mechanics	
2006	Monograph generalizing twenty years of research in the field of Tribo-Fatigue is published. For the first time fundamentals of mechanothermodynamics are given in this monograph (*Sosnovskiy, L. A.* Mechanics of Wear-Fatigue Damage / L. A. Sosnovskiy. – Gomel : BelSUT, 2007. – 434 p.)	
2007	O. M. Yelovoy defended the Ph. D. thesis (*Yelovoy, O. M.* Evaluation of Durability of Active Systems of Machines and Equipment Based on Local Wear-Fatigue Damages Analysis : Ph. D. thesis : 01.02.06 / O. M. Yelovoy. – Gomel : BelSUT, 2007. – 143 p.), which first developed and introduced experimental methods for measuring local wear-fatigue damages during the tests of models of Tribo-Fatigue systems	
	A. A. Kebikov defended the Ph. D. thesis (*Kebikov, A. A.* Criterion and Technique of the Estimation of the Mechanical Conditions of Rails in Operation : Ph. D. thesis : 01.02.06 / A. A. Kebekov. – Gomel : BelSUT, 2007. – 126 p), which first established the relationship characteristics of hardness, static strength, contact resistance and mechanical fatigue of steels	

2007	Approved standard of Belarus: *STB 1758-2007. Tribo-Fatigue. Method of Combined Tests of the Toothed Gearing Materials to Rolling and Bending Fatigue*. – Introduced 01.12.2007. – Minsk : Gosstandard, 2007. – 45 p.	
2007, October 16	Plenary report summing up research developments in the field of Tribo-Fatigue for 20 years is presented at the III Belarusian Congress on Theoretical and Applied Mechanics (″Mechanics-2007″) (New Approaches in Mechanic of Wear-Fatigue Damage and Fracture / M. S. Vysotsky [et al.] // ″Mechanics-2007″ : proceedings of III Belarusian Congress on Theoretical and Applied Mechanics, Minsk, October 16–18, 2007). – Minsk: OIM NASB, 2007. – P. 38–114.	
2008	Monograph generalizing research on limiting states of Tribo-Fatigue systems is published (*Bogdanovich, A. V.* Forecasting Limiting States of Tribo-Fatigue Systems / A. V. Bogdanovich. – Grodno: Ya. Kupala Grodno State University, 2008. –372 p.)	
	V. V. Komissarov defended the Ph. D. thesis (*Komissarov, V.V.* Estimation Volumetric Faulty and Resistance of Rolling Fatigue of Toothed Gearing in View of Size Effect : Ph. D. thesis : 01.02.06 / V. V. Komissarov. – Gomel : BelSUT, 2008. – 125 p), which for the first time experimentally and theoretically proved that the fundamental regularity of the scale effect is valid not only for the mechanical (volume) fatigue, but also for the conditions of friction (surface fatigue)	
	S. S. Sherbakov defended the Ph. D. thesis (*Sherbakov, S. S.* Three-Dimensional Stress-Strain State of the Active Systems of Roller – Ring Type in Conditions of Contact Interaction and Volume Deformation : Ph. D. thesis : 01.02.04 / S. S. Sherbakov. – Minsk : BSU, BNTU, 2008. – 129 p.), which first got the solution of the problem of co stress-strain state in the simultaneous action of contact and non-contact loads	
2008, November 3-7	Presentations of mechanical and mathematical models in Tribo-Fatigue are for the first time made at Belarusian Mathematical Conference ″BMC-10″ (section ″Mathematical Problems of Mechanics″) (M. A. Zhuravkov, L. A. Sosnovskiy, S. S. Sherbakov)	

2008, November 21	L. A. Sosnovskiy receives the higher award of JSC "Russian Railways" (RZD) – "Honorable Railwayman" sign (the order was signed by president of Open JSC "RZD" V. I. Yakunin) for the significant contribution to creation of methodological, theoretical and experimental fundamentals of Tribo-Fatigue, increase of operational reliability of system *"brake block – wheel – rail"*, training of highly skilled specialists for railway transport	
2009, September 6–11	On the World Tribology Congress WTC-IV (Kyoto, Japan) PG Gomselmash and TRIBOFATIGUE S&P Group organized for the first time an exhibition "Surprises of Tribo-Fatigue" with demonstration of the machine for wear-fatigue tests SI-03M; the project is awarded by the Diploma in which "unique possibilities" of machine are noted	      
2009, September 28	S. S. Sherbakov was awarded the prize of A. N. Sevchenko for young scientists "For a cycle of works on research of features of the is intense-deformed condition of mechanical systems in the conditions of contact interaction and volume deformation with reference to technical objects of responsible appointment" by the Academic council of BSU	
2009	V. V. Komissarov is awarded by the Diploma of the Gomel regional executive committee to talented young scientists and experts "For achievement of considerable results in economy and thrift at carrying out of scientific researches and applied workings out in the field of natural and engineering science"	
	On the initiative of M. A. Zhuravkov, S. S. Sherbakov the curriculum course "Fundamental and applied problems of Tribo-Fatigue" was introduced at the Belarusian State University for students of mechanics and mathematics faculty	

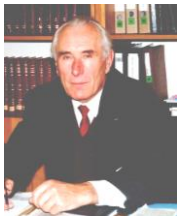
2010, May 24	Gosstandart of the Republic of Belarus accredits the Research laboratory of dynamics, durability and wear resistance of Lida college of the Grodno State University of Ya. Kupala. A. V. Bogdanovich was appointed the scientific leader of the laboratory	
2010, October 25 – November 1	The VI International Tribo-Fatigue Symposium ISTF 2010 (Minsk, Belarus), dedicated to the 25 anniversary of development of researches in this area has taken place   	
	The Proceedings of ISTF 2010, dedicated to the 25 anniversary of development of researches on Tribo-Fatigue and the 75 anniversary of professor L. A. Sosnovskiy is published (Tribo-Fatigue : Proc. of VI International Tribo-Fatigue Symposium (ISTF 2010), October 25 – November 1, 2010, Minsk (Belarus) / Editors: M. A. Zhuravkov (chairman) [et al.]. –Minsk : BSU, 2010. –V. 1. –840 p.; V. 2. – 724 p.)	
	At ISTF 2010 scientific session "Philosophy, Synergy and Tribo-Fatigue" L.A.Sosnovskiy was awarded the Honour Certificate of Institute of Philosophy NASB "For the outstanding contribution to development of interdisciplinary scientific researches, propagation of modern philosophical knowledge, working out of innovative principles of introduction of philosophical methodology to the decision of the major natural-science and technical problems"	

2010, October 25 – November 1

25 scientists and experts of the different countries are awarded by the Honourable Anniversary Sign "TRI-BO-FATIGUE-25" for the special contribution to the organisation of the International Symposiums, research and development carrying out to this area for more than 10 years

BOGDANOVICH
Aleksandr
Valdemarovich

BORDOVSKIY
Aleksandr
Mikhailovich



VITYAZ
Pyotr
Aleksandrovich

VOROBJOV
Vladimir
Vladimirovich

VYSOTSKIY
Mikhail
Stepanovich

GAO
Wanzhen

GAPANOVICH
Valentin
Aleksandrovich

Drozdov
Yuri
Nikolaevich

YELOVOY
Oleg
Mikhailovich

ZHMAILIK
Valery
Alekseevich

ZHURAVKOV
Mikhail
Anatolievich

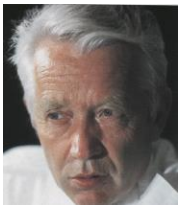
ZAMIATNIN
Vladimir
Olegovich

KARPUSHCHENKO
Nikolay
Ivanovich

KOMISSAROV
Viktor
Vladimirovich

KORESHKOV
Valery
Nikolaevich

KUHAREV
Anatoly
Vasilyevich



MAKHUTOV
Nikolay
Andreevich

SENKO
Veniamin
Ivanovich

SOSNOVSKIY
Leonid
Adamovich

TROSHCHENKO
Valery
Trofimovich

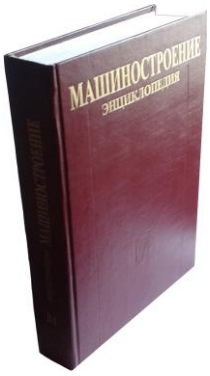
TJURIN
Sergey
Aleksandrovich

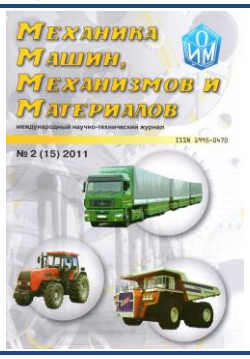
KHOMENKO
Andrey
Pavlovich

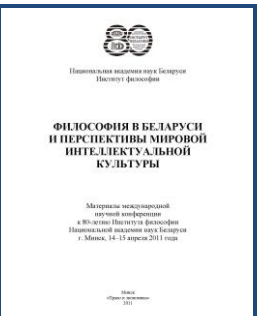
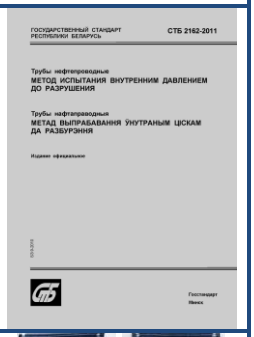
CHIZHIK
Sergey
Antonovich

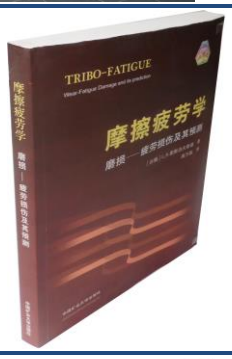
SHERBAKOV
Sergey
Sergeevich

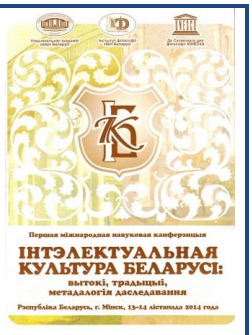
YASNIY
Pyotr
Vladimirovich

2010	The textbook "Introduction to Tribo-Fatigue" is published, in which the general (initial) information on the methodological, theoretical and experimental foundations of Tribo-Fatigue (*Sosnovkiy, L. A*. Introduction to Tribo-Fatigue: Textbook for Students of Mechanical-Mathematical Faculties, Specialty 1-31 03 02 "Mechanics" (by directions) / L. A. Sosnovskiy, M. A. Zhuravkov, S. S. Sherbakov. – Minsk : BSU, 2010. –77 p.) is set out briefly and clearly	
	Original monograph "Mechanic of Tribo-Fatigue systems" is published (*Sherbakov S. S.* Mechanic of Tribo-Fatigue Systems / S. S. Sherbakov, L. A. Sosnovskiy. – Minsk : BSU, 2010. – 407 p.), in which a generalization of the results of two decades of research in the new field of knowledge is given	
	A collection of popular science articles "Nine Surprises of Tribo-Fatigue", which sets out the main methods and results of research of Tribo-Fatigue systems was published in the academic journal "Science and Innovation" (authors Bogdanovich A. V., Vityaz P. A., Vysotsky M. S., Goman A. M., Zakharik A. M., Komissarov V. V., Sosnovskiy L. A.)	
	A chapter on Tribo-Fatigue testing methods was published in the technical encyclopedia (Russia) for the first time (*Sosnovskiy, L. A*. Wear-Fatigue Tests / L. A. Sosnovskiy, N. A. Makhutov // Mechanical Engineering : Encyclopedia / Ed. by: K. V. Frolov (chairman) [et al.]. – V. II-1. Physical and Mechanical Properties. Tests of Metallic Materials / L. V. Agamirov [et al.] ; chairman editor E. I. Mamaeva. – M.: Mashinostroenie, 2010. – P. 354–385)	
	An SI-04 machine for wear-fatigue tests was first presented by the Ya. Kupala Grodno State University at the St.-Petersburg Technical Exhibition in the nomination "The Best Innovation Project and the Best Scientific and Technical Development of the Year". The project was awarded by the 2nd Degree Diploma and the Silver Medal in the nomination "New High-Technology Developments of Equipment and Science Intensive Technologies"   	

2011, March 15–17	The section ″Tribo-Fatigue: Methodology and Experience of Study of Wear-Fatigue Damage in Complex Force and Functional Systems″ was first launched at the 1st International Philosophy Congress ″Harmonious Evolution of Systems is the Third Way of Mankind″. Eight reports were presented by the following authors (Bogdanovich A. V., Vityaz P. A., Vorobyov V. V., Vysotsky M. S., Golovina E. S., Yelovoy O. M., Zhmailik V. A., Zhuravkov M. A., Kozik A. N., Komissarov V. V., Lazarevich L. A., Soroko E. M., Sosnovskiy L. A., Tjurin S. A. and Sherbakov S. S.)	
2011, October 8–10	A special item ″Mechanics of Tribo-Fatigue Systems″ was instituted in the International Scientific and Technical Journal ″Mechanics of Machines, Mechanisms, and Materials″. Ten papers were published in this item in 2011 (Bogdanovich A. V., Vityaz P. A., Vorobyov V. V., Vysotsky M. S., Elovoy O. M., Zhuravkov M. A., Kozik A. N., Sosnovskiy L. A. and Sherbakov S.S.)	
2011	A special course of lectures ″Fundamental and applied problems of Tribo-Fatigue″ is published, in which sets out the main content of the lecture course, a brief analysis of Tribo-Fatigue place among scientific disciplines – modern branches of mechanics (*Sosnovskiy, L. A.* Fundamental and applied problems of Tribo-Fatigue: course of lectures / L. A. Sosnovskiy, M. A. Zhuravkov, S. S. Sherbakov. – Minsk : BSU, 2010. – 488 p.)	
	A monograph ″Crack resistance″ is published, that presents a systematic analysis of the effect of cracks on the resistance of deformation and fracture of metals and elements of structures under static, dynamic and cyclic loading (*Sosnovskiy, L. A.* Crack resistance / L. A. Sosnovskiy, A. V. Bogdanovich. – Gomel : BelSUT, 2011. – 366 p.)	
	A report was presented at the V Belarusian Congress of Theoretical and Applied Mechanics for the first time (*Sosnovskiy, L. A.* Dynamical Systems with Elements of Intelligence : Problems and Prospects / L. A. Sosnovskiy // ″Mechanics 2011″. – Minsk : OIM NASB, 2011. –V. I. – P. 64–79) which was first staged, in the first approximation, solved the problem of the emergence of ″the elements of intelligence″ in the dynamic system	

2011	At the International Scientific Conference on the 80th anniversary of the Institute of Philosophy of National Academy of Sciences of Belarus L. A. Sosnovskiy for the first time presented a report (*Sosnovskiy, L. A.* On the Possibility of a General Theory of Evolution Systems / L. A. Sosnovskiy // Philosophy in Belarus and the Prospects for the World Intellectual Culture. – Minsk, 2011. – P. 152–157), which sets out the generalized theory of A-evolution of inorganic and organic systems	
	Approved standard of Belarus: *STB 2162-2011. Oil Pipeline Pipes. Testing Method by Internal Pressure to Fracture.* – Introduced 01.07.2011. – Minsk : Gosstandard, 2007. – 34 p.	
	"For significant contributions to the development of new areas of research and developments in the field of the service life of industrial products, the active co-operation with the organizations of the National Academy of Sciences of Belarus", L. A. Sosnowskiy awarded a commemorative medal "In honor of the 80th anniversary of the Belarusian National Academy of Sciences"	
2012	A monograph "Reliability. Risk. Quality" is published, in which for the first time three branches of technical sciences are discussed together, constitute the modern concept of quality – risk – reliability (Reliability. Risk. Quality: [monograph] / L. A. Sosnovskiy [et al.]; Science ed. L. A. Sosnovskiy. – Gomel : BelSUT, 2012. – 358 p.)	
	The original article in English was published for the first time, which sets out the basic principles of Mechanothermodynamic (*Sosnovskiy, L. A.* Mechanothermodynamical System and Its Behavior / L. A. Sosnovskiy, S. S. Sherbakov // Continuum Mech. Thermodyn. – 2012. –V. 24, Issue 3. – P. 239–256)	
	A. N. Kozik defended the Ph. D. thesis (*Kozik, A. N.* The Strength of Underwater Section of Pipelines after Prolonged Use and Refurbishment : Ph. D. thesis : 01.02.06 / A. N. Kozik. – Gomel : BelSUT, 2012. – 155 p.), which first showed that the corrosion damage of underwater section of the pipeline can lead to premature failure due to the accumulation of damages	

2013	At the Belarusian State University (BSU) the presentation of the universal testing center SZ-01 level Hi-Tech (developer TRIBOFATIGUE S&P Group, manufacturer PG Gomselmash) took place. The presentation was attended by well-known scientists and engineers of BelSUT, OIM NASB, MAZ, BelAZ and others. Center SZ-01 has no analogues in the world  	
	The first monograph on Tribo-Fatigue is published in Chinese (*Sosnovskiy, L. A.* Tribo-Fatigue. Wear-fatigue damage and its prediction (in chinese) / L. A. Sosnovskiy. – Beijing : China University of Mining and Techology Press, 2013. – 324 p. 摩擦疲劳学 磨损 – 疲劳损伤及其预测. L. A. 索斯洛夫斯基著, 高万振译 – 中国矿业大学出版社, 2013. – 324 p.).	
	Monograph *"Sosnovskiy, L. A.* Principles of Mechanothermodynamics / L. A. Sosnovskiy, S. S. Sherbakov. – Gomel : BelSUT, 2013. – 154 p." is published, which unites two fundamental areas of physics: mechanics and thermodynamics	
	The articles "Sosnovskiy Leonid Adamovich. Persona". – P. 33 and "TRIBO-FATIGUE S&P Group. Reliable Business Partner". – P. 83 // Best People : Big International Encyclopedia. Successful People. Russia. Kazakhstan. Ukraine. Belarus. – M., 2013. – Issue 2013. – 920 p." were first published in the Big International Encyclopedia "Best People". Russia. Kazakhstan. Ukraine. Belarus	
	The decision on publication (in Russian, English and Chinese) Encyclopedic Dictionary Directory "TRIBO-FATIGUE", which will bring together basic information on the Mechanics, Physics and Statistics of Fatigue Fracture, Friction, Wear and Lubrication, Complex wear-fatigue Damage and Destruction; will also include the necessary information on related scientific disciplines (Strength of Materials and Structures, Materials Science, etc.) (2015)	

2014	A report on Tribo-Fatigue "On the Methodology of Technical Science as Organical component of intellectual culture of Belarus" (authors L. A. Sosnovskiy, S. S. Sherbakov, A. A. Lazarevich) was presented for the first time at the First International Scientific Conference "Intellectual Culture of Belarus: Origins, Traditions, Research Methodology", Institute of Philosophy of the National Academy of Sciences of Belarus	
	The Department of Tribo-Fatigue at the Faculty of Mechanics ("Dynamics, strength and durability of vehicles") was established for the first time on the initiative of V. I. Senko and supply L. A. Sosnovskiy and A. V. Putyato by the decision of Academic Council of BelSUT. Professor A. V. Putyato was elected the Head of the Department	
2014–2015	For the first time experts on Tribo-Fatigue introduced the development of nano-technology (*Sherbakov, S. S.* Some Methods of Traffic Control and Deformation of Nano-Objects / S. S. Sherbakov, L. A. Sosnovskiy // Nanostructured materials-2014 : Belarus – Russia – Ukraine (NANO-2014) : (Proceedings of IV International Scientific Conference, Minsk, October 7–10, 2014); ed. by : P.A. Vityaz [et al.]. – Minsk : Belarusian science, 2014. – P. 328; *Sherbakov, S. S.* Manipulation of Nanoobjects by Electromagnetic and van der Waals Forces / S. S. Sherbakov, L. A. Sosnovskiy // Proceedings of VIII International Symposium on Mechanics of Materials and Structures and Fracture and Fragmentation in Science and Engineering Conference (Augustow, Poland, May 31 – June 3, 2015). – Augustow, 2015. – P.147–148	
2015	"For active cooperation with the Belarusian National Academy of Sciences and high achievements in research activities", L. A. Sosnowskiy awarded a Certificate of Honour of the Belarusian National Academy of Sciences	
2015, November 26-27	There VII International Symposium on Tribo-Fatigue ISTF 2015 (Gomel, Belarus) will be held	

Compiled by A. V. Kuharev and S. A. Tyurin