Otakar Borůvka [English resume]

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Otakar Borůvka

Professor Otakar Borůvka, a nestor and legend among Brno mathematicians, for decades one of the leading figures in the world of mathematics in Moravia and throughout the country, an outstanding representative of Czech learning abroad, an excellent teacher and scientific life organizer, died on 22 July 1995 at the age of over 96 years, in the time when this monograph was being completed. He departed from this world in the middle of a period of incredible mental youth, activity and never-ceasing interest in mathematical activities of „his" university and all over the world, as well as vigour that many a youth could have envied him – as he used to tell his junior colleagues. For five decades he was active at the Faculty of Natural Science of the Masaryk University of Brno, where he left a permanent trace of his exceptional personality. His rare personal qualities were another reason for making at least part of his great achievement accessible, as its contribution to the history of mathematics in this country is enormous.

Otakar Borůvka was born in Uherský Ostroh in Moravia, where his father was the headmaster at local elementary and council schools. He studied grammar school in Uherské Hradiště, where he came to like mathematics as well as the rest of the subjects, including music, and was an excellent student. After finishing the sixth form in 1916 he completed his secondary studies, under the pressure of the events of World War I, with the last form of the military Realschule in Hranice na Moravě, from where he went on to the Military Technical Academy in Mödling near Vienna. In 1918 he began his university studies at the Czech Technical College in Brno as a student of civil engineering. There he got acquainted with Professor Matyáš Lerch who, learning about his excellent knowledge of mathematics, offered him the

position of assistant professor at the Institute of Mathematics of the Faculty of Natural Science at the newly founded University of Brno. Borůvka completed there his university studies, obtaining his habilitation at the age of 29.

Professor M. Lerch died in 1922 and was succeeded by Professor E. Čech, who introduced Borůvka to differential geometry, sending him to Paris for a two years' course with Professor E. Cartane (1926–27 and 1929–30), as well as to Hamburg for a six months' course with W. Blaschke (1930–31).

After completion of his first year in Paris Borůvka received in 1927 a serious offer of a position of professor of mathematics from the Yugoslavian University of Zagreb. After some hesitation, however, he refused, in the hope of a potential career in Brno.

In 1934 Borůvka was appointed first an assistant professor and then, in 1940, a chair-holder at the Brno University. Immediately after the end of World War II he helped several Brno colleges as a lecturer, including the Comenius University of Bratislava (1947–58), where he commuted. In Bratislava he met a number of gifted, hardworking and grateful students, who have since become leading figures in Slovak mathematics.

In 1953 Professor Borůvka became a correspondent member, and in 1965 an Academician. Since 1969 he also worked at the Institute of Mathematics of the Czech Academy of Science.

In the course of the nearly five decades of his work at the Brno University, Professor Borůvka performed a number of major functions in scientific councils and commissions, in the Collegium of Mathematicians of the Czechoslovak Academy of Science, in the organs of the Union of Czechoslovak Mathematicians and Physics, and in editorial boards of several scientific journals.

Professor Otakar Borůvka wrote 86 works of science, including 8 monographs, and 44 popular scientific and bibliographical publications and over 200 reviews. His scientific writings reflect Czechoslovak and world history of several areas of mathematics. He was excel-

lent in careful work with details, which also was a quality typical of his first teacher, Mr. Lerch. He was also capable of conceptual approach to wide problem areas, typical of his other teachers, Misters Čech, Cartane and Blaschke. Borůvka, however, was not only concerned with solutions of partial problems; he also created complete theories of a width and depth making them applicable for long subsequent periods. A good example is Borůvka's pioneer work *„O jistém problému minimálním"* (On a Certain Minimum Problem) from 1926, offering an algorithmic solution to a practical problem of cost minimalization of electric network building. This fundamental contribution of his to the area of transportation problems, which began to grow only some decades later, became one of the principal issues of the diagram theory, then not yet existing.

In his first works from 1923–25, inspired by his teacher Lerch, he concerned himself with classical mathematical analysis, a problem he returned to once again in 1957–59, in the context of a profound analysis of his teacher's achievement.

In 1924–35 he became absorbed in differential geometry. He was the first to study analytical correspondences between two projective planes and discovered their properties invariant with respect to pairs of transformations of the projective group. He created a general theory of the normal curvature of surfaces in n-dimensional spaces with constant curvature and extended Frenet formulas for analytic curves in high dimensional parabolic Hermitian space. His large work on spheric (two-dimensional) surfaces in $2n$-dimensional constant-curvature spaces are being widely applied in modern differential geometry. The School of Geometry in Bologna largely followed Borůvka's original work in analytic correspondences. Also S. Chern's work on minimal varieties immersion into hyperspheres uses the name of Frenet-Borůvka formulas for certain differential equations. Having acquired extensive knowledge in the course of his previous research and study he joined in the 1930s the rapid progress of algebra and topology. On the mathematical set basis he created the notional struc-

ture of general algebra, the theory of groupoids, being one of the first to study mathematical set analysis and to lay the foundations of a theory of scientific classifications. He founded a school of modern algebra in Brno and published a monograph *„Základy teorie grupoidů a grup“* (Foundations of the Theory of Groupoids and Groups), which was published several times in Czech, in German (1960) and in English (1974), In 1971 he published *„Základy Teorie Matic“* (Foundations of the Theory of Matrixes), which was the first book to analyze Ed. Weyr's results. His research in the field of algebra in 1936–52 and 1961 was completed in 1988 by his last work in the field.

In the 1950s he purposefully focused on the study of differential equations, a discipline largely neglected in the Czechoslovakia of the time, at the same time not completely abandoning his previous specializations, algebra and geometry. Making use of his profound knowledge of these areas, as well as of classical analysis, he founded a scientific course and presented a project of global investigation of linear differential equations in the real domain. Solving the problem of global equivalence of linear differential equations of the second order he created a qualitative theory of the global character of these equations with a distinctive feature of a high level of algebraisation and geometrisation. These results were surveyed in the monograph *„Lineare Differentialtransformationen 2. Ordnung“*, published in 1967, and also in English in 1971. A number of Czech, Slovak and foreign mathematicians have used the results and methods of this theory for solutions of problems concerning not only equations of the second order but also equations of higher orders.

Scientific achievement of Otakar Borůvka has extended mathematical thinking, adding new methods and results. He was the first in the world to solve a basic transportation problem, to create elements of the theory of correspondences between two projective areas, later developing into a large section of modern differential geometry. He created a theory of mathematical set analysis, a theory of groupoids and a theory of global transformations of linear differential equations

of the second order, which has deeply affected world literature of the subject.

The significance of Otakar Borůvka's scientific achievement can also be seen from foreign rèsponse to his work, and from the number of distinctions obtained, not only in his country but also abroad. His great discoveries obviously brought about numerous invitations to lecture at foreign research institutes (see biography).

In the context of evaluation of Professor Borůvka's work and influence his important role in the foundation of the Mathematical Institute of the Czechoslovak Academy of Science in Brno in 1969 (now a branch institute of the Mathematical Institute of the Academy of Science of the Czech Republic) and the new mathematical journal Archivum mathematicum in 1965, soon becoming respected abroad, must be emphasized. Slovak mathematicians highly appreciate his help to the University of Bratislava, which he offered for over 10 years in addition to his Brno duties, regarding it a substantial contribution to the progress of Slovak mathematics.

In the course of his research and teaching activities Professor Borůvka worked with a lot of future active researchers in mathematics. Most of the mathematicians working at Moravian and Slovak universities are his pupils, or pupils of his pupils. He was capable of giving them stimuli from a wide range of issues of abstract algebra, differential geometry, theory of differential equations and relative areas of mathematics.

Let us conclude with one of his own judgments of his approach to mathematical research: „Taking a critical look at my scientific work I believe now that the methodology I used was, on the whole, correct: I studied problems from different areas of mathematics, usually starting from unanswered questions close to classical matters. That was how I achieved my overall knowledge of vast spheres of mathematics, enabling me to find relations between knowledge from mutually remote areas of mathematics."