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## SIXTY YEARS OF PROFESSOR MIROSLAV NOVOTNÝ

VÍTĚZSLAV NOVÁK, Brno

Professor RNDr. Miroslav Novotný, DrSc., chief research worker of the Mathematical Institute of the Czechoslovak Academy of Sciences, branch Brno, reached sixty years of age on 11 May, 1982.

The creative activity of a scientist does not cease at the age of sixty; nonetheless, such an anniversary offers an opportunity of looking back and evaluating the results



achieved. The aim of this article is to give a brief survey of Professor Novotný's contribution to the development of the theory of ordered sets, algebra, topology and mathematical linguistics, and to show his share in educating the young generation of mathematicians.

M. Novotný was born in Tovačov in the year 1922; however, he entered the university only after the World War II, since the Czech universities were closed during the Nazi occupation. He studied Mathematics and Physics at the Faculty of Science

of the Brno University, graduating in 1948. Among his teachers were Professors E. Čech, J. Novák, O. Borůvka, V. Knichal, L. Seifert and others. In 1947, Professor Novák recommended him as Assistant Professor to the Technical University in Brno. In 1951 he came to the Department of Mathematics of the Military Technical University in Brno, where he was appointed Associated Professor in 1953. In the same year he joined the Faculty of Science of the Brno University. In 1956 Novotný defended the thesis *Representation of ordered sets*, thus obtaining the scientific degree of Candidate of Science, and in 1962 was granted the degree of Doctor of Science. A year later he was appointed Full Professor of Mathematics. In the years 1965–66 he visited Bonn, where among other he led a seminar on mathematical methods in linguistics. Since 1971 he has been affiliated with the Brno branch of the Mathematical Institute, Czechoslovak Academy of Sciences.

The beginnings of Novotný's scientific activity were strongly influenced by the personalities of his teachers. His doctoral thesis was prepared under the supervision of Professor Borůvka and concerned the construction of a certain groupoid operation [1]. In [2], some notions of the theory of decompositions introduced by Borůvka were applied to Čech topological spaces.

In [9], Novotný generalized and solved a problem originally proposed by Borůvka: for given sets  $M, N$  and maps  $f: M \rightarrow N, g: N \rightarrow N$ , a transfinite construction of all maps  $F: M \rightarrow N$  with  $F \circ f = g \circ F$  is given. (For  $M = N$  and  $f = g$  we obtain the original Borůvka's problem.) Novotný resumed his research in this direction in [20], when he realized that the construction from [9] yields all homomorphisms of one monounary algebra into another and, moreover, provides all solutions of a certain functional equation. The results of [9], [20] later proved very useful for the study of the so-called Pawlak machines (cf. [46]).

The history of the problem of construction of all homomorphisms of one monounary algebra into another is described in [51], where also the original Borůvka's problem concerning endomorphisms of linear spaces is solved. The result is rather surprising since the solution of the problem involves only monounary algebras of a very special type.

The early period of the scientific work of M. Novotný was strongly influenced by his collaboration with Academician J. Novák. The latter led a seminar in Brno, which in a sense continued the tradition of the pre-war topological seminar of Professor E. Čech. The starting problem in this seminar was the study of linearly ordered sets in terms of the theory of topological spaces. M. Novotný was one of the most active members of the seminar and achieved in this field many valuable results. His papers [3], [4], [5] and [7] essentially contributed to the theory of ordered continua.

Birkhoff's book *Lattice Theory* attracted Novotný's attention to (partially) ordered sets. The results of his paper [6] facilitated a very simple proof of Sierpiński's theorem on the representation of linearly ordered sets; a similar proof was later published by D. Kurepa and E. Mendelson and in 1978 by A. Abian. The study of

cardinal powers of the type  $2^G$  ( $G$  a linearly ordered set) led Novotný to the investigation of cardinal powers  $R^G$ , where  $R$  is the linearly ordered set of reals. The elements of the set  $R^G$  are isotonic functionals on the ordered set  $G$  and hence represent a certain dual space to  $G$ . This similarity with functional analysis inspired Novotný for further study of related problems (see in particular [13] and [15], on the basis of which Novotný was granted the Doctor of Science degree, and also [16], [17] and [19]).

In early 60's Novotný was asked by the linguistic departments of Brno University to deliver an introductory course in Mathematics for teachers and researchers of these departments. This proved decisive for the direction of his further scientific work. Novotný found out that theoretical works of foreign linguists, in particular of O. S. Kulagina and A. V. Gladkii from the Soviet Union, are of algebraic character. Therefore, he deduced the fundamental theorems of the theory for relation systems [23], [27] and later for free monoids with a distinguished subset [28].

One of the principal problems studied by Novotný in the next period was that of construction of grammars of formal languages. He was mostly interested in the so-called special grammars without non-terminal symbols ([24]–[26]).

Novotný improved and formalized the notion of configuration introduced by the above mentioned Soviet linguists. The configurations of all types yield the so-called generalized special grammars, which can include infinitely many of both the rules and the initial sentences. Languages for which such a generalized grammar is a grammar form special classes; Novotný introduced several such classes, using them to characterize the classes of Chomsky ([31]–[36]).

In further works, Novotný developed the theory of the so-called reducing operators for generalized grammars and applied it to generalized Lindemayer systems and various formal systems ([37], [38], [47], [49]). The results on grammar categories and on the construction of grammars are collected in the unpublished manuscript [56].

M. Novotný has cooperated with mathematicians from abroad, especially from Roumania and Poland. For instance, with S. Marcus he studied the so-called contextual grammars and their modifications ([41], [43], [44]).

Professor Novotný is not only a prominent researcher, but also an outstanding teacher. Those who were lucky enough to attend Novotný's lectures were offered the opportunity of getting a perfect view of the discipline and its beauty, as well as of a perfectly prepared – both in contents and form – university course. Professor Novotný's lectures were always very popular among students and attended by numerous audience due to their exactness, clarity as well as to the lecturer's understanding for the students' needs. When working at the Faculty of Science, Prof. Novotný educated a number of mathematicians of the young generation, passing them both his rich experience and deep mathematical knowledge. His experience is also reflected in six lecture notes, which exhibit ideal balance of rigour and exactness on the one hand and intelligibility and clarity on the other.

Professor Novotný has also played an important role in the organization of science in Czechoslovakia. He was Head of Department of Mathematical Analysis (1963 to 1970) and Vice-Dean of the Faculty of Science; member of the Scientific Board for Mathematics of the Czechoslovak Academy of Sciences (1966–1970) and of various committees of the Ministry of Education. In 1963 he founded a seminar on ordered sets and general algebraic structures, which has ever since attracted mathematicians from various research centres in Moravia. It was on his initiative that the first summer school on ordered sets was organized in 1961, a modest affair with only six participants. Since then, this summer school has been organized every year and has developed in an international event with about 60 Czechoslovak and 20–30 foreign participants.

Professor Miroslav Novotný is an outstanding representative of Czechoslovak Mathematics, whose contribution to the development of various mathematical disciplines gained him high esteem among the mathematicians in Czechoslovakia and abroad. We join his friends, colleagues and students in wishing him firm health, personal satisfaction and many years of successful scientific activity.

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