

Group Position Paper: MEMS Applications

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The micro-electro-mechanical system (MEMS) marketplace has been predicted to have exponential growth within the next few years, which is fueled by a large number of applications. Many people have attempted to draw parallels between the exponential growth of microelectronics over the last 30 years and MEMS ; however, there are significant differences. Those differences are readily apparent when reviewing the position papers of this workshop. Microelectronics technology presents a relatively homogeneous set of fabrication technologies and applications with a mass marketplace. There is currently a *wide variety* MEMS fabrication technologies and applications with the marketplace for each application being diverse. In my opinion, the long-term success of MEMS will as dependent on the business models as the technology. This means, the technology involved in the various applications (fabrication, design tools, measurement methods, packaging techniques) will in eventually need to coalesce in a synergistic fashion. This will enable each MEMS application to build upon its predecessors instead of needing to develop the complete infrastructure unilaterally.

The white papers submitted to the applications subcommittee were extremely well thought out and prepared, and the range of MEMS applications presented illustrates the true breadth MEMS technology has the potential to achieve. The topics presented also show how intertwined the issues of the fabrication, application and packaging sections of this workshop really are. Since the authors of the particular white papers can best represent the details of their particular research areas, I decided that my best contribution may be to propose a framework of discussion to organize our thoughts about our particular topic, MEMS applications.

The framework I am suggesting for the discussion of MEMS applications consist of two main areas:

- Enabling Requirements for MEMS applications.
- MEMS applications

I will outline these areas and insert the various issues and topics highlighted in the position papers I reviewed. I am sure that I have not been all-inclusive, but that is what we will complete during the workshop.

- **Enabling Requirements/Issues for MEMS:**
 - Needs: Commercial/Military/Research ...
 - Fabrication Technology: (fabrication subcommittee)
 - CAD/Design Tools and Methods: layout, visualization (2-D, 3-D), automated realizations between 2-D and 3-D domains, Design optimization

- Modeling of the physics at the microscale: multi-domain physics, phase change processes, physics unique to the micro-scale (adhesion, micro-channels...), reacting flows in micro-channels.
- Experimental validation of models and devices at the microscale: measurement and characterization techniques (optical, thermal, ...)
- System Integration: (Packaging subcommittee)
- **MEMS applications**
 - Components
 - Actuation: mechanical, electrostatic, thermal, piezoelectric, electrostrictive, fluidic, pneumatic
 - Sensing: electrostatic, piezoelectric, drive and signal electronics.
 - Systems: pressure sensors, accelerometer, gyroscopes, optical devices, rf-devices, micro-fluidic, bio-medical devices, power-generation, and nanotechnology.

An overview of the areas represented by the committee member contributing white papers may give us a view of the breadth represented by the committee.

Fabrication Issues: G. K. Ananthasuresh, Q. M. Wang, G. P. Vakanas

CAD/Design Tools: N.R Aluru, G. K. Ananthasuresh, S. Mukherjee

Modeling and Experimental Validation: F. Zenhausern, F. K. Forster, N. R. Aluru

Actuation and Sensing: Q. M. Wang, K. Chen, S. Tung

Systems: F. Zenhausern, F. K. Forster, S. Tung

Interconnection Issues for applications: F. Zenhausern, F. K. Forster

Education: G. P. Vakanas

I encourage the members of the applications subcommittee to think about the future of the MEMS field and think expansively. The challenge of the workshop will be the capture the wide range of expertise and thought in a coherent framework that can be presented to NSF as well as the MEMS community at large.