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**TEN YEARS OF RESEARCH AT THE DEPARTMENT
OF THEORETICAL CYBERNETICS**

EDUARD TOMAN, Bratislava

During the first ten years of its existence the research activity at the Department of Theoretical Cybernetics of the Comenius University in Bratislava has been focused on three main areas:

- a) discrete mathematics and mathematical cybernetics,
- b) computer science,
- c) methodology of programming.

The research in the area of discrete mathematics and mathematical cybernetics centered mainly on the study of the properties of Boolean functions and construction of discrete control systems. The study of minimization of random Boolean functions led to estimating some parameters characterizing their complexity in the class of disjunctive normal forms (e.g. the length of the minimal sum-of-products form, the number of irredundant d.n.f.'s, the length of the shortest d.n.f.). Interesting results concerning this topic include also estimates of the complexity of local minimizing algorithms for random Boolean functions. In the late seventies the problem of the geometrical structure of random Boolean functions (i.e., the number and composition of the connected components of the graph of a random Boolean function) was fully solved. The research in the theory of Boolean functions continues. Various classes of functions and some of their important parameters are still under study. Recently some estimates on the number of monotone Boolean functions and monotone functions in multivalued logics have been obtained. Very active is also the current study of the structural properties of Boolean matrices and the complexity of their realization as characteristic functions for recognition algorithms. Important results were obtained in estimating the complexity of realization of the class of Boolean matrices of a given size with a given number of the main informational elements — the angle elements of the matrix. It was proved that the principal element of the complexity function of the realization of the class of Boolean matrices with

a given ratio of unspecified elements is monotone. Several classes of Boolean matrices representing patterns with linear complexity of realization with respect to the area of the matrix were constructed. The interest has also aimed on the approximate realization of Boolean matrices (i.e. the relation between the exactness and the complexity of the Boolean matrix realization).

Theoretical results have found their use in applications. For example, the study of the problems of Boolean matrices and homogeneous structures has led to their use in modelling of various ecological dynamic systems and processes, in artificial intelligence (construction of medical expert systems), to construction of models and algorithms in biocybernetics and geocybernetics.

The main thrust of the research in computer science was in the theory of formal languages and automata. The results on the abstract families of languages with bounded generators found their way to a single monography in the field. Many other results were published in reputable international journals and proceedings of international conferences. For example, some long standing open problems for multihead automata were solved, a general framework for studying grammars was developed and used for comparison of parallel and sequential rewriting, and complexity measures for grammars were studied. Besides, some results for real time computations on Minsky machines were obtained. The attention in the artificial intelligence research gradually shifted from the general studies to the problems of knowledge representation and expert systems. The programming language FRL was implemented in this context. Partial results were obtained in the area of abstract data types. Besides some partial problems in the study of parallelism in operating systems, the parallelism is currently studied in the context of VLSI and automata. Recent research activity in this area has brought several important results for alternating automata and communication complexity.

A lot of effort was invested to the problems of methodology of programming and programming education, to both theoretical and practical aspects. Several lecture notes were published, especially for introductory programming courses. The original orientation towards Fortran was soon changed to Pascal, the latter being more suitable for educational purposes. The students of the Department implemented Pascal on EC 1010 computer and their compiler has been supporting the teaching process to this date. Several other programming languages geared to the teaching of programming and problem solving at the elementary school level have been designed and implemented. Most of them use graphical output since picture drawing seems to be the area of the most natural appeal to children. Currently the dialogue approach to programming in the form of the so-called "experimental programming" is being investigated with a structured alternative to Basic under implementation.

The research in the Department is supported by three separate research

grants, with all members of the Department, graduate students, research assistants and top undergraduate students involved. Many results achieved have been recognized internationally. Several results received awards in the Competition of young mathematicians and in the Student papers competition. The Department is also involved in popularization of modern methods of cybernetics research and computer utilisation. Several domestic and international seminars and conferences achievements of the research work in the Department are illustrated by the papers published in this issue of Acta Mathematica.

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SÚHRN

DESAŤ ROKOV VEDECKEJ PRÁCE NA KATEDRE TEORETICKEJ KYBERNETIKY

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V článku autor podáva informáciu o vedeckom zameraní Katedry teoretickej kybernetiky Matematicko-fyzikálnej fakulty Univerzity Komenského v Bratislave za desať rokov jej existencie. Vedecká činnosť katedry je sústredená do troch oblastí, ktoré veľmi úzko súvisia:

- a) diskretná matematika a matematická kybernetika,
- b) matematická informatika,
- c) metodológia programovania.

Ďalej autor charakterizuje výsledky dosiahnuté v týchto troch oblastiach.

РЕЗЮМЕ

ДЕСЯТЬ ЛЕТ НАУЧНОЙ РАБОТЫ НА КАФЕДРЕ ТЕОРЕТИЧЕСКОЙ КИБЕРНЕТИКИ

Эдуард Томан, Bratislava

В работе автор информирует о научном направлении Кафедры теоретической кибернетики Математическо-физического факультета Университета Коменского, Bratislava за

десять лет ее существования. Научная деятельность кафедры сосредоточена до трех отраслей, которые имеют очень тесную связь:

- а) дискретная математика и математическая кибернетика,
- б) математическая информатика,
- в) методология программирования.

В следующем автор кратко характеризует результаты полученные в упомянутых выше областях.