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Chapter 10

N. F. Gerasyuta and His Scientific and Technical School (To the 90th Anniversary of His Birth)*

Irena Fedorenko† and M. Kaliapin‡

Abstract

After the development of atomic weapons in the USSR,§ the problem of the means of delivering them to the territory of the supposed enemy became very urgent. The USSR placed its money on rockets, and after the successful development of the first ballistic missiles, at the Design Office of Sergei P. Korolev, the decision was made for large-scale mass production. The operational Dnepropetrovsk Automobile Plant (located in Ukraine) was selected for the mass production facility. In a relatively short time, the plant was re-tooled for rocket production, and commenced the mass production of missiles R-1, R-2 and R-5, developed by Korolev.

Concurrently with this, the young team of designers at the facility initiated its own development of a new missile using high-boiling-point propellant components: this missile would have advanced strike capabilities, particularly in re-

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† A. M. Makarov National Youth Aerospace Education Center, Ukraine.

‡ Oles Gonchar Dnepropetrovsk National University, Ukraine.

§ Union of Soviet Socialist Republics, or Soviet Union.

gard to its reduced launch-preparation time. This rocket was developed, built, and tested for three to four years. As the R-12 missile (also known as K863), it is a classic example of national rocket production.

Naturally, the complex task of such missile development required carrying out new investigations, the creation of theoretical precepts and the development of calculation practices. This work demanded task-oriented coordination of effort, scientific insight, and practical activity directed toward solving a number of problems (strength, aerodynamics, heat-and-mass transfer, and so on). One of the principal directions of research activity was ballistics and rocket flight dynamics. This field, in particular, provides the basic war-fighting capabilities of rocket weapons, such as range and targeting accuracy.

Nikolay Fedorovich Gerasyuta, Hero of Socialist Labor, Corresponding Member of the Academy of Science of the UkrSSR,* Laureate of the Lenin Prize and State Prize of the USSR, became the leader in this field in Ukraine. Under his guidance, a Ukrainian school of ballistics specialists and dynamics experts was formed, and this school has made a substantial contribution to the development of unsurpassed examples of rocket engineering in the USSR. More than 100 scientists and highly proficient specialists (including 88 Candidates of Technical Science) received training at the scientific school of N. F. Gerasyuta. Students from this school published over 1,000 scientific papers, 15 monographs and received about 400 certificates of authorship for pioneer technical solutions.

Figure 10–1: Nikolai Fedorovich Gerasyuta (18 December 1919 – 10 April 1987).

* Ukrainian Soviet Socialist Republic.

Introduction

Dnepropetrovsk, like Teheran, Yalta, and Potsdam, can be considered a symbol of the current world order, and also a symbol of solving tasks, at the highest scientific and technical level, so as to secure the Teheran, Yalta, and Potsdam agreements. It is characteristic that such an appraisal of the contribution made by the Dnepropetrovsk missile developers to the world order of this planet has been offered in the various speeches of states-people and in the opinions of journalists and frontline workers of the Dnepropetrovsk rocket-and-space center.

New rocket-building subjects at the Dnepropetrovsk State University gave an incentive to developing scientific investigations in various directions. Beginning in the middle of the 1950s, new scientific schools began to emerge at the university. This chapter is devoted to the history of the origins and development of the N. F. Gerasyuta scientific school, which is devoted to ballistics, flight dynamics, and rocket control.

In the early 21st century, when many formerly secret documents are in the public domain, the historical role of the Dnepropetrovsk missile developers in the life of civilization on Earth in the 20th century can be seen more distinctly. This statement is not a rant: people know that the initiation of a "hot war," with the use of nuclear weapons, could cardinally change life on Earth and annihilate a considerable part of its population and achievements. The effective deterrent forces created in Dnepropetrovsk preserved the planet from disaster.

Ukrainian journalist A. A. Sukhonos, a veteran of Yuzhnoye State Design Office (SDO), has suggested the idea that the role of Dnepropetrovsk in the 20th century can be likened to the roles of Teheran, Yalta, Potsdam in the past—places that became symbols of the world order on this planet, representing times when, at high diplomatic levels, great powers made decisions that determined the destiny of humankind for the following decades: decisions that controlled the fate of Earth.

The Establishment of the Rocket and Space Center in Dnepropetrovsk

The history of the establishment of the rocket and space center in the city of Dnepropetrovsk is well known.[5,pp.72-173] The landmarks of this establishment are as follows:

- reconstruction of the motor works in Dnepropetrovsk into a missile production plant;

- organization of the Chief Designer's Department of the reconstructed plant to provide engineering support for drawing up documentation for the first domestic missiles R-1, R-2, and R-5, developed by S. P. Korolev;
- successful mastering of the mass production of the first missiles;
- proactive development of missiles of a new type, using high-boiling-point propellant components, undertaken by the Dnepropetrovsk missile specialists;
- development and delivery to the arms inventory, of the first Dnepropetrovsk-developed missile, the R-12, the basis for the future strategic rocket forces;
- development of missile R-14 with improved military characteristics;
- development of intercontinental ballistic missile R-16, laying the foundations of real parity in the Cold War nuclear-missile confrontation;
- development of second-generation missile R-36, with significant new characteristics (separable warheads, silo version, orbital version, antiballistic missile—ABM—defense system, etc.);
- development of missiles of the third generation (15A14, 15A15);
- development of missiles of the fourth generation, including the 15A18M missile (known by the NATO* designation SS-18 Satan), which is still unsurpassed;
- development of launch vehicles for spacecraft on the basis of combat missiles R-12, R-14, and R-36 (Kosmos, Tsyklon) and the principally new launch vehicle, Zenit, which has no competitor in its class;
- development and launching of spacecraft for various requirements in the interests of defense, science, and the national economy; and
- development of solid propellant rockets with improved characteristics, including movable railway versions offering enhanced survivability.

Even just listing the above landmarks demonstrates the tremendous scale, and the scientific and technical complexity, of tasks accomplished. But every step was connected with various problems that needed to be solved by the team of experts at Dnepropetrovsk.

The Role of V. S. Budnik

Naturally, scientific issues needed to be dealt with first, and for this purpose highly skilled workers were required. Recruitment of personnel was given

* North Atlantic Treaty Organization.

close attention at all levels, particularly on the part of the first Chief Designer of the Dnepropetrovsk plant, Vasiliy Sergeievich Budnik. Budnik's role in the formation of the Dnepropetrovsk rocket and space center was invaluable, and at least two important facts should be mentioned. The first, and most important, was that he initiated his own project for the development of new types of missiles in Dnepropetrovsk. The successful solutions to the task of developing the R-12 missile actually predetermined the status of Dnepropetrovsk as the future missile capital of Ukraine. This achievement was deservedly recognized by the Dnepropetrovsk authorities when, in 2006, V. S. Budnik became an honorary citizen of Dnepropetrovsk.

The second factor characterizing V. S. Budnik's role was his work in the training of highly skilled personnel. It is well-known that, as a result of the government decision to develop mass production of missiles in Dnepropetrovsk, a physical-technical facility, focused on the training of missile specialists across all disciplines, was also established at the Dnepropetrovsk State University (DSU). V. S. Budnik was set the task of simulating training and practice to maximum extent, for which purpose he assigned the most qualified specialists of the Chief Designer's Department as teachers at that facility.

The first candidate for this activity (on a part-time basis) was Nikolay Fedorovich Gerasyuta—a young scientist, with the degree of Candidate of Science (Engineering), and an expert in the domain of ballistics and missile flight dynamics. He received comprehensive training in Germany, working with captured documents relating to the V-2, and further training at S. P. Korolev's Design Bureau. There he completed postgraduate studies and defended his thesis on the stability of missile travel.

Human resource activity at the university was carried out in three areas:

- training engineers to work at the Design Office and at the missile plant;
- training its own teaching staff for the relevant departments;
- training of scientific personnel for research into solutions for new emerging tasks.

New rocket production subjects at Dnepropetrovsk State University provided the impulse for research activity in various fields.[5,p.205] At the same time, commencing in the middle of the 1950s, new scientific schools begin to emerge at the university. Here it is appropriate to quote from the book *DSU Professors*, issued for the 85th anniversary of this higher education establishment. In the preamble is written:

> During post-war years, the active development of DSU started. In 1951 a physical-technical facility for training specialists in the new domain of rocket production was opened. At most of the faculties and Chairs, investi-

gations on fundamental and applied sciences were under way. There were new scientific schools actively developed in the fields of mechanics and mathematics (V. I. Mossakovskiy, N. P. Korneychuk), and rocket and space technology (N. F. Gerasyuta, V. M. Kovtunenko, V. A. Makhin).

This chapter is devoted to the history of origins and development of the N. F. Gerasyuta scientific school, which focused on ballistics, flight dynamics and missile control. This school was highly esteemed by V. S.Budnik, one of the founders of Ukrainian rocket construction (and a Member of the Academy of Science of the UkrSSR) [3,p.34-35] and S. N. Konyukhov, the General Designer of State Enterprise "Yuzhnoye Design Office named after M. K. Yangel" (also a Member of the National Academy of Science of Ukraine).[3,p.41-42]

Figure 10–2: Stanislav Nikolaievich Konyukhov, General Designer of the Yuzhnoye Design Department 1964–1974, General Director of the NF Gerasyuta scientific school (for ballistics, flight dynamics and missile control) since 1991.

Nikolai Fedorovich Gerasyuta (18 December 1919–10 April 1987)

Born in the town of Aleksandriya (now in the Kirovograd region), Gerasyuta fought in the Great Patriotic War (1941–1945) and was awarded the Red Star and Patriotic War orders and seven medals. He graduated from the physical-mathematical facility of Odessa State University, majoring in mathematics in 1941, later earning a Doctor of Science (Engineering) degree and the title of Professor in 1961. He became a Corresponding Member of the Academy of Science of the UkrSSR in 1967.

In the post-war years, Gerasyuta took part in the study of documentation for the V-2 rocket at the Nordhausen Institute.* He then worked at the Experimental Design Office (OKB)-1 under the guidance of S. P. Korolev (1947–1951) and the Special Design Office (SKB) of plant 186 (1951–1954). N. F. Gerasyuta was one of organizers of the Yuzhnoye Design Office, where he worked from 1954 to 1987. He finished his career with the rank of Deputy Chief Designer on matters pertaining to ballistics, dynamics, and systems for controlling long-range missiles and spacecraft launch vehicles (1962–1987).

Nikolay Gerasyuta made a great contribution to the establishment of the Yuzhnoye Design Office as a powerful design enterprise, being a prominent scientist in the domains of applied mechanics, dynamics, and computing mathematics. Under his guidance, and with his participation, methods were developed and implemented for solving multiparameter boundary and variational problems connected with the optimal tracking of missiles and space vehicles, statistical methods of flight evaluation, and the technical performance of rockets. He was one of the authors of the development of four generations of combat missile systems, from the R-12 (8K63) to the R-36M2 (15A18M), and the space launch vehicles Kosmos, Interkosmos, Tsyklon and Zenit.

N. F. Gerasyuta held the Automation Chair on the physical-technical faculty of the Dnepropetrovsk State University (1952–1985). He was a winner of Lenin Prize (1972), the State Prize of the USSR (1967), a Hero of Socialist Labor (1961), holder of the Order of Lenin (twice), and the Order of the October Revolution. A memorial plaque to N. F. Gerasyuta was opened at the main building of Odessa National University in 2005.

The Concept of the "Scientific School"

What does a "scientific school" mean? Collective activity on the elaboration of scientific and technical knowledge is typical for modern science and engineering. It is expressed in the creation of formal and informal teams, and also various schools. For many years, the phenomenon of the "scientific school" has attracted the attention of science historians. The versatility and complexity of this phenomenon predetermines the variety of approaches and interpretations thereof.

The notion of a "scientific school," in its modern reading, is connected with the process of the growth of the role of the personality of the head of the research team. This process began to appear more clearly at the beginning of the 20th century, with the emergence of research teams combining several scientists

* Editor's Note: outlined in Chapter 9, p. 145.

in one laboratory. These teams generated a new pedagogical function of the manager, acting under these circumstances both as scientist and mentor, that is, as the head of a new scientific school,[8] alongside the functions of the collection and systematization of information, the division of spheres of labor, and management.

For the development of talent, it is necessary to be fostered by other talent. This fostering is provided by collaborative activity between the teacher and student over a number of years. The teacher gives to the student something greater than knowledge—he/she teaches ways of working and thinking and imparts those special traits necessary for the formation of a real scientist: a high level of investigation, self-discipline, work efficiency, enthusiasm for new ideas, and dedication.

The school is the brightest manifestation of the collective form of creative activity, under the direct ideological and practical guidance of a scientist and teacher, who supplies this team with scientific ideas and determines the methods and content of the research carried out at the school. It is a custodian of traditions and scientific ideology, comprising the concentrated experience of a number of generations and providing a kind of express delivery of scientific knowledge.

By concentrating the huge creative energy of scientists, and coordinating their activity in the process of scientific inquiry, the school promotes to the maximum the flowering of creativity in newcomers to science, enhancing their training and turning them into mature research workers. It also initiates new "growth points" of science and scientific trends and favors their formation. Listed below are some typical indices of the scientific school: the presence of a scientific leader; a definite style of working and thinking; a scientific ideology; a research program; a specific atmosphere in the collective; obtaining results and recognition in the scientific community.

However, a "scientific school" is not restricted by the framework of a single institution or organization. Other scientists use the term "scientific school" for an informal research team, which is formed around a prominent scientist, on the basis of a research institution, and combines a number of formally segregated research teams, with the purpose of the joint development of a certain scientific idea (problem, direction). Therefore, the "scientific school" is characterized by at least three features: a common scientific idea; a generality of principles and methodical means of solving assigned tasks; and the development of a new, original scientific direction.

According to one of models, the "scientific school" is categorized as an

> informal creative community of researchers of various generations, having high scientific qualifications, and guided by a scientific leader; within the

limits of the specific area of science; with a unified approach to problem solving; a particular style of working and thinking; originality and novelty of ideas and methods of implementation of their research program, which obtains significant scientific results and gains prestige and public recognition in the given branch of learning.

Based on this model, certain criteria can be formulated, according to which informal collectives can be identified with "scientific schools." These are:

- high individual results of the leader;
- pedagogical skills;
- a specific scientific atmosphere;
- a specific style, scientific ideology, and program;
- a number of students of the highest qualification (more than 10); and
- high performance.

The Concept of the "Scientific and Technical School"

Everything that has been outlined about "scientific schools" can also be attributed, to a great extent, to the "scientific and technical school." The latter has the basic characteristics of a scientific school, but also some peculiarities of its own. Typical features of a "scientific and technical school" are as follows:

- a precise scientific-technical orientation of the research activity carried out in the school;
- theoretical research results brought to practical implementation;
- close cooperation among science, technology, and production workers aimed at the performance of specific tasks connected with the development of scientific and technical progress in the given branches; and
- strongly marked economic effect and financial viability of the scientific and technical research and developments.

The above features of the "scientific and technical school" represent additional criteria of identification. Among them, the most convincing criterion is the positive result of the school's activity, with a high degree of efficiency. As distinct from the purely scientific (academic) school, where the negative results of research can be useful, the results of the scientific and technical school should only be positive. This result should be a structure, system, et cetera, possessing new technical characteristics. Informal collectives that produce no progressive results break down and disappear from the cycle of research and production activity. The "scientific and design school" is one form of the scientific and technical school.[2]

Scientific and Technical School of Gerasyuta

Scientific and technical school of N. F. Gerasyuta falls completely within the above definitions. First, Gerasyuta meets the requirements of the school leader.[3,pp.208–227] Second, the school has all the necessary segments in its structure:

- a production and research segment: the design and theoretical complex created by Gerasyuta at the Yuzhnoye SDO (Complex 2), which was in charge of research, with the results thereof implemented in production (in ballistics, flight dynamics, and Antimissile Defense Penetration Aids—AMD PA);
- a university segment: the Chair of Automatic Control Systems created by Gerasyuta for the training of future specialists and teaching staff;
- an academic segment: a section on the "problems of technical mechanics" created by Gerasyuta within the Academy of Science of the UkrSSR. This has grown further into the self-contained Institute of Technical Mechanics under the National Academy of Sciences of Ukraine and the National Space Agency of Ukraine. The Flight Dynamics Department of this entity carries out research on fundamental problems of rocket technology; and
- the combined section on rocket dynamics of the Yuzhnoye Design Office research council.

The conception of the N. F. Gerasyuta school, as with the school of any leading scientist, began with the leader's education and learning on the fundamentals of the subject, where his natural talent was further developed.[3,pp.27-28]

Nikolay Gerasyuta obtained his classical university education at the Mechanical-Mathematical Facility of the Odessa State University (where he majored in mathematics). The fundamentals of such an education were strong enough, as is demonstrated by the fact that after a four-year interval of serving his country during World War II, he quickly became a leading expert in the group of Soviet specialists studying captured missilery. Gerasyuta was destined for dealing with matters of rocket flight stability, though it can be said with certainty that in any other field he would have been equally proficient. N. F. Gerasyuta expanded and deepened the knowledge he obtained in Germany at S. P. Korolev's Design Bureau, where he completed external postgraduate studies under the guidance of well-known scientist N. D. Moiseyev, and, in 1951, successfully defended his Master's thesis on the topic: "On Methods of Studying the Stability of Long-Range Missiles According to Pitch Angle." His thesis is now a classic example of work for the degree of Candidate of Science (Engineering), and issues developed by him were the basis for the enhancement of a home-grown theory of ballistic

and dynamic design of missiles. This was the first phase in the origins of his scientific school.

The second very important stage began in Dnepropetrovsk. Gerasyuta moved there with V. S. Budnik's group of specialists for the mass production of rockets developed by the S. P. Korolev Design Bureau. Being the only Candidate of Science (Engineering) in the newly created Chief Designer's Department, he became the executive responsible for finding solutions to emerging issues, and he solved them successfully. At the same time, Gerasyuta was engaged in designing a principally new rocket, operating on high-boiling-point propellant components. In the 1950s, under his guidance, a scientific methodology was created for solving ballistic questions and problems of transient processes' dynamics. Mathematical models were developed, with algorithms and the fundamentals of program support for the design and ballistic characteristics of test and operational rockets. A wide range of research tasks was offered by the work itself: the design, production, testing, and commissioning of rockets 8K63, 8K65, and 8K64 was performed in the shortest time possible. All problems were solved successfully.[5,p.88]

Understanding that it is not possible to develop rocket technology without properly trained specialists, N. F. Gerasyuta began actively teaching at the new physical-technical facility of Dnepropetrovsk State University (DSU). He gave lectures on the dynamics and stability of missile flight at high levels. He summarized the wide range of scientific and technical issues that he had solved in the development of new missiles and presented this to the Scientific Council of the University in the form of a report. The Scientific Council consequently awarded Gerasyuta the Degree of Doctor of Science (Engineering). At the same time, Gerasyuta began to train the first students, who proceeded to solve independent scientific and technical problems under his guidance. These students went on to become well-known scientists in their own right, for example, A. A. Krasovskiy, P. N. Lebedev, G. D. Makarov, and I. V. Aleksakhin, to name just a few. At this stage, two areas of specialization were formed in the scientific school, namely, ballistics and flight dynamics.

Development of the Gerasyuta School in the 1960s

The third stage of development of the scientific school relates to the middle of the 1960s. Missiles of a new generation were being created at the Yuzhnoye Design Office, and the specialists in ballistics and dynamics faced new problems.[5,p.119] These questions were connected with individual calculations of the filling levels for missiles with high-boiling-point propellant components; the dy-

namics of the launch of long-range missiles, using their own propulsion units, from silos; the dynamics of "cold," "warm," and "hot" separation of stages; the development of methods for evaluating missile accuracy; and for analyzing the effects of various factors on that accuracy, etc. During this period, the third scientific school specialty originates, namely the creation of Antimissile Defense Penetration Aids (AMD PA). Gerasyuta assigned the guidance of this specialty to one of the heads of departments at Yuzhnoye, N. I. Uriyev, who quickly became a leader in this area.

At that stage of the development of the scientific school, the process of specialist training at DSU (in the flight control specialty) was enhanced.[3,pp.57-59] Gerasyuta was elected the holder of a Chair, with his department recruited from young scientists, students of his who had received excellent technical training at the Yuzhnoye Design Office. Gerasyuta's immediate assistant in his role as Chair was Yuri D. Sheptun, who defended his Doctoral thesis and received the academic title of Professor a short time later. This group performed a radical renewal of the curriculum on special subjects, and a number of new methodological and teaching aids were drawn up. Their authors were professionals who worked at the Yuzhnoye Design Office. The Department of Control Dynamics at the N. F. Gerasyuta complex was managed by I. M. Igdalov, who became the leader of that specialty at Yuzhnoye SDO.

The third stage of development of the N. F. Gerasyuta scientific school is characterized by a number of organizational improvements and innovations, objectively reflecting the growing demands of both production and the training of scientific personnel.

First, at the beginning of the 1960s, the design and theoretical complex was formed at the Yuzhnoye SDO on the basis of the department headed by N. F. Gerasyuta. This complex consisted of three departments: the Ballistics Department, Dynamics and Control Department, and the Computing and Special Devices' Department. Each of these departments became a research cell in which the above specialties of the scientific school were developed.

Second, it is necessary to mention the above reorganization of the DSU Chair, which became the basis for the training of future scientists in parallel with academic activity.

Third, in the middle of the 1960s, the demand for fundamental scientific research on wide range of topics connected with rocket technology called for creation of a purely scientific subdivision within the Academy of Science of the UkrSSR. On the instructions of M. K. Yangel, the organization of such a subdivision was assigned to N. F. Gerasyuta. The "section for the problems of technical mechanics" was created, and it was further transformed into a self-contained de-

partment of the Institute of Mechanics, under the Academy of Science of the UkrSSR. From the outset, Gerasyuta employed his best efforts to strengthen this scientific entity with the required personnel. Talented students of N. F. Gerasyuta, such as G. L. Madatov, V. V. Gorbuntsov, and others, were transferred to the Dynamics Department from the Yuzhnoye Design Office.

The role of N. F. Gerasyuta in the establishment of scientific departments engaged in studies of the dynamics of controlled rockets and space objects should be specifically mentioned. At the Institute of Technical Mechanics under the National Academy of Sciences of Ukraine and the National Space Agency of Ukraine (the Chief Institute of NSAU) there are now creative and efficient departments, whose basic activities were formulated by Nikolai Fedorovich Gerasyuta.[3,p.45]

The Department of Dynamics and the Control of Mechanical Systems is one of the subdivisions whose team is now undertaking successful research activity. Its foundation was laid by scientists who worked under the direct supervision of N. F. Gerasyuta. The scientific and technical specializations of the department's work were further developed through the accumulation of experience in solving production tasks associated with the mechanics of flight for rocket and space systems: tasks relating to the optimal dispensing of payload elements (multiple warheads, penetration aids, satellites); issues relating to the evaluation of injection accuracy, and the prediction of parameters for the disturbed orbital motion of space vehicles. The specializations of the department were developed in the process of creating a methodical framework for the design of sophisticated technical systems.

The Systems Analysis and Management Problem Department further developed Gerasyuta's ideas, establishing extended and deepened variations. Its scientific core was also formed by scientists who had worked with him. The department's fields of investigation were as follows: space activity; satellite and space transport systems, spatially transformed systems of space deployment; and medical informational and diagnostic systems.

This third stage of development proved to be fruitful in terms of the transformation of the research achievements of N. F. Gerasyuta and his students into a scientific school. A. A. Krasovskiy, I. M. Igdalov and Yuri D. Sheptun were all awarded the title of Doctor of Science (Engineering). The rich scientific material accumulated as a result of the research activity at the Yuzhnoye Design Office, at the DSU Chair, and at the Department of Mechanics under the Academy of Science of the UkrSSR secured a successful defense of their Master's theses for a number of specialists.

Investigations and pilot-scale works were under way, and their results were characterized by a high level of novelty. In the process of solving the important scientific and technical problems needed for rocket and space technology, the basis for scientific personnel training was formed. The leader and consultant for most of studies was N. F. Gerasyuta himself and his immediate assistants, the leaders of the various specializations: A. A. Krasovskiy, I. M. Igdalov, N. I. Uriyev.

Gerasyuta was the initiator of the establishment of external postgraduate studies at the Yuzhnoye Design Office. In accordance with Decree No. 14c of the Minister of Higher and Secondary Education of the USSR, dated 3 February 1969, it was decided to open external postgraduate studies at the Yuzhnoye SDO in the following major fields: aerodynamics, construction and design, strength, technology, propulsion units, dynamics, ballistics, and control of space vehicles.[3,p.67]

N. F. Gerasyuta was elected as a Corresponding Member of the Academy of Science of the UkrSSR. At that time, the textbook published by N. F. Gerasyuta, in cooperation with A. A. Lebedev, titled *Rocket Ballistics*, became the main teaching aid for students and practical engineers.

Further Development of the School: 1970s and Beyond

The fourth stage of development of the N. F. Gerasyuta scientific school was connected with the development of third-generation missiles and space launch vehicles in the 1970s. At this stage, new scientific issues were solved.[4,pp.300,305,316-317,376]

In the field of ballistics:

- development of new, efficient methods for choosing power values and optimal trajectories;
- development of methods for solving boundary problems in ballistics, taking into account restrictions as to strength, controllability, temperature regime, and the conditions of stage separation;
- creation of engineering methods for determining the power characteristics of rockets, using statistical methods from the results of a limited number of launches;
- resolution of issues relating to the discharge and consecutive separation of warheads at stage separation; and
- development of methods for the calculation and control of flight tasks for missiles with separable (multiple) heads for control systems based in onboard and ground-based computers.

In the field of dynamics and control:

- investigation of the processes of stabilization for post-boost vehicles, at the area of motion with fixed values of phase coordinates and a sharp change in mass-inertia and center characteristics;
- development of methods for improving the quality of separable-stage stabilization processes;
- optimization of spatial maneuvers for retargeting the separable stage to several target points;
- development of an algorithm for determining the optimal program for the spatial turning of stages;
- development of algorithms for the combined control of the spatial motion of space vehicles;
- development of evaluation methods for the determination of limit values for stabilization time and propellant consumption, using new and established control algorithms;
- creation of methods to resolve dynamics issues for "mortar"-launched heavy missiles and dynamics issues for the "mortar"-style separation of stages;
- generalization of problems relating to the dynamics of launch and the investigation of all possible launch methods (open launch, silo launch, or from a transporter-based launch container, TLC); and
- creation of methods for the dynamic analysis of nose fairing removal, either by means of "opening," or by "pulling-off" and removal.

In the field of creation of AMD PA:

- development of general principles for the design of AMD PA and methods of ground-based and flight trials; development of AMD models for a potential enemy; investigation of ballistic and signal indices for the recognition of AMD PA elements;
- development of AMD PA performance evaluation methods;
- development of methods of AMD penetration and optimization of the structure of AMD PA;
- analysis of background indices, enabling the identification of true targets;
- development of methods for the calculation of statistical effective scattering surface (ESS) in radiolocation and laser ranging; development of the radiolocation image of false targets; development of methods of dipole reflector spread, investigation of the dynamics of spreading devices;
- development of algorithms for the construction of AMD PA combat patterns; and
- analysis of the dynamics of AMD PA transient processes.

The head of this scientific specialization, N. I. Uriyev, became a Doctor of Science (Engineering). During this period, Gerasyuta continued his work in the domain of the improvement of the organizational forms of his scientific school. He created a special-purpose "Automation Control Systems" research laboratory at the Automation Chair, becoming its first scientific leader.

The above is far from being a complete list of the issues dealt with, the results of which were tested in practical work. It is evidence of the high technical level employed in dealing with emerging problems. This period in development was a rather fruitful one for the N. F. Gerasyuta school. A number of research workers (more than 30 people) from among employees of the Yuzhnoye Design Office, the N. F. Gerasyuta Complex, the DSU Automation Chair and the Dynamics Department of the Institute of Technical Mechanics of the UkrSSR, successfully defended their academic theses. It was a period of confirmation for the scientific school formed by N. F. Gerasyuta in the scientific world. Students of this school managed to solve both fundamental research tasks, and urgent practical issues. This is fully confirmed by the research and practical works completed by students from N. F. Gerasyuta school over the following years (from the beginning of 1980s until 2010).

It is worth mentioning the creation of solid propellant missiles of the fourth generation, which implemented, for the first time in the world, the Military Railroad Missile Complex (MRMC)—which required solutions to a number of dynamics and ballistics problems—and also the implementation of projects in the space domain.

The successful results of this scientific school became the fundamentals of teaching aids. The same results allowed N. F. Gerasyuta's students to organize the training and re-training of specialists at the rocket-and-space educational and research center (RC ERC) at the Yuzhnoye Design Office in various specializations:

- theoretical fundamentals of ballistics,
- engineering methods of ballistics,
- ballistic and navigation support for spaceflight,
- dynamics of transient processes,
- systems of control and the dynamics of rocket flight, and
- control systems and the set of command tools.

Conclusion

A "scientific school" means, first of all, the people who absorbed the scientific ideas and methodology of research activity formulated by the school's founder and further used and developed such ideas. It is appropriate to list the genealogical tree of the N. F. Gerasyuta school, which includes scientists, chief specialists, postgraduates, and Candidates.

The scientific school of N. F. Gerasyuta had a significant influence on formation of the scientific vision and practical research activity of such prominent persons as:

- Vladimir Fedorovich Utkin—General Designer Yuzhnoye Design Office, Doctor of Science (Technical), Member of Academy of Science of the UkrSSR and the Russian Federation;
- Mikhail Ivanovich Galas—Deputy Chief Designer of the Yuzhnoye Design Office, Doctor of Science (Technical), Corresponding Member of the Academy of Science of Ukraine;

Figure 10–3: Vladimir Fedorovich Utkin (1923–2000).

Figure 10–4: Mikhail Ivanovich Galas.

- Boris Ivanovich Gubanov—Deputy General Designer of the Yuzhnoye Design Office, Deputy General Designer of RSC "Energia" (in the town of Korolev in the Russian Federation), General Designer of the Rocket Complex "Energia", Doctor of Science (Technical);
- Aleksandr Alexeievich Negoda—General Director of the National Space Agency of Ukraine, Doctor of Science (Economy).

Figure 10–5: Boris Ivanovich Gubanov (1930–1999).

Figure 10–6: Aleksandr Alexeievich Negoda.

At different time, these people were dealing with problems of ballistics and flight dynamics and consulting with specialists from the N. F. Gerasyuta school. They successfully solved those problems and defended their theses.

Therefore, the scientific school of N. F. Gerasyuta trained more than 80 scientists and first-class specialists. Students of this school published more than 1,000 scientific papers, 15 monographs, and received about 400 author's certificates for innovative technical solutions.

In 1987 Nikolai Fedorovich Gerasyuta died, but the scientific school he created continues his traditions and is further growing and developing. All of this allows leads one to state reasonably that the scientific and technical school of N. F. Gerasyuta is of significant importance in the history of science and engineering in Ukraine in the 20th century.

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