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## Editorial

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**Biographical notes:** Doru Talaba is currently a Professor in the Department of Product Design and Robotics, Transilvania University of Brasov. He is also the Director of Virtual Reality Laboratory. He has a 24-year experience in teaching and research in various subjects of mechanical engineering particularly related to mechanisms, robotics and virtual reality. The research lab on CAD/CAE and Virtual Reality he founded in 2001 at the Transilvania University of Brasov in Romania includes now five professors and two posdocs as permanent staff as well as more than 12 full time PhD students. His research interests include mechanisms, 3D graphics, virtual reality and mechatronic systems design. He has experience in FP5, FP6, Erasmus, Tempus, Minerva and Leonardo programmes.

E. Ilhan Konukseven is an Assistant Professor at the Department of Mechanical Engineering, Middle East Technical University. He obtained his PhD in Mechanical Engineering from the METU in 1997. During his Postdoc studies he has focused on mobile robotics and sensor based motion planning at Mechanical Engineering Department, Carnegie Mellon University. He is the Principal Investigator of the project called 'Dental Education Simulator (DiHES) Development' funded by the Scientific and Technical Research Council of Turkey (TUBITAK). Also, he is involved in the projects: 'Robot based design to be used in rough terrains for military applications' – funded by T.R. Prime Ministry State Planning Organization (DPT), and 'Haptic interface design' funded by TUBITAK. His current research interests focus on robotics, virtual reality, haptic devices, sensor based motion planning and mobile robotics.

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Computer simulation has become a standard approach for all aspects of machine design and production engineering, not only reducing the need for real prototypes but also evolving steadily towards a veritable virtual prototyping concept. Naturally this invaluable engineering paradigm turns out to be in the focus of many scientific events including the well established International Conference on Machine Design and Production (UMTIK) which is traditionally organised by the Middle East Technical

University (Ankara, Turkey) since 1984. In particular the 13th UMTIK Conference, which took place in the spectacular city of Istanbul in September 2008, allowed the presentation of very interesting studies in this field and sparked fascinating debates among the researchers. Consequently, the discussions led to the proposal for a special issue of the *International Journal of Engineering Design*. This special issue, which has been keenly devoted to present some of the important contributions in this field, includes nevertheless some relevant works from outside UMTIK Conference contributions.

All papers in this issue deal with process simulation in the field of machine design and production. The first group of four papers proposes on novel simulation methodologies that are particularly coupled to design processes. The first paper titled 'A new micro-fabrication process simulator for micro-electro-mechanical system (MEMS) designs' by Alper Yildirim and Melik Dolen introduces a new process simulator for MEMS. The open-source program, which has been developed via C/C++ language along with the OpenGL library functions, significantly speeds up the design phase by providing realistic outcomes about the micro-fabrication processes involved. The proposed software can conveniently simulate additive micro-fabrication processes such as doping and material deposition by extending its basic cellular automation algorithm. The paper also shows that the simulation results are in agreement with the experimental ones both qualitatively and quantitatively.

The second paper 'Virtual prototyping in design of synchronous belts drives' by Silviu Butnariu and Doru Talaba presents a methodology and dedicated software for the simulation of the mechanical behaviour of power transmission systems. CAE methods, such as finite elements analysis or multi-body analysis are used in an attempt to replace classical tests after experimental validation of computer software results. The authors demonstrate that for special applications, the design of the belt drives components (including pulleys, tensing device and belt), performed now using algorithms, nomograms, equations, coefficients, can be optimised by simulating the drive tests under different loading with the aim to optimise the load distribution, using finite element method and multi-body model.

The object of the third paper entitled 'Modelling of complex structures using superlements' by Anton Ianakiev is to present a transient analysis for complex structures using a model based on superelements – a modern technique for structural analysis. The working arm of a hydraulic excavator is taken as a case to illustrate the method, by employing sub-structuring (superelements) in a sample working cycle, where a pre-defined potential cutting force taken as a function of time is the main external load. The forces in all the joints of the working arm and the stress distribution in all the sub-structures are presented and recommendations are given for the digging cycle to produce lower dynamic loads.

'Multi-objective design optimisation of ball bearings using a modified particle swarm optimisation technique' by Vimal Savsani, R. Venkata Rao and D.P. Vakharia is the fourth paper in the first paper group, dealing with the problem associated with ball bearings design and selection that are based on different operating conditions to reach excellent performance, long life and high reliability. Optimisation aspects of a ball bearing are therefore proposed considering three different objectives namely, dynamic capacity, static capacity and elastohydrodynamic minimum film thickness. The design parameters include mean diameter of rolling, ball diameter, number of balls and inner and outer race groove curvature radii. The constraints considered are pertaining to the assembly angle, ball size, bearing width size, ensuring running mobility, thickness of

bearing rings and curvature radii. The optimisation procedure is carried out using a modified particle swarm optimisation technique considering both single and multi-objective optimisation aspects. The results of the proposed technique are compared with the previously published results showing considerably improved results.

The second group of two papers concentrates on the simulation of production processes. The paper 'Improving free form surface machining performance by ball end milling model', by Ahmet Canberk Manav, Enis Akgun and Ismail Lazoglu is the first in this group and describes the determination of the optimum tool path for the case of a free form surface machining, for which the cutting time is minimised and the cutting forces are limited below a threshold. The cutting forces in each direction for all CL points referring a uniform Cartesian mesh are computed using a force map that shows the pre-computed possible cutting forces from each CL point to its neighbours. The force simulation of the optimised path and its experimental validation are obtained and compared.

The second paper related to the machine production field 'Computerised cutting simulation of involute helical gears generated with rack cutters' by M. Cunevt Fetvaci and C. Erdem Imrak presents the equations of rack cutters for generating helical gears with involute teeth. By applying the equations of the designed profile for rack cutter along with the principle of coordinate transformation, the mathematical models of involute helical gear are developed with the utilisation of differential geometry and the gear theory. Furthermore, a computer simulation program is developed to generate the tooth profile of involute gears and to illustrate the effect of tool geometry on generated surfaces while illustrating the simulation of the generating process as well.

### **Acknowledgements**

The guest editors would like to thank all authors and reviewers along with the journal editors, who all largely contributed to this special issue. It was a pleasant and memorable task for us to assemble all the research papers presented in this special issue. We hope the readers will find the articles both interesting and useful.