

SoftMEMS approach to MEMS DfMM

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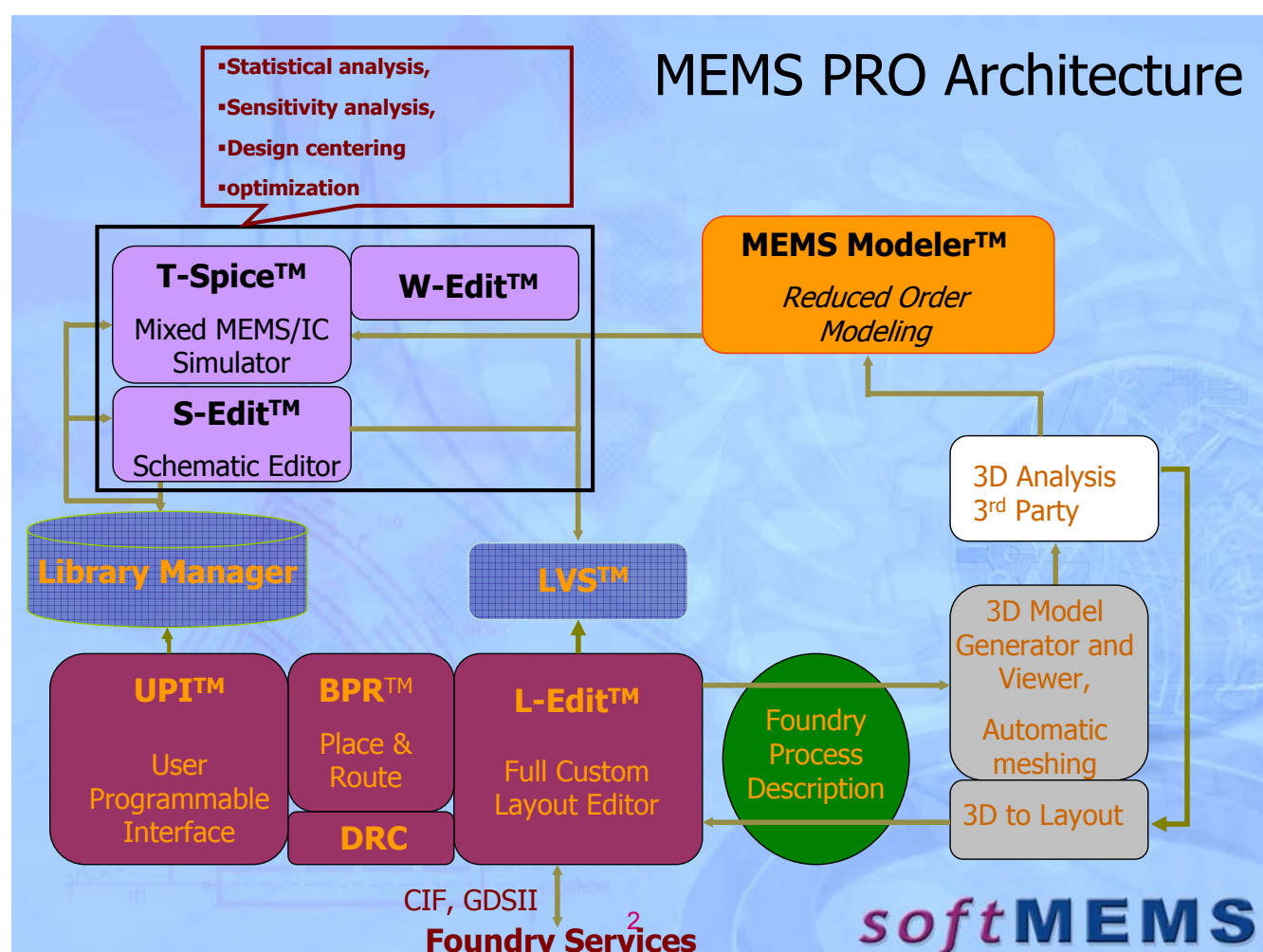
Mary Ann Maher

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www.softmems.com

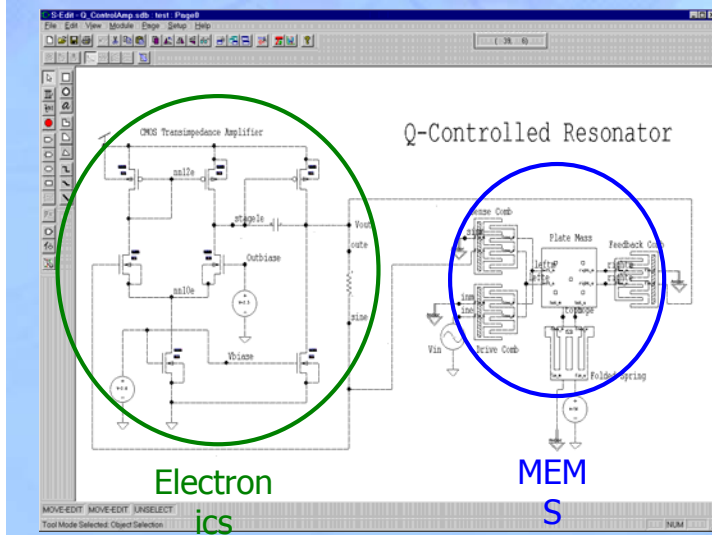
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Combined MEMS & IC Schematics

- Schematics can contain both IC and MEMS modules
 - IC modeled using standard IC models
 - MEMS modeled using behavioral macro models
- Component library
 - Behavioral models for standard MEMS components

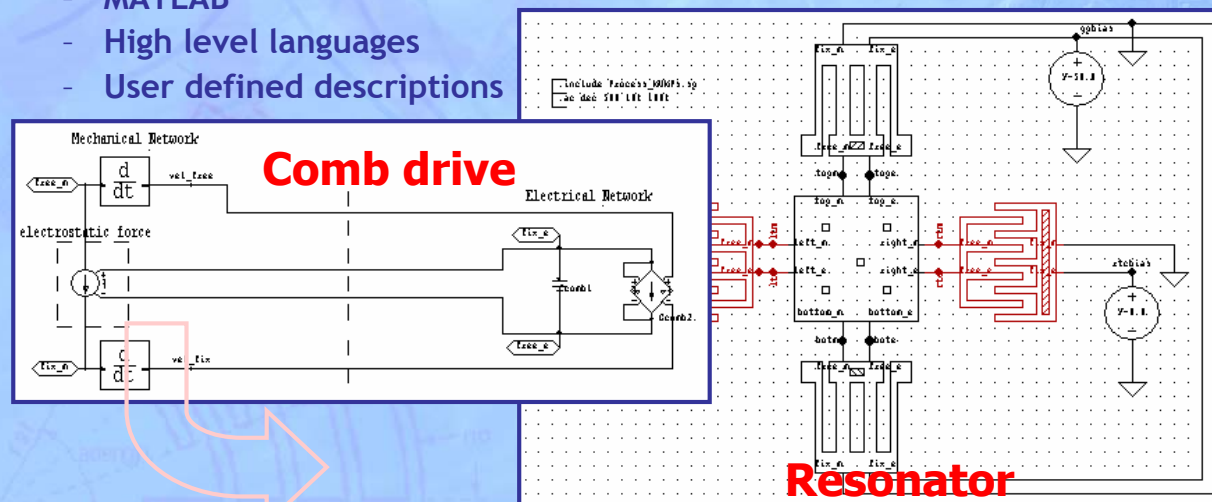


- Simulation of MEMS Macromodels at ODE Level
- Model Representation
 - Equivalent Circuit Models
 - Functional Models
 - Table Based Models
- Transient/DC/AC Analysis
- Parametric Analysis

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Equivalent Circuit Model

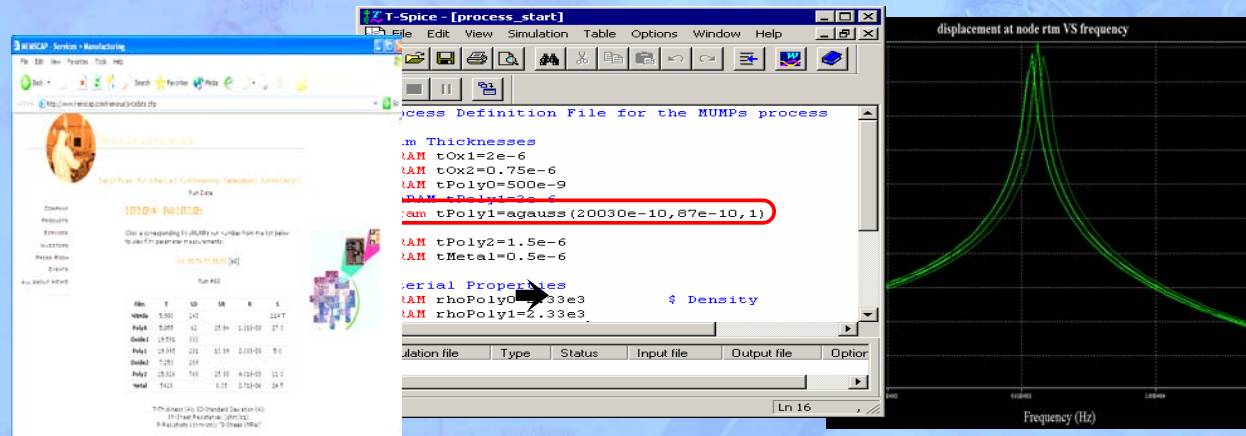
- Coupled mechanical and electrical network
- Hierarchical symbolic representation
- Describes models with
 - SPICE
 - MATLAB
 - High level languages
 - User defined descriptions



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Statistical Analysis

- Statistical analysis based on process/mask variations
 - Incorporates statistical data from foundries into models
 - Develop process corners for simulation
 - Monte Carlo analysis



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What parameters for statistical analysis ?

- MEMS and IC models to take into account all process variations on :
 - Material properties,
 - Thermal coefficients,
 - Etch rate ratios, over-etch variations.
- Information must be made available by foundries in “design kit”

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Sensitivity Analysis

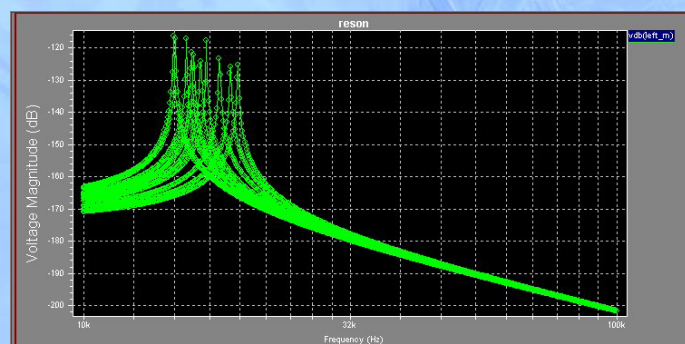
- Sensitivity calculation: parameters contribution to performance
- Sensitivity analysis is performed to investigate influence of individual parameters on the device behavior
- Easy set up : parameter sweep simulations
- Help designers to indicate to foundry what process parameters must be closely watched

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Design centering

- Sensitivity analysis can help then to do “design centering”, i.e. choose mask/process designs which maximize yield and are the most tolerant to variation

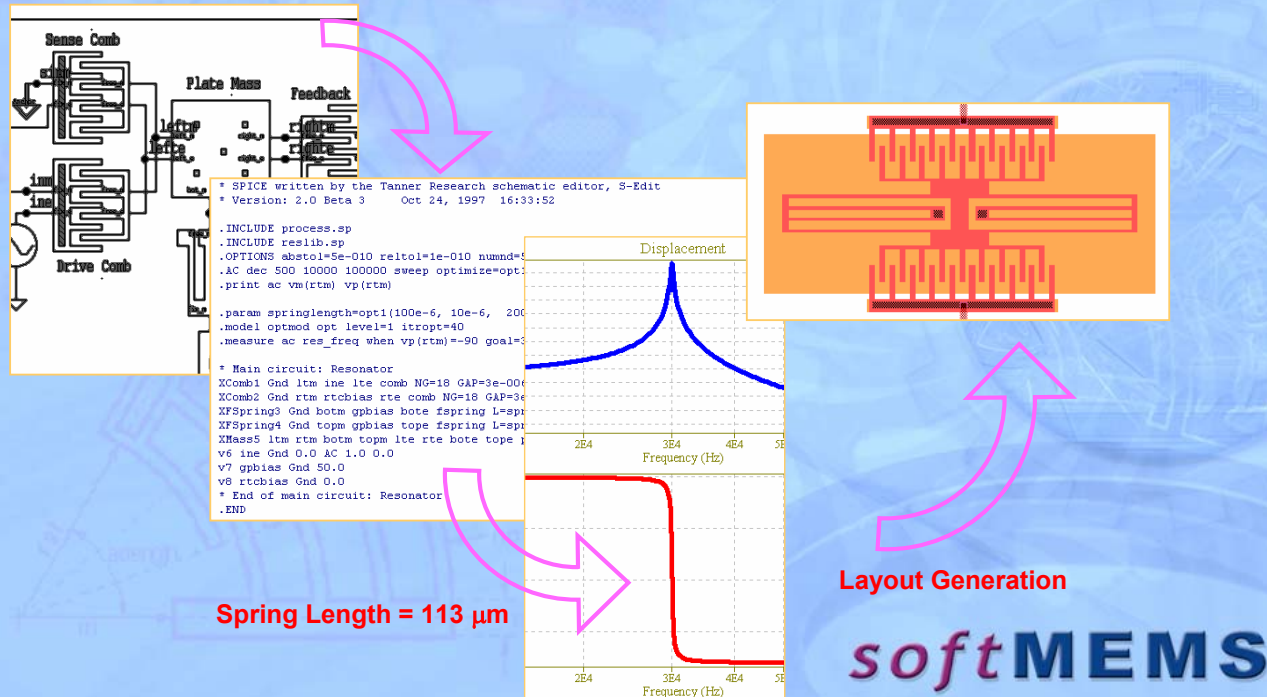


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Optimization

Example: Optimize springlength using minimum area with resonant frequency = 30 KHz



Conclusion

- Design for Manufacturing is possible on the analytical level provided that you have a good knowledge of the process variations.
- It could save you a lot of time to use analytical methods rather than FEM simulations.

- This talk is described in details within the June 2005 issue of MST News.

- Thank you!