ACTUAL TASKS AND TRENDS IN DEVELOPING MULTIDOMAIN MEMS MODELS FOR EDUCATIONAL PURPOSES

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Abstract - **In this paper the instructions for preparing camera ready paper for International Conference MEMSTECH 2011 are given.**

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I. INTRODUCTION

Microelectromechanical systems (MEMS) represent a modern field in engineering with a significant impact on industrial applications. By combining together electrical, mechanical, thermal and optical elements, MEMS revolutionize the market of sensors and actuators. Clearly, each discipline mentioned above is a long-established and thoroughly researched field. However, there are still many MEMS phenomena left to be explored. The reason is twofold:

1. MEMS are fabricated in the micrometer scale and microscale-related phenomena have not yet been fully researched
2. MEMS are based on merged set of disciplines and, as result, new mutual dependencies at the microscale level are created. Thus, it leads to appearing new research areas when two or more domains meet.

The continuing growth of multidisciplinary knowledge and supporting information together with the increasing complexity, multi-domain character and diversity of MEMS devices require the designers to specialize in several interdisciplinary domains in order to create a successful design. Currently, there are many research groups across Europe involved in one particular discipline. However, only few of them may have researchers specializing in all of them, which may limit or even impede MEMS research in Europe.

II. MAIN OBJECTIVES IN MEMS TEACHING

Even simplified MEMS development process includes a set of complicated tasks: <**Conceptual Design**> → <**System Design**> → <**Physical Design**> → <**Detailed Modeling and Simulation**> → <**Developing Technological Masks**> → <**Fabrication of Prototype**> → <**Testing and Sectioning**> → <**Assembling and Packaging**> → <**Final Testing**>. All these steps should be covered by Universities programs and supported by real hands-on training.

The real prototype MEMS development cycle is expensive and time-consuming. Rapid prototyping is new innovative MEMS technology, but it can be applied only into the environment of modern computer-aided design (CAD) tools for multi-physics domains. Such software tools are limited or even not available in most educational institutions. The solution is implementing in educational process virtual technologies for MEMS design, like Rapid Virtual Prototyping and Rapid Virtual Manufacturing. Several educational and research groups conduct work in this direction.

One of the first approaches for developing an innovative MEMS education program that combines virtual fabrication with actual testing of classic MEMS devices was proposed by group of US universities in [1]. This approach is suitable both for large classes and in university environments that do not have access to fabrication facilities. A learning framework for MEMS education proposed by researchers from India [2]. The proposed modern education methodology is based on computer training systems, which embedded modeling and simulation tools and resources, like MATLAB, ANSYS/Metaphysics and rapid prototyping tools into teaching-learning framework for MEMS education.

Current computer tools for product design are generally stand-alone applications. However, multidomain MEMS design activities may involve many participants from different disciplines and require a team of designers and engineers with different aspects of knowledge and experience to work together. Nevertheless, new software tools, which appear during last decade gives possibility to improve, modify and highly activate the effectiveness of educational process by applying virtual collaborative technologies [3, 4]. Thus, developing and using MEMS Design & Educational Framework with elements of virtual technology laboratory can be reasonable solution for supporting and coordinating Universities research teams.

The greatest role this Design & Educational Framework can play for the purpose of developing new multidomain

models for virtual prototyping and virtual manufacturing. To solve these difficulties appeared in educational process, our group proposed EduMEMS project. The main aim is to develop and supply existing university programs with new models and approaches in order to provide graduates with required skill set. Six main objectives, which are planned to be achieved in the project are following:

1. Development of a new MEMS design workflow, which will incorporate the design efforts of international distributed team of researchers.
2. Design of a structure, an architecture and component connections of specialized MEMS devices. The choice of MEMS technology for the design and the simulation.
3. Development of mechanical, electrical, thermal, optical and other models for MEMS components on the system and physical design levels.
4. Simulation and testing of developed models for MEMS devices in computer-aided-design (CAD) tools.
5. Design of technological masks for the production of developed MEMS devices.
6. Elaboration of project outputs and results and their use for educational purposes.

As it was mentioned, the proposed project requires from participants specific knowledge in several domains, like MEMS System Design, Component Modeling and Simulation, Usability of CAD Tools, modern MEMS Fabrication Technologies, Design of MEMS Technological Masks, etc. The exchange program was planned in order to achieve maximum effects from mutual visits. Thus, visited staff will bring to host institution knowledge and experience from home institution and will receive adequate support for their research.

The EduMEMS project is directed, first of all, on creating new multidomain models of complex MEMS devices and for bringing hands-on practice on Microsystems engineering to young researchers and students. Besides, the project will create a strong cooperation between partners and new methodologies for the development of international multidisciplinary design teams will be established. The technological impact of the research project consists of newly developed MEMS models, specific design layouts and technological masks, which could be used for further MEMS fabrication.

III. Conclusion

The primary objective of the modern university teaching and research groups is to combine efforts within the European research teams. Such team was organized within the EduMEMS collaborative project, which was created for directing such international efforts for solving educational challenges in MEMS multi-domain phenomena. Each involved partner specializes in at least one research field related to MEMS design and fabrication. The researchers from each domain have to communicate with other partners to organize courses and lectures related to their specialization. Each partner will then gain knowledge about the domain, which previously he has not specialized in. As a result, each partner should expand their narrowly specialized research to other disciplines and become capable of performing multidomain MEMS research independently.

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