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VĚRA TRNKOVÁ'S UNBELIEVABLE 60

JIŘÍ ADÁMEK and MIROSLAV KATĚTOV, Praha

One who knows the energy and the depth of the recent research of Professor Věra Trnková will be surprised to learn that she will be 60 on March 16 of 1994. She is a leading category theorist, an excellent teacher, and a swell colleague. It is difficult to describe the vast research contained in the two monographs and more than a hundred papers of hers, but we will try our best.

Věra Trnková was born in Berehovo in Carpatian Ukraine (then a part of Czechoslovakia), where her father, a forester, was working. After several moves of her family, due to the professional advancement of her father, Věra finished her high-school studies in Prague, and she entered Charles University in 1952. She finished in 1957 with a thesis, written under M. Katětov, devoted to topological spaces with stronger properties than normality, see [1] in the list of publications below. Then she became a doctoral student at the Faculty of Mathematics and Physics of Charles University (between 1957 and 1960). Her supervisor was Eduard Čech, and her CSc. thesis was devoted to closure spaces not satisfying the axiom F (= the idempotency of the closure operator), see [2]–[5] and [10]. She received the CSc. title in 1961. In 1960 she became an assistant professor at the above faculty, in 1967 an associated professor, and in 1991 a full professor. In 1989 she received the title Doctor of Science (DrSc.).

The research of Věra Trnková from the early 1960's until today showed three strong features: originality, depth, and abundance. She devoted her attention to a number of topics and in several of them, all in the realm of category theory and general topology, she created a highly original methodology and obtained results of often breath-taking technical difficulty. For example, just recently she solved the number-one open problem of Walter Taylor's monograph on clones by constructing, for each natural number n, metric spaces X and Y with isomorphic algebras of continnuous self-maps of less than n variables which, nevertheless, have clones not only non-isomorphic but even non-equivalent in first-order logic. This intricate and beautiful construction, see [111], is a good sample of Věra's work.

In her research Věra Trnková soon got interested in categories, and she referred about her first results on formal completions of categories [6], [11]–[14], [16] at the Topological Seminar of M. Katětov. Her colleagues Zdeněk Hedrlín and Aleš Pultr referred at that seminar on their research on representations of monoids as endomorphism monoids of topological spaces and related representations of categories.This led to a joint research in the realm of possibilities of embeddings of categories into basic categories of algebra and topology, see [15], [17], [19], [25]. Later Věra went much deeper into the realm of embeddings of topological categories. She introduced the important concept of an almost full embedding of a category K into a category L of topological spaces: it is an embedding $E\colon K \to L$ such that, for arbitrary objects X and Y of K, a morphism from EX to EY lies in the image of E iff it is nonconstant. She proved in [26] that if no measurable cardinal exists, then every concrete category has an almost full embedding into the category of all compact T_2 spaces and continuous maps, or into the category of metric spaces and uniformly continuous maps. And she ramified this result in several directions (see [38], [45], [60]). Her results also inspired Václav Koubek who proved that, without any set-theoretical restrictions, every concrete category has an almost full embedding into the category of paracompact spaces (Comment. Math. Univ. Carolinae 15(1974), 655–663). Results obtained by the "Prague School" on embeddings of categories are summarized in the influential monograph published by Věra Trnková and Aleš Pultr [PT]. Many of the profound results published there use Cook's continuum. This is a continuum X constructed by H. Cook (Fund. Mathem. 60 (1967), 241–249) such that for any subcontinuum Y the only nonconstant continuous function from Y to X is the inclusion. To decipher the 8-page incomplete proof of Cook and present a (tough) 50-page version was Věra's accomplishment in its own right (see [PT]). But the constructions she used applying Cook's continuum were simply wonderful. She showed, for example, that every monoid is isomorphic to the monoid of all nonconstant self-maps of a regular space Y having no nonconstant real function [45], or that for every submonoid A of a monoid B there exists a Tichonov space whose nonconstant self-maps form a monoid isomorphic to A, while nonconstant self-maps of its Čech-Stone compactification form a monoid isomorphic to B, see [91].

A highly inspiring student research seminar was started by V. Trnková in 1969 and it is running still, the first participants were Václav Koubek, Pavel Pták, Jan Reiterman, and Jiří Adámek. The participants will never forget the enthusiasm with which Věra posed her research problems and showed them her methods. The seminar first studied properties of set functors, a topic on which V. Trnková published her papers [20]–[23] and to which all of the first participants devoted their theses and a part of their later research. An application of the methods developed here came later when M. A. Arbib and E. G. Manes published their papers on categorical automata theory. Věra immediately answered a problem they posed on the existence of minimal realization, see [29]–[30], and showed in [34] that only sequential automata with resets have universal realization. A lot of other results concerning the role of functors in automata theory were obtained by V. Trnková and members of her seminar, they are summarized in the monograph [AT].

A subject in which Věra Trnková not only obtained beautiful and deep results, but where she created a profound theory, is that of isomorphisms of products. The inspiration came from the following result of P. M. Cohn (Topology 5 (1966), 215–218): for each natural number n there exists a module M over a ring such that two powers $M^k = M \times M \times \ldots \times M$ are isomorphic iff the two exponents k are congruent modulo n. Věra reformulated this by saying that finite cyclic groups are representable by products of modules, where, more generally, a representation of a commutative semigroup $(S, +)$ by products in a category K is understood to be a collection of pairwise non-isomorphic objects M_s for $s \in S$, such that M_{s+t} is always isomorphic to $M_s \times M_t$. Věra started a systematic research of possibibilities of such representations, presenting both a deep result on semigroups, and nontrivial constructions in basic categories K. For example, she proved in [35] that every commutative semigroup has a representation by products of topological spaces.This implies e.g. that there is a topological space X for which it is meaningful to form rational powers $X^{\frac{1}{2}}$, $X^{\frac{1}{3}}$ etc: just use the multiplicative semigroup of rational numbers as $(S, +)$. (Careful, X^0 will not be a singleton space!) Very strong ramifications of this result were obtained by Věra Trnková and a number of researchers who followed her project. For example, every countable commutative semigroup can be represented by products of subspaces of the real line (!) see [59], or by products of countable paracompact spaces [66]. One of the most spectacular results obtained by Věra in this realm concerns products of Boolean algebras. In his famous paper J. Ketonen (Annals of Math 108 (1978), 41–89) proved that every countable commutative semigroup can be represented by products of countable Boolean algebras. Věra showed that Ketonen's conjecture (expressed in the preprint form of that paper) that the same result holds for coproducts of countable Boolean algebras, or products of subspaces of Cantor's discontinuum, is wrong, see [59]. Věra showed namely that every countable Boolean algebra B isomorphic to $B + B + B$ must also be isomorphic to $B + B$.This research was continued by H. Dobbertin and R. S. Pierce, the latter constructed a countable Boolean algebra B such that $B + B$ is isomorphic to $B + B + B$ but not to B (Lecture Notes Mathem. 1004, Springer 1982, 232–239). Věra's paper [59] has been fully presented in the Handbook of Boolean Algebras (J. D. Monk and R. Bonnet, editors, North Holand 1988) where R. Pierce writes, concerning the isomorphism types BA of countable Boolean algebras: "After Ketonen's discovery that every countable commutative semigroup can be embedded in BA, it was generally assumed that the arithmetical structure of this semiring is completely intractable. It was a major surprise when Trnková showed that the multiplicative analog of the cube problem has positive solution in BA."

It is usually difficult to try to identify the research style of a mathematician. There are, however, clearly distinguished features in Věra's research: in a number of problems she solved, constructions of fascinating technical difficulty play the central role, and their depth is just adequate to the depth of the problems. These constructions are sometimes compared to intricate embroidery. Their source is imagination respecting, and at the same time disclosing, the deep order of the mathematical world. One is reminded of the words with which G. B. Shaw's Saint Joan replies to the objection that the voices she hears stem just from her own imagination—she says: "Of course. That is how the messages of God come to us."

We have by far not exhausted all research topics to which Věra Trnková devoted her efforts, and for those topics we mentioned we have by far not indicated the depth of her vision and the originality of her methods. Věra is a very good speaker and her lectures at international conferences are well known for their clarity and depth. And she is an excellent teacher, from which a number of students have benefited at her lectures and her seminars. We hope of enjoy the warm personality and original talent of Věra Trnková for many years to come.

List of publications of Věra Trnková-Šedivá

a) Papers:

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