# Blending MEMS into IC design flows

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The design and simulation of MEMS and circuits together is typically done with oversimplified behavioral models of the MEMS inserted into IC design environments. Creation of these models requires communication between MEMS designers, IC designers, and modeling experts not only for the initial model but also when design parameters change or manufacturing tolerances must be explored. This human intervention makes the true blending of MEMS into IC design flows impractical.

MEMS designers are asked to generate MEMS models for circuit and system simulators such as SPICE and MATLAB-Simulink in order for IC-designers to design control and read-out circuits for MEMS devices and optimize the two together. The three options available for creating such MEMS models are:

1. Hand-crafted analytical models
2. Create macro models extracted from Finite Element simulations
3. Discrete element representation using Network Models

These MEMS models need to describe the MEMS behavior accurately in the mechanical and electrical domain. Such models have been available to designer but required modeling experts to use them. The new innovation we present extends the concept of Network Models to the construction of 3-D mechanical models that automatically create the behavioral models.

The direct creation of a MEMS device in a 3-D view is expected to be more natural for MEMS engineers who are used to working in a 3-D CAD environment. Also, the behavioral model of the complete MEMS device can be fully parameterized thus requiring no human intervention under parameter variation.

Because of the combination of full-parameterization, automation and familiar user interface for both the MEMS designer and IC designer, this solution has broad ranging consequences that are new to the MEMS industry. The presented solution specifically offers designers of traditional digital and mixed-signal ICs, ASICs and SOCs a way to efficiently integrate MEMS into their design methodology without having to be experts in mechanical design.