Organization(s): **Analog Devices**

Title: CAD for Integrated MEMS Devices

Duration of Effort: September 1996 - September 2001

MTO **Composite CAD**

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Objectives:

Develop a suite of CAD tools that provide a self-consistent modeling environment enabling the effective design, simulation, verification, and manufacturing of integrated MEMS devices. Further, to be useful for real-world design the modeling environment must be valid for large displacements such that overload characteristics can be calculated with high accuracy.

Major Accomplishments:

- Identification of Verilog-A as the language which will allow both mechanical models and circuits to be simulated in a uniform environment (Q2-01).
- Improvement of the coupled electromechanical simulation capability in AutoBEM (Q1-01).
- Large displacement accurate mechanical schematic (SPICE 2-DOF) (Q4-00).
- Implementation of macromodeling functionality in AutoBEM (Coventor) (Q2-00).
- Demonstration of large displacement mechanical schematic using real-world acceleration input (Q2-00).
- Large displacement accurate mechanical schematic (SPICE 1-DOF) (Q2-00).
- Mechanical schematic (SPICE 2-DOF) (Q1-00).
- Demonstration of tool suite using a real design (Q4-99).
- Manufacturing analysis package for macromodels (SPCMEMS) (Q4-99).
- In-line monitoring test structures (Q4-99).
- Design tools: MemsCheck (Q2-99), MemsDbx (Q1-99), MemsXview (Q3-98).
- Co-Solve-Lem (Coupled electromechanical simulator) for large rigid structures (Microcosm) (Q3-99).
- AutoMM electro-mechanical macro model generator for 6-DOF (Microcosm) (Q2-99).

DOD Impact:

- This project will decrease the design time and help to insure the "1st silicon success" of any future DOD MEMS designs (integrated or not).

Technology Transfer/Products:

- AutoBEM with macromodeling functionality (Coyote/Coventor).
- Design tools: MemsCheck, MemsDbx, and MemsXview (Coventor).
- Co-Solve-Lem: coupled electromechanical simulator for large rigid structures (Coventor).
- AutoMM: electro-mechanical macro model generator for 6-DOF using Saber's MAST language (Coventor).

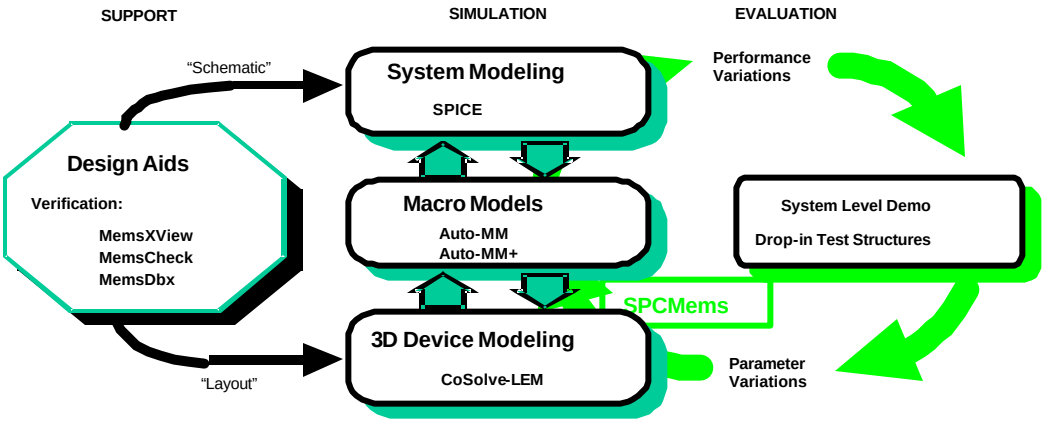

Figure 1: Project Overview

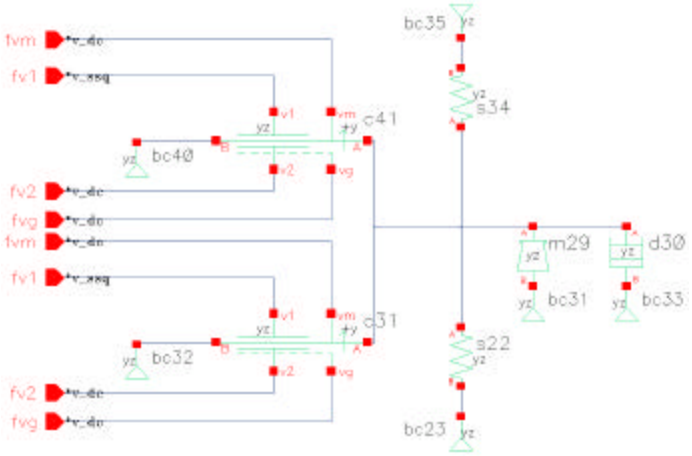

Figure 2: 2-DOF Mechanical Schematic implemented in Cadence. Underlying models are in SPICE. Spring, Mass, Damper & Capacitors are shown in this example.

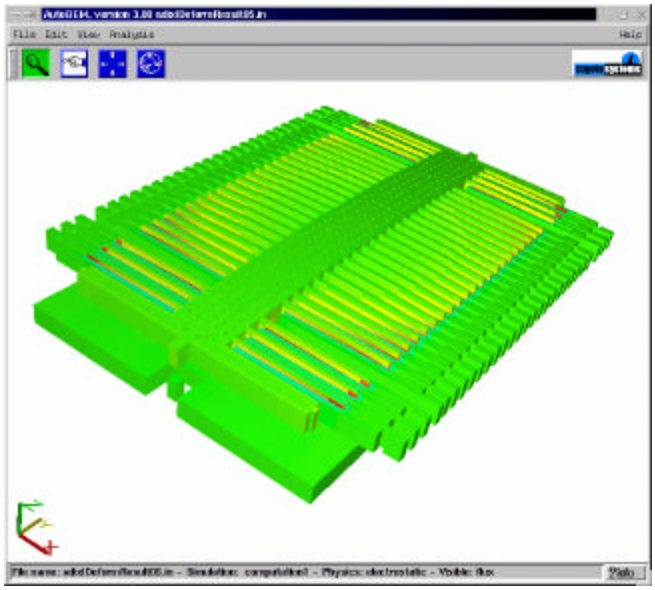

Figure 3: AutoBEM model of ADXL76 with curvature included in the model. The modifications of AutoBEM for macromodeling allow any distortion of the geometry: displacement, rotation, and bending.