Customer-Oriented Product Engineering of Micro and Nano Devices

CORONA: Innovative Product Engineering Tools for MEMS

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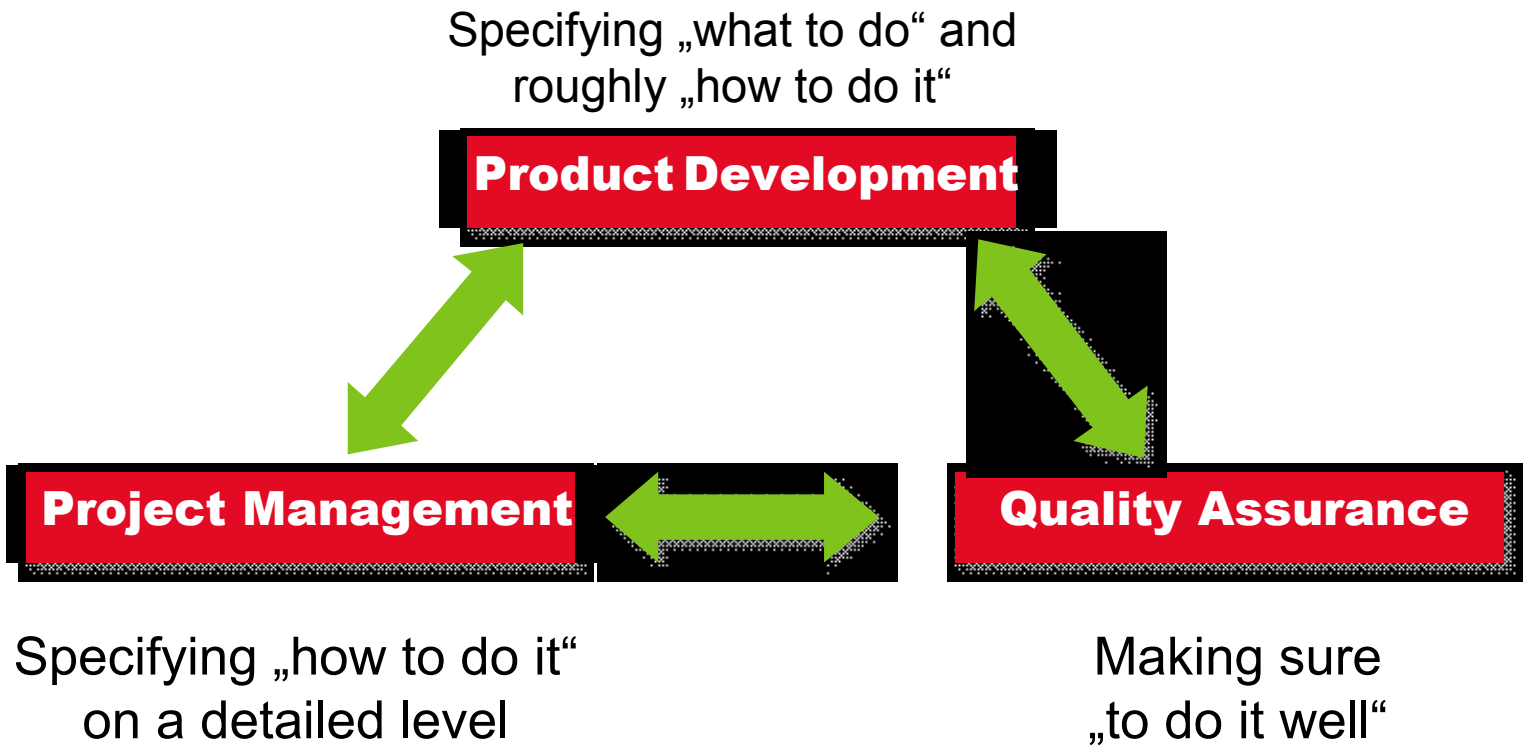
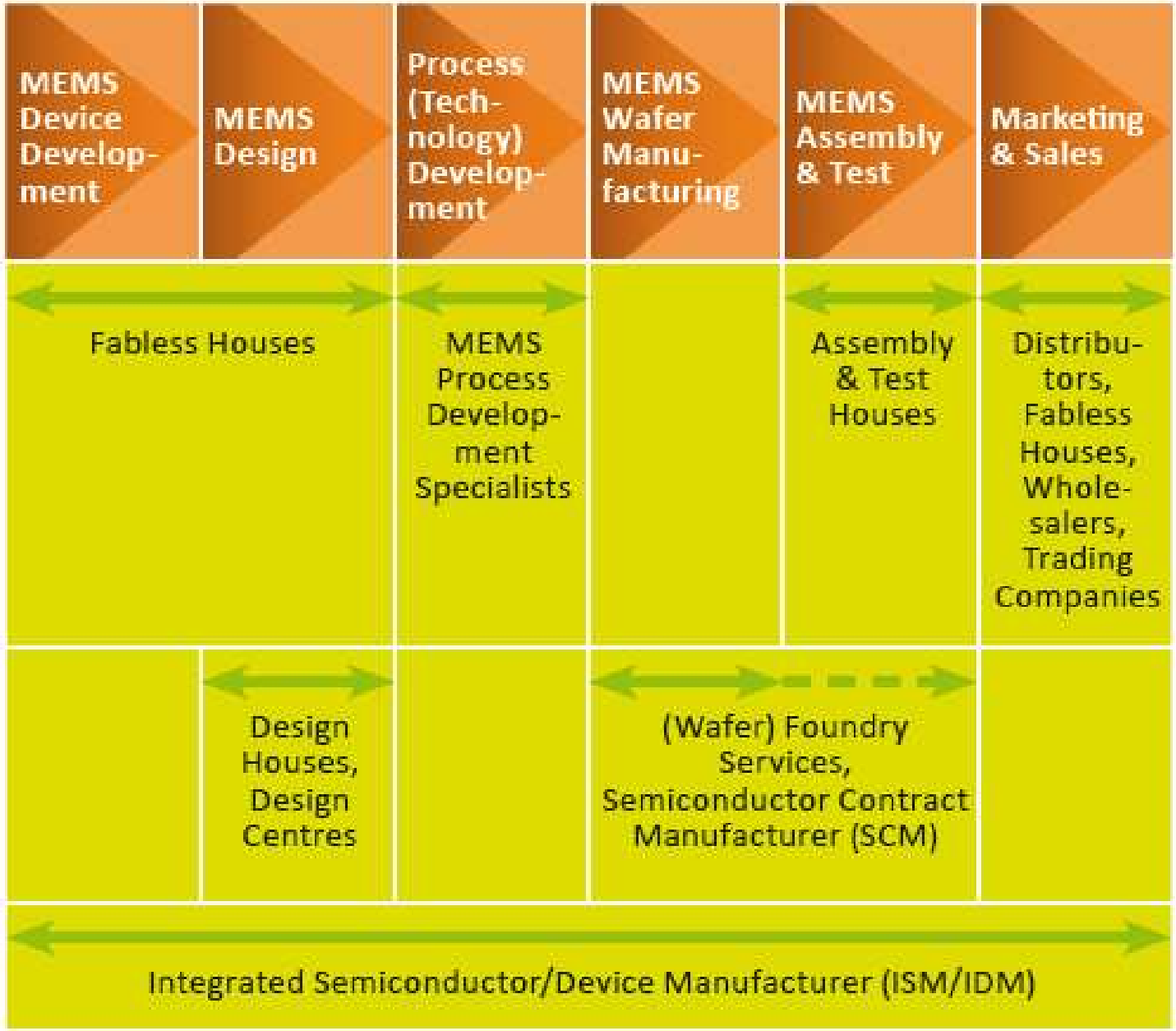
April 21, 2010, Forum Innovations for Industry

Product Engineering …

- **… is the process of gradually turning the idea of a technical device into a physical realisation.**
- **… includes both the design and the fabrication stages.**



Value chain in MNT



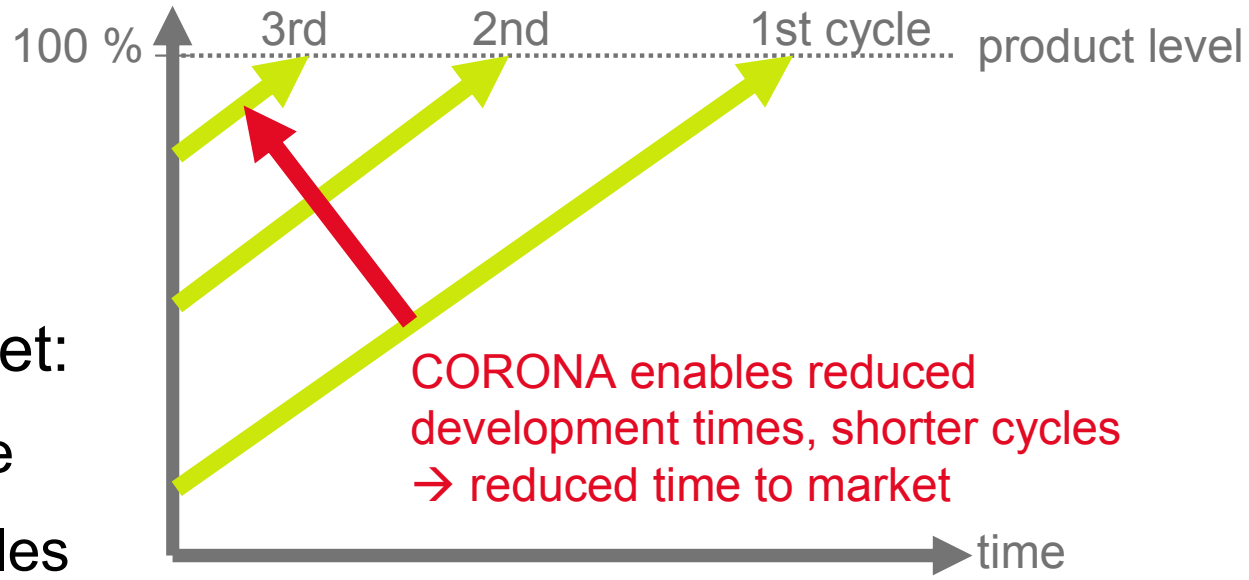
Challenges in MNT PE

- **A large variety of business models**
  - From large IDMs to specialised companies
- **Distributed development and manufacturing**
  - Different companies (or departments) at different locations
- **SME focus**
  - Frequently SMEs involved with small development budget
- **Customer orientation**
  - Only the customer knows product and constraints

- **But…**
  - There is currently no appropriate product engineering methodology and tools available to support these aspects.

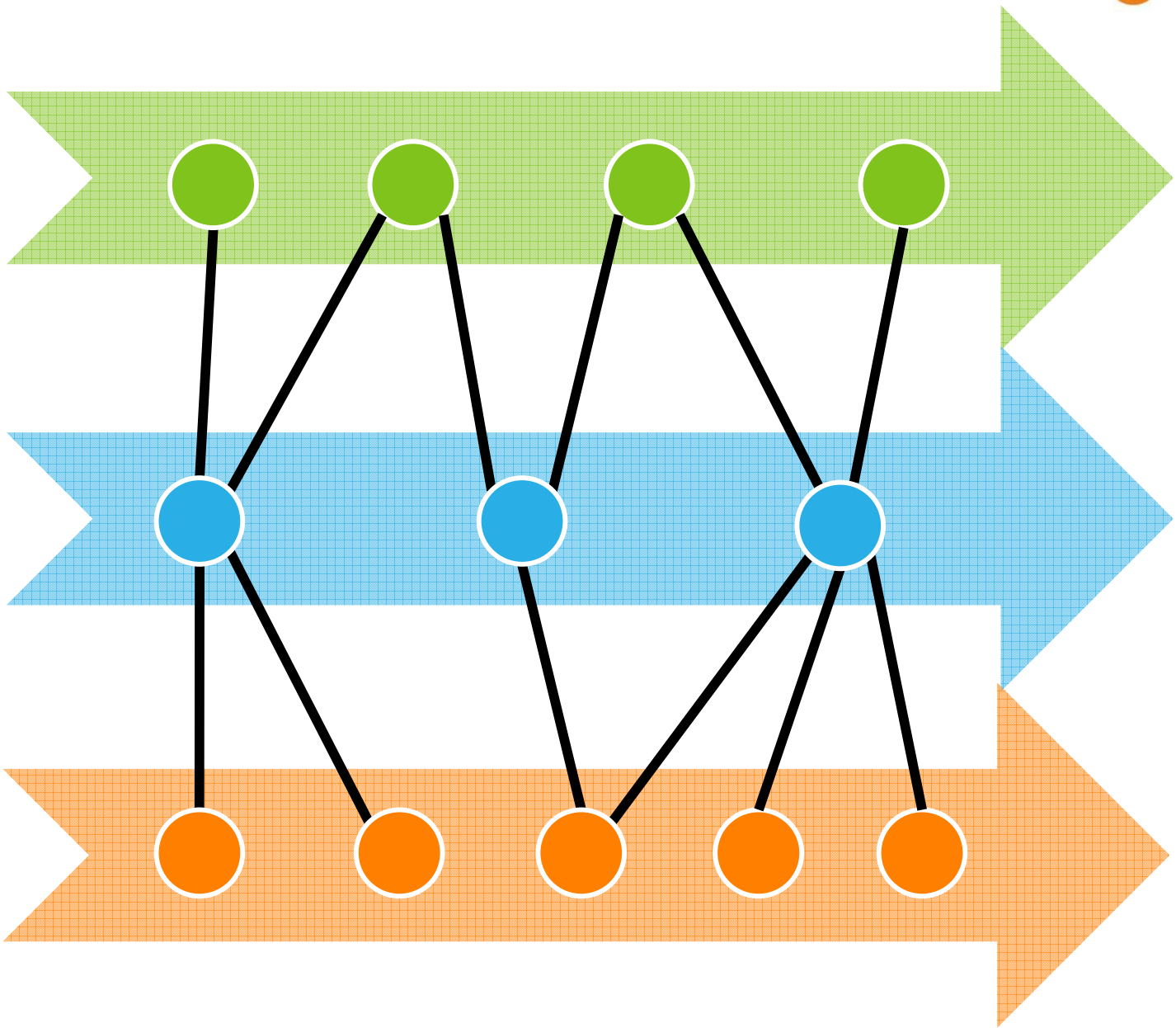
Benefits from MNT PE

- **What can be expected from MNT product engineering?**



  - Shorter time-to-market:
    - Reduced cycle time
    - Fewer learning cycles
  - Access to knowledge-bases on design and fabrication
    - ICT based structure and tools
    - Improved transfer of knowledge from design to production
  - Customer-lead multi-site product development

Workflow in CORONA

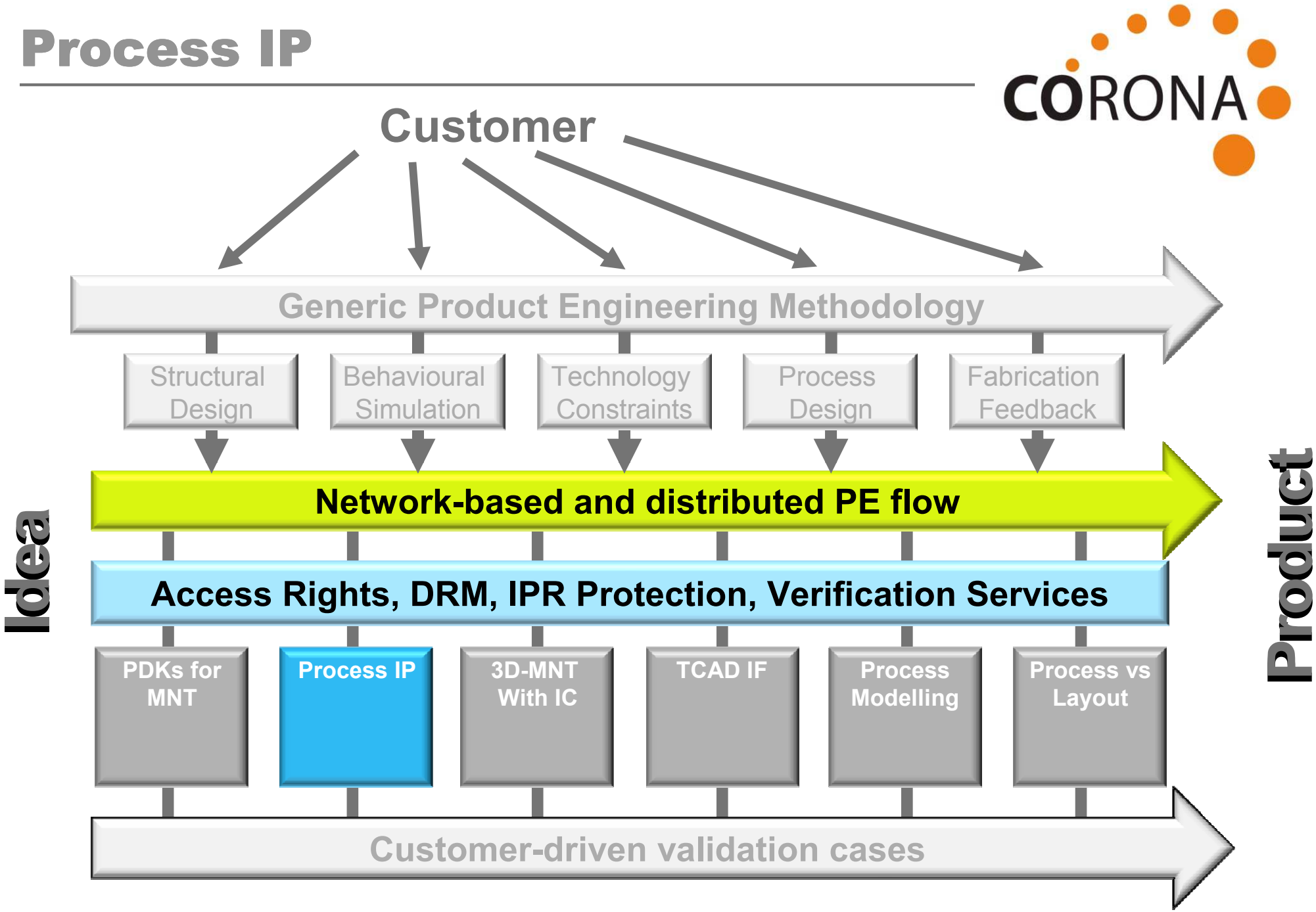


Methodology
Workflow Definition

Middle Ware & Tools
Workflow/Designflow Integration

Validation
by real-life business cases

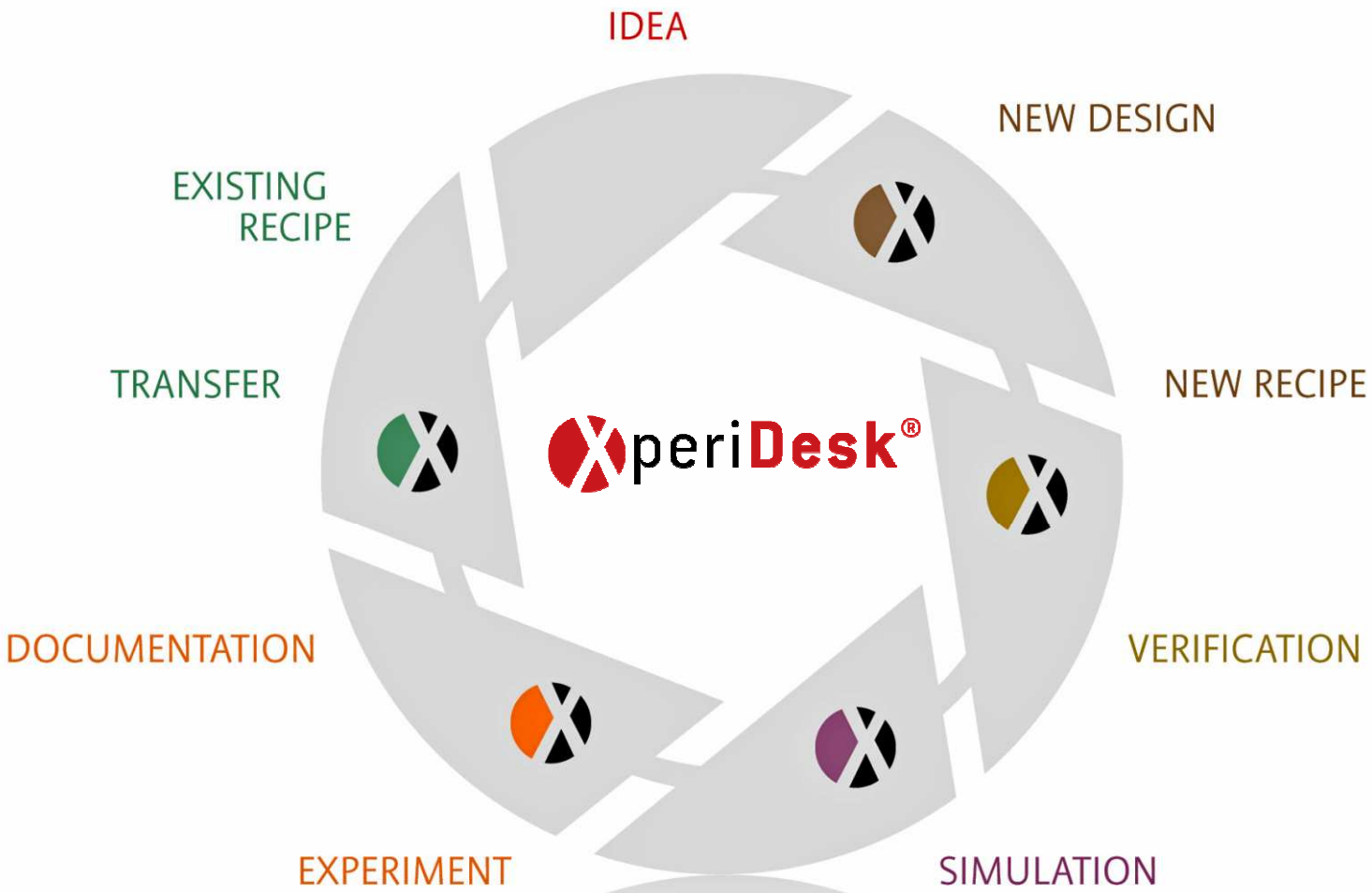
Process IP


Customer
Generic Product Engineering Methodology
Structural Design
Behavioural Simulation
Technology Constraints
Process Design
Fabrication Feedback
Network-based and distributed PE flow
Access Rights, DRM, IPR Protection, Verification Services
PDKs for MNT
Process IP
3D-MNT With IC
TCAD IF
Process Modelling
Process vs Layout
Customer-driven validation cases
Idea
Product

Process development cycle

XperiDesk®

CORONA



Management of Entity Rights

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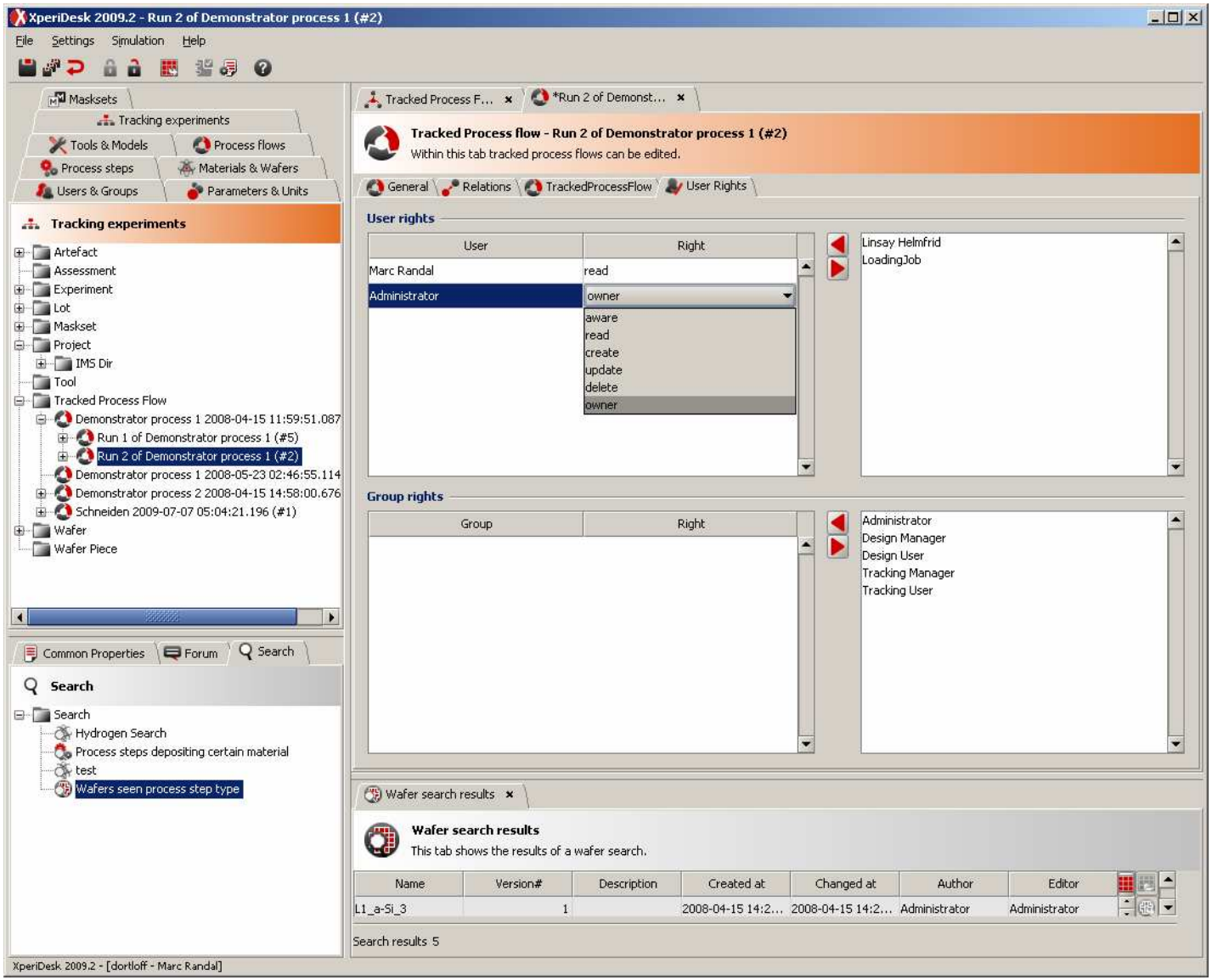


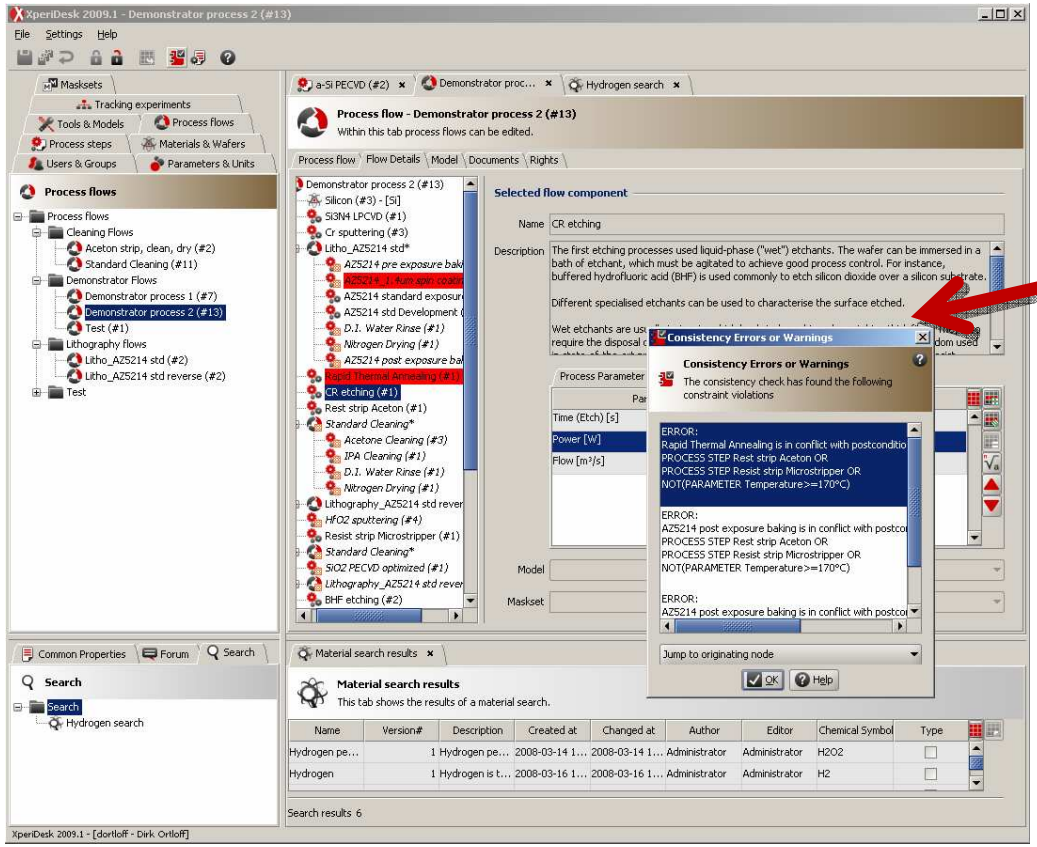
Process Tools

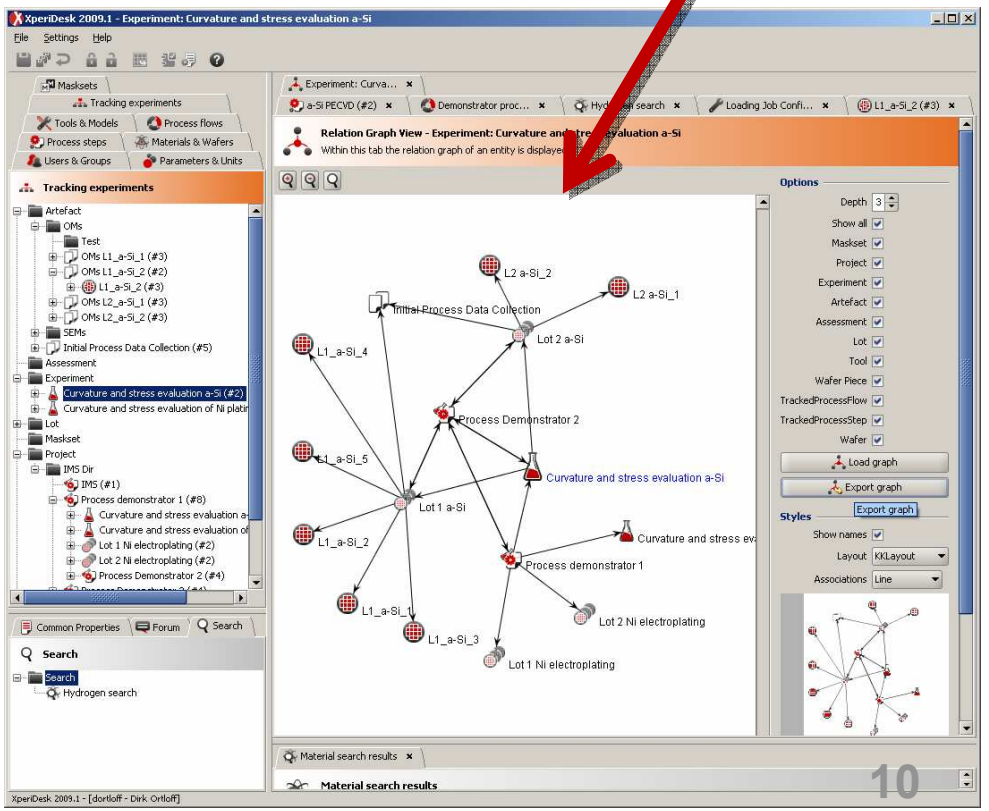
- **A framework for process design verification and tracking**

XperiDesk®

Process Flow Editor

Process Tracking





Ways to build PKDKs

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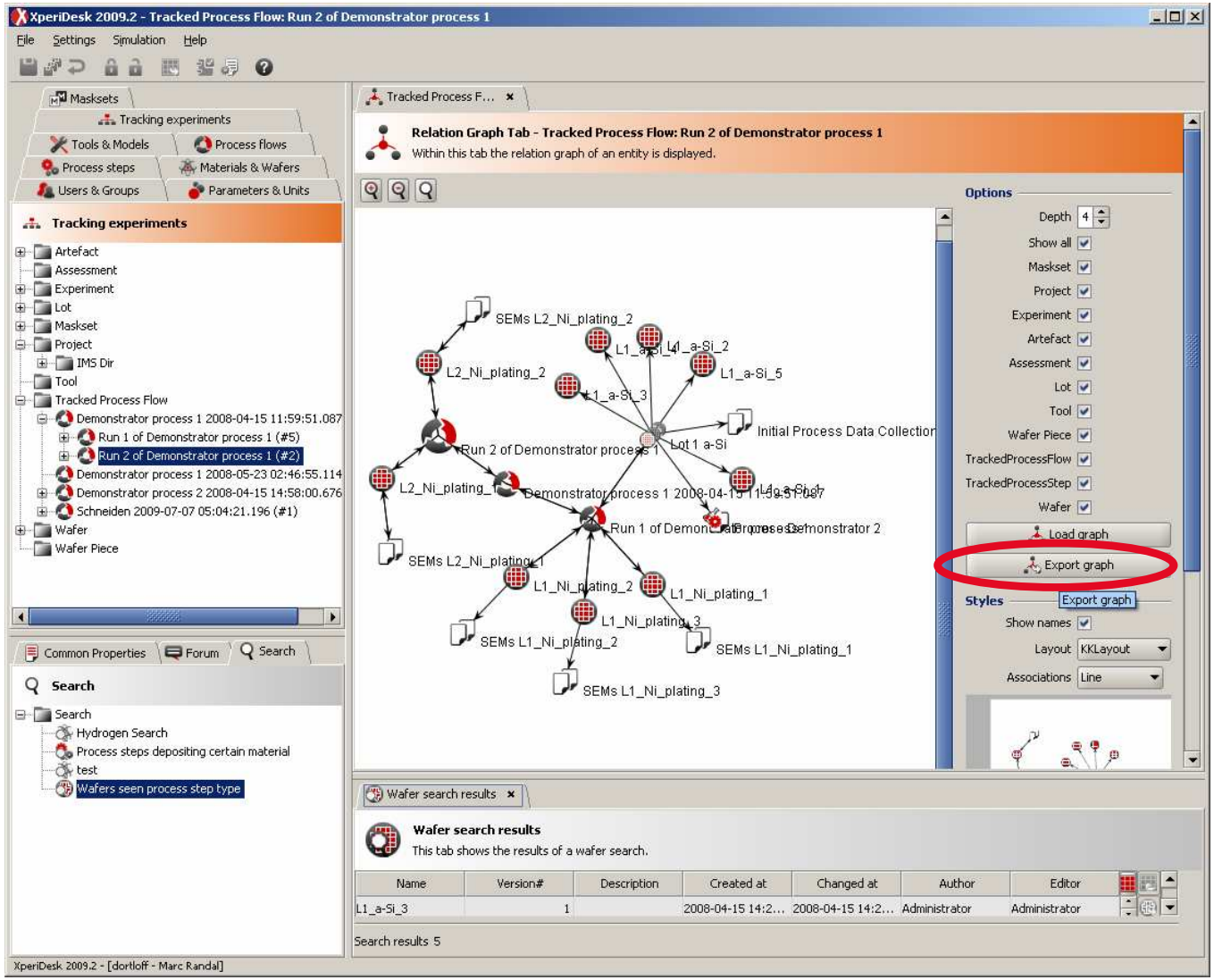
- **Export experiment data from graphic view**



Ways to build PKDKs

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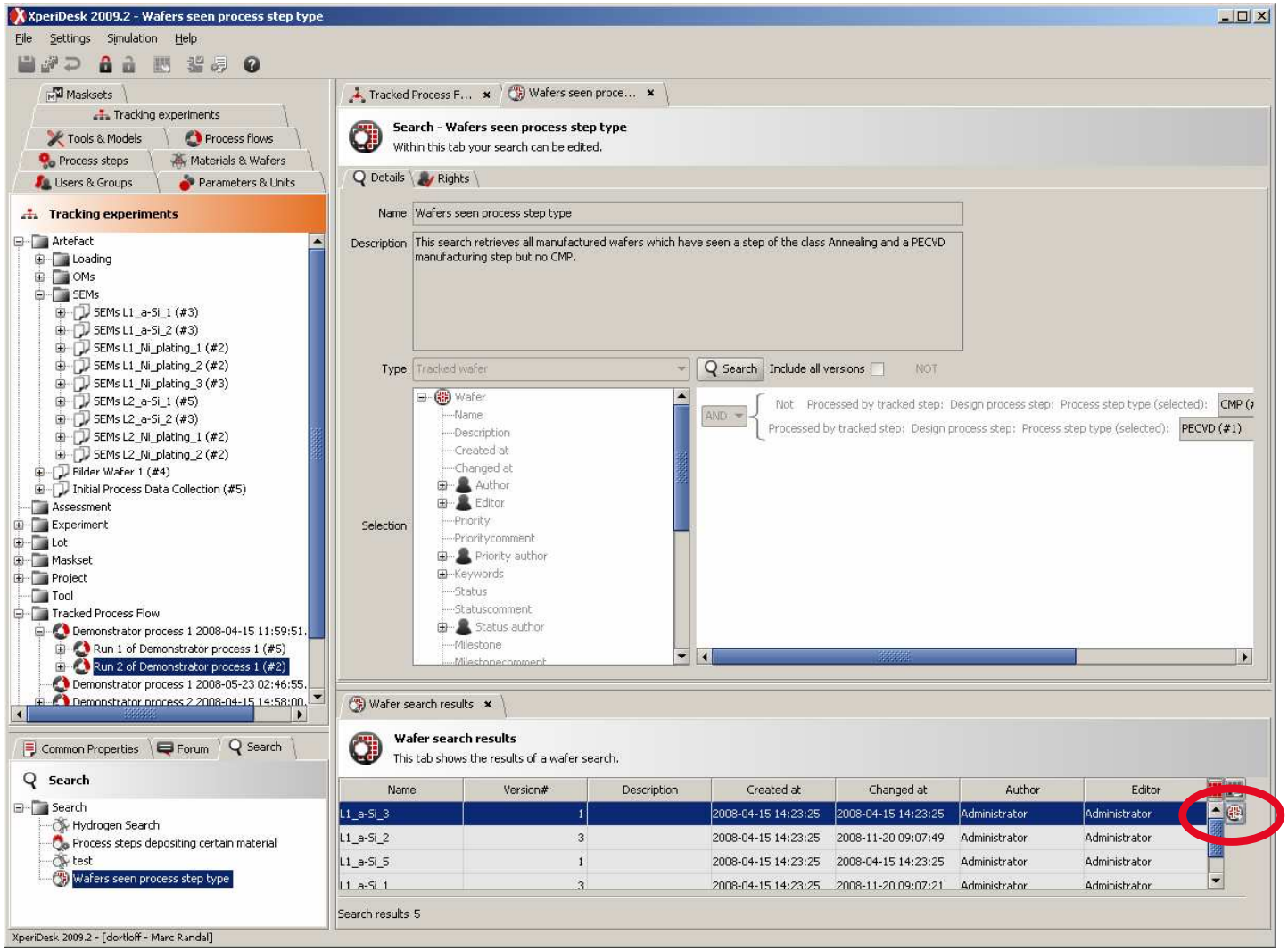
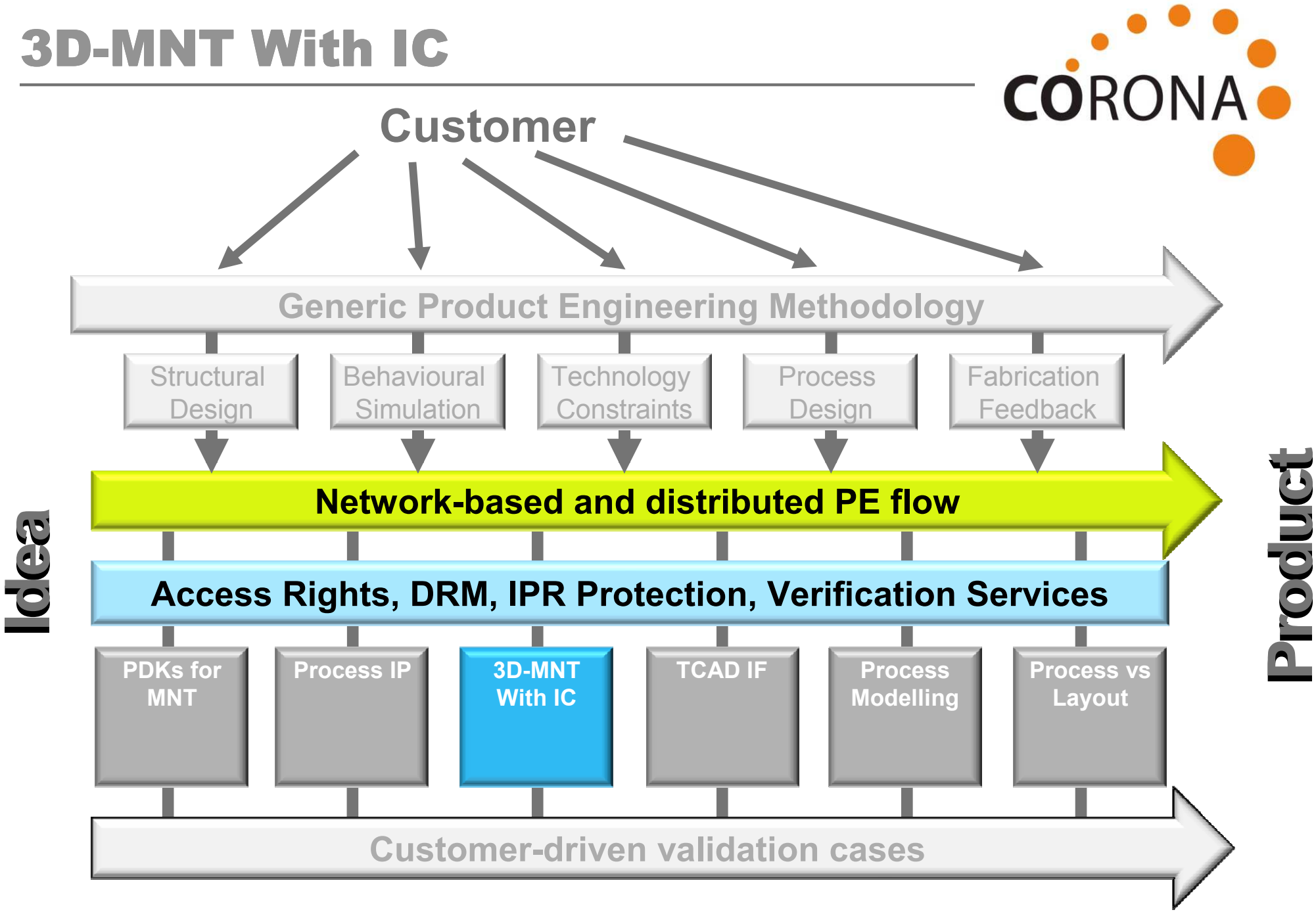
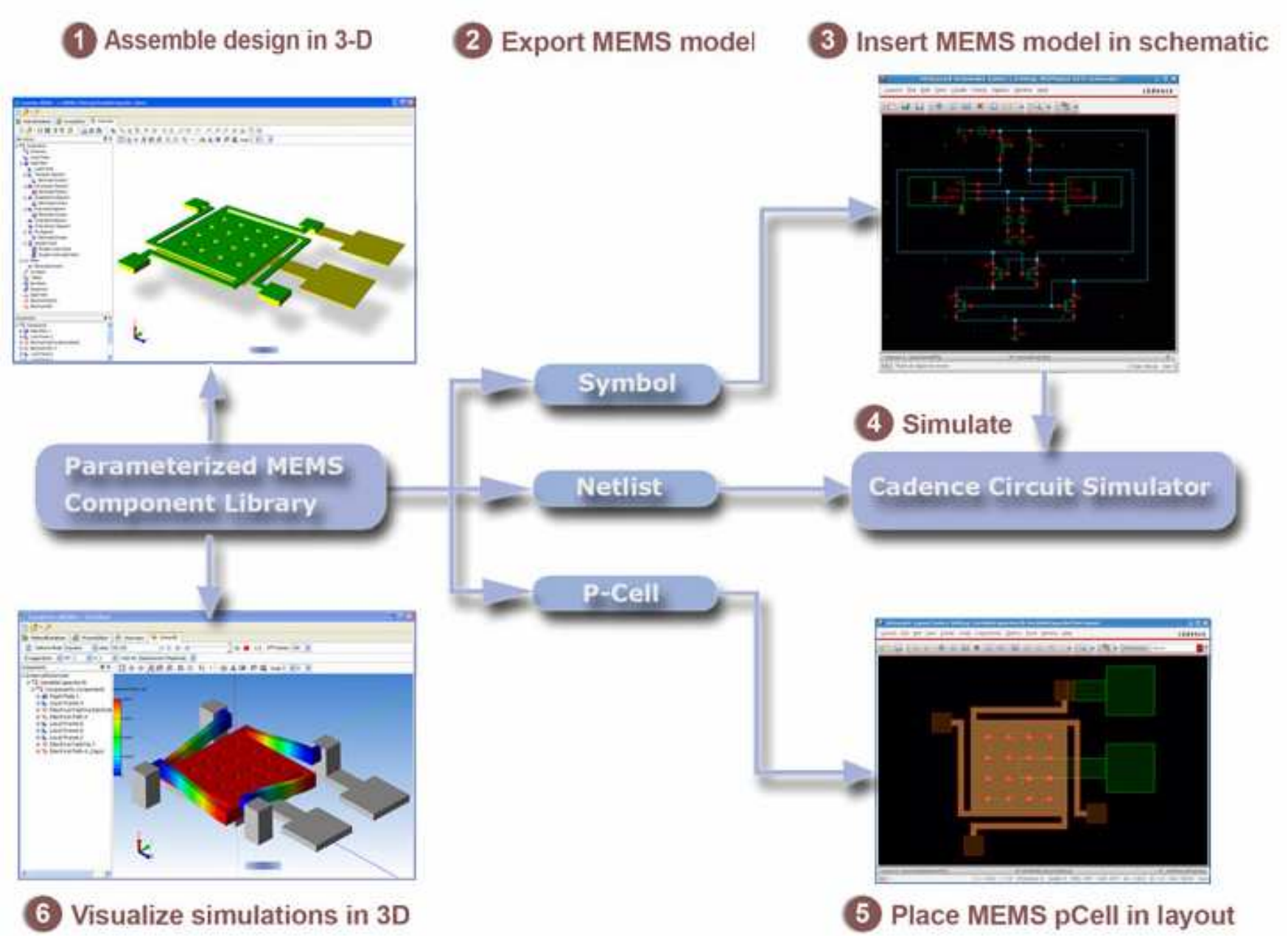
- **Export search results**



3D-MNT With IC

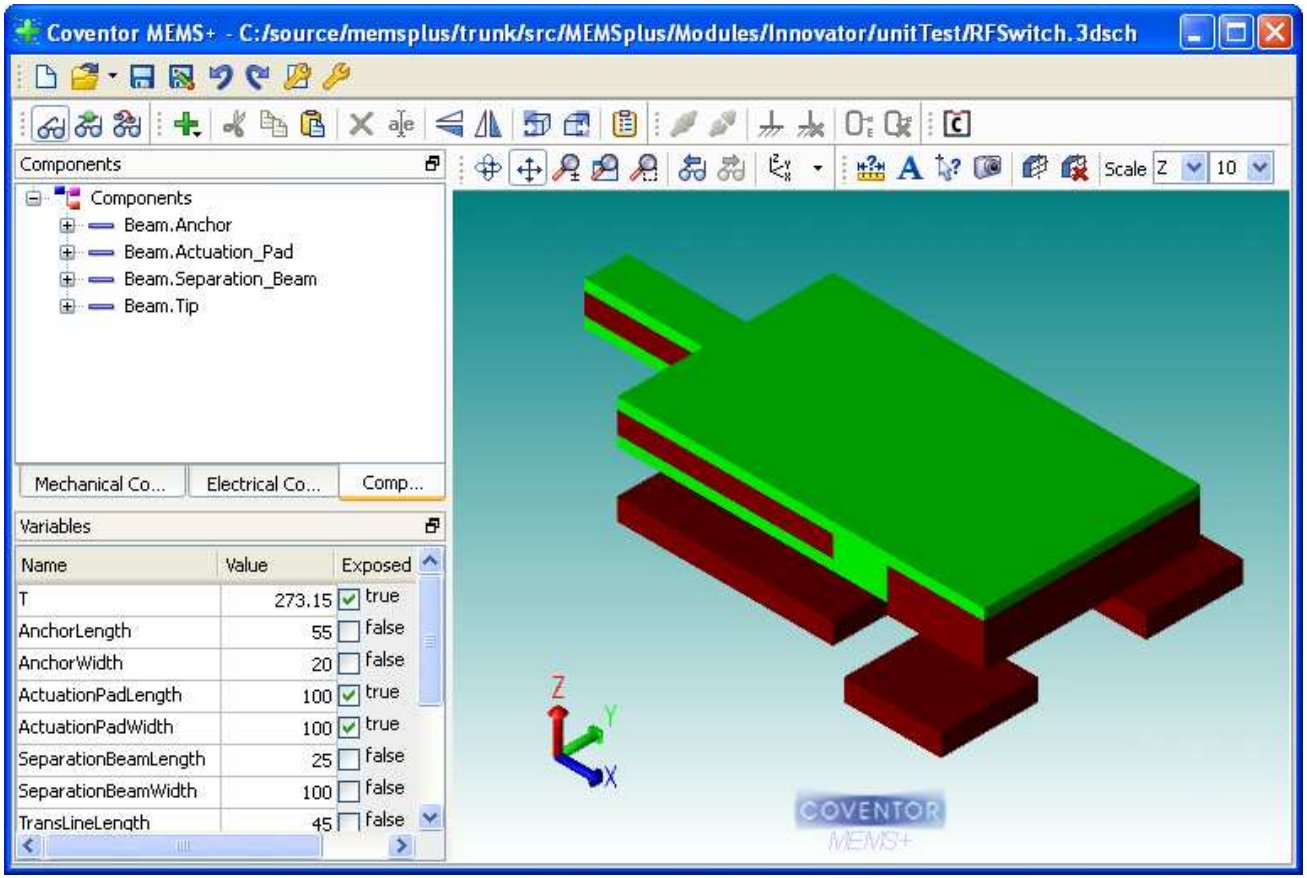


Design of 3D MEMS with IC

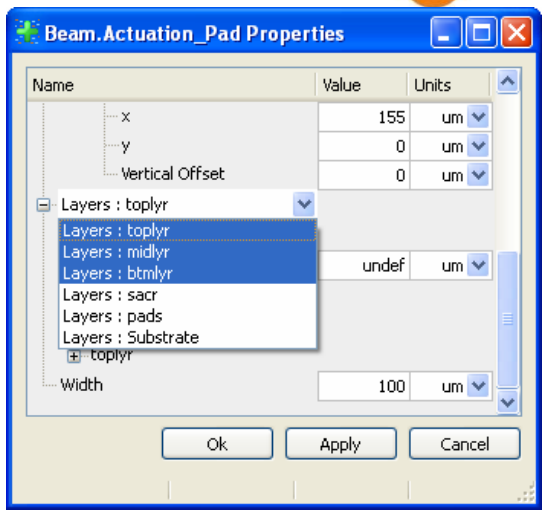


3D Schematic Editor for MEMS

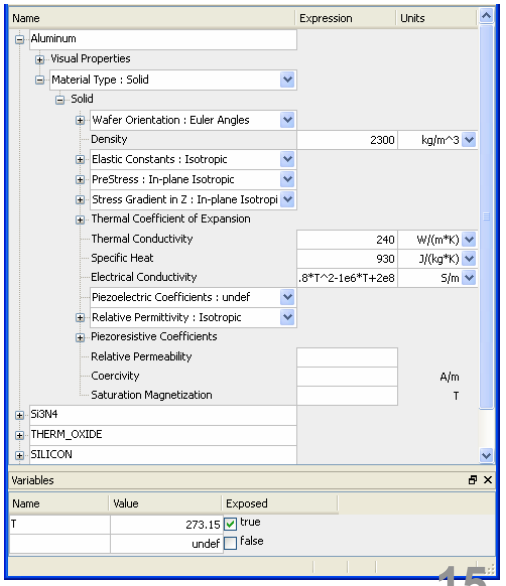
- **MEMS Design in 3D**
  - Intuitive 3D environment for device creation
  - Based on validated MEMS component library
  - Parameterization of material, process and design



3-D view of RF switch in new 3D schematic Editor GUI (Graphical User Interface)



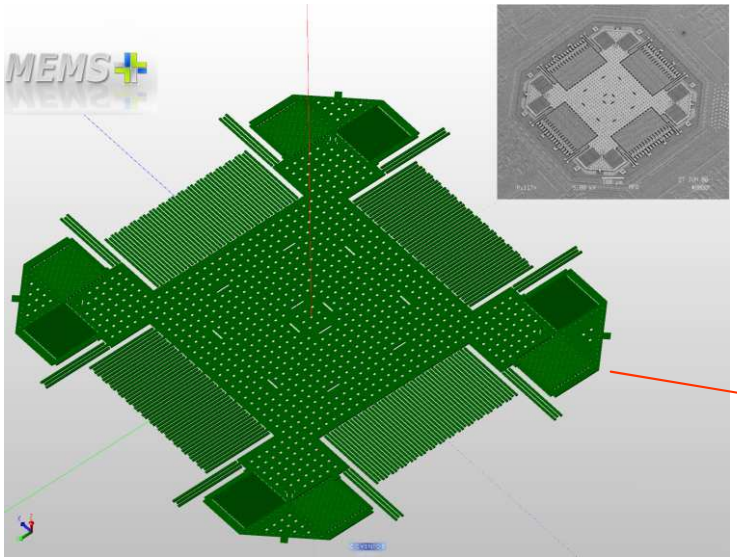
Layer Browser in a Property Window of a Straight Beam Component

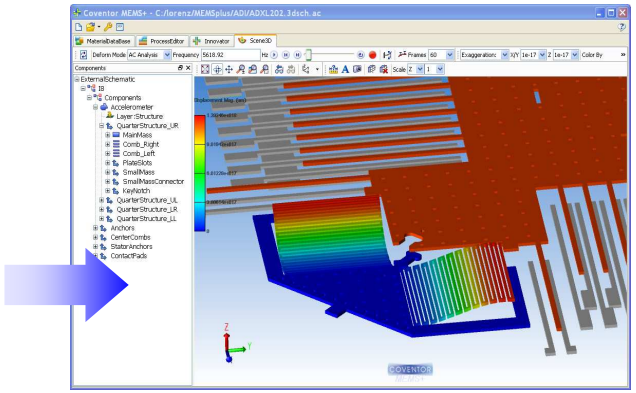


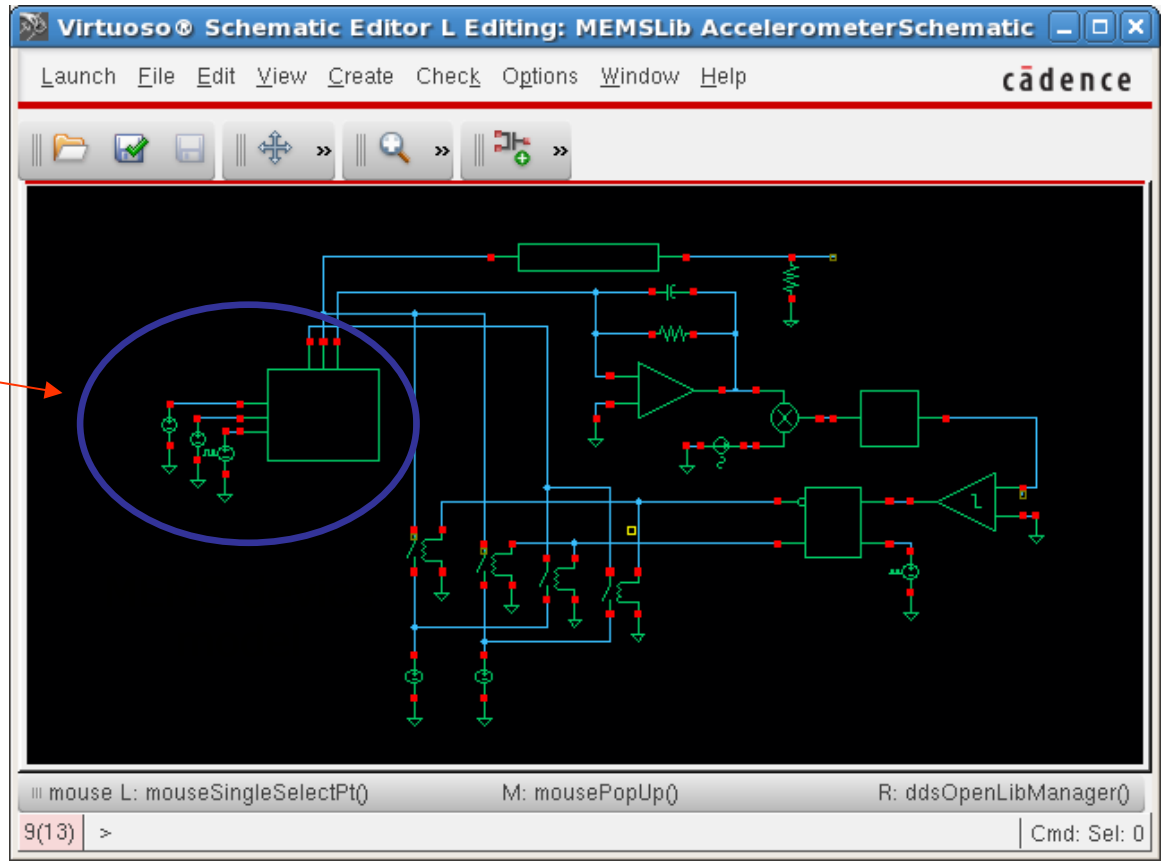
Material Property Editor

Integration with MEMS and EDA

- **Seamless Connection to IC Design**
  - The MEMS designer transfers the model to the IC-designer
  - The IC designer does electronic system design







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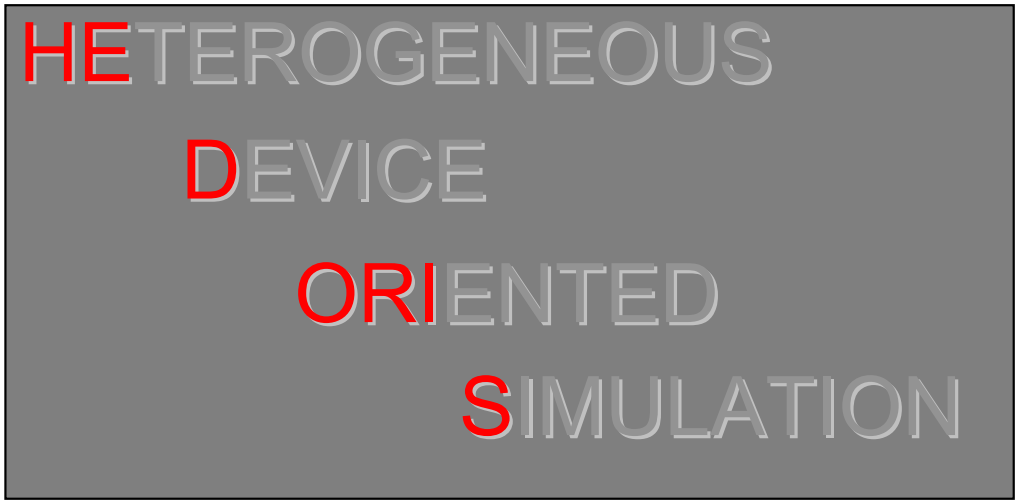

- **HDL-based**
- **3D multimodule structures**
- **Fast and easy thermal model implementation**
- **Thermal device simulation**
- **Verification of temperature distribution**

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1. PHYSICAL DESCRIPTION OF THE DEVICE STRUCTURE

2. MATLAB LIBRARY
(ITE developed)

Verilog-AMS BASED
THERMAL MODEL ELEMENTS

3. DYNAMIC GENERATION

THE Verilog-AMS THERMAL MODEL OF THE DEVICE

MODULES
INTERCONNECTS
APPLICATION
ANALYSIS INTERFACE

4. TEMPLATE LIBRARY
(ITE developed)

CADENCE

INTERFACING TOOLS & ALGORITHMS
(ITE developed)

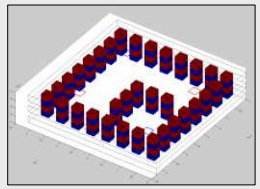
5. IMPORT TO CADENCE

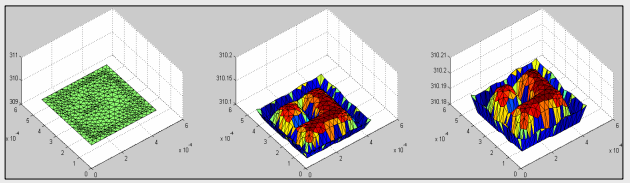
6. CADENCE THERMAL SIMULATION

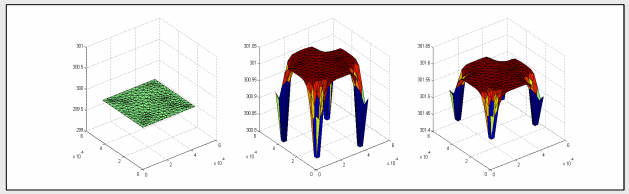
Steady-State and Transient

7. THE SIMULATION OUTPUT DATA ANALYSES
(ITE developed)

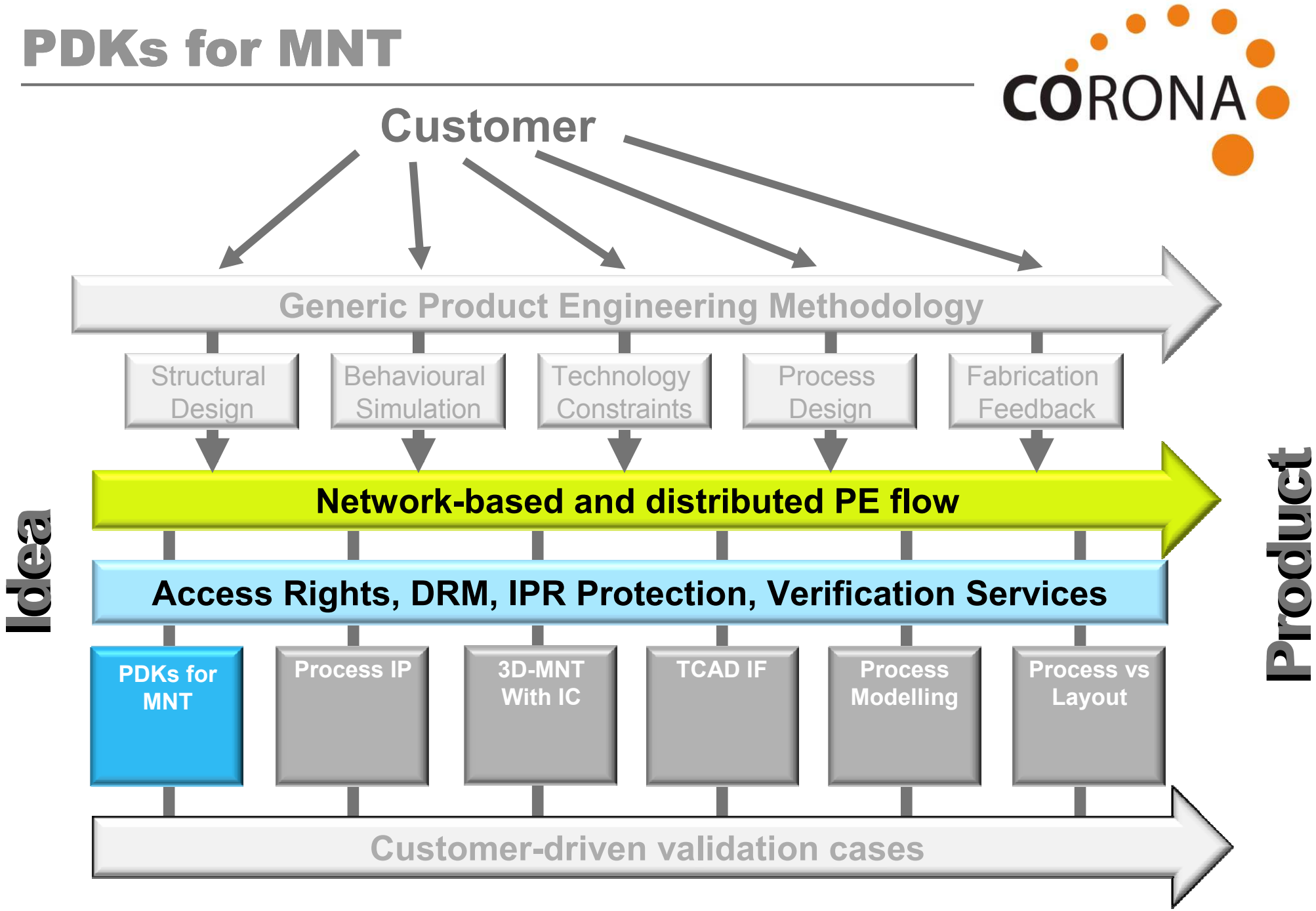
- TEMPERATURE
  - IN SELECTED POINTS
  - IN SPOTS
  - THE TEMPERATURE DISTRIBUTION
- FEEDBACK TO THE DESIGNERS







PDKs for MNT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Process vs Layout
Customer-driven validation cases
Idea
Product

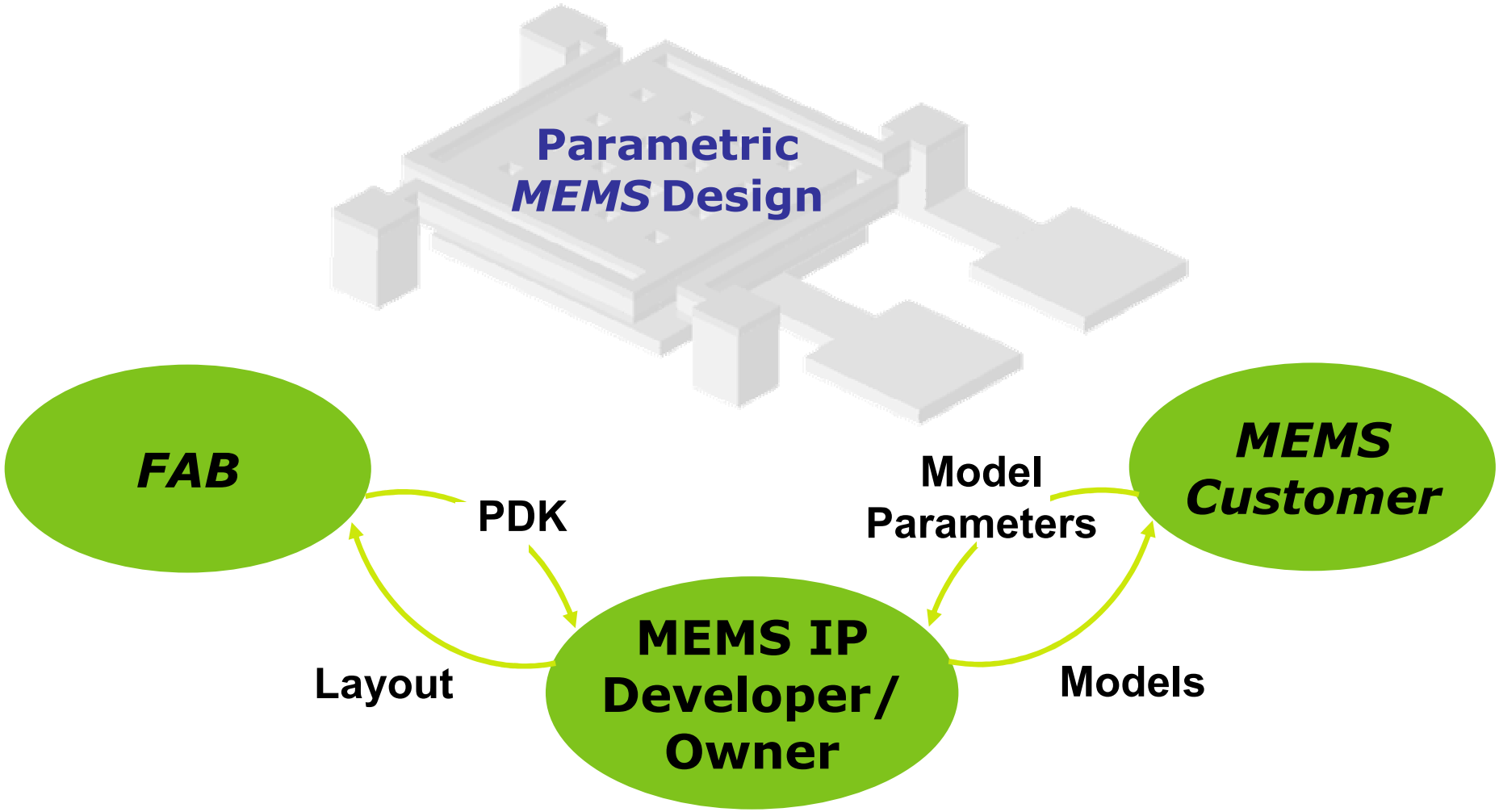
Design Kit Motivation

Designer

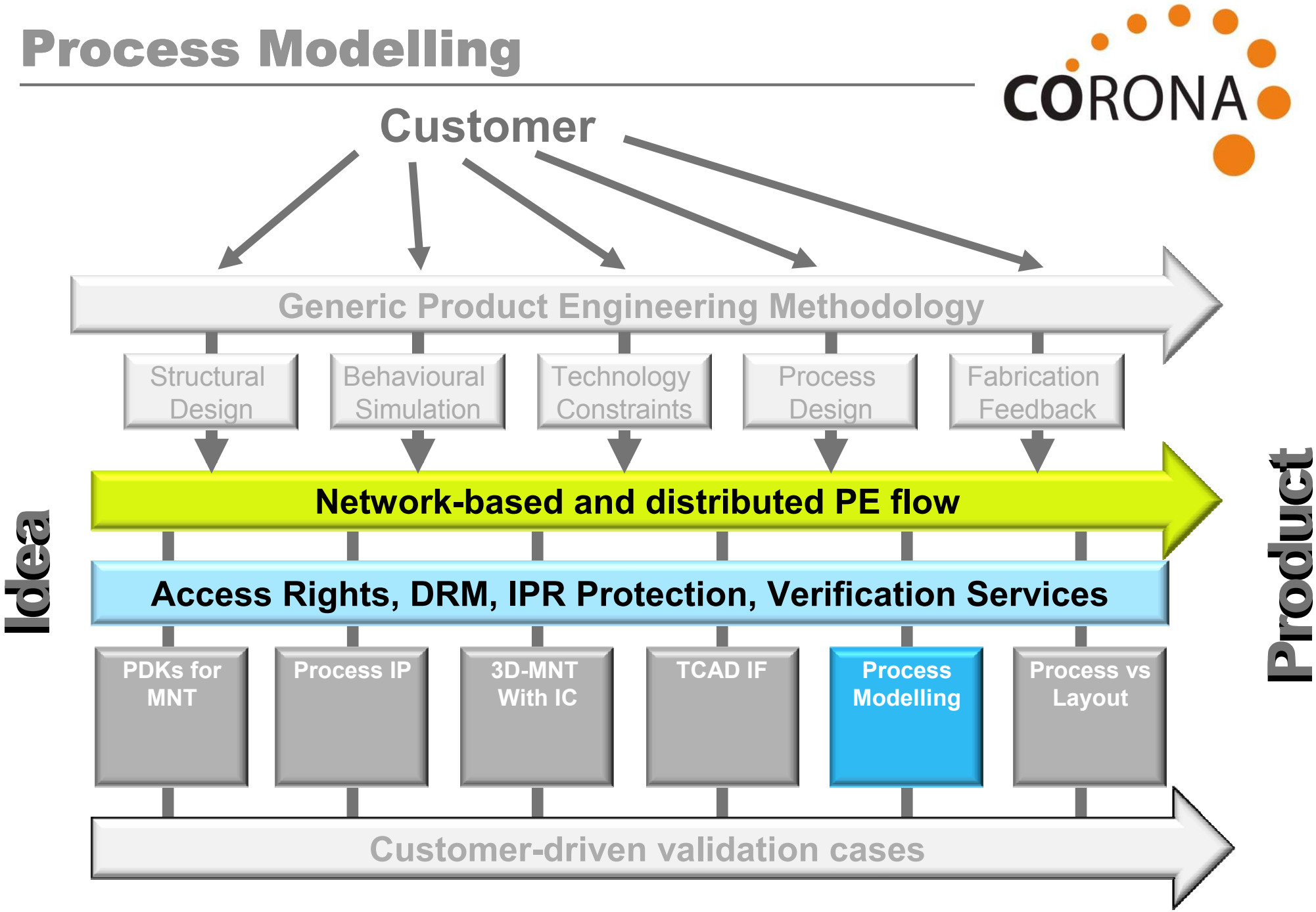
… use tools to build a bridge

Enable MEMS Eco-System

- Facilitate communication between the distributed partners of the MEMS eco-system



Process Modelling



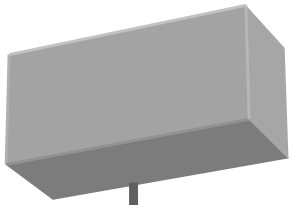
Virtual Fabrication

Actual Fab

Virtual Fab software

Blank wafer

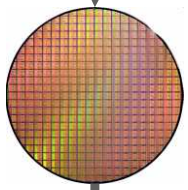
2-D layout



Rectangular area of interest

Move wafer thru line, following recipe *(partial or full sequence)*

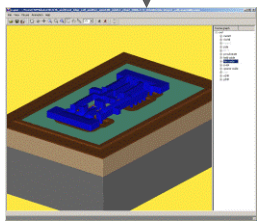
Mimic equipment to build 3-D model *(partial or full sequence)*



Processed wafer

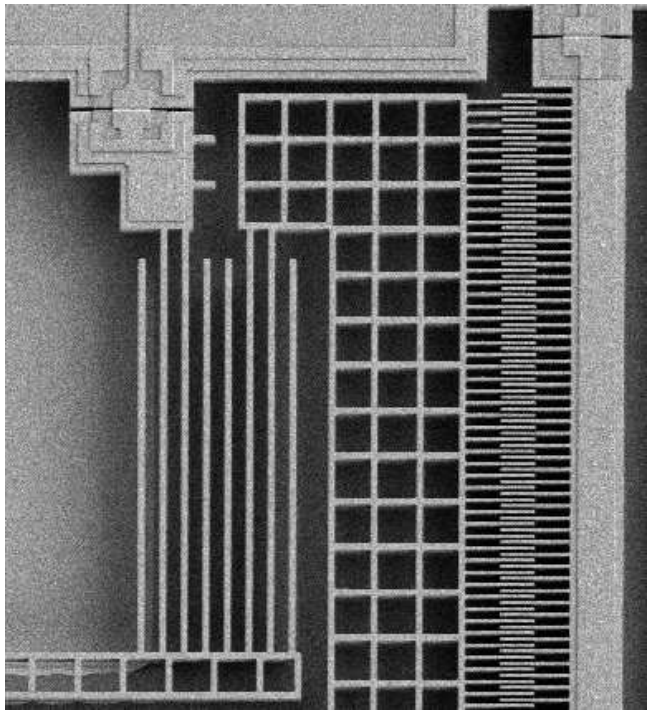
3-D model

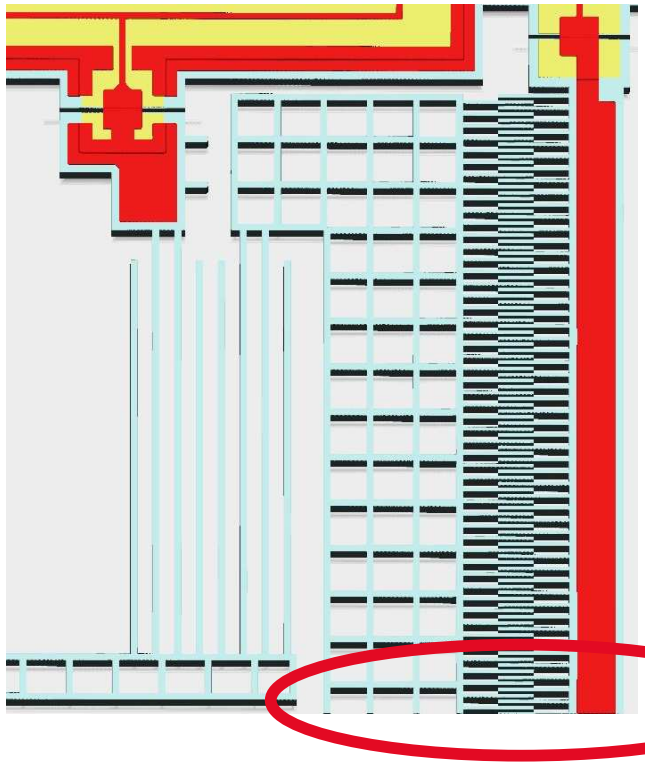
Sample, image, measure

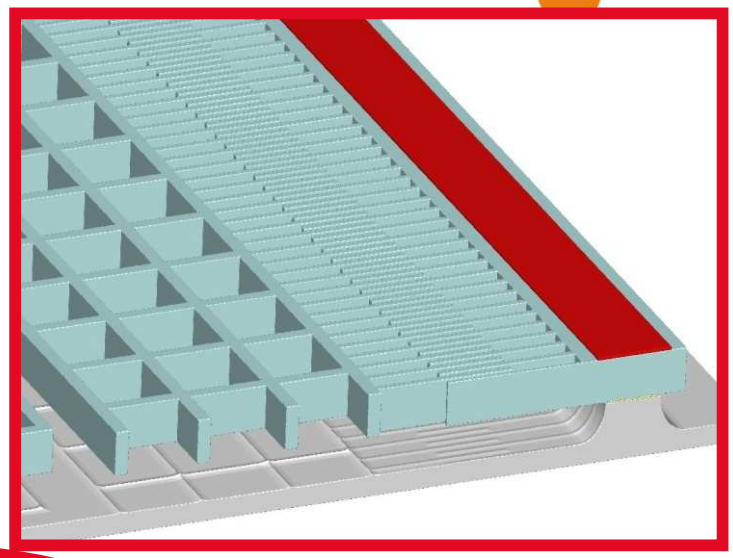


Visualize, image, measure

Use case example: X-FAB SOI







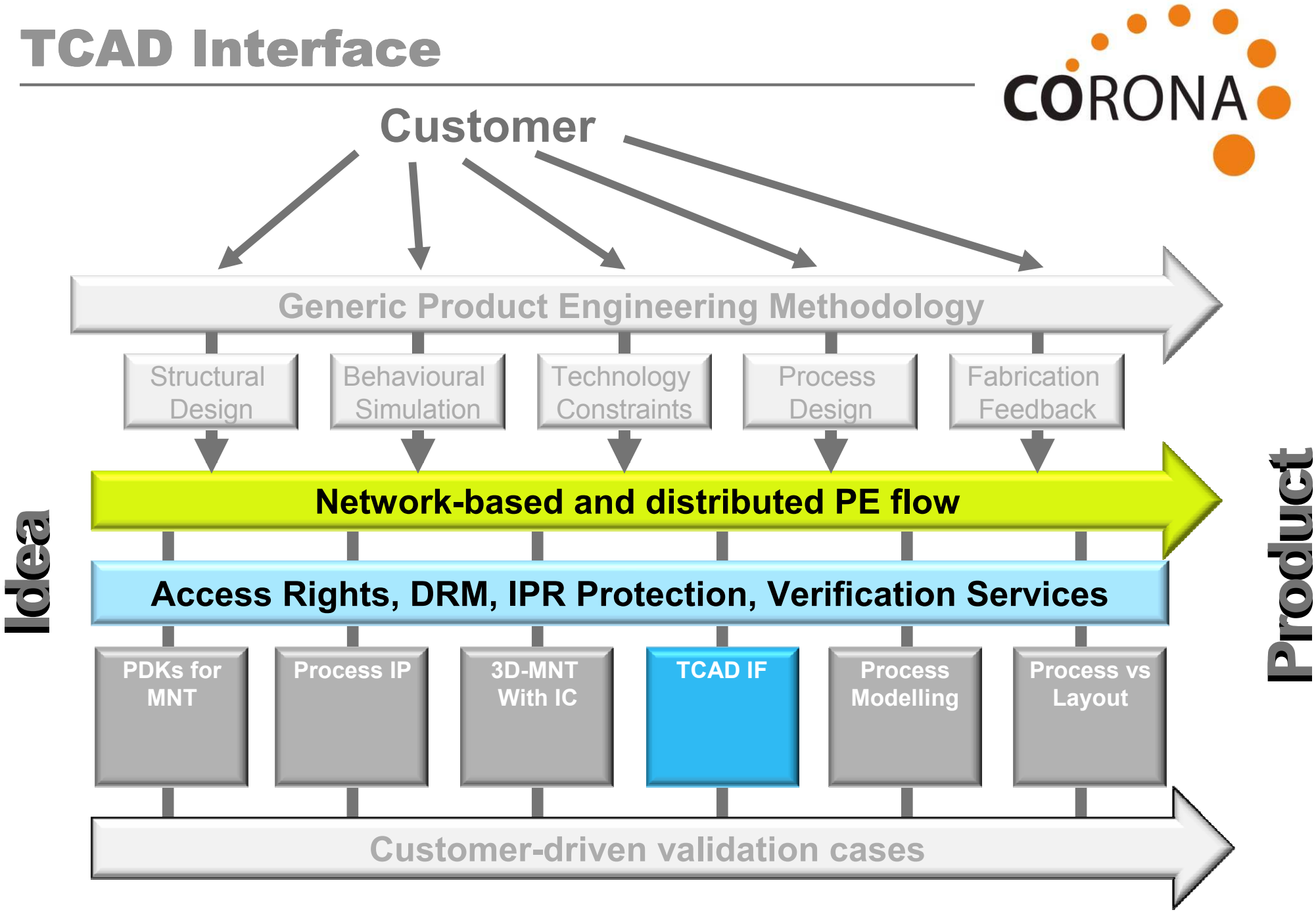
SEM image

images created with SEMulator3D

X-FAB uses virtual fab runs for…

- Customer support, marketing of MEMS foundry technologies
- Checking new designs prior to actual fabrication
- Process development
- Failure analysis

TCAD Interface



XperiSim – verification by simulation

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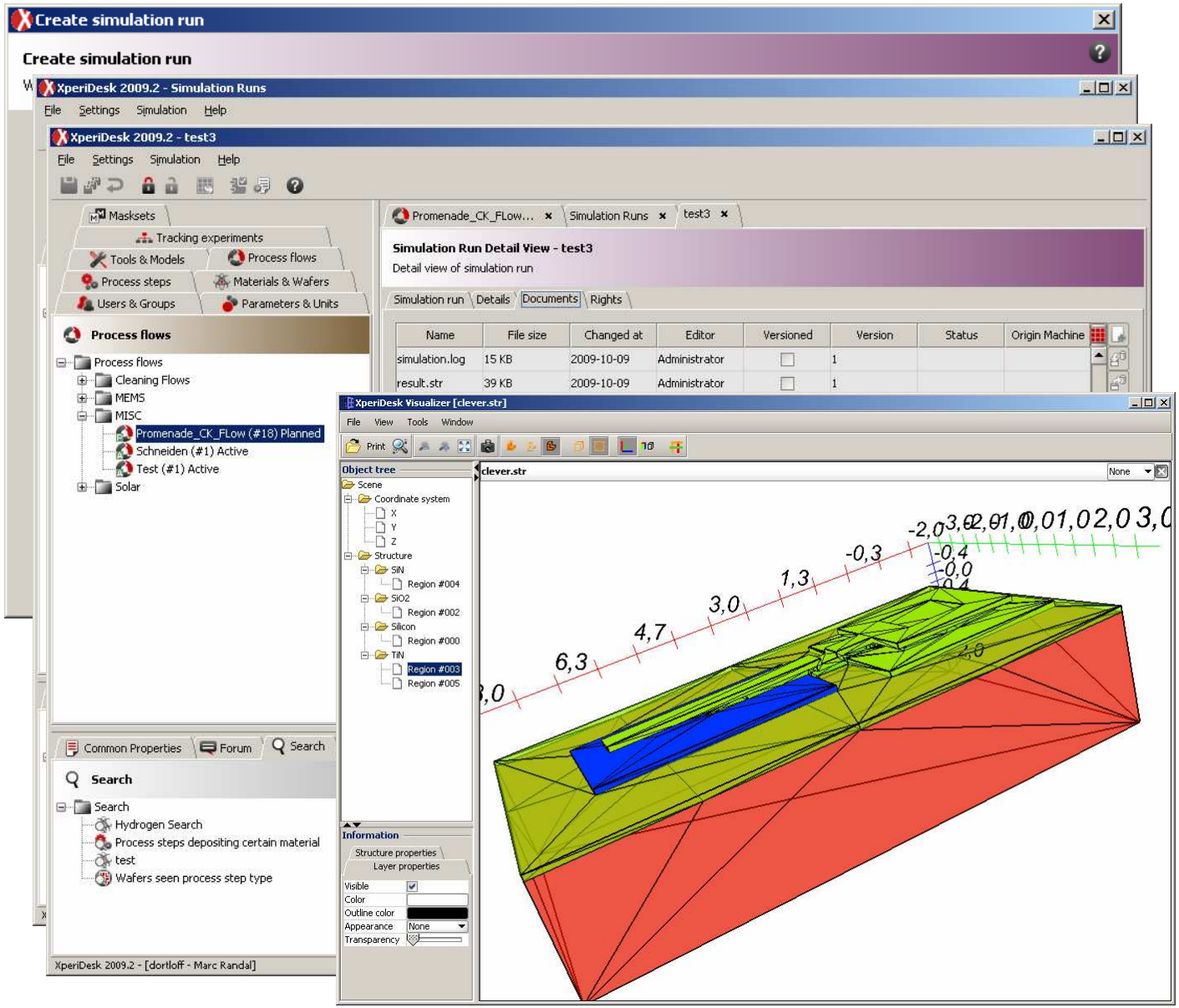
- **Starting a simulation**
- **Checking previous runs**
- **Previous run details**



SEMulator3D and XperiDesk
Bi-Directional Integration

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XperiDesk
Central Database

Process Data

3D Model

Server

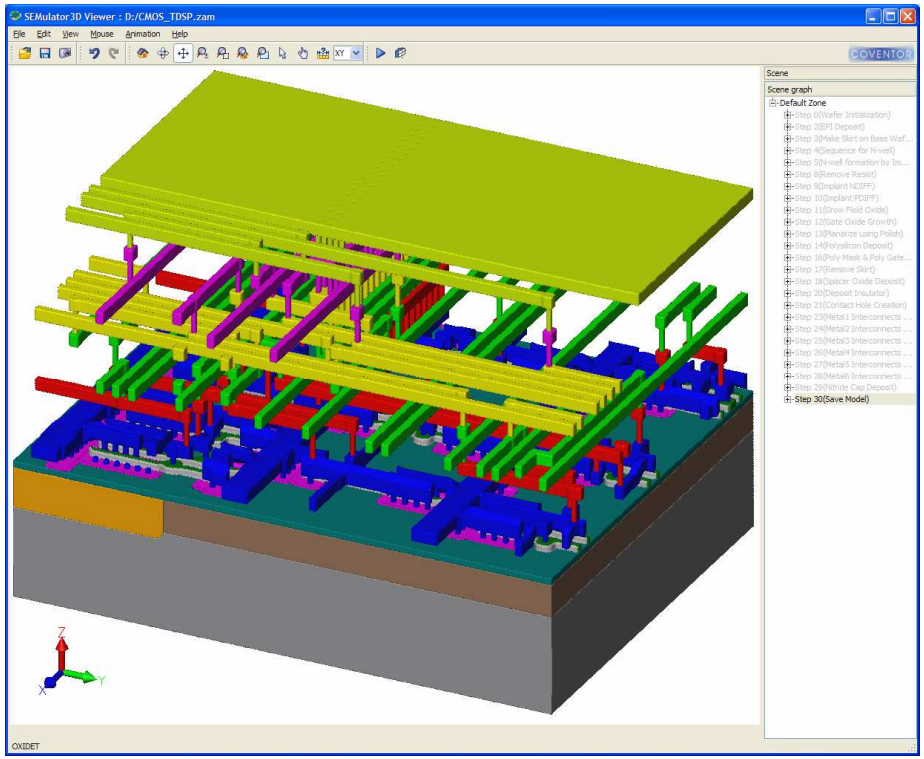
Builds SEMulator3D Model

3D Model

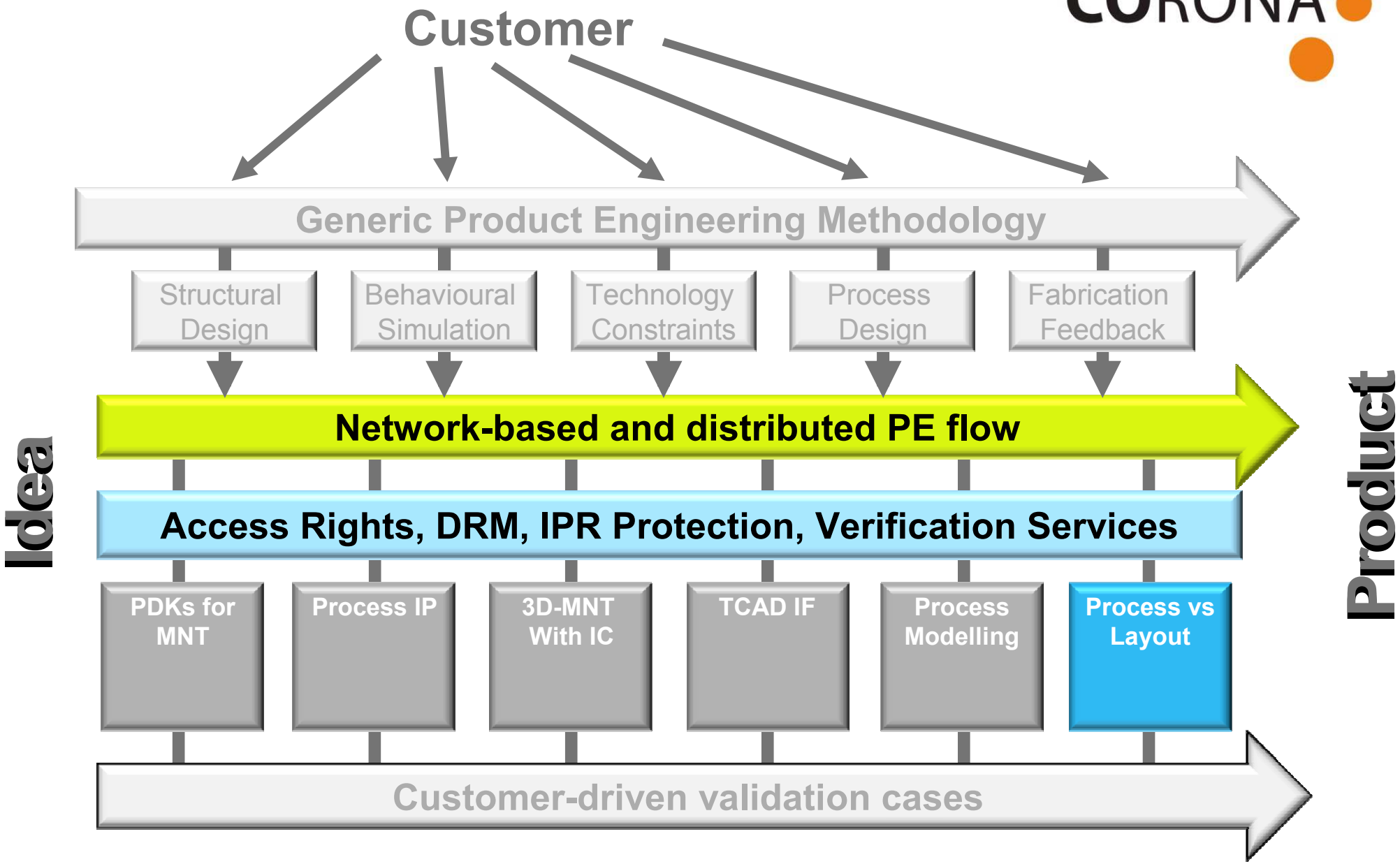
User's Computer

View Process in 3D

Generate pictures, PPT, PDF



Process vs. Layout



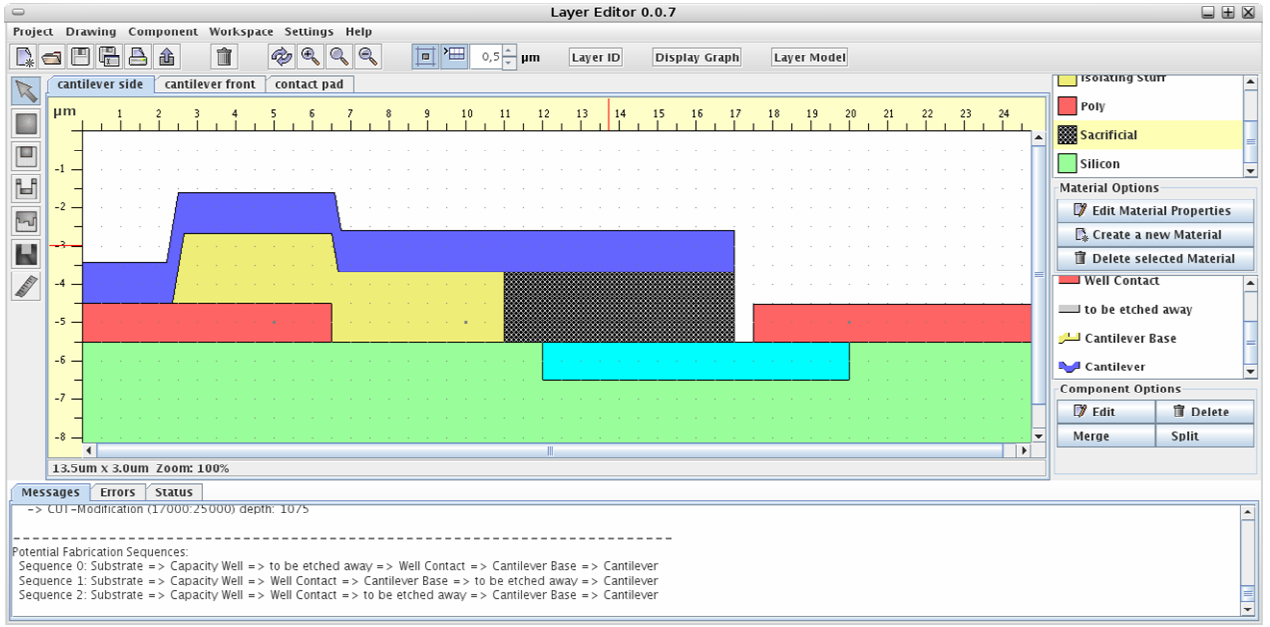
Cross Section Editor Prototype

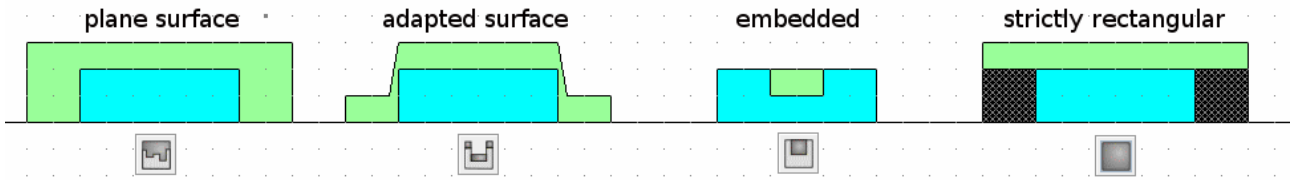
Cross-Section

- Common Method for illustrating process capabilities

Cross-Section Editor

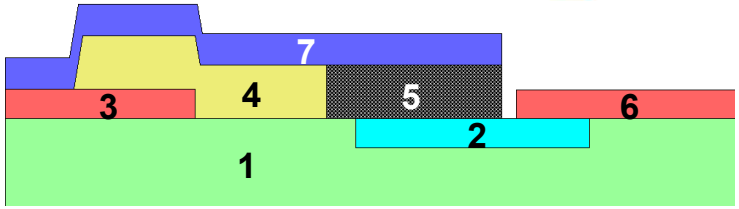
- Drawing support for typical cross-section geometries
- Prevents drawing of non-manufacturable geometries

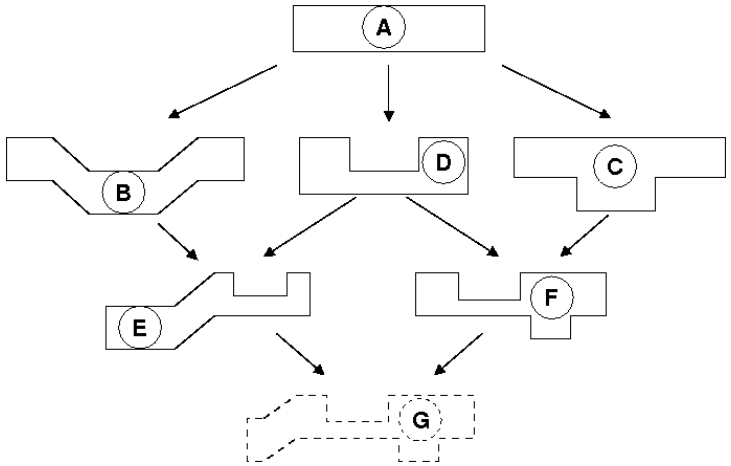


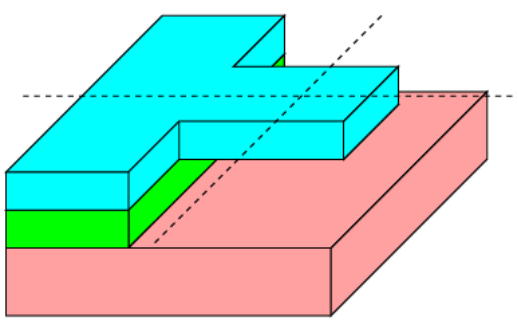


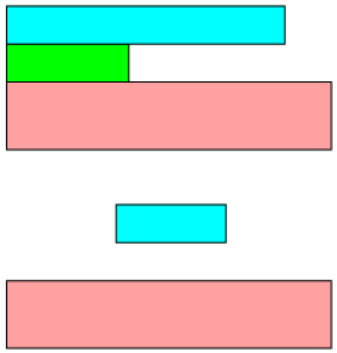
Physical Layer Analyzer

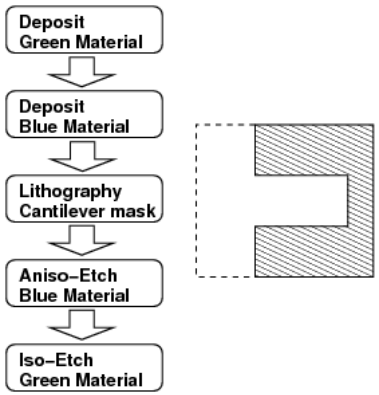
- **Identification and classification of**
  - Layers
  - Topological Dependencies
  - Shapes
  - Modifications
- **Structural Decomposition**
- **Preparation of Layer Model**

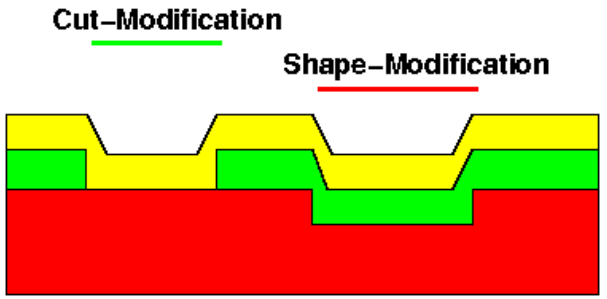






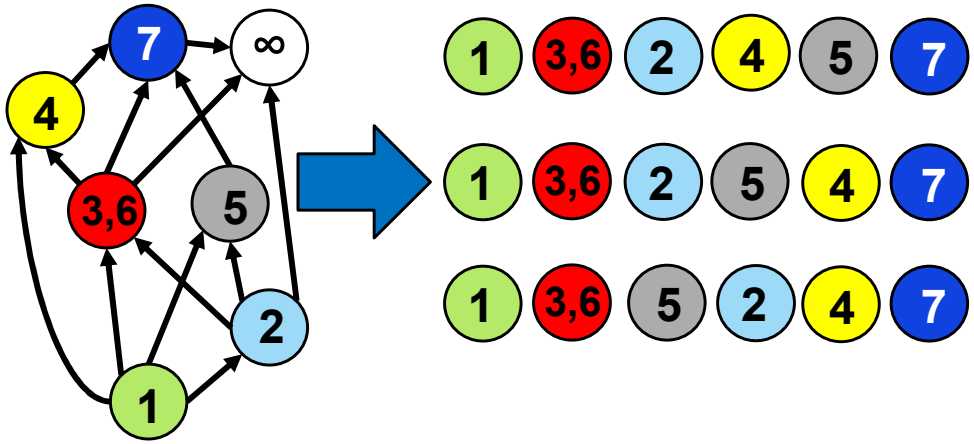


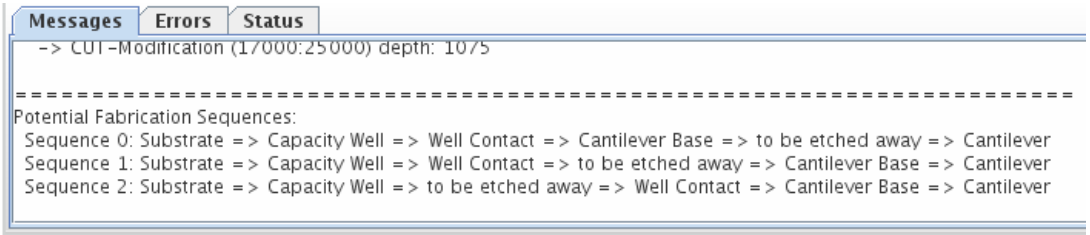


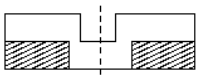
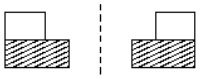
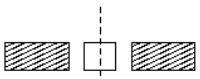


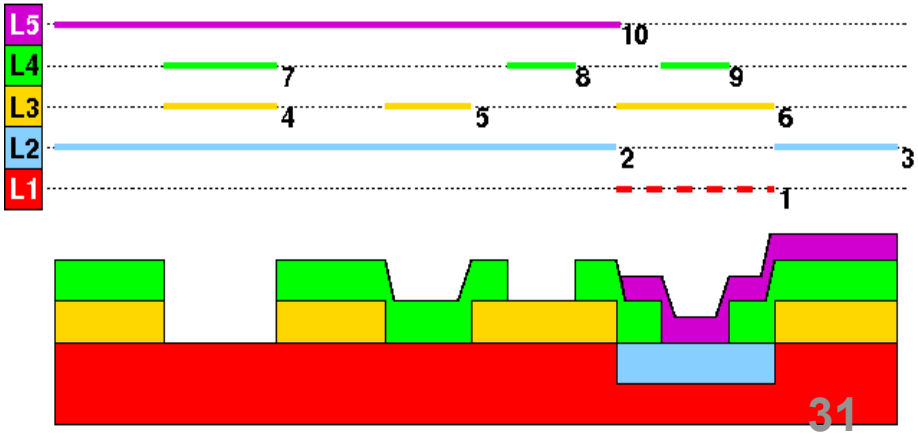
Technology Recommender

- **Defines Sequence of**
  - Layer generation
  - Layer modifications
  - Lithography masks
- **Prepares process draft**
  - Recipe Search
  - Process Design





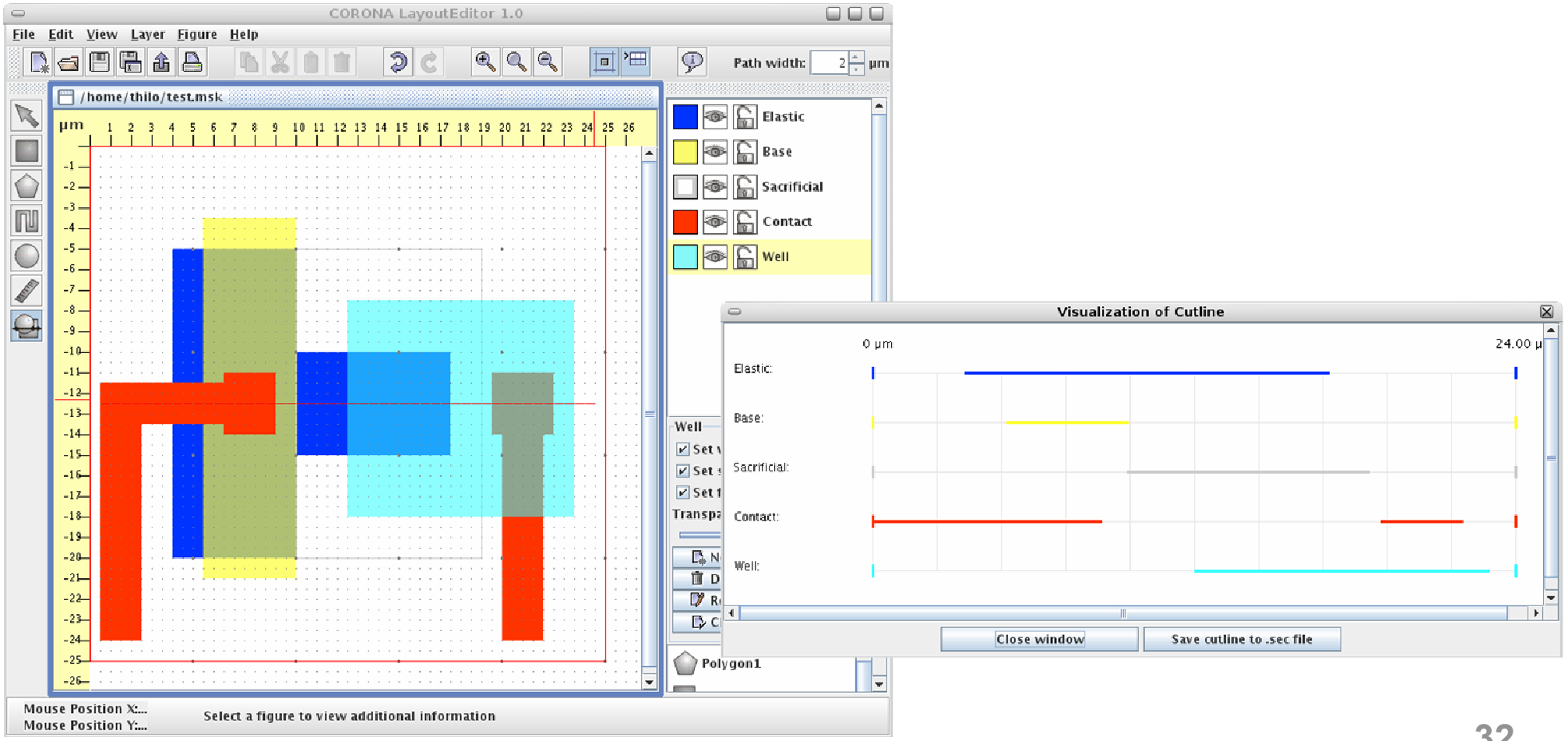
	Layout	Modifications	Action	
			Visibility	Order
A			block	block
B			propagate	propagate
C			propagate	block



Process vs. Layout

Layout Editor

- Layout editor with basic editing functions
- Goal: Linking layer model (analyzer) to physical layout



Contact

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Meet us at the IVAM. booth

in hall 6, H16/C1