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PREFACE

1. Introduction

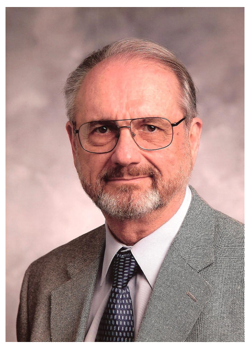
The present issue of JCAM is dedicated to two excellent scientists: Professor Barna Szabó, who turned 80 in 2015 and Professor Imre Kozák, who is 85 this year. For political reasons Professor Szabó had to leave Hungary in 1956 – he was a student of the University of Miskolc between 1954 and 1956. He has made a scientific carreer and did and still does his best to provide help and support to the University of Miskolc, more precisely to the Institute of Applied Mechanics (which was called the Department of Mechanics until 2014).

Professor Kozák graduated from the University of Miskolc in 1954 and has been working for the university since then. He chaired the Department of Mechanics from 1971 till 1993 and had a vey significant influence on the scientific activity of the department in various ways: as a scientific leader of promising young PhD students and by starting a separate track in applied mechanics.

Further information about their scientific and educational activities are presented in Sections 1 and 2 of this Preface.

With this and the next issue their former and present students, co-workers and friends wish them many more productive years in good health.

2. A professional life dedicated to Computational Mechanics Professor Barna Szabó 80 years old



Barna Szabó was born in Martonvásár, Hungary in 1935. After graduating from the Franciscan High School in Esztergom in 1954, he was admitted to the Faculty of Mining Engineering of the Technical University of Heavy Industry in Miskolc (now University of Miskolc). Following the failed Hungarian uprising in 1956 he emigrated to Canada, where he resumed his undergraduate studies at the University of Toronto.

He was employed as Mining Engineer by the International Nickel Company of Canada (INCO) in Thompson, Manitoba between 1960 and 1962. In 1962 he joined H. G. Acres Ltd., a large civil engineering firm located in Niagara Falls, Ontario, where he was employed in the Department of Applied Mechanics. He worked on the design of major hydroelectric power stations, such as the Jean-Lesage Generating Station in Quebec and the Churchill Falls Generating Station in Labrador, as well as on a variety of interdisciplinary projects. In the following year he began part-time studies at the State University of New York at Buffalo where he received the degree

Master of Science in Civil Engineering in 1966. Recognizing that digital computers would play an increasingly important role in the practice of engineering, he decided to continue his graduate studies in that area. He received his Ph.D. degree in 1968.

From 1968 until his retirement in 2014 he was a member of the Faculty of Engineering and Applied Science of Washington University in St. Louis, Missouri. He was named The Albert P. and Blanche Y. Greensfelder Professor of Mechanics in 1975 and appointed Director of the Center for Computational Mechanics in 1977.

From the very beginning his research activities were guided by the idea that engineering decisions cannot be based on computed information unless procedures for the estimation and control of the errors of approximation are available.

An experimental computer code, called COMET-X, was developed under his direction at the Center for Computational Mechanics. The distinguishing feature of this code was that converging sequences of finite element solutions could be generated based on hierarchic sequences of finite element spaces. This allowed investigation of the convergence characteristics of what is known today as the p-version of the finite element method.

He observed that increasing the polynomial degree of elements on a fixed mesh results in a rate of convergence in energy norm that is faster than if fixed p and uniform or quasi-uniform mesh refinement, known as the h-version, were used, even when the solution being approximated contained singular points. This result was surprising because it contradicted the then generally accepted interpretation of a key mathematical theorem concerning the asymptotic rate of convergence of the finite element method. This contradiction was demonstrated in a paper published 1978 [1].

The practical importance of the early results obtained by Szabó and his research team was recognized by the Istituto Sperimentale Modelli e Stutture (ISMES) in Bergamo, Italy, where the first industrial-scale implementation of the p-version was undertaken with the goal to perform numerical simulation of the mechanical response of arch dams in the Italian Alps as part of a safety monitoring system mandated by the government of Italy. The justification for early adoption of the new methodology was based on the fact that solution verification was a technical requirement which could not be met by conventional methods. The code developed at ISMES is called FIESTA.

The term "p-version of the finite element method" first appeared in a publication 1981 [2] in which the theoretical foundations were established of a discretization strategy whereby the finite element mesh is fixed and the polynomial degree p of the elements is progressively increased. The results presented in this paper motivated research in the applied mathematics community on the properties of high order finite element methods, which continues to this day.

Today the distinction between the h- and p-versions exists primarily for historical and theoretical reasons. Conceptually the h-version is a subset of the p-version, in the sense that any implementation of the p-version can be used in such a way that p is fixed and the mesh is progressively refined. In practical applications the design of the mesh and the choice polynomial degrees are both important. In fact, it is possible to realize exponential rates of convergence when the p-version is used in combination with proper mesh design. This point was first discussed from the engineering perspective [3] and from the theoretical perspective [4] in 1986. Details are available in a textbook published in 1991 [5].

The first industrial-scale implementation of the p-version in the United States was undertaken by Noetic Technologies Corporation in St. Louis in 1984, which produced the FEA software PROBE. The first release of PROBE (1985) featured a number of innovations, which included posteriori error estimation, the realization of exponential convergence rates and superconvergent extraction of stress intensity factors. The first applications of PROBE were in the aerospace industry in support of mechanical fatigue and damage tolerance modeling. Other large implementations of the p-version were MECHANICA[1] by the Rasna Corporation in 1987 and STRIPE by the Aeronautical Research Institute of Sweden[2] in 1988.

Szabó recognized that while solving mathematical problems by approximate methods, subject to estimation and control of the errors of approximation, was fundamentally important, it is also of fundamental importance from the engineering and scientific perspectives to formulate mathematical problems that simulate some specific aspects of a physical reality with sufficient reliability to justify basing engineering decisions on them. He outlined the concept of hierarchic sequences of mathematical models with reference to structural plates and shells at a conference in 1986[3] which was published two years later [6]. In this view any mathematical model is understood to be a special case of a more comprehensive model, one with fewer limitations imposed by the assumptions incorporated in the model. Szabó published a textbook, co-authored by Professor Ivo Babuška, on the formulation, verification and validation of mathematical models in 2011 [7]. The Chinese translation of this book was published in 2013.

In order to make development of a computational framework designed to support hierarchic modeling and discretization strategies possible, it was necessary to assemble a professional team of engineers and programmers. To this end Szabó co-founded a company, called Engineering Software Research and Development, Inc. (ESRD) in 1989. The mission of this company is "to create and market software tools for the advancement of the quality, reliability and timeliness of information that serves the engineering decision-making process[4]". ESRD produces and markets the software StressCheck, which is the only finite element analysis software tool designed to meet the technical requirements of simulation governance [8]. It is used primarily in the aerospace sector. ESRD received the Boeing Gold Performance Excellence Award in 2014.

Szabó has published over 150 papers and two textbooks. He is a founding member and Fellow of the US Association for Computational Mechanics. Among his honors are election to the Hungarian Academy of Sciences as External Member in 1995 and Doctor Honoris Causa, University of Miskolc in 1998.

Szabó was honored on the occasion of his 65th birthday by an international conference held in St. Louis in 2000[5]. Two journals issued special editions in connection with that conference[6, 7].

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[1] Now called Creo Simulate.

[2] Now called the Aeronautics Division of the Swedish Defense Research Agency.

[3] The Impact of Mathematical Analysis on the Numerical Solution of Engineering Problems. University of Maryland, College Park, MD September 17-–19, 1986.

[4] www.esrd.com

[5] International Conference on p and hp Finite Element Methods: Mathematics and Engineering Practice.

[6] Int. J. Numer. Meth. Engng. **53**(1) (2002), Guest Editors: Z. Yosibash and M. Suri

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The Council of his hometown, Martonvásár, awarded him honorary citizenship in 2015.

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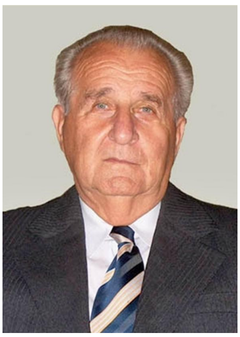
3. A professional life dedicated to Mechanics of Solid Bodies Professor Imre Kozák 85 years old



Imre Kozák was born in Gór, a small village in Western Hungary, in 1930. After graduating from the grammar school Nagy Lajos in Szombathely in 1949 he was admitted to the Faculty of Mechanical Engineering of the Technical University of Heavy Industry in Miskolc – today's University of Miskolc. In 1953 he obtained an M.Sc. degree in Mechanical Engineering. He began his graduate studies at the Department of Mechanics of the same university with the then Department Head István Sályi as his scientific supervisor, in 1953. This work later culminated in a Ph.D. thesis entitled *Small elastic plastic deformations of a thin walled cylindrical shell subjected to internal pressure.* This thesis was the first in which the Prandtl-Reuss equations were applied to bent cylindrical shells. The main difficulty of the problem raised lay in the fact that the solution required large amounts of computations before the advent of computers [1]. He was awarded his Ph.D. degree in 1961 and was appointed Associate Professor at the Department of Mechanics.

In 1967 he took part in the organization of the first Colloquium on Plasticity held in Miskolc in honor of Professor Endre Reuss, who was a well-known specialist in this field. This was the first scientific meeting of mechanical nature in Hungary after

World War II.

From 1967 to 1970 he was the Prorector responsible for scientific matters.

In 1968 Kozák was appointed Full Professor. Three years later, in 1971 he took over leadership at the Department of Mechanics and held the post of Head of Department till 1993.

Since 1971 the Hungarian Conference on Engineering Mechanics has been organized at the University of Miskolc every four years. He has taken part in the preparations and organization of the conferences on each occasion.

From 1966 to 1969 he greatly contributed in cooperation with Professor Béda (Technical University of Budapest) and Professor Sályi to a new initiative by launching academic programs for mechanical engineers specialized in theoretical and applied mechanics. The students who chose the new program of theoretical and applied mechanics graduated from the university with an M.Sc. degree. He took part in designing the new curriculum and gave lectures, for the first time in the academic programs for mechanical engineers in Hungary on such subjects as Theory of Shells, Mechanics of Continua, Differential Geometry with Indicial Notations etc. It is worthy of mention that eight of his former students are Full Professors today.

In the years 1972 to 1978 he was appointed General Prorector of the University of Miskolc. After office hours he devoted time to updating the materials of the fundamental courses of engineering mechanics (Statics, Strength of Materials, Dynamics, Theory of Vibration).

In 1978 he received the Gold Medal of the Order of Labor.

As regards his research, his aim was to work out a linear shell theory in terms of stresses. Because of the unresolved problems in connection with the compatibility of strain fields – what the independent, necessary and sufficient conditions are the strains should meet in order to be compatible if the displacements are not variables of the governing equations, what the solution to the Southwell paradox is[8], – he had to do some supplementary research.

As regards his results, it is worthy of mention that he modified and supplemented the dual formulation of linear elasticity and the system of dual variational principles by solving the aforementioned Southwell paradox, i.e., by pointing out that only three of the six Saint-Venant compatibility conditions are independent, provided that the so-called compatibility boundary conditions are satisfied, and showing that the independent compatibility conditions and independent stress functions should be chosen according to the same rule [2, 3, 4]. Based on these results he was able to establish a general theory of shells in dual system regarding the stresses as fundamental variables [5]. This work led to the thesis *Theory of thin shells in terms of stresses.* After its defense the Committee of Scientific Qualifications at the Hungarian Academy of

[8]It was Southwell (1936, 1938) who first derived the compatibility conditions from the principle of minimum complementary energy as a variational principle. He pointed out that, by utilizing Maxwell's (1870) and Morera's (1892) solutions, only three of the six Saint-Venant compatibility conditions follow from the principle of minimum complementary energy. Since any stress condition can be given in terms of three stress functions chosen appropriately, he arrived at a contradiction, because for the displacements to be single-valued all the six Saint-Venant compatibility conditions should be satisfied. This contradiction was named Southwell's paradox after him. After Southwell's papers the following problems remained unresolved. Is it sufficient for the strains to satisfy three Saint-Venant compatibility equations? If so, which three? If so, are there further conditions to satisfy?

Sciences awarded him the degree Doctor of Science in 1981.

From 1980 to 1983 he was again the Prorector responsible for scientific matters.

Between 1983 and 1985 Kozák wrote the textbooks *Continuum Mechanics* (in Hungarian)] and *Mechanics of Elastic Bodies* [6] (in Hungarian)] with co-authors. The book *Continuum Mechanics* contains his most important results concerning the investigations he carried out in a dual system.

In the late 80s Kozák began to deal with the relative motion of continua. By relative motion we mean the motion of a solid body (continuum) with respect to an arbitrary curvilinear coordinate system, which is also in motion and therefore is capable of deformation (one can regard it as if it were a fictitious body). This motion is distinguished from the motion of the solid body (continuum) relative to an arbitrary but fixed curvilinear coordinate system (absolute motion). Within the framework of these investigations he set up the necessary formalism. In headwords: relative and absolute velocity fields, relative and absolute deformations, deformation gradients, strain tensors, volume and surface elements, material time derivatives (for the deformation gradients, volume and surface elements), some questions of the physically objective material time derivatives of the strain tensors, principle of virtual power and work in each configuration with special regard to the case of follower loads. One of his major results was the derivation of some new and known materially objective (invariant under any coordinate transformation) time derivatives with a systematic method [7, 8, 9].

In 1988 he won the Apáczai Csere János Prize. In 1990 and 1993 he was awarded the medals Pro Unversitate and Pro Urbe of Miskolc.

The graduate education that leads to the degree of Doctor of Philosophy had earlier been controlled formally by the Hungarian Academy of Sciences (Russian system) but was taken over by the hungarian universities in 1990. He took part in establishing new curricula for the graduate students at the Faculty of Mechanical Engineering of the University of Miskolc.

A revised and supplemented English edition of his book *Continuum Mechanics* [10] was published in 1995. This edition contains, among others, Kozák's method of deriving materially objective time derivatives.

He was elected corresponding member of the Hungarian Academy of Sciences in 1995. He gave his inaugural lecture with the title *Continuum Mechanics and Geometry* at the Seat of the Miskolc Committee of the Hungarian Academy of Sciences in 1996.

In 1996 the City Council of Miskolc awarded Kozák honorary citizenship.

In the '90s he proceeded with his research in continuum mechanics. The results are applicable to investigating geometrically non-linear static stability problems and postcritical equilibrium paths. Some of the results are listed below very briefly:

- The incremental form of the principle of virtual displacements for follower loads and the derivation of the formulae for the Newton–Raphson iteration procedure that solves the corresponding non-linear problem. When applying a finite element discretization it is reasonable to introduce, in addition to the usual linear and geometric stiffness matrices, the load-correction stiffness matrix which is symmetric if the follower loads have a potential and is asymmetric if the follower loads have no potential.

- The Newton-Raphson iteration can be initiated not only from an equilibrium configuration under the given load but from an arbitrary non-equilibrium configuration provided that the latter is appropriately chosen, independently of the loads. In this way both fundamental equilibrium paths and bifurcation paths as well as complementary paths and limit points can be investigated. The critical load can be determined by the path following method and the determinant search algorithm. The equilibrium surfaces due to the geometrical imperfections and the load parameter(s), their stable and unstable regions and the critical loads can be determined numerically [8].
- It has been shown that linear eigenvalue problems for follower loads cannot be investigated properly if the load correction matrix is left out of consideration.

In 1999 Kozák won, together with his colleague István Páczelt, the Széchenyi Prize which is the highest scientific award in Hungary.

He was elected an ordinary member of the Hungarian Academy of Sciences in 2001. He gave his inaugural lecture with the title *3D Stability Analysis of the Equilibrium States of Solid Bodies for Deformation Dependent Loads* at the Seat of the Miskolc Committee of the Hungarian Academy of Sciences in the same year.

Since 2000 he has been working for the Institute of Applied Mechanics as a professor emeritus.

In 2013 he was awarded the Hungarian Decoration With Cross.

Kozák participated actively in the work of a number of scientific associations and societies. Since 1966 he has been a member of the today's Committee of Theoretical and Applied Mechanics of the Hungarian Academy of Sciences. Since 1973 he has also been a member of the Hungarian National Committee of the International Union of Theoretical and Applied Mechanics. From 1984 to 1996 he was a member of the Committee of Scientific Qualifications at the Hungarian Academy of Sciences.

Kozák has been taking part in the work of the Miskolc Committee of the Hungarian Academy of Sciences since it came into existence in 1979. Since its foundation he has been a member of the Expert Committee of Mechanical Engineering. Between 1984-96 he was the Chair of the Club Council. In 1990 he was elected a member of the Committee. From 1993 to 1996 he was the vice chairman of the Committee. From 1996 till 2002 he was the Chairman of the Committee.

Kozák has visited a number of foreign cities (Vienna, Graz, Leoben, Prague, Brno, Bratislava, Kosice, Cracow, Berlin, Magdeburg, Dresden, St. Petersburg, Moscow, Kharkov, Frunze, Detroit, Algir, Oran, Constantine).

He is an excellent lecturer. He has the gift to present very complicated things – relationships, lines of thoughts – in an elegant and simple manner and to make his audience understand what at first seems difficult. Those who have had the privilege to attend his courses will remember these lectures fondly.

He has written altogether 17 university textbooks for his students on Statics, Strength of Materials, Dynamics, Elasticity, Plasticity, Theory of Shells etc. These books came out in Hungarian.

He has published a total of 61 scientific papers so far.

Kozák has been the scientific supervisor of 8 Ph.D. dissertations and a number of M.Sc. theses. Four of his PhD students (Edgár Bertóti, Béla Csizmadia, György Szeidl and Károly Váradi) are full professors.

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Miskolc, October 30, 2015 Lászó Baranyi, István Páczelt and György Szeidl