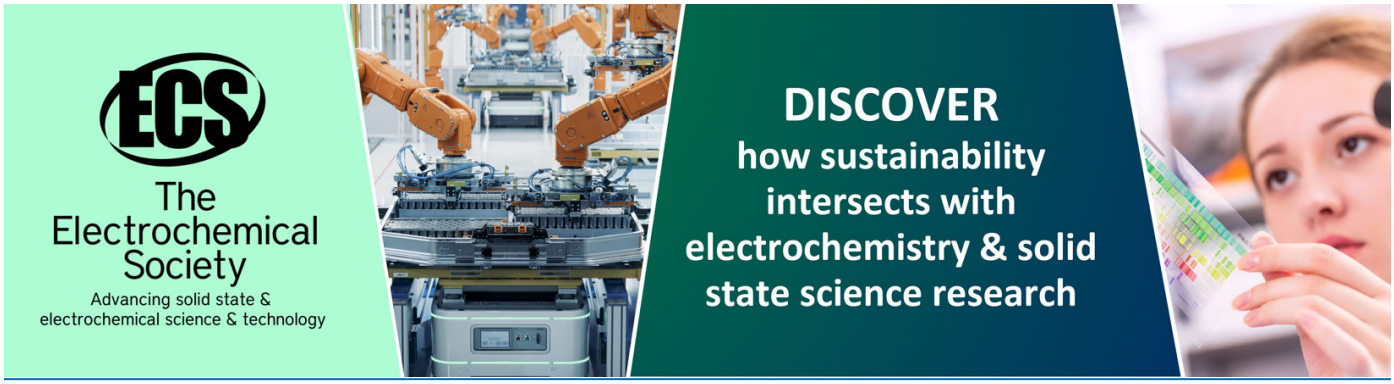
G.A. Leonov: eminent scholar, admired teacher and unconventional administrator



G.A. Leonov: eminent scholar, admired teacher and unconventional administrator

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Abstract. Gennady Alekseevich Leonov (1947 – 2018) – Corresponding member of the Russian Academy of Sciences, Foreign Member of the Finnish Academy of Science and Letters, a Council Member of International Federation of Automatic Control, the Highly Cited Mathematician of the Russian Federation, a bearer of many notable awards – passed away on April 23, 2018 after a short battle with a grievous illness. This paper is written in his memory. The authors remember Prof. Leonov as eminent scholar, admired teacher, and unconventional administrator.

Fig. 1. Prof. Leonov in his office, 2016.

1. Early years

In 1969, Gennady Leonov was admitted by V.A. Yakubovich [1], Head of the Laboratory of Theoretical Cybernetics of the Faculty of Mathematics and Mechanics (referred to below as the Faculty) of St Petersburg (then Leningrad) State University, to begin his post-graduate studies (aspirantura in Russian; from Latin/English aspiratio/aspiration) in the laboratory. His first articles, based on the ideas of V.A. Yakubovich, V.A. Pliss, and the scientific school of A.A. Andronov, demonstrated ways of extending those ideas to be applicable to both classic and new problems of differential equation and control theory. In 1971, he defended the first (Candidate of Science) dissertation titled "About certain problems of non-linear dynamics of control systems" in which a negative answer to the famous in control theory conjecture by Aizerman [2] was given in the most general case. In 1983, he defended the second (Doctor of Science) dissertation titled "Stability in the

whole", something that enabled his appointment as full professor at the Department of Theoretical Cybernetics. This appointment was supported not only by his personal scholarly achievements but was a reflection on success of his numerous post-graduate students. Already by the early 1980s, under the direction of Prof. Leonov, ten Candidate of Science dissertations have been defended in which important problems of differential equations and control theory were investigated. Remarkable eagerness to devote a large part of his personal time and intellectual resources to the supervision of scholarly work and subsequent achievements of others (figure 2) earned him sincere admiration of students and great respect of colleagues.

2. State Prize

One of the directions of research work of Prof. Leonov in 1970-80s was the development of mathematical theory of phase-locked loop systems for which mainly non-rigorous engineering methods of investigation existed. Insightful audacity of using rigorous mathematical methods as tools of investigation of outstanding engineering problems resulted in the major scientific achievement: for "*the development of the theory of phase synchronization in radio engineering and communication*" a team of researchers, Prof. Leonov included, was awarded a 1986 State Prize of USSR, the second by the societal prestige and the academic standing award that existed in the Soviet Union. The significance of this achievement was corroborated at the end of the 20th century when the systems of phase synchronization, due to their universal integration into new information systems, have come to be considered as tools of critical importance. In particular, frequency synthesis devices are based on such systems of phase synchronization and can be found in every modern computer. Phase-locked loops have also been used in the Global Navigation Satellite System. The effectiveness and error-free functioning of such systems would not be possible without designers' utilization of rigorous mathematical methods developed by Prof. Leonov.

Fig. 2. Working on a joint paper [3] in a classroom of the Faculty at the 10th Line of Basil's (Vasilyevsky) Island, Leningrad, 1976. Near the blackboard: G. Leonov (left) and Yu. Koryakin.
At the desk: S. Abramovich (left) and V. Reitmann.

3. Custodian and architect of scientific achievements

In 1988, Prof. Leonov was elected to become Dean of the Faculty, a position he held continuously till the very last day of his life. In the 1990s, during difficult years for Russian science, Prof. Leonov was instrumental in preserving rich traditions of scientific achievements of mathematicians, mechanical engineers, and astronomers of the Faculty. At the same time, he was not only the major custodian of celebrated traditions of the St Petersburg University mathematics, but was also an architect of his own research advancement. The latter included integrating Lyapunov's functions into the theory of the dimension of attractors, something that enabled the development of analytically exact formulas for the Lyapunov dimension of attractors for a number of well-known dynamical systems [4, 5]. Another major achievement [6] of that time was the solution in the most general form of an open problem of the theory of control proposed in Harvard by Brockett [7].

By carrying on and expanding work by V.A. Yakubovich, V.A. Pliss, and A.A. Andronov, Prof. Leonov was able to establish his own scientific school of mathematical control theory, qualitative theory of dynamical systems and their applications in science and engineering. One of such applications deals with the study of chaotic dynamics and hidden oscillations. Over the past 40 years, the mathematical theory of chaos grew into one of the most vigorous domains of scholarly research. The significance of the development of this theory is due to the phenomena of turbulence in hydrodynamics, the problem of weather prediction, investigation of ocean currents flow, and the discovery of chaotic oscillations in electric circuits and systems. More recently, homoclinic and heteroclinic orbits were found to play an important role in the scenarios of the loss of stability and transition to chaos. To this end, Prof. Leonov proposed the general methodology (called fishing principle) of investigation of such orbits [8, 9]. As a result, the fishing principle made it possible to provide mathematicians with universal tools of analytic proof of the existence of homoclinic orbits for a number of well-known dynamical systems [10]. Last, but not least, the notion of hidden oscillations and the development of new mathematical methods of investigation of such oscillations in classic dynamical systems [11] have attracted interest of a wide range of researchers, especially mathematicians and physicists [12]. It is mostly (but not only) due to the discovery of hidden oscillations in dynamical systems that G.A. Leonov and N.V. Kuznetsov were proclaimed (according to the Web of Science Core Collection; see also [13]) the most cited Russian mathematicians over the span of two consecutive years (2016-2017). In 2019 and 2020, N.V. Kuznetsov and G.A. Leonov (posthumously), among only four (2019) and six (2020) scholars from Russia out of six thousand worldwide, earned the international status of Highly Cited researchers. According to Shanghai Ranking Criteria and Weights (http://www.shanghairanking.com), see also (https://spbu.ru/news-events/novosti/issledovateli-spbgu-voshli-v-01-samyh-citiruemyh-uchenyh-mira-eto-luchshiy), the Highly Cited researchers criterion is given the same weight as that of the Nobel Prize and the Fields Medal winners. Not a small measure in the recent upgrade of the SPBU Shanghai Ranking (range 301-400) was Prof. Leonov's posthumous contribution (along with N.V. Kuznetsov) with the status of Highly Cited researchers to the alma mater's advancement (figure 3). Mapping Shanghai Ranking to two particular subject matters associated with work of Prof. Leonov and his scientific school, the following figures represent SPBU rankings. In the area of Automation and Control (one of the major threads running through scientific milieu of Prof. Leonov, his school, and the direction of the preparation of students at the Department): 2017 (range 51-75), 2018 (the 32nd individual place), 2019 (the 36th individual place), 2020 (range 51-75). In the area of mathematics, the ranking figures for SPBU Mathematics are: 2017-2018 (range 101-150), 2019-2020 (range 151-200). At home, in the area of Automation and Control, SPBU has secured and currently retains in Shanghai Ranking the 1st place among the institutions of higher learning of the Russian Federation.

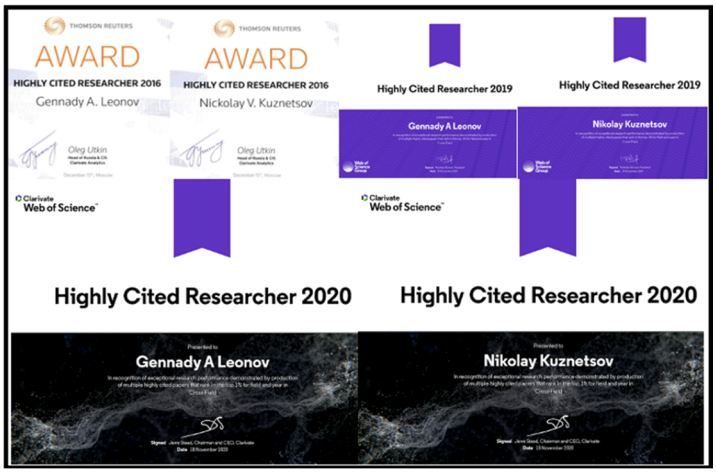

Fig. 3. Highly Cited Researchers.

4. The study of concrete problems as educational motto

Prof. Leonov had strong belief that advances in the development of mathematical sciences are the result of studying concrete problems. In one of his books [14], he advised the learners of control theory that it is the study of concrete control systems that motivated the development of mathematical machinery needed for solving such problems. At the same time, the power of tools developed for rigorous solution of concrete problems enabled far-reaching generalizations of those tools to make them applicable to solving numerous problems both within and outside mathematics. In another book [15], he argued that a student is interested in studies and appreciates learning as an intellectual endeavor if he or she is confident in the usefulness of material to be studied. The usefulness implies applicability. That is, Prof. Leonov's educational motto was the importance of concrete problems as pedagogical tools in the teaching of mathematics. Furthermore, he demonstrated [15] that experience in the study of concrete systems makes it possible to carry out qualitative analysis of many complex systems without presentation of their formal mathematical models. For example, for a real-life system in which its every subsystem develops with a positive derivative, the effect of instability is subdued. That is, a continuous growth within a system implies stability of the system's functioning. This principle can inform the policy of management – try not to demote employees but only promote them. Any element of a system that moves only forward is a guarantee of the system's desirable stable behavior. Such qualitative understanding of the stability of functioning of a real-life system has important implication for the success of the enterprise of mathematics education: never blame a student for an erroneous answer but instead, turn an incorrect answer into a thinking device keeping in mind that one of the main responsibilities of a mathematics teacher at any educational level is to encourage rather than to suppress a mathematical discourse. Students at the Faculty admired their Dean for such an educational position as they saw it unconventionally student-friendly.

5. Establishing a new department

One of the important steps in the administrative activity of Prof. Leonov was the establishment of the department of Applied Cybernetics at the Faculty [16]. In December 2005, Prof. Yakubovich and Prof. Leonov have applied to the Academic Council of the Faculty with a request to create at the department of Theoretical Cybernetics a new specialization "Non-linear dynamics, informatics and control". In 2006, after Prof. Leonov was elected a corresponding member of the Russian Academy of Sciences, the Academic Council of the Faculty petitioned to Rector of SPBU about the establishment of the department of Applied Cybernetics under the chairmanship of Prof. Leonov to allow for a greater expansion of this new specialization. In 2007, Prof. L.A. Verbitskaya, then Rector of SPBU, signed the decree to secede from the department of Theoretical Cybernetics a new department of Applied Cybernetics. The first members of this new department were Prof. Leonov (Chair) and Associate Prof. Kuznetsov (scientific secretary). In 2008, the consortium of two departments, Applied and Theoretical Cybernetics, with Prof. Leonov and Prof. Yakubovich as co-leaders, earned and shared the status of the Leading Scientific School of the Russian Federation (Center of Excellence).

Fig. 4. Diplomas for 2016 (left), 2018 (middle) and 2020 (right).

Later, under the leadership of Prof. Leonov, the Department of Applied Cybernetics earned the status of the Leading Scientific School of the Russian Federation in the field of mathematics and mechanics in 2014 and 2016 (figure 4, left). In 2018, under the scientific leadership of Prof. Kuznetsov, the Department of Applied Cybernetics was awarded the status of the Leading Scientific School of the Russian Federation again in the field of mathematics and mechanics (figure 4, middle), one of only five such schools in Russia. Same year, after untimely passing of Prof. Leonov, Prof. Kuznetsov was elected Chair of the Department, at that time already having 15 members. In 2020, the Department retained this status being awarded just to two schools in the field of mathematics and mechanics (figure 4, right) under the umbrella of the priority direction "Transition to advanced intellectual digital technology of mass production, robotic systems, new materials and methods of fabrication, creation of the systems of big data processing, computer-assisted instruction and artificial intelligence" in the development of the Russian Federation. Furthermore, since 1996, the status of a Leading Scientific School of the Russian Federation was awarded more than 50 times to different scientific units due to Prof. Leonov's support in the development of three Research Institutes, run under the umbrella of the Faculty, for one of which he was Director; another Institute was created due to his critical endorsement and assistance.

6. Administrative effectiveness of eminent scholar

Prof. Leonov's uncanny possession of dual effectiveness as a scholar and an administrator is second to none in its unconventional manner. Just as in his research he was truly astute by applying modern methods of investigation to unsolved classic problems of pure and applied mathematics, in his administrative endeavors he was instrumental in not only preserving rich traditions of the of the Faculty but in demonstrating an acute sense of the need for instigating forward-looking reforms. A critical virtue of Prof. Leonov as an administrator can be recognized in his mastery of a prompt adaptation to innovations stemming from the ubiquity of information technology in education, industry, and other major real-life contexts. In particular, as Dean, he had to encourage and supervise the revision of traditional ways of mathematical preparation of students by taking into account the needs of information technology (IT) companies such as *Intel*, *Hewlett-Packard*, *Exigen Services*, *Motorola* and *Samsung Electronics* with offices in St Petersburg. These companies expected to benefit from the presence of a renowned center of mathematical preparation of students, provided the center takes necessary steps to educate the students to become future managers of the IT workforce [17-19]. Furthermore, the process of education should include teaching students to be adaptive to the changes of the digital era. This required the appropriate integration of computers into the traditional mathematical courses with the goal to demonstrate how technology allows for solving problems earlier inaccessible and thus remaining open for a long time.

In reciprocity, the Faculty benefited from the presence of IT companies. After untimely passing of Prof. Leonov, the SPBU redistribution and control of space traditionally occupied by the Faculty has created a gap in this mutually beneficial relationship. Indicative is the story of Lanit-Terkom, one of the leading Russian providers of software and hardware solutions. For many years, Head of the company and Chair of the Department of Computer Programming at the Faculty, Prof. Terekhov, rented suites for his company from SPBU, something that allowed him to recruit employees of the company to teach formal languages used in coding. Nowadays, this renting arrangement deteriorated sharply making it quite a challenge to keep up the quality of the preparation of computer programmers.

7. Olympiads, summer camps and boarding schools as a pipeline of talented youth

Perhaps the most important administrative responsibility of the Dean of the Faculty with rich academic achievements over several centuries span deals with the search of talented youth to allow for a continuous flow of future high achievers in the pipeline. In 1990, Prof. Leonov initiated the idea of administering mathematical Olympiads for schoolchildren with the goal of using these Olympiads as an attractive alternative to entrance examinations for future students. Prior to 2009, two highest Olympiad scores were equivalent to successful passage of the entrance exams. Since 2009, after the

results of the Uni-Federal Exam became the provision of acceptance to the Faculty, the Olympiad-diploma of the first category enabled acceptance without entrance examinations; the Olympiad-diplomas of the second and the third category were considered being equivalent to the 100-score at the Uni-Federal Exam in mathematics. During the first eight years, the Olympiad was administered in St Petersburg only; beginning 1998 it was expanded to other Russian towns as well as countries of the former Soviet Union. The first towns included Sarov and Almaty; later the Olympiads were administered in Arkhangelsk, Bakhchisarai, Cherepovets, Dudinka, Elista, Neftekamsk, Nizhnevartovsk, Nizhny Tagil, Norilsk, Sevastopol, Sterlitamak, Surgut, Ufa, Yuzhno-Sakhalinsk, and other towns of the Russian Federation.

In addition to Olympiads, the Faculty recruited interested professors to conduct one-to-two-week long off-campus preparation classes in the same towns using volunteering schools as educational sites (nowadays, such classes in part are offered online). At the conclusion of the preparation classes, regional mathematical Olympiads were administered. Those schoolchildren who were not accepted to the Faculty on the basis of their Olympiad results were given an opportunity to participate in the regular entrance exams or to be enrolled into the tuition-paid cohort. Besides, the system was in place to allow well-performing students at the end of their freshman year to be transferred to the tuition-free cohort provided there were vacancies available (due to the natural discharge of students). Such system made it possible both to attract to the Faculty talented students from different regions of the Russian Federation and to fund effectively the next regional (off-campus) preparation classes. Furthermore, in St Petersburg, Prof. Leonov created conditions for the availability of summer camps and, most importantly, a reliable cohort of sponsors financially supporting diverse high school students' participation in programs offered by the camps [20]. He paid special attention to the work of boarding schools and other already established centers of preparation of youth with interest in STEM disciplines [21].

8. Advanced educational program (POMI-section) at the Faculty

The next administrative concern of the dean was to provide superb education to those already admitted to the Faculty, bearing in mind "special needs" of mathematically advanced students. In the mid 1980's, a number of leading mathematicians of St Petersburg (then Leningrad) came up with an idea to take care of such needs by replacing (for this category of students) the traditional, often way too routine, teaching of mathematics by more intense study of such basic underclassmen courses as algebra, analysis, and geometry. For some time, such advanced courses were taught by volunteers, however without any official arrangement. Sometimes, the teaching could take place in a tiny personal place of an apartment building where a volunteer teacher lived, to avoid a tiresome train commute to Peterhof (a suburb of St Petersburg, the Faculty's location since 1979). However, soon this unofficial advanced teaching initiative faded and eventually died out.

In the early 1990s, the idea was given a new pulse, perhaps being inspired by educational activities of research physicists [22]. Towards this end, Prof. Leonov teamed-up with Director of St Petersburg Branch of Mathematical Institute of the Russian Academy of Sciences (POMI RAN, in Russian-language abbreviation) Prof. Ludwig Faddeev and Vice-President of St Petersburg Mathematical Society Prof. Anatoly Vershik, to promote the idea of the creation of an advanced program in the study of fundamental mathematics at the Faculty. Prof. Leonov's approbation of this program as Dean was crucial in order for the program to become a part of the official schedule of classes at the Faculty. That is, already in the early 1990's, an advanced educational program at the first/second-year level was created and continued for at least two decades [23, 24]. That made it possible to uplift interest in fundamental mathematics among capable and aspiring students and to create a pipeline of future professional mathematicians joining research institutes of the Russian Academy of Sciences. As mentioned by Prof. Nazarov [25] this program, known as POMI-section (POMI-potok, in Russian) "*has demonstrated its unambiguous effectiveness*" (p. 65, the authors' translation from Russian).

The enrollment into this advanced program was contingent to the results of the exams of the first semester. Students enrolled into this program could leave it without any penalty to join the regular program. Students enrolled into the regular program could switch to the advanced program (POMI-

section) any time but were required to take more comprehensive exams comparable with the demands of the advanced program. Such flexibility that students were provided with was another example of a good administrative judgement by Prof. Leonov for which he was always admired by students. The best of the best from those sections were later accepted to post-graduate studies (aspirantura) either at the Faculty or POMI and some were offered a POMI-based internship. This initiative was especially important for the preservation of mathematical traditions and support of mathematically advanced students. The leadership of the Faculty (Prof. Leonov), POMI (Prof. Faddeev) and St Petersburg Mathematical Society (Prof. Vershik) can be given credit for support of the implementation of the POMI-section idea.

In 2015, at the meeting of the Educational Council of the Faculty [26], during the discussion of presentations by G.A. Leonov and S.K. Smirnov regarding the transformation of the POMI-section into a new bachelor's degree program in mathematics, a number of high-profile professors commented on the need for preserving an option for students to transfer from the advanced program to the regular one. For example, S.K. Smirnov estimated that out of 45 students enrolled into this new bachelor's degree program approximately 20-25 would be able to continue studies at the advanced level implying the importance of providing students enrolled into the regular program with an option of using their mathematical abilities within auxiliary specializations in an number of widely needed areas (e.g., statistics, computer programming, etc.). Such educational advantage was available within the POMI-section which existed at the Faculty comprised of the departments of fundamental mathematics, applied mathematics, mechanical engineering and computer programming, offering a variety of specializations within regular programs. Nonetheless, after 2015, in a course of separation of the new bachelor's degree program from the Faculty, the traditions and merits of the POMI-section at the Faculty have fallen through the cracks. Nowadays, this program has been taking place with the establishment of the third faculty of mathematics at SPBU (Faculty of Mathematics and Computer Science). According to [27], following the vote by secret ballot (23 in favor of the new faculty, 52 against, 18 invalid), Rector of SPBU decided to establish the new faculty. As mentioned in [27], students admitted to this new faculty based on the results of the Uni-Federal Exam in mathematics, were given no option to switch to the regular program of studies and if they fail an exam (in fall or in spring), they become dismissed from SPBU.

According to Prof. Terekhov who in 2016, at the request of Prof. Leonov, taught informatics in the program from which the new faculty ensued: "I started teaching a group of 12 very bright students; by winter this number was shrunk by half; by spring only 3 students remained. In all honestly, my course had nothing to do with the students' dismissal" [27, the authors' translation from Russian]. This is a rather grim state of affairs when the dismissal of the country's very best future mathematicians has no courteous alternative. In all, over the span of four years since the SPBU, in good faith, opened the doors of the new faculty, 70 future mathematicians ended up being expelled from the university [27]. Alas, such predicament is in stark contrast with Prof. Leonov's meritorious care of mathematically ambitious youngsters who entrusted their future to the Faculty he supervised till the last day of his life.

9. Russian-Finnish partnership and the first PhD defenses in the modern Russia

One of the goals of the formation of the Department of Applied Cybernetics was to connect fundamental mathematics education at the Faculty with the demands of international companies of information technologies that graduates of the Faculty working in that area have to satisfy. To achieve this goal, Prof. Leonov drew on the experience by Prof. Neittaanmäki of the University of Jyväskylä (Finland) Faculty of Information Technology and the affiliated Technopark established under the auspices of Nokia. Since 2008, the department accepted annually about 20 students of the third year of studies; the most successful of them have been invited for post-graduate studies and the best of the best were selected for participation in the joint Russian-Finnish program of PhD studies originally supervised by Prof. Neittaanmäki (Finland) and Prof. Leonov (Russia) and later augmented by Prof. Kuznetsov's supervision. Productive collaboration between SPBU and University of Jyväskylä towards the joint preparation of highly qualified workforce for the frontiers of information technology

research has been in place since 2007. A testament to high international level of the program's activities has been the enlistment in its Council a number of leading foreign scholars towards expert analysis of various research and educative activities, including the appraisal and opponency of PhD dissertations [28]. This collaborative PhD program was supported by the study abroad stipends of President of the Russian Federation and by academic grants of Finland. The program's first PhD defense at the University of Jyväskylä was in 2008, with Prof. Abramovich (State University of New York) serving as the opponent (figure 5). All graduates of the program continued working for SPBU after obtaining their European-type PhD diploma. In 2017, in recognition of the success of the program and masterful collaboration in research, the Finnish Academy of Science and Letters elected Prof. Leonov as its foreign member, one of only six representatives from the Russian Federation.

Fig. 5. After the program's first PhD defense at the University of Jyväskylä. From right to left: G. Leonov, N. Kuznetsov, P. Neittaanmäki, S. Abramovich.

Fig. 6. After the first PhD defenses at SPBU. From right to left: G. Leonov, M. Yuldashev, V. Filippov, N. Kuznetsov, P. Neittaanmäki.

In 2013, at the request of N.M. Kropachev, Rector of SPBU, the Department of Applied Cybernetics, using its unique experience of the joint PhD program with the University of Jyväskylä, organized the very first in the modern Russia defenses of SPBU PhD dissertations. The defenses of R. Yuldashev, M. Yuldashev and M. Kiseleva (with N.V. Kuznetsov, G.A. Leonov and P. Neittaanmäki as major professors/scientific supervisors) took place on June 19, 2013, in the presence of Prof. Filippov, Chairman of the Higher Attestation Commission of the Russian Federation (figure 6). At the conclusion of the defense, the three holders of the first PhD diplomas of SPBU were offered teaching and research positions at the Faculty, sponsored by the Rector.

10. Upgrading the appeal of Faculty

Another administrative achievement of Prof. Leonov deals with the organization of an auxiliary educational and research site in the historic center of St Petersburg at the 14th Line of Basil's (Vasilyevsky) Island (figure 8) where the picture shown in figure 1 was taken. This initiative substantially upgraded the appeal of the Faculty as a site to work and study to residents of St Petersburg including high-profile scientists, managers of IT corporations, and talented youth. In the same building, supervised by Prof. Leonov over a large period of time, a SPBU Center of in-service training of experts in mathematics and informatics had been functioning [29]. Although formally affiliated with SPBU, the core of the Center was an alliance of the IT-experts of the Faculty. The Center became one of the most successful sites of in-service training in St Petersburg.

In 2013, as the recognition of remarkable success in the development of the IT direction at the Faculty (including multiple wins of student teams at the International Collegiate Programming Contests held under the auspices of the Association for Computing Machinery, active educational and scientific collaboration with the leading international and national IT companies, initiating joint programs with foreign universities, evidence of high demand at the labor market for the graduates of the Faculty and for the participants of in-service IT training), the status of the Center of High Visibility and Reputation in the IT area was awarded to the alliance of several departments of the Faculty [19]. An application prepared by the Faculty on behalf of SPBU was included in the list of 19 winners of

the competitive search process, advertised by the Federal Ministry of Mass Media and Communication, requesting Federal support for the creation of such centers.

Beginning 2016, Prof. Leonov chaired a Federal Consortium of Higher Education in the area of computer science and information technology. In 2018, the scientific council of SPBU nominated Prof. Leonov and his collaborators for a prestigious award of the Government of the Russian Federation in the area of education for the work "*The development of innovative frameworks for the study of information technologies on the principles of the modern mathematics*" [30]. Unfortunately, with the untimely passing of the leader, this nomination did not reach the final stage.

Fig. 7. During an administrative coffee break.
From right in the counterclockwise order: G. Leonov
A. Razov, V. Kiyaev, N. Kuznetsov, G. Pavilayinen.

Fig. 8. A site of the Faculty in
the historic center of St. Petersburg.

11. Administrative flexibility principle

Prof. Leonov promoted the principle of administrative flexibility [17]. He noticed that whereas courses in pure mathematics may be taught for a long period of time without significant modification, the IT field is characterized by almost daily advances and this rapid change in the development of software products calls for a continuous modification and amendment of IT courses. As a result, the Department of Applied Cybernetics necessitates using an operational mixture of a small group of regular faculty members and a large pool of adjuncts with expertise in various areas of informatics and computer science. This combination is especially important if one looks at the cybernetics through the lens of the seminal book by Wiener [31] in which it was made clear that the subject matter of cybernetics includes mathematical methods and practical design of their algorithms. The principle of administrative flexibility was extended by Prof. Leonov from the department to the entire Faculty. In particular, this extension was beneficial for the Department of Computer Programming making it possible to combine theoretical courses and the internship of highly qualified workforce of the future, including prospective managers of the IT industry.

12. Conclusion

The legacy of Prof. Leonov embraces more than 470 papers, 22 monographs, 10 patents, supervision of 5 Doctors of Science, 16 Doctors of Philosophy (PhD), and 37 Candidates of Science. All members of the Department of Applied Cybernetics are his former students, the core of whom participated in the joint Russian-Finnish program at the University of Jyväskylä. As faithful followers of Prof. Leonov, they proudly devote their academic life at the Faculty by carrying on and proliferating his ideas. In 2018, the Faculty's Academic Council elected Professor A.I. Razov, who for many years was deputy dean, to the position of Dean of the Faculty. In 2020, the Finnish Academy of Science and Letters elected Prof. Kuznetsov as its foreign member (the youngest one at the time of election). The celebration of Prof. Leonov's life, cut short at the zenith of his eye-catching creativity, continues through diverse initiatives by a great number of his followers; the initiatives which can be traced back to their direct or

indirect association with this outstanding individual. Various publications have been dedicated to his memory [32-37]. The authors hope that their remembrance of Prof. Leonov as eminent scholar, admired teacher and unconventional administrator will be shared by the readers of this paper.

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