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Editorial

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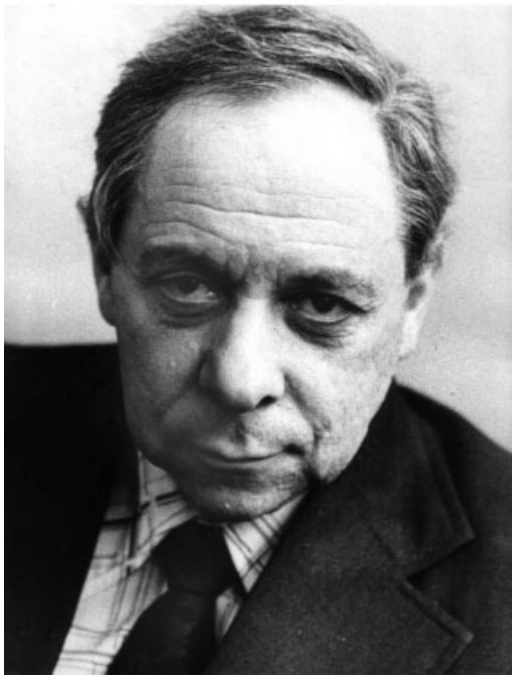
Academician Iosif I. Vorovich

Leonid P. Lebedev[1,2,*] **and Victor A. Eremeyev**[3,4,**]

[1] Universidad Nacional de Colombia, Cr. 45, # 26-85, Bogotá D.C., Colombia
[2] South Federal University, Milchakova str., 8a, Rostov-on-Don, 344090, Russia
[3] Lehrstuhl für Technische Mechanik, Zentrum für Ingenieurwissenschaften, Martin-Luther-Universität Halle-Wittenberg, Kurt-Mothes-Str. 1, 06099 Halle (Saale), Germany
[4] South Scientific Center of RASci & South Federal University, Milchakova str., 8a, Rostov-on-Don, 344090, Russia

Iosif Izrailevich-Girshevich Vorovich, an outstanding Soviet and Russian mathematician and mechanicist, was born 21 June 1920 in Starodub, a town in the Bryansk region of the USSR. In 1937 he left his small Belorussian town to study mathematics at Moscow State University (MSU). After earning top grades in his first-year courses, Vorovich decided to transfer to Bauman Moscow State Technical University to pursue studies of a more applied nature. However, deputy dean D. E. Men'shov did not wish to lose such a good student and was able to convince Vorovich to enter the mechanics department at MSU. Although this department prepared students for engineering work, it also maintained a rigorous theoretical underpinning in all subjects taught. Various mathematical questions in mechanics were to occupy I. I. Vorovich for the rest of his life.



I. I. Vorovich. 21 June 1920–6 September 2001.

It is worth noting that, unlike western universities, the mathematical units of Soviet universities had (and still have) mechanics departments. These departments offered almost all the courses in pure mathematics taken by mathematics students, but in addition offered courses in classical and technical mechanics, the theory of elasticity, hydrodynamics, numerical methods, and many other subjects related to mechanics. They prepared specialists who were able to communicate with engineers and to pose engineering problems in mathematical form, solve them numerically, and understand the results from an engineering viewpoint. Such mechanicists were required in the various bureaus that designed airplanes, submarines, ships, etc. They occupied roles somewhere between those of mathematicians, physicists, and engineers.

At MSU Vorovich was exposed to many professors who were, or were to become, globally recognized. His assigned mentor was A. Yu. Ishlinskij, a future academician and director of the Institute for Problem in Mechanics of the Academy of Science of the USSR. Ishlinskij became known for his work in the theory of gyroscopes and other areas of classical and technical mechanics. Vorovich absorbed the lectures of A. N. Kolmogorov, I. G. Petrovsky, S. L. Sobolev, B. N. Delone, A. G. Kurosh, P. K. Rashevskij, A. A. Ilyushin, and L. I. Sedov. That time he listened to talks by Stefan Banach, Julius Shauder, M. V. Keldysh, S. A. Chaplygin, N. G. Chetaev, and B. G. Galerkin whose results were later used in his own works.

Upon its entry into World War II, the USSR found it necessary to prepare many war specialists quickly. Hence the government decided to move all physics and mathematics students to military universities. In 1941, Vorovich became a student at the Zhukovsky Air Force Engineering Academy (ZAFEA). Times of war are always unfortunate, but Vorovich was lucky. Luck for a young scientist differs from that for other people: he must find a mentor who can teach and who stands as a great scientist in his own right. At ZAFEA, Vorovich found V. S. Pugachev, later to become recognized for his work in statistics and control theory, a military general, and a member of the Academy of Sciences of the USSR.

* E-mail: llebedev@unal.edu.co
** E-mail: eremeyev.victor@gmail.com; victor.eremeyev@iw.uni-halle.de

Another ingredient in the preparation of a real scientist is a competitive peer environment. The group with whom Vorovich studied at ZAFEA produced seven academicians and many famous mathematicians, mechanicists, and military engineers. One was the academician and military general E. I. Zababakhin, later famous in Soviet rocketry. Despite its wartime backdrop, the atmosphere in ZAFEA was joyful, friendly, and humor laden. At a 70-year celebration, A. D. Myshkis recalled a joke among the students: "At the academy there is just one honest man but even he is Vorovich." This involved a play on words: the Russian root *vor* means *thief*, making it sound as though the name Vorovich must pertain to thieves.

Vorovich had many superb professors at ZAFEA. Their courses were delivered at the highest scientific levels but with a definite practical slant. One professor was D. A. Ventzel, a military general and academician recognized for his expertise in artillery, statistics, and other applied problems.

So Vorovich went through two very different programs: one of nearly pure theory at MSU and one of engineering practice at ZAFEA. The combined spirit he represented was later reflected in the school he created at Rostov on Don: there his students and collaborators worked across a spectrum of areas ranging from theoretical mechanics to engineering.

In 1944 Vorovich graduated from ZAFEA with honor and served as a navigator in the war against Japan. He told comparatively few stories regarding this period of his life. One concerned his discovery, in a Japanese headquarters, of a batch of open orders for kamikaze. These were signed by emperor Hirohito but the names and assignments were still blank. Vorovich gave the sheets to his friends as mementos of the war.

When the war ended Vorovich worked at one of the military research institutes. His Ph.D. thesis topic was secret and never shared explicitly with his students. Only much later, when one of the present authors was discussing a new course in control theory that he had to teach, did Vorovich mention that control theory was the principal topic of his work after the war.

In 1951 Vorovich lost his job. He never shared how or why this happened, and we can only suppose that it was related to antisemitism under Stalin. Finding a new job was difficult. However, Vorovich was eventually accepted by rector Yu. A. Zhdanov of Rostov State University (RSU). The two maintained a warm relationship throughout their lives. Zhdanov was a son of A. A. Zhdanov (one of I. I. Stalin's close collaborators) but outside the USSR he was known for being one of the husbands of Stalin's daughter Svetlana Alilueva. He was a significant person in his own right, however, and during that time he wanted to transform a provincial Rostov university into a great one. RSU arose in Rostov on Don during World War I when Warsaw University was evacuated in 1914 inside Russia. Warsaw University was famous for its faculties, many of whom worked in the mathematics and medicine. By the 1950s, however, many of the old Warsawian professors had died or returned to Poland. Only the great mathematician D. D. Morduhai-Boltovskoi remained. For political reasons he did not work at the university during that time.

Along with Vorovich, other young scientists were invited to RSU. One was his friend N. N. Moiseyev, a future academician known for his work on satellites and ecology. He also helped originate the theory of the nuclear winter as one possible outcome of an atomic war.

Vorovich worked at RSU until his final days. He developed new courses in mechanics and sought a new area of scientific inquiry as he did not wish to be accused of the unauthorized circulation of military secrets. After submitting a paper on boundary value problems for a nonlinear system of beams to the journal *Applied Mathematics and Mechanics*, he was told that studies in the related area of nonlinear shell theory would be of greater interest. The outcome was a series of important and complicated works on the theory of shallow shells. A few detailed publications attracted many mathematicians. Many others were published in *Doklady of AN USSR* as mere summary papers. The amount of interest generated is indicated by the list of people who have reviewed Vorovich's papers in *Mathematical Reviews*. The names that appear include J. L. Lions, future President of the French Academy of Sciences, and John Ball, future President of the Mathematical International Union.

I. I. Vorovich delivers a lecture at RSU, 1985.

In 1958 Vorovich defended his doctoral thesis, entitled "Some mathematical problems of the nonlinear theory of shells," at Leningrad State University. In addition to the customary experts in mechanics, Prof. O. A. Ladyzhenskaya, a mathematician known for her work in partial differential equations and hydrodynamics, was appointed as an opponent at the defense. The dissertation contained existence theorems for boundary value problems of shallow shell theory, discussions of numerical methods used to calculate practical problems, problems on non-uniqueness of solution, and some theoretical studies of shell buckling that remain open problems to this day. The work on shell theory was quite

theoretical; Vorovich used topological methods in Sobolev spaces, which were new in applications at that time. It is worth noting that his achievements in this area would have been nearly impossible without the use of mechanical intuition in conjunction with mathematical techniques. Intuition suggested possible theorems and ideas for proofs, while mathematical techniques were used to confirm these suggestions. By the end of the defense, it was suggested that Vorovich publish the dissertation as a book. His response was that it should be extended significantly and improved. However, it turned out that his studies covered much of what could be done regarding these questions in the context of what was known at the time. Vorovich said that around the time of his defense, Prof. Jean Leray studied with great interest the Cyrillic letters of Vorovich's dissertation which showed how to apply Leray's abstract degree theory to the theory of shells. Eventually Vorovich's dissertation was stolen from Leninskaya Biblioteca in Moscow, the institution that kept all the Soviet dissertations. His own students had to study photographs of a third copy of the dissertation, which of course had been prepared using a typewriter. Many results from the dissertation were not published along with proofs during that time and were largely unknown in the West. Some were rediscovered independently by other mathematicians. In the USSR Vorovich was an absolute authority on mathematical problems in mechanics.

Vorovich always sought practical applications of his results. Quickly realizing that without computers any progress toward the solution of real engineering problems would be limited, he was among the first in the USSR to use computers in his work. He never wrote programs himself, but did lead a computational team. His programmers said that he often predicted numerical results beforehand and that this was essential in the success of their numerical endeavors.

Around that time Vorovich worked on numerical research related to the problem of buckling of shallow shells. He also began work on contact problems, developing a school represented by workers such as Prof. academician V. A. Babeshko. Vorovich was interested in all problems of mechanics. He collaborated on problems in hydrodynamics (with V. I. Yudovich) and plasticity (with Yu. P. Krasovskij). Later he worked on problems in ecology. Vorovich and his students and collaborators prepared more than 120 Ph.D. and 47 D.Sc. defended theses, a very influent school of mechanics in the USSR and Russia.

In 1970 Vorovich was elected as a corresponding member of the Academy of Sciences of the USSR, and in 1990 as a full member.

The principal outcome of the work of any scientist is his or her set of publications. Vorovich published more than 300 papers and 14 monographs.

In the 1980s he finally decided to publish his dissertation on shell theory. Because he wanted to update the work, however, he rewrote it using tensor calculus. The book was good but very complicated; indeed, one of his former students and a professor at that time was quoted as saying that Vorovich was so great that he wrote a book that nobody could read. When asked why he did not want to publish the dissertation in its original and much less formidable form, Vorovich replied that it was old fashioned and very simple. A translation was published in 1989 by Springer under the title *Nonlinear Theory of Shallow Shells*.

During the last 20 or so years of this life, Vorovich worked on a textbook about Newtonian dynamics. Two volumes were published in Russian. The text sheds new light on many questions in classical mechanics.

Vorovich delivered a large number of clear, precise, and interesting lectures that will never see publication. He typically approached even theoretical problems by way of real examples. One of the present authors recalls a very short and interesting course on the strength of materials. It started with a question: What is the displacement of the end of a 60 meter long airplane wing in flight? The audience was impressed to learn that it could be up to one meter. Another question: How could one calculate this displacement using the theory of very small deformations? In his courses, Vorovich always returned to the issue of practical applicability of the theory.

Vorovich created a cathedra of elasticity at Rostov State University and served as its chief. Later he created and served as director of the Research Institute of Mechanics and Applied Mathematics. Both of these were principal centers for the study of mechanics in the USSR. It is interesting to note that a large number of the graduates from the cathedra of elasticity at RSU during the period from 1960 through the 1980s earned the Ph.D. degree and many of them earned the D.Sc.

Iosif Izrailevich-Girshevich Vorovich passed away on 6 September 2001.

This issue of ZAMM includes papers on mathematical problems in continuum mechanics. It is dedicated to Professor Iosif I. Vorovich on the occasion of his 90th birthday.

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