2003 유체기계 연구개발 발표회 논문집, pp. 133~139
선문대학교 아산캠퍼스, 2003. 12. 5~6

COVENTOR

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DAVAN TECH CO., LTD.

CoventorWare™

Design Tool for Bio-MEMS & Microfluidics

2003. 12. 05 ~ 06

Seungoh Han
CoventorWare AE, DavanTech

CoventorWare™ Addresses Most MEMS Applications

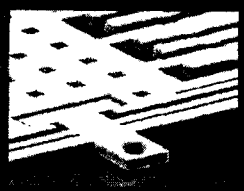
Sensing
Pressure sensors
Accelerometers
Gyroscopes
Microphones
Mass spectrometers

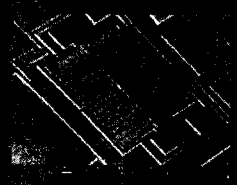
Optics
Mirrors
VOAs
Tunable lasers

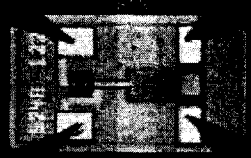
RF
Switches
Varactors
Resonators (FBAR, SAW)

Actuators
DC relays
Data storage

Microfluidics
Inkjet heads
Dispensing
Lab-on-chip
Fuel cells
Cell sorting







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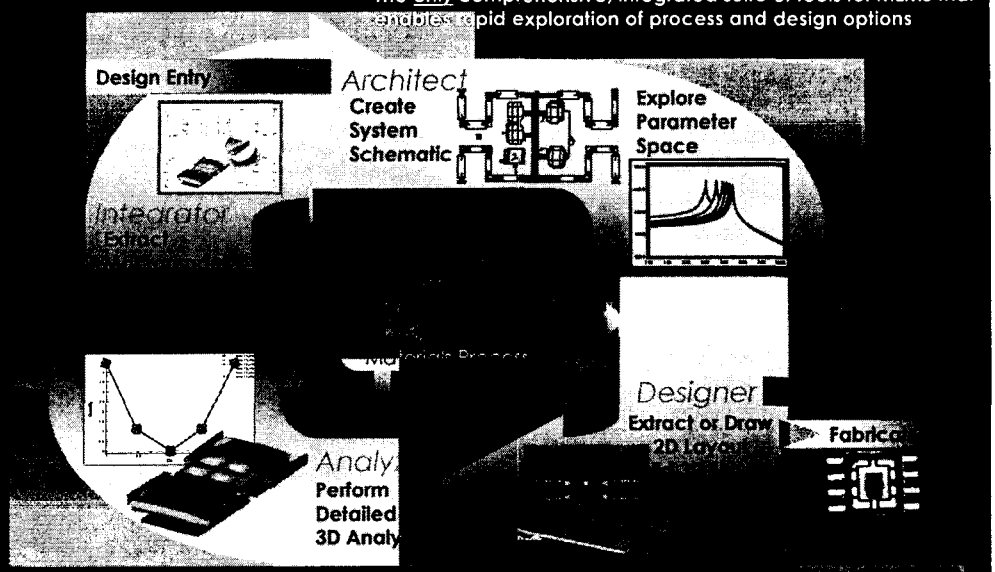
CoventorWare - Design Flow

The only comprehensive, integrated suite of tools for MEMS that enables rapid exploration of process and design options



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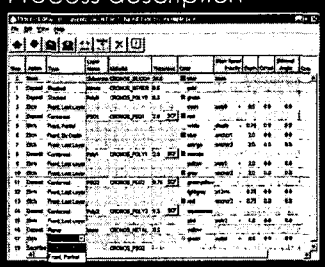
Process-Centric Design Flow

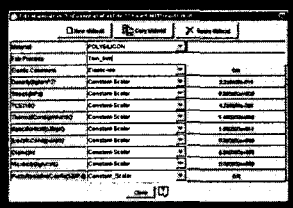
Process centric

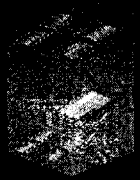
Start by specifying the manufacturing process

Process description



Materials database





Materials and Process data are shared by ARCHITECT and DESIGNER

Saves time by eliminating double entry of data

Makes it easy to explore effects of process variations on device performance in ARCHITECT™

Clean User Interface

Easy to use, prevents input errors

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ARCHITECT™ Key Benefits

ARCHITECT

Evaluate device architectures rapidly
- Explore wide design space
- Quickly determine viable solutions

Perform thorough parametric variation
- Optimize performance with sensitivity analysis
- Account for fabrication tolerances to assure a working design

Evaluate multiple aspects of performance
- Transient, packaging, damping, RF, optics,
- Co-design device and system

Automatic Schematic driven layout (SDL) extraction
- Behavioral model geometries are converted to physical 2D layout descriptions
- Optimized material property descriptions are ported back into the FEM front end

Accelerate your time-to-market

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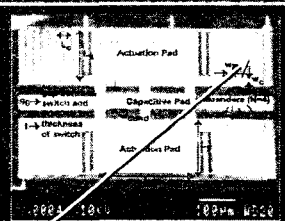
ARCHITECT™ – a new MEMS design paradigm

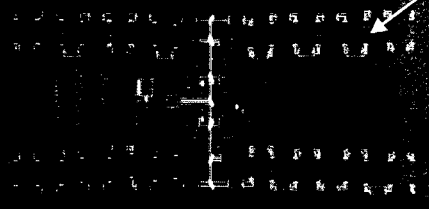
- Create device schematic from library of MEMS-specific "parametric elements"
- Simulate device behavior within sub-system rapidly and accurately
- Perform Monte-Carlo and Sensitivity analyses to optimize design



S.P. Pacheco, L.P.B. Katehi, and C.T.-C Nguyen: Design of Low Actuation Voltage RF MEMS Switch. Proceedings of the 2000 IEEE MTT-S, Boston, MA, June 11-16, 2000.

Beam

Parameters
- Length & width
- Cross section
- Material properties
- Tolerances
- Top and bottom electrodes
- Curvature
- Sacrificial layer thickness
- Electrode thickness
- Electrode relative permittivity
- Mirror-electrode height ratio
- Mirror-electrode width ratio
- Gimbal-electrode offset
- Bias voltage
- Many more



RF Switch Schematic

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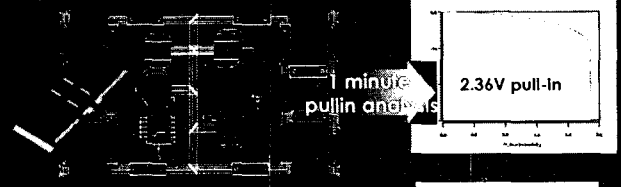
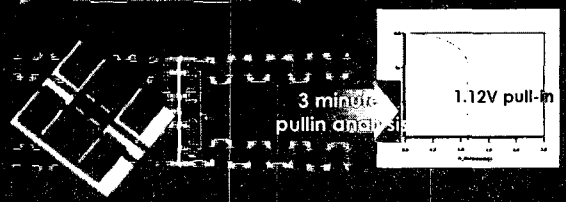
ARCHITECT™ – the fastest way to optimize a MEMS design

Example: Ability to quickly simulate RF switch enables rapid design improvements

Initial design



Improved design



Examples of Simulation Capabilities

- Electrostatic force behavior
- Transient electromechanical
- Mechanical deflection
- Frequency response
- Sensitivity analysis
- Monte Carlo analysis

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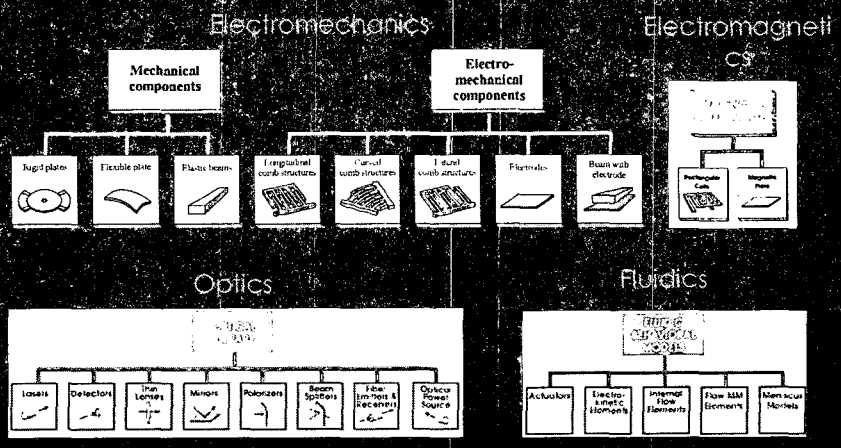
Comprehensive Library of Parametric Elements

Each element (component) is an analytical model that captures essential MEMS physics



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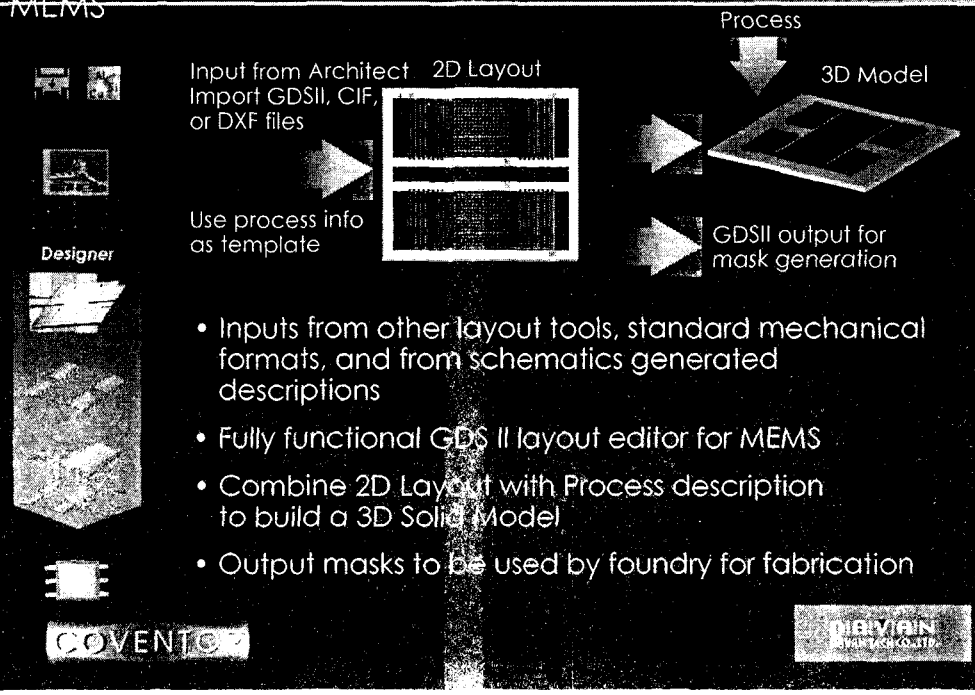
DESIGNER™ – 2D layout and 3D modeling for MEMS



- Inputs from other layout tools, standard mechanical formats, and from schematics generated descriptions
- Fully functional GDS II layout editor for MEMS
- Combine 2D Layout with Process description to build a 3D Solid Model
- Output masks to be used by foundry for fabrication

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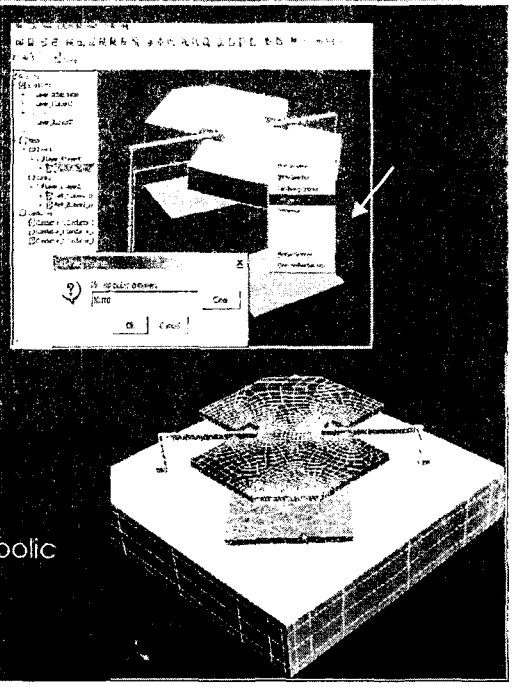
Designer - State-of-the-Art 3D Preprocessor

Saves Time

- Multi-select and name patches and conductors
- Patch and conductor names survive re-meshing
- Intuitive, synchronized "tree view"

Produces Better Meshes

- Apply best mesher for each layer
- Refine mesh locally, on faces, edges or vertices
- Get immediate feedback on mesh quality
- Snaps middle vertices of parabolic elements to true geometry



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ANALYZER™ – comprehensive coverage of Microfluidics

Microfluidics

- Compressible and incompressible flows
- Laminar analysis
- Bouyancy driven flow (temperature dependent variable density)
- Newtonian and non-Newtonian
- Viscosity models such as Bingham, Carreau, power-law shear thinning
- Steady-state or transient
- Multiple species transport by Electrokinetics (EP, EO, DEP)
- Multiphase flow including pressure driven & surface tension driven flow
- Electrohydrodynamics: Electrostatic droplet manipulation
- Reaction Chemistry including Enzyme kinetics
- Fluid-Structure Interaction
- Non-inertial reference frame

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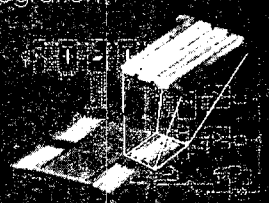
INTEGRATOR™ – Macromodel Extraction

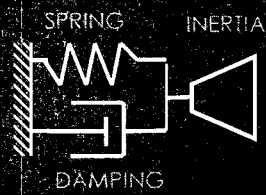
Extract Reduced-Order Models for Integration with...

- Control electronics
- Architect schematics,
  - add custom components.



Features

- New, intuitive interface includes all essential dynamics
  - SpringMM
  - DampingMM
  - InertiaMM
  - FlowMM
- New springs: Electromechanical and Double-Ended
- Extracted models are fully compatible with parametric models in ARCHITECT
- Generates Verilog-A templates too!



NOTE: INTEGRATOR was formerly known as SYSTEM BUILDER

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Important applications of CoventorWare

- ✓ Conventional pressure-driven analysis
- ✓ thermo-capillary analysis for micro-cooling system
- ✓ multi-fluids mixing analysis
- ✓ micro-pump analysis driven by PZE, electrostatic, bubble, etc
- ✓ electrokinetics such as EP, EO, and DEP
- ✓ bead analysis
- ✓ inkjet design including nozzle analysis
- ✓ chemical reactions for hybridization, enzyme-related application, etc
- ✓ coupled physics analysis including moving structure

and so on

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Take-Away Messages about **CoventorWare**™

Provides the only complete end-to-end design methodology for MEMS today

Works with best-of-breed EDA tools such as Cadence and Synopsys

Can be flexibly configured to suit customer preferences – go with the entire end-to-end flow or choose from behavioral system modeling or FEA modules

ARCHITECT™ / DESIGNER™ can serve as a front end to other popular field solver suites from Ansys, Ansoft, Agilent, Fluent and Flow3D

Product is industrial strength

- Battle tested with 150+ commercial customers
- Used in 400+ universities as a research and teaching tool
- Used by Coventor in dozens of successful professional services programs

The best-in-class solution

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