

# MY WAY TO RELIABILITY AND SAFETY

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## Abstract

*I was born in Moscow on September 10, 1934. I wrote about my family and previous generations of Yastrebenetsky (a soldier under Emperor Nicholas I, a businessman, a doctor, a chemical engineer) in my book "Generations of Yastrebenetsky" [1]. After finishing the institute and postgraduate studies, 2/3 years of my life were connected with activity in the fields of reliability and safety of technical systems. This activity is the subject of the article.*

**Keywords:** Reliability, Safety, Nuclear Power Plant, Instrumentation and Control system.

## 1. Reliability

I worked in the Central Scientific Research Institute of Complex Automatization (CSRICA) in Moscow and was engaged in the analysis of the dynamic characteristics of industrial automatic regulators. At the international exhibition in Moscow, I saw a big poster with the inscription "We have high reliability:  $\lambda = \dots 1/\text{hours}$ ". I didn't know, what its reliability? What its  $\lambda$ ? And a question naturally happened: what is the reliability of the regulators with dynamic characteristics I researched? Neither we nor the creators and manufacturers of the regulators knew this. We did not have stands for reliability tests, manufacturers did not fulfill reliability tests at that time, and an analytical assessment of reliability could not be done due to the lack of data on the component's reliability. I got "carte blanche" in CSRICA for reliability work and created in CSRICA the group of reliability (what later became the Reliability Laboratory and the Reliability Department). The idea arose- the determination of reliability measures from collecting and processing statistical data on regulators' failures and repairs during their operation. At that time, it was not clear whether operational data could be used to obtain objective information about the reliability of industrial automation. We began with the development of methods for collecting and processing information, ways to increase its validity. We chose the nearest thermal power plant with many new automatic regulators, trained and monitored the plant personnel who collected information. The first quantitative estimates of automatic regulator reliability measures were published in 1965 [2]. In the future, the analysis of statistical data about operational reliability, in particular point stochastic processes (flows) of failures became one of the directions of my future work.

My activities in the reliability area included:

- Assessing and ensuring the reliability of information computer systems (ICS) developed by CSRICA in different branches of industries ( thermal power plants with units 300 MWt and 800 MWt , nuclear power plants (NPP) in the USSR and Bulgaria with VVER-1000 reactors, including 6 units of Zaporizhzhya NPP (ZNPP)- the biggest in Europe, and unit RBMK-1500 Ignalina NPP in Lithuania, chemical-technological enterprises, metallurgy etc.). Even before the first fuel loading at unit 1 ZNPP I was taken around the locations inside the reactor and touched the reactor equipment with my hands. After the start-up of unit 1 ZNPP, we collected and analyzed data on the reliability of the ICS and all Instrumentation and Control systems (I&C) of this unit. It turned out that the weak point of these systems was the Universal Complex of Technical Means (UCTS). I remember what the adjusters said to me about the UKTS at unit 1: "We'll start the unit with it, but will we be able to stop it later?". We

analyzed information about the reliability of this complex - as a result, it was soon replaced. It's hard to count the time I spent on business trips to ZNPP. I often remember the resolution of the USSR Deputy Minister of Energy and Electrification A. Maioretc on the letter: "Efforts to improve the reliability of NPP instrumentation and control systems (I&CS) can never be considered sufficient".

- Collecting and processing statistical data on the reliability of I&C components -sensors, actuators, meters, various devices, and first, new computer systems. The aims of these works were to create feedback with information about reliability between the users of automation equipment and its manufacturers, development of recommendations on reliability improvement (e.g., Moscow plant "Manometer", plant "Lvivpribor"), create reliability databases, collection and processing of information for maintenance optimization (overhaul intervals, nomenclature and several spare parts, etc.). Proposed norms for overhauls and spare parts for automation equipment were developed together with the enterprises of the USSR Ministry of Energy and Electrification and introduced at all USSR thermal power plants.

- Development of methods to assess and ensure the reliability of automatic I&C systems for technological processes, including methods of assessing these systems functional reliability, analysis of the impact of reliability on efficiency, analysis of metrological failures, etc.

- The analysis of the operating reliability of the I&CS in different branches of industry resulted in the necessity to develop new mathematical models of reliability which were published in Russian ("Proceedings of the USSR Academy of Science. Technical Cybernetics", "Automatic and Remote Control"), then translated and reprinted in English:

- new class of regenerative random processes [2],
- models of unrenewable and renewed elements reliability under external disturbances ([3], [4]),
- models of failures flow, when external disturbance are stochastic processes ([5]),
- a rarefaction of the Markov renewal process ([6])
- flow of failures caused by the crossing of non-constant levels''''''00/ by regenerating random process [7].

I can add the model of regenerative processes with some types of regenerative points (together with V. Rykov), published in Ukrainian journal [8].

- Elaboration of USSR standards ([9], [10]), and sets of departmental standards (example- [11]) which contain requirements for the reliability of ICSTP and components, their reliability assessment and testing, organization of the maintenance.

- My first books on reliability [12], [13] (together with B. Solyanik) and [14] (author of foreword – acad. B.V. Gnedenko) were published in 1968, 1978 and in 1982 in Moscow. These books contained reliability models and information on the reliability of I&C systems and their components under operating conditions. Those were the times of rapid development of reliability research when such books were sold out in 14000, 10000 and 7000 copies -unthinkable quantities for the present time. The books were based on the data of the operational reliability of automatics collected by us.

I participated in many scientific and technical conferences, meetings, and reliability tests in different parts of the huge Soviet Union: - from the northeast (Bilibinskaya NPP in Chukotka) to the southwest (Azerbaijan, Armenia). From the southeast (Vladivostok, Irkutsk) to the northwest (Riga, Tallinn). The map of the USSR with the places of my official trips is shown in Fig. 1.

These places included different parts of USSR from Nord-West (Riga- collaboration with schools of prof. Kordonsky and Scliarevich) to South-East (Vladivostok, Branch of USSR Academy of Science- O.V. Abramov), from Nord-East ( Bilibino NPP in Chukotka- verification of reliability and safety) to South-West ( Baku, Sumgait- common work with Reliability Department of Oil and Chemical Avtomatization Institute- Sh.A. Kiasbeily) Safety of Nuclear Power Plants (NPP's) Problems of NPP's safety have always been urgent since NPP's began to operate. In Ukraine the work on NPP safety was especially vital after the accident at Chernobyl NPP - the most severe and widely known in the world of all technogenic accidents. In all countries, where NPP's are operated, there are state organizations that regulate the state policy in the field of NPP safety. Currently, such an organization in Ukraine is called the State Nuclear Regulatory Inspectorate of Ukraine (SNRIU). It includes Technical Support

Organization - State Scientific and Technical Center for Nuclear and Radiation Safety (SSTC NRS), also subordinate to the National Academy of Sciences of Ukraine.



**Figure 1.** The map of USSR with marked places of trips

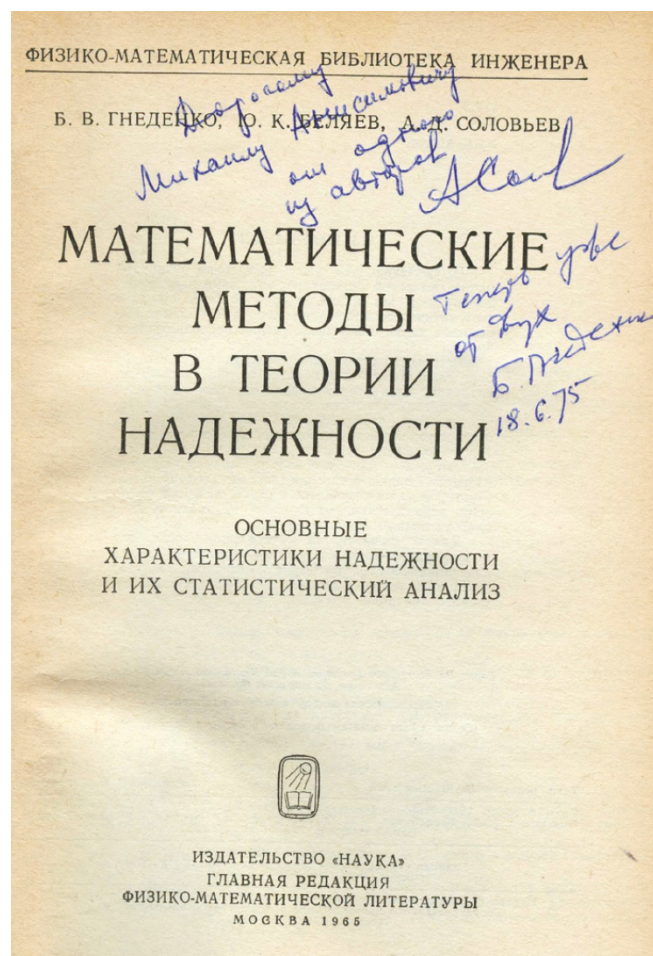
The impetus for the work on the reliability of Information and Control Systems was the Board of Directors of the enterprises of the Ministry of Instrument Engineering in 1984 under the leadership of the Director of the Institute of Control Problems Acad. V.A. Trapeznikov and the Minister of Instrument Engineering M.S. Shkabardni. I made a report on the state of work on the reliability of NPP automation. After my report, I was regularly invited to the Industrial Department of the Central Committee of the CPSU (Yu.I. Abramov) – Moscow, Old Square to discuss the situation with work on the reliability of NPP automation.

My university activity in reliability:

- lectures on reliability as a professor of Kharkov Polytechnical University (Departments “Technical Cybernetics” and “Systems Analysis”) and the other universities in USSR and the other countries (the most distant university was Havana, Cuba),
- issue of textbook for universities on the reliability of automatic control systems, agreed upon USSR State Educational Committee (together with G. Ivanova) [15].

A considerable help to me, as to many my colleagues in reliability, was rendered by the outstanding specialists in the mathematical reliability theory, grouped around the of the Moscow State University Department of Probability Theory, headed by acad. B.V. Gnedenko. Guidance of this Department had handed him by famous mathematic – acad. A. Kolmogorov. The book B.V. Gnedenko, A.D. Soloviev, Yu.V. Beliaev [16] became as classical for reliability specialists and was issued in many languages (fig. 2).





**Figure 2.** The book "Mathematical methods in reliability theory" with autographs of two authors

I gave reports on the seminars and school organized by this Department. Prof. A.D. Soloviev (Fig. 3) and prof. I.A. Ushakov performed as opponents in defense of my Dr. Sc. thesis. The most memorable meeting for me was the school in Dilijan (Armenia) in 1970. The Department of Probability Theory at Moscow University brought together reliability specialists from all over the Soviet Union. Many of them became my lifelong friends.

Subsequently in 2006 Gnedenko was named international non-commercial association "Gnedenko-Forum" created by I.A. Ushakov and A. V. Bochkov. "Gnedenko-Forum" joined the specialists working in the fields of reliability and mathematic statistics applications in safety, risk analysis, survivability. "Gnedenko-Forum" aims are establishing contacts between specialists in the world and exchange of professional information (about new publications, international conferences, meetings, participation in organization of conferences, etc.).

"Gnedenko-Forum" publishes in the USA the quarterly electronic journal in English "Reliability: Theory & Applications". Since 2006 about 1000 articles have been published that contained both theoretical and methodological problems and practical papers related to reliability. The journal is registered with the U.S. Library of Congress. Prof. V. Rykov is the Editor-in-Chief of the journal now. I was honored to be as President of the "Gnedenko-Forum" in 2014-2020. Before me, President of the "Gnedenko-Forum" in 2012-2015 was prof. Way Kuo, one of the world's most famous specialists in safety and the reliability of electronic systems. After me President of "Gnedenko-Forum" became prof. B. Dimitrov (USA). I am very glad that thanks to "Gnedenko-Forum" I have renewed regular contacts with my long-time reliability colleagues – prof. V. Kashtanov, prof. V. Rykov, prof. I. Shubinsky, who continue to be active.



The word "regulation" has gone through my life. My first business trip was to test regulators for a steam boiler. Then was followed by work on the analysis of dynamic characteristics of technological processes automatic regulators, the results of which are given in the book "Industrial Automatic Regulators" [17]. And then, for many years, safety regulation of NPP's and other critical facilities was the area of my activity.

SNRIU and SSTC NRS were based on the specialists who worked at the Chernobyl NPP during the accident and later connected with the restoration of the Chernobyl NPP after the accident. The first SNRIU head and creator was N.A. Steinberg, who was appointed to position chief engineer Chernobyl NPP immediately after the accident.

The former employees of the Chernobyl NPP who joined SNRIU and SSTC NRS felt on their shoulders what it is NPP safety. I had a lot to learn from these people because after the USSR collapse my activity related to SSTC NRS, which included Kharkov Reliability Department as Kharkov subsidiary. Main objects of SNRIU and SSTC NRS activities were 4 operating NPPs of Ukraine with 13 (after commissioning of two power units in 2004 - 15) power units. Besides, the objects of activity are NPP spent fuel storage facilities, "Shelter" facility above the unit 4 of Chernobyl NPP, research nuclear reactors, various sources of ionized radiation, etc.

Starting from 1993, for long time I have been supervising a set of activities on nuclear and radiation safety regulation, defined by instrumentation and control systems (I&CS), for all these objects. The main directions of my work on safety were:

- Development of SNRIU regulatory requirements to NPP I&CS and their components (hardware, software, software-hardware complexes) according to nuclear and radiation safety criteria. The document [18] containing such requirements was issued in 2000. The I&CS creation for two new VVER-1000 power units and I&CS modernization of many Ukrainian units for their life extension were carried out in accordance with the requirements of document [18]. In 2015, this document was revised [19] taking into account the experience of Ukrainian NPPs operation, the lessons of the accident at Fukushima NPP and changes in the international requirements (first of all, IAEA and In addition, the requirements were divided into regulatory requirements established by SNRIU, and technical requirements established by the operating organization – National Energy Company "Energoatom". [20]. According to [18] and [19], Ukrainian companies developed I&CS for NPPs in Bulgaria, the Czech Republic, Armenia and other countries.
- Development of SNRIU regulatory requirements:
  - methods of assessment of compliance of safety important ICS NPP with the requirements for nuclear and radiation safety;
  - requirements for the procedure and content of work for the life extension of I&CS included in NPP safety important systems, etc.
- More than 1000 state nuclear and radiation safety expertise's (safety reviews) of I&CS for NPP's , research reactors, NPP spent fuel storage facilities, the Object "Shelter" above unit 4 Chernobyl NPP, etc. It was performed ICS safety reviews, designed for Ukrainian NPP not only by Ukrainian companies, but also by the largest foreign companies - "Westinghouse" (USA), "Siemens" (Germany), "Skoda-Controls" (Czech Republic).
- Development of methods of safety analysis:
  - Fukushima NPP accident lessons related to ICS and the participation in the Ukrainian NPP activity following from these lessons (stress- tests, the implementation of post-accident monitoring systems, reserve diesel generators control systems, black boxes systems, etc.)
  - I&CS for NPP units life extension,
  - development of NPP I&CS hardware ageing investigations, including analysis of the drift of their characteristics in time,
  - impact of I&CS failures on NPP violations,
  - new NPP I&CS safety important digital systems reliability in operation conditions.

- determination of ICS NPP functional safety measures.

My international activities in NPP I&CS safety included:

- the activity in International Atomic Energy Agency (IAEA) as a member of Technical Working Group on NPP Instrumentation and Control (1999-2011). Co-author of IAEA documents, the main of them - IAEA Safety standard SSG-39 [21] and book "Core knowledge of I&CS in NPP" [22],
- the activity in International Electrotechnical Commission (IEC) as an expert in Subcommittee SC-45 A "Instrumentation, control and electric power systems of nuclear facilities" of Technical committee TC-45 "Nuclear Instrumentation" (from 2002 to now).
- Participation in elaboration of different IEC standards, in IEC meetings, collaboration with regulatory bodies and organizations for technical support USA, Germany, France, Bulgaria and other countries.
- the organization in Kharkov by Kharkov Department SSTC NRS 1-5 International Scientific Technical Conferences "NPP Instrumentation and control systems: safety aspects" with participants of countries from Argentina to Hong Kong, including USA, Russia, Germany, France, etc.
- Speaker at 7 (2000- 2015) American Nuclear Society conferences "Nuclear power instrumentation, control and human-machine interface technologies (NPIC &HMIT)".

My activity in NPP Safety related to a lot of business trips in the world. The map of the world with marked places of business trips is shown in fig.3.

As the result of the work were published the books:

- Two books on I&CS NPP safety published in Russian in Ukraine in 2004 [23] and 2011 [24], where I was an editor and one of the authors. Book [23] was translated into English by the US Nuclear Regulatory Commission.
- Two books in English published by IGI Global (USA) on the safety and cybersecurity of NPP I&CS in 2014 [25] and in 2020 [26] edited by myself and prof. V. Kharchenko. The authors of most chapters of these books were my colleagues from SSTC NRS and V. Kharchenko's colleagues from the National Aerospace University KhAI (Ukraine).
- In 2022 SSTC NRS began to publish the books series to 30th anniversary of SSTC NRS (in Ukrainian). Among them there is the book [27] prepared by SSTC NRS Kharkiv subsidiary with the results of our works devoted to NPP I&CS safety. New direction of work related to NPP safety- safety of small modular reactors [28].

## 2. Safety of Nuclear Power Plants (NPP's)

Problems of NPP's safety have always been urgent since NPP's began to operate. In Ukraine the work on NPP safety was especially vital after the accident at Chernobyl NPP- the most severe and widely known in the world of all technogenic accidents. In all countries, where NPP's are operated, there are state organizations that regulate the state policy in the field of NPP safety. Currently, such an organization in Ukraine is called the State Nuclear Regulatory Inspectorate of Ukraine (SNRIU). It includes Technical Support Organization - State Scientific and Technical Center for Nuclear and Radiation Safety (SSTC NRS), also subordinate to the National Academy of Sciences of Ukraine.

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- I&CS for NPP unit's life extension, NPP I&CS hardware aging investigations, including analysis of the drift of their characteristics in time, impact of I&CS failures on NPP violations,

- Comparison of NPP and other systems safety development and safety assurance principles (launch vehicles control systems for nuclear warheads -example most powerful intercontinental ballistic missile SS-18 "Satan" [21] together with the Chief Constructor of this system Y. Aizenberg; control systems for rocket-cosmic complexes [22] together with Prof. V. Kharchenko and V. Scliar; hydraulic power plant-example emergency on Saiano-Sushenskaia plant [23] together with Prof. S. Artuh )

- Analysis of new NPP I&CS safety important digital systems reliability in operation conditions.

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- Two books in English were published by IGI Global (USA) on the safety and cybersecurity of NPP I&CS in 2014 [28] and in 2020 [29] edited by myself and Prof. V. Kharchenko.

SSTC NRS published the book series on the 30th anniversary of SSTC NRS (in Ukrainian). Among them, was the book [30] prepared by SSTC NRS Kharkiv subsidiary with the results of our works devoted to NPP I&CS safety.



Figure 3. My activity in NPP Safety

The new direction of my work is related to NPP safety - small modular reactors (SMR) ([31]). In this definition: small- physically a fraction of the size of a conventional nuclear power reactor, modular-making it possible for systems and components to be factory-assembled and transported as a unit to location for installation, reactor- harnessing nuclear fission to generate heat to produce energy.

My colleagues from SSTC NRS S.A. Trubchaninov and I.I. Chervonenko are now prepared "M.A. Yastrebenetsky. Biographical indexes. Aladin Print. Kharkov. 2024 (In Ukrainian, Russian, English)" [34]. (Author of preface - Academic A.V. Nosovsky, Director of "Nuclear Power Plant Safety Institute" of Ukrainian National Academy of Science). The common number of my publications in this document included 350 names.

### 3. Big Safety

The definition of "Big Safety" for safety-critical technical and organization-technical systems was proposed and introduced in our articles with Prof. V. Kharchenko in 2020-2021 ([32], [33]). Big Safety is a result of a crossing of the following 10 attributes:

- big/complex systems,
- big safety properties (types of Big Safety)- nuclear, radiation, fire, information, transport, functional, ecological, infection safety, protectability from natural hazards, from military hazards,
- big/complex environment,
- big consequences from fatal failures,
- big number of fatal failures reasons,
- big data,
- big requirements for safety,
- big time system development,
- big toolbox for safety assessment and assurance,
- big resources for safety assurance.

A typical example of Big Safety is NPP safety.

Unfortunately, time leads to the originating of new types of Big Safety. Not so far, the problem of cybersecurity raised. Infection safety was included in some Big Safety types after the COVID-19 appearance. Military actions in Ukraine made it relevant to calculate as protectability of non-military objects (NPP, hydraulic and thermal power plants, offshore gas pipelines for military hazards. What may be the next?

### 4. My nearest teachers and colleagues

In this anniversary article I would like to thank my teachers and colleagues in reliability and safety, who have provided me with great assistance throughout my life



#### **Academician Boris Vladimirovich Gnedenko (B.V.) (1912-1995)**

B.V.'s works on probability theory are widely known throughout the world - they were the pride of Soviet science, and many generations of specialists were educated in them. My acquaintance with B.V.'s textbook "Probability Theory Course" dates to 1961. B.V. quickly appreciated that reliability theory is based on works on probability theory, and in 1965 a classic appeared - the book by B.V., A.D. Soloviev, Yu.K. Belyaev [34]. I'd like to say about signatures on this book: A.D. Soloviev's "To dear Mikhail Anisimovich from one of the authors" and B.V.'s "Now from two." Personal acquaintance with B.V. took place at the All-Union school - meeting "Theory of queueing systems", headed by B.V. in Dilijan (Armenia) in 1970, where I met many of my future

colleagues for life. It was "a holiday that is always with me." B.V. invited me to report on my works, and one day he even asked me to chair a meeting. Then I participated in the following schools in Pushchino-on-Oka and Zagulba (Azerbaijan). The role of B.V. in my fate is extremely high. B.V. invited me to participate in the seminars he led at Moscow University, supported my doctoral dissertation and suggested opponents for it, and wrote a preface to my book [15]. He visited me in Kharkov and spoke there at my seminar. I am glad to have friendly relations with B.V.'s descendants - his son Dima, who works at the Department of Probability Theory at Moscow State University, and in Boston (USA) - with B.V. granddaughter Katya.



**Professor Alexander Dmitrievich Soloviev (A.D.) (1927-2001)**

The next gift that the school in Dilijan gave me was meeting A.D. A.D.'s whole life related to Moscow State University - he graduated from it and taught there, and for many years - at the department headed by B.V. In Dilijan we tried not to leave A.D. - we listened to his stories and tales. A.D. reviewed my articles in the journal "Izvestiya of the USSR Academy of Sciences. Technical Cybernetics" and it is not surprising that B.V. suggested him as my opponent for my doctoral dissertation. We often met at his home, discussing the results. And when A.D. came to Kharkov for my defense, I did not recognize him - he sacrificed his luxurious long artistic hair for me - "So that there would be no negative reaction from conservative members of the Kharkov Academic Council." After the main defense, he again defended me in the Academic Council of the Moscow Bauman Higher Technical School, where the Higher Attestation Commission sent my work. A.D.'s authority was indisputable. A.D. twice (in 1974 and 1977) came to Kharkov for my seminar, where his reports attracted a full hall of listeners, visited my home and his favorite place - the Kharkov bazaar, charmed my entire family and, to the horror of the women, he himself went to show off his culinary skills in our kitchen.



**Professor Igor Alekseevich Ushakov (I.A.) (1933-2015) (Fig.),**

I.A. - a pupil of B.V. Gnedenko, was the leader of my generation of reliability specialists. Much of what he did is associated with the word "first" - the first reference book on reliability calculations, repeatedly reprinted in different languages, the first works on optimal redundancy, on the analysis of complex networks, etc. I got acquainted with I.A. before Dilijan and met him many times in Moscow, in Kharkov, in Irkutsk, in Leningrad, (where I.A. arrived one summer in a light shirt with a tennis racket, and there it snowed,) and after that in San Diego. His talents were diverse and energy colossal - he worked at the research institute on a closed topic. headed departments at universities, supervised countless dissertations, supervised reliability journals, wrote a series of children's books "History of Science through the Prism of Insights", wrote wonderful memoirs, drew and played football. I.A.'s results to domestic science should have made him a member of the USSR Academy of Sciences, but this did not happen because of envy and lack of objectivity. I.A. moved to the USA, taught, and worked in well-known companies. He came up with the idea of uniting reliability specialists who remained in the USSR, those who left the USSR abroad, and foreign specialists in an association under the name of his teacher - "Gnedenko-Forum". I was proud that I.A. offered me to become one of the next vice presidents (and then president)) of "Gnedenko-Forum".





**Professor Volodymir Vladimirovich Rykov (V.V.)**

Of all my colleagues, the duration of my contacts with V.V. is the longest - we came to work at CSRiCA almost simultaneously - he to the computing center after Moscow Lomonosov University (The head of his diploma was Acad. A.N. Kolmogorov), me- I to the dynamics department. V.V. was the editor of my book [14] and a co-author of an article [9] on regenerative processes with several types of regeneration points. And he also gave me a bed in his apartment in Praslin during difficult times. I continued to work at CSRiCA until the collapse of the USSR. V.V. went to universities-at the Gubmint Institute of Petrochemical and Gas Industry and at the University of Peoples Friendship. He is a professor at both to this day. V.V. is a world-famous specialist in reliability and queueing systems". He retains great energy. His books and articles have been published in Russia and abroad. He implements the interface between specialists from Russia and the rest of the world through various conferences and meetings. In addition, VV is the editor-in-chief of the journal "[Reliability: Theory & Applications](#)". Of all my colleagues, V.V. is the absolute record man of the number of grandchildren () and great-grandchildren!



**Professor Boian Dimitrov (B.D.)**

B.D. was a postgraduate student at Moscow Lomonosov University- he was a pupil of Acad. Gnedenko and he had contact with this school all his life. My acquaint with him began from Dilijan. B.D. long time lived in the USA; he was a professor at Kettering University. Thank him, V.V. Rykov was invited to this university for 2 years. B.D. change me to the position of Gnedenko -Forum President. I think that he is more energetic than me.



**Professor Victor Alekseevich Kashtanov (V.A.)**

V.A. graduated Department "Probability Theory" in Moscow Lomonosov State University and after that he was the first post-graduate student of Prof. A.D. Soloviev. During long time V.A. was head of Department and Dean of the Moscow Institute of Electronics and Mathematics, named after A. N. Tikhonov. Now he is an ordinary Professor of Department of Applied Mathematics of National Research University's "Higher School of Economics". He is an Honors Scientist of Russia. V.A. scientific results related to controlled stochastic models, controlled random processes, theory of complex systems service, methods of assurance complex systems reliability. Now V.A. is Vice-President (and future President) of Gnedenko- Forum. I had contact with V.A. for many years.



**Professor Igor Borisovich Shubinsky (I.B.)**

I.B. graduated in 1961 from Kyiv High Engineer Radio Technic School (KVIRTU). This was a very non-standard school - leading specialists in probability theory and reliability were the teachers, and my near colleague in reliability and friend General Nikolai Shishonok was the deputy of the chief. I first time met I.B. in the Leningrad area in 1970 in the military form- he served in the Pushkin military school of radio-electronic. In 1989 colonel I.B. ended military activity and began to work/ at Leningrad University instead of famous specialist Prof. A.M.Polovko. Then I.B. created the power organization "Information Security in Railway Transport ", I.B. is the author of an - interesting book about the analysis of information system's functional reliability. I didn't see I.B. for a long time. After that, I met him at the Second International Symposium on Stochastic Models in Reliability Engineering, Life Science, and Operations Management, 2016, in Beer Sheva, Israel. Now we have regular contacts during "Gnedenko Forum" meetings. I add, that I.B. is the chief redactor of the scientific-technical journal "Dependability", I am his deputy.



**Professor Viacheslav Sergeevich Kharchenko (V.S.)**

The number of common works with co-authors in my bibliographic indexes [34] is the maximum together with V.S., more than 20. There are books in Russian and English [26, 27, 28, 29] and a lot of articles. V.S. graduated from Kharkiv High Command Engineering Military College of Rocket Troops where his scientific supervisor was my friend Prof. Alexander Larin- an honored scientist of Ukraine and Russia. V.S. was a "real colonel"- his military activity ended as head of the department of the Kharkiv Military University. V.S. is the author of more than 700 inventions (!) and an Honored Inventor of Ukraine. Now V.S. is the head of the department "Computer Systems, Networks, and Cybersecurity" At National Aerospace University's Kharkiv Aviation Institute". The energy of V.S. is fantastic- he prepared more than 60 PhD and D.Sc. and organizes every month seminar "Critical Computer Systems and Technology" (2001 - at present time), he is a founder and general chair of international conference "Dependable Systems, Services and Technologies" (IEEE DESSERT, 2006 - at present time), he was the President of Ukrainian Scientific-Educational IT Society (2018-2023). I fulfilled all my work in the Big Safety area together with V.S. Today we live in different countries, but we can have regular contact. We continue our common work!



**Dr. Sc. Alexander Vladimirovich Bochkov (A.V.)**

A.V., as I.A. Ushakov, graduated from the Moscow Aviation Institute. I wrote higher about Gnedenko-Forum. Together with I. A. Ushakov , A.V. was the so-founder Gnedenko-Forum and for many years he fulfilled a huge work devoted to its development, he is the Scientific Secretary of the e-Journal "[Reliability: Theory & Applications](#)". Area of his scientific interests - safety very big systems, and now he is Scientific Secretary of the Scientific and Technical Council Research and Design Institute for Information Technology, Signaling and Telecommunications in Railway Transportation – NIIAS, JSC. I became acquainted with A.V. thanks to our invitations to Hong Kong City University President Prof. Way Kyo. One of his colleagues at this university was a famous specialist in reliability prof. Singpurwalla. Many talented people are very rare events. But A.V. is included in this class. He is lyrical poet, and I have his 7(!) books on my shelf. Every poem is accompanied by the corresponding picture of different artists. I'm waiting music and song on A.V. poems!

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