VisualDOC Software

Current Features and Capabilities

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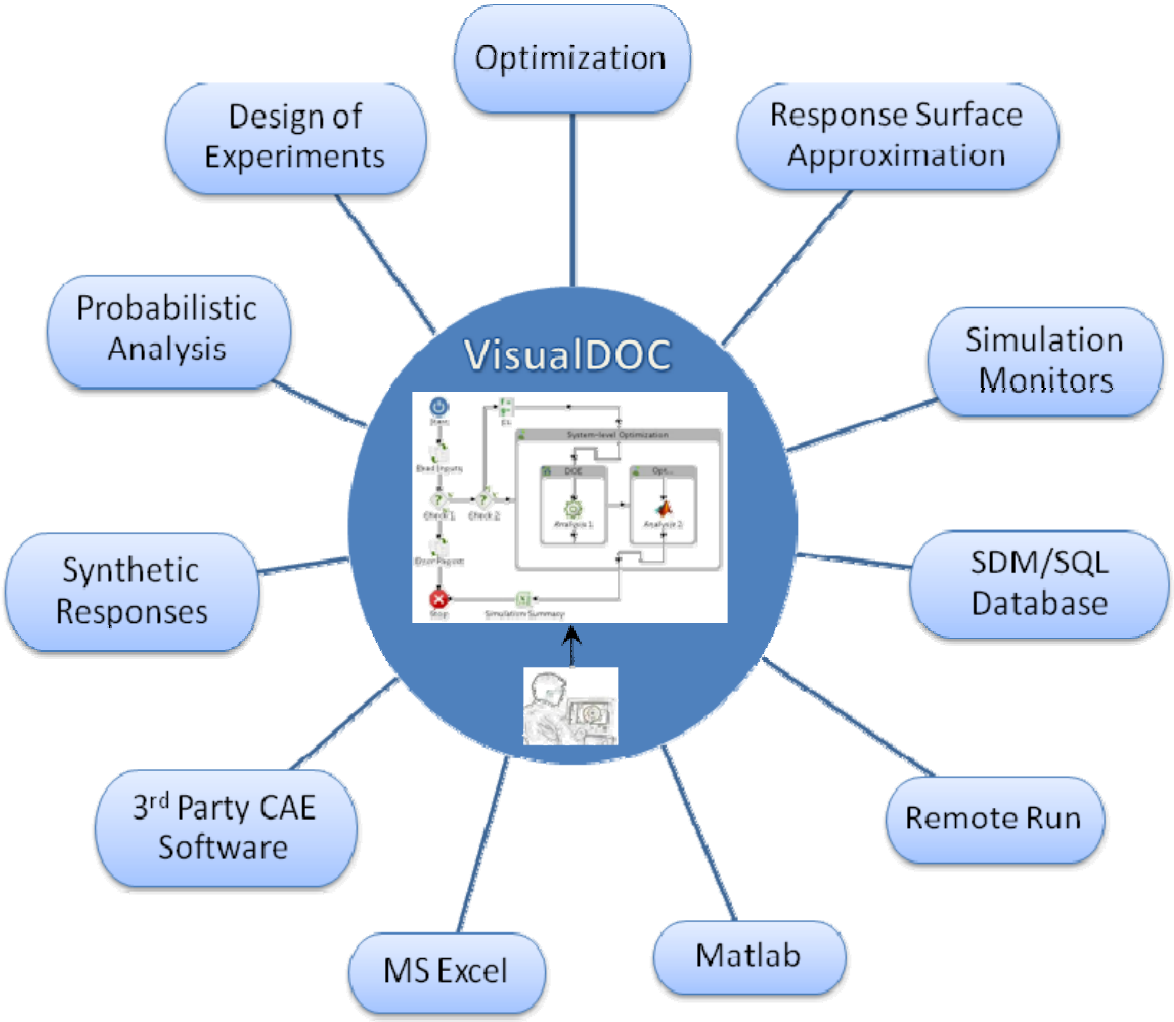
Presentation Outline

- What is VisualDOC
- VisualDOC Evolution / History
- Features and Capabilities
- Some Examples

VisualDOC

- A general purpose multi-disciplinary design, optimization, and process integration software
- Can add design modules to almost any analysis program (e.g. Genesis, Nastran, Ansys, LS-Dyna, etc.)
- Multi-level/multiple design studies in a single simulation

VisualDOC


Optimization
Design of Experiments
Response Surface Approximation
Probabilistic Analysis
VisualDOC
Simulation Monitors
Synthetic Responses
SDM/SQL Database
3rd Party CAE Software
Remote Run
MS Excel
Matlab

Evolution of VisualDOC

Design Modules

v1	v2	v3	v4	v5	v6.x	**v7.x**
DOT RSA DOE	User-supplied gradients New DOE designs	BIGDOT GA PSO	Probabilistic optimization Monte Carlo MVA	Discrete RSA	Combinatorial Multi-objective Discrete DOE	Multi-level OPT, DOE, RSM, Probabilistic, … Full MDO capability

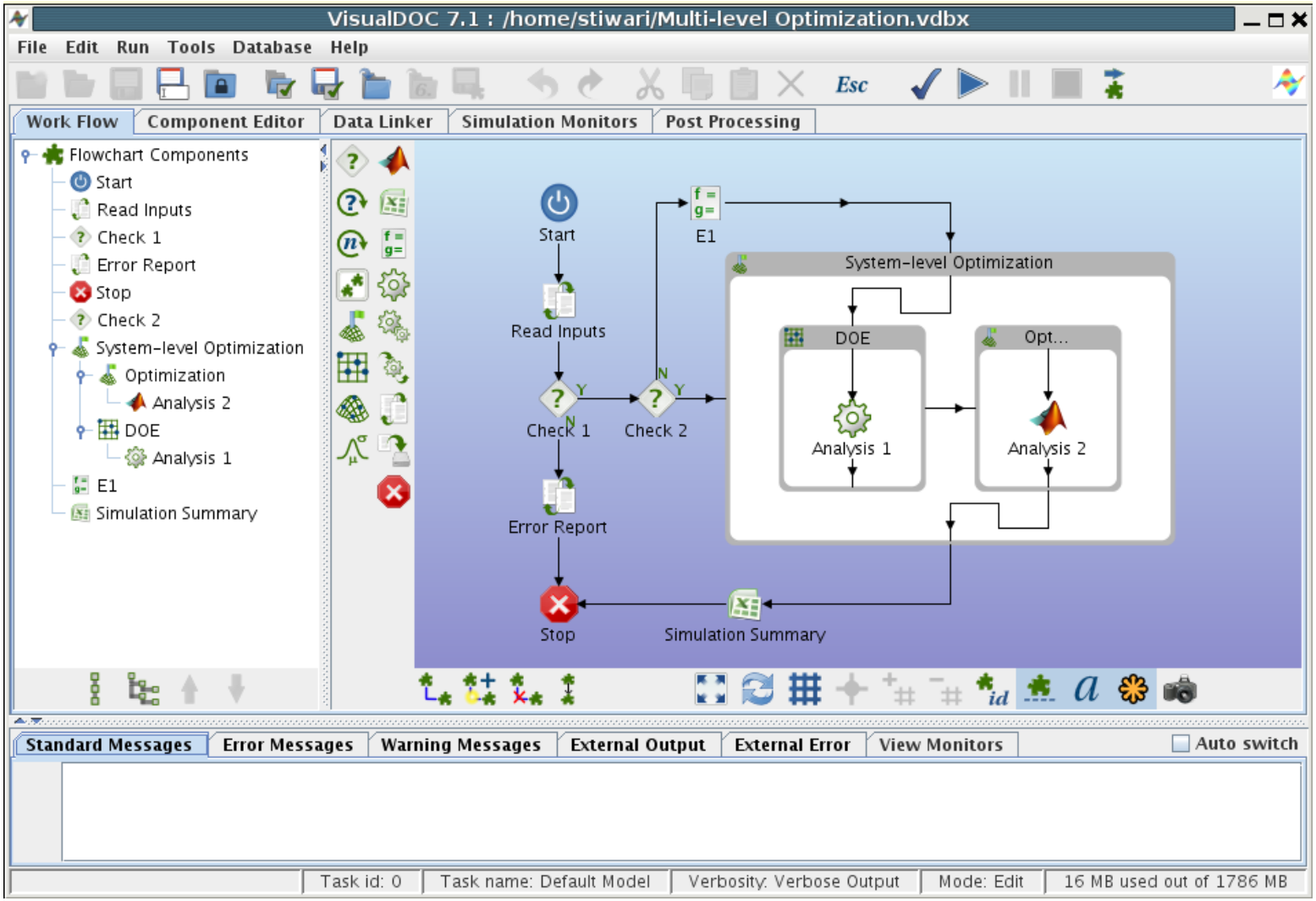
Process Integration

v1	v2	v3	v4	v5	v6.x	**v7.x**
Standalone program	VisualScript Text file interface API	If stat. Excel ADAMS LS-DYNA	Loop Matlab Array element	Shared library	Synthetic functions Morpher	Workflow Components Auto data/connect/link Full parameterization

Design Environment

v1	v2	v3	v4	v5	v6.x	**v7.x**
GUI	Database	Real-time plots Parallel (MPI)	What-If	DOE plots Remote run	Scatter, matrix plot 2D & 3D plots Approx. viewers Parallel (Shared) Parallel VisualScript	Simulation Monitors SDM, Debugger SQL database Partial model execution
1998	2001	2002	2004	2005	2006-2009	**2011-Present**

VisualDOC Interface

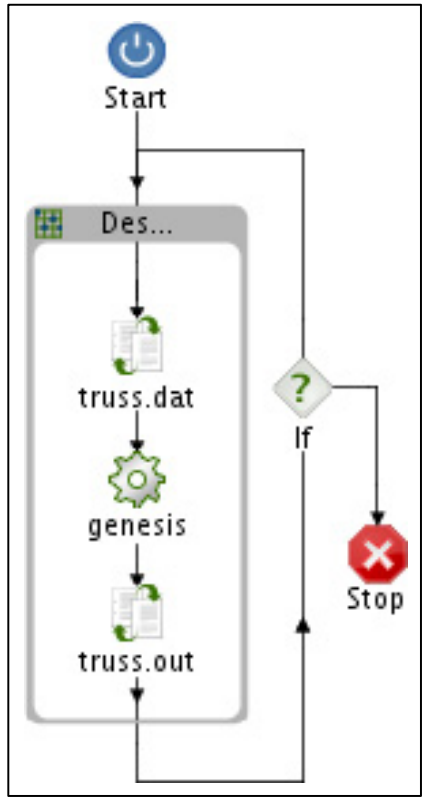


VisualDOC Setup

- Define the VisualDOC Model
  - Setup the workflow components
  - Components are designed to perform specific tasks
- Data definition
  - Define the data for each component
- Data Linking
  - Define the flow/transfer of data between components
- Validate and Run

VisualDOC Model

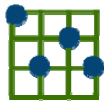
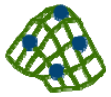
- Connected workflow of components
- Visual programming approach to model creation
- Resembles a typical flowchart
  - Natural and easier (intuitive)
  - Correctly envision the design process, semantic validity
- Each component performs a specific task



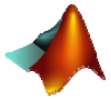
Flow Control Components

-  For Loop
-  While Loop
-  If Condition
-  Stop Execution
- … and more

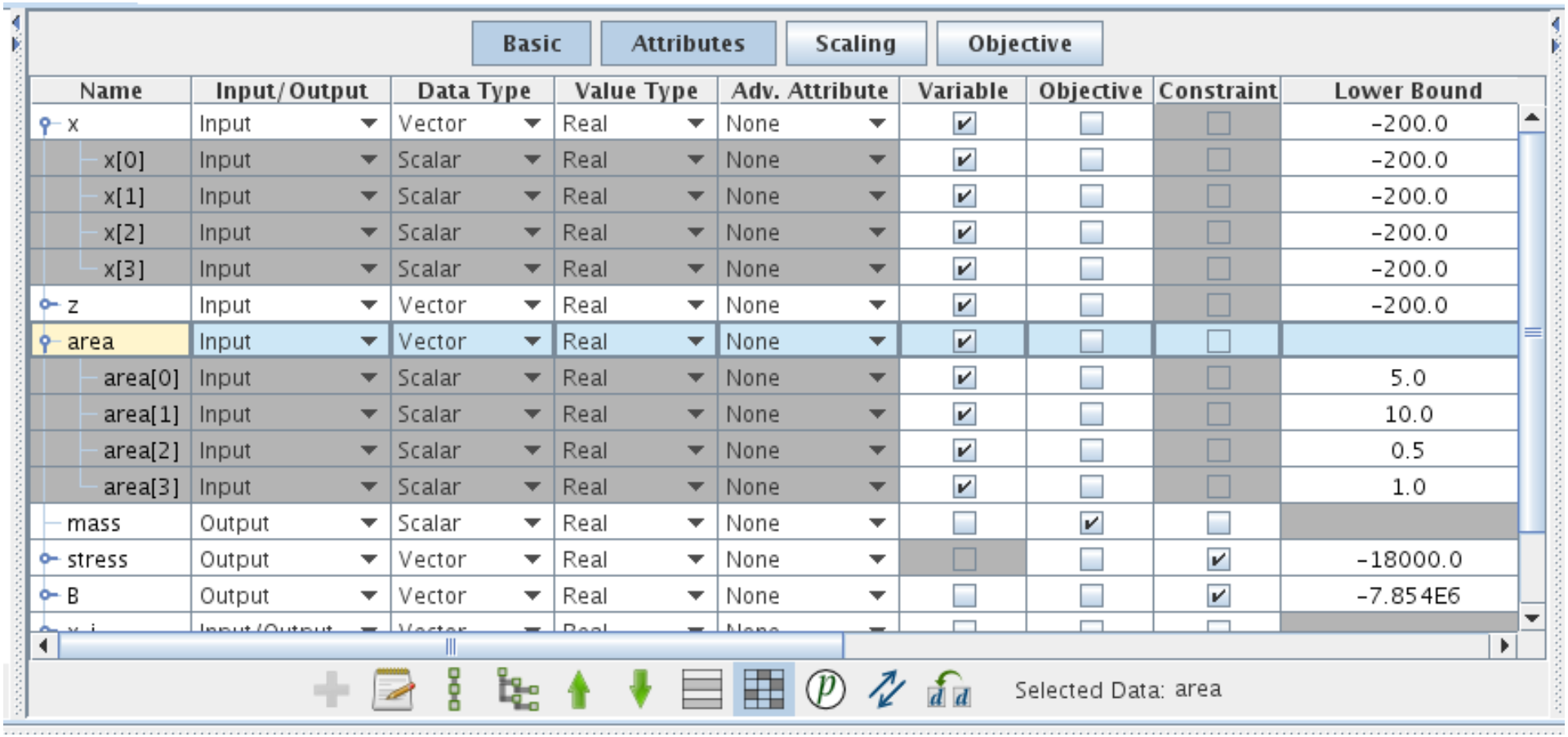
Design Components

-  Optimization
-  Design of Experiments
-  Response Surface
-  Probability Analysis

Analysis Components

-  **Matlab**
-  **Excel**
-  **Equation**
-  Executable
-  **Shared Library**
-  **Executable Wrapper**
-  **File I/O**
-  File Backup
-  **GENESIS**

Component Data

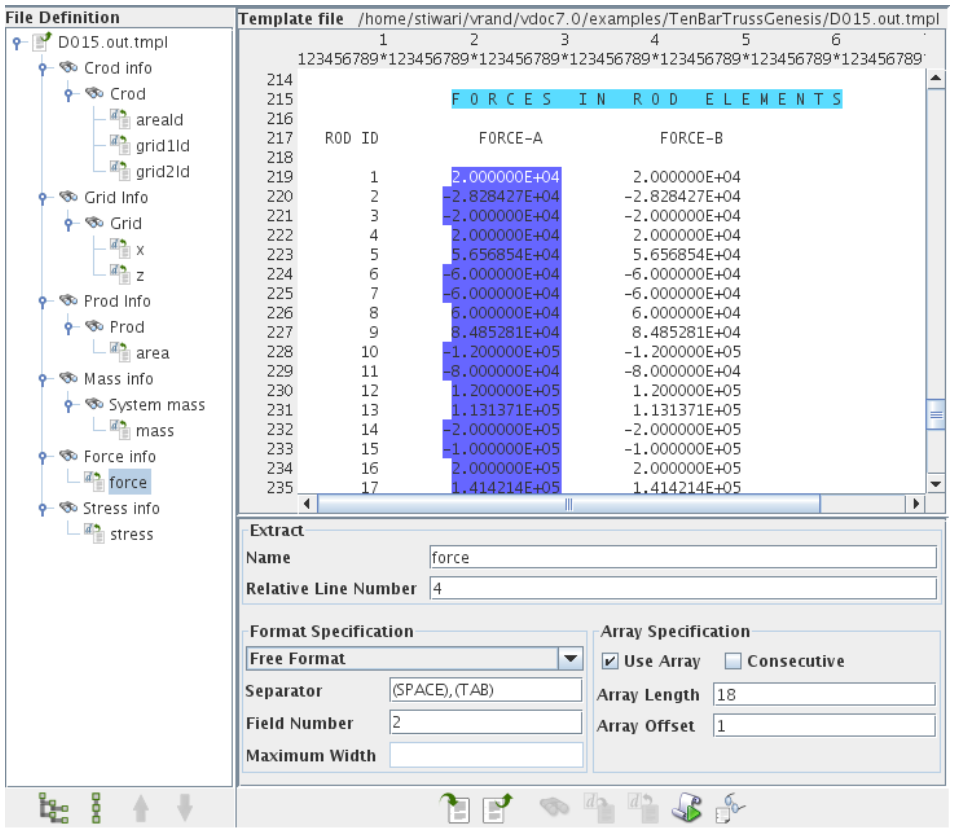


Basic | Attributes | Scaling | Objective

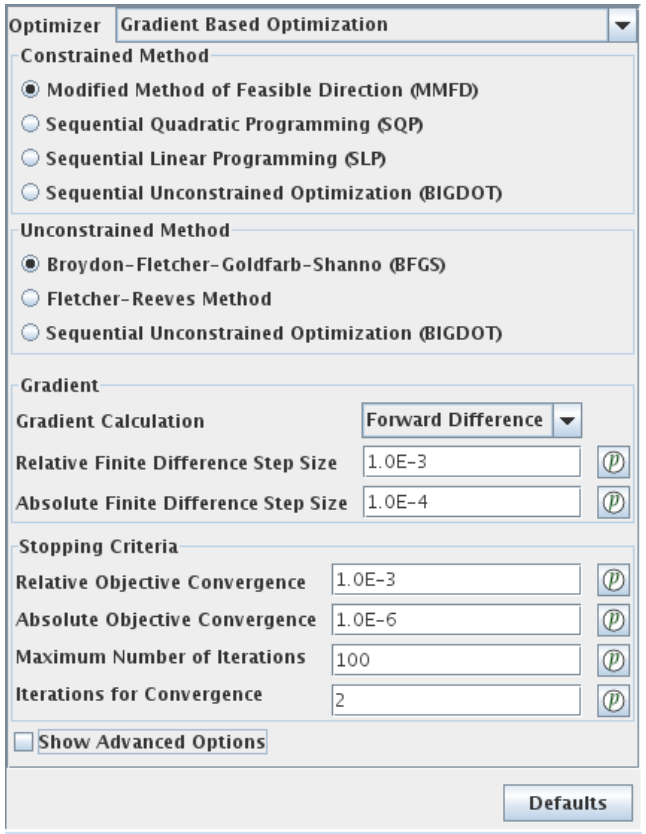
Name	Input/Output	Data Type	Value Type	Adv. Attribute	Variable	Objective	Constraint	Lower Bound
x	Input	Vector	Real	None	✔			-200.0
x[0]	Input	Scalar	Real	None	✔			-200.0
x[1]	Input	Scalar	Real	None	✔			-200.0
x[2]	Input	Scalar	Real	None	✔			-200.0
x[3]	Input	Scalar	Real	None	✔			-200.0
z	Input	Vector	Real	None	✔			-200.0
area	Input	Vector	Real	None	✔			
area[0]	Input	Scalar	Real	None	✔			5.0
area[1]	Input	Scalar	Real	None	✔			10.0
area[2]	Input	Scalar	Real	None	✔			0.5
area[3]	Input	Scalar	Real	None	✔			1.0
mass	Output	Scalar	Real	None		✔		
stress	Output	Vector	Real	None			✔	-18000.0
B	Output	Vector	Real	None			✔	-7.854E6

Selected Data: area

Component Editors

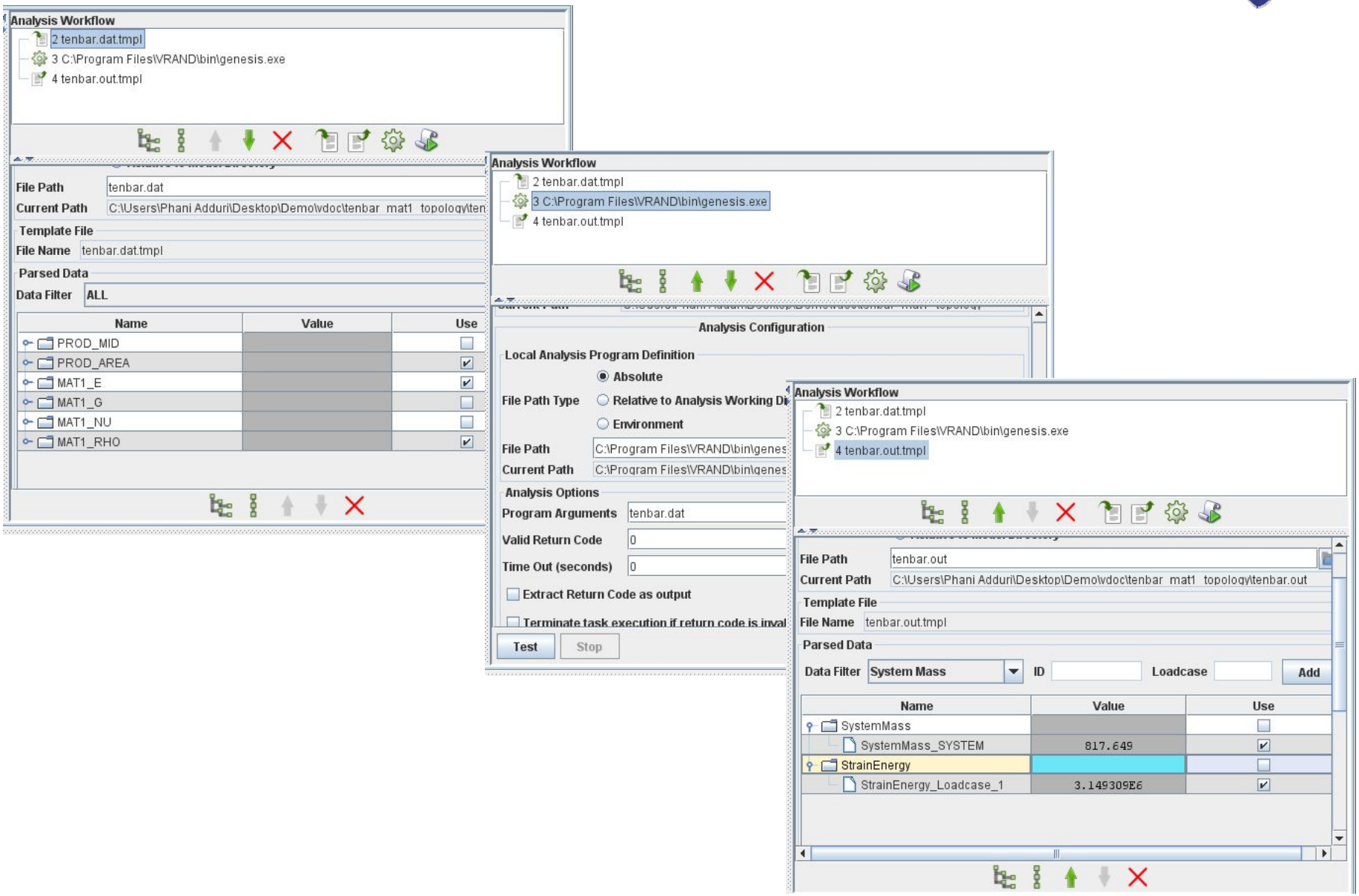


File I/O

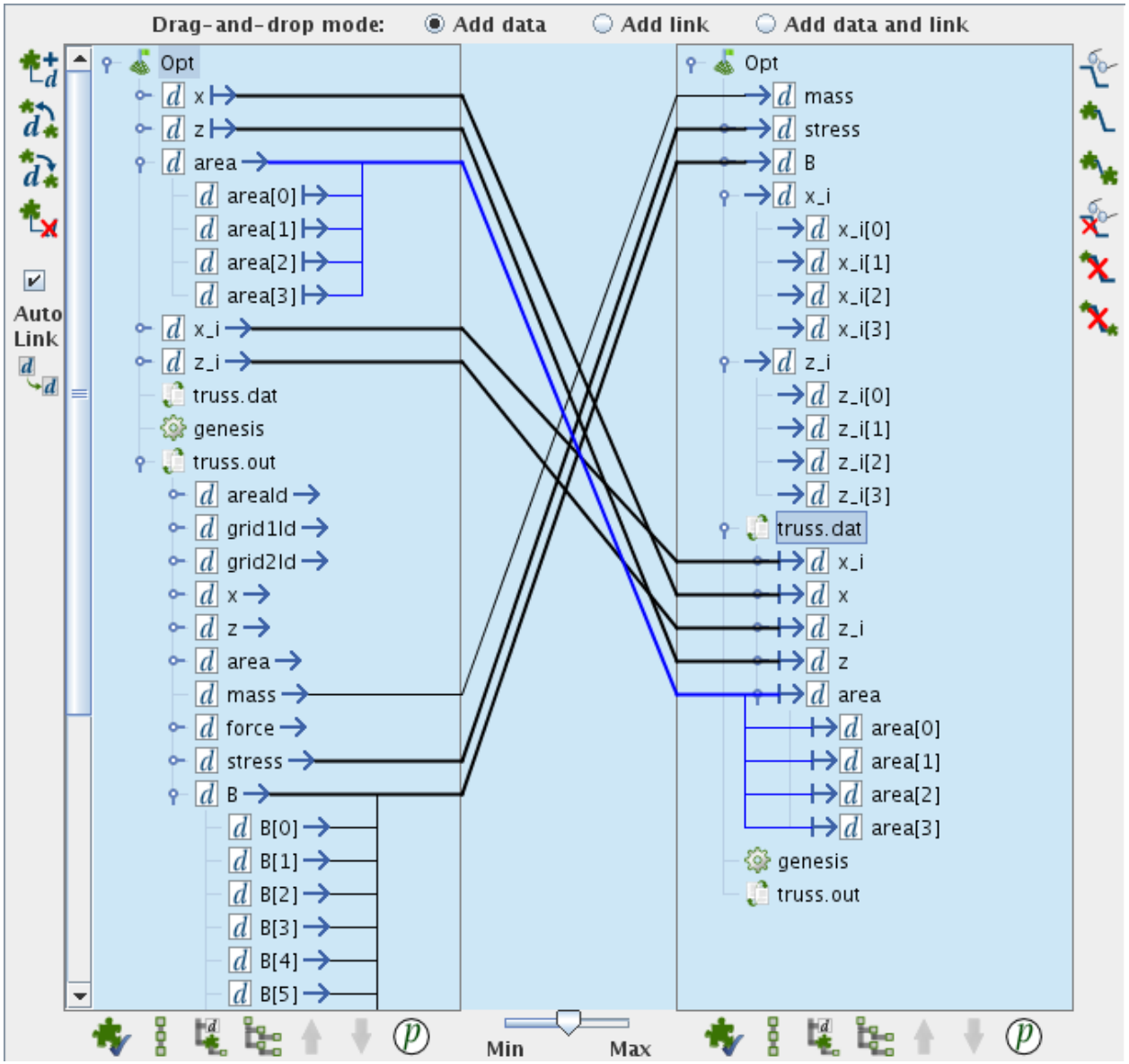


Optimization

GENESIS Component Editor



Data Linker


Drag-and-drop mode:
Add data
Add link
Add data and link
Auto Link
Opt
x
z
area
area[0]
area[1]
area[2]
area[3]
x_i
z_i
truss.dat
genesis
truss.out
areaId
grid1Id
grid2Id
x
z
area
mass
force
stress
B
B[0]
B[1]
B[2]
B[3]
B[4]
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x_i
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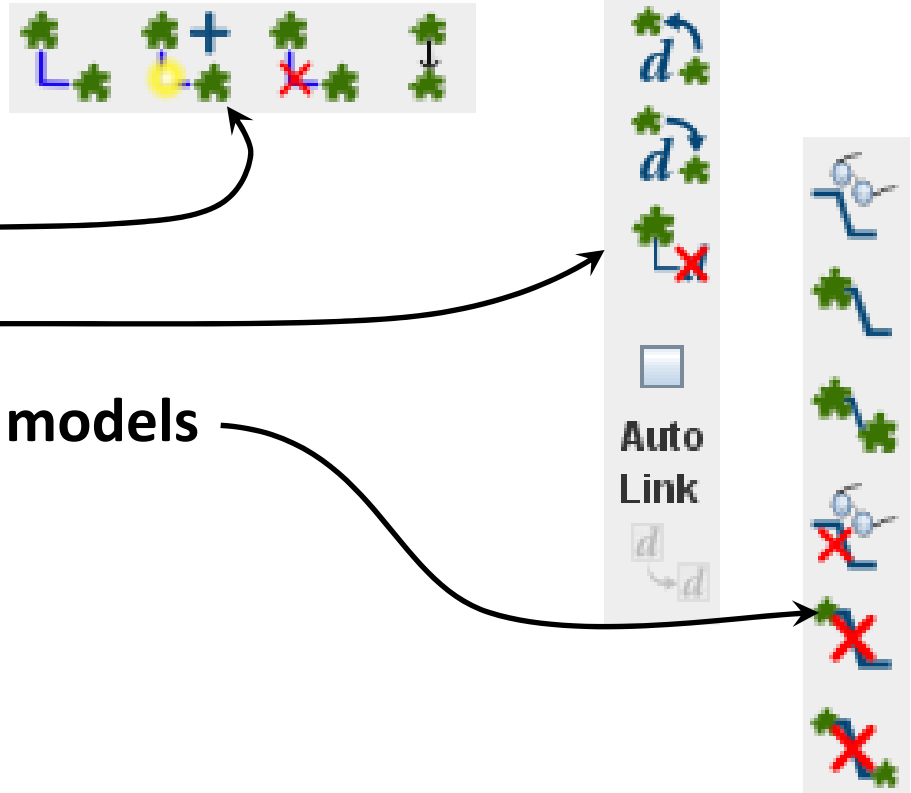
z_i
z
area
area[0]
area[1]
area[2]
area[3]
genesis
truss.out
Min
Max

Model Execution

- Real-time visual feedback for model execution
- Cyclic execution (conditional branching) of sub-flows
- Ability to reuse simulation data from previous runs
- Execute individual components or only part of a sub-flow
- Remote Run
- Parallel Execution
- Batch Execution
- Monitor the execution

Advanced Capabilities

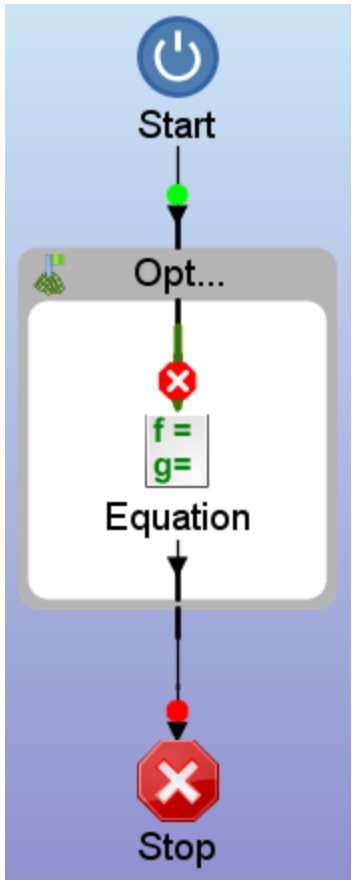
- **Setup multi-level/multiple design studies in the same model**
- **Full parameterization support**
- **Auto-completion**
  - Rearrange the model tree
  - Connect the model tree
  - Populate with data
  - Link data between different models



Advanced Capabilities

- Import/Export/Validate/Run/ Post-process only part of a sub-flow
- Add/remove/enable/disable break-points while model execution in progress
- Ability to
  - Start/stop/pause/continue model execution
  - Step-by-step execution (interactive)

Break Points

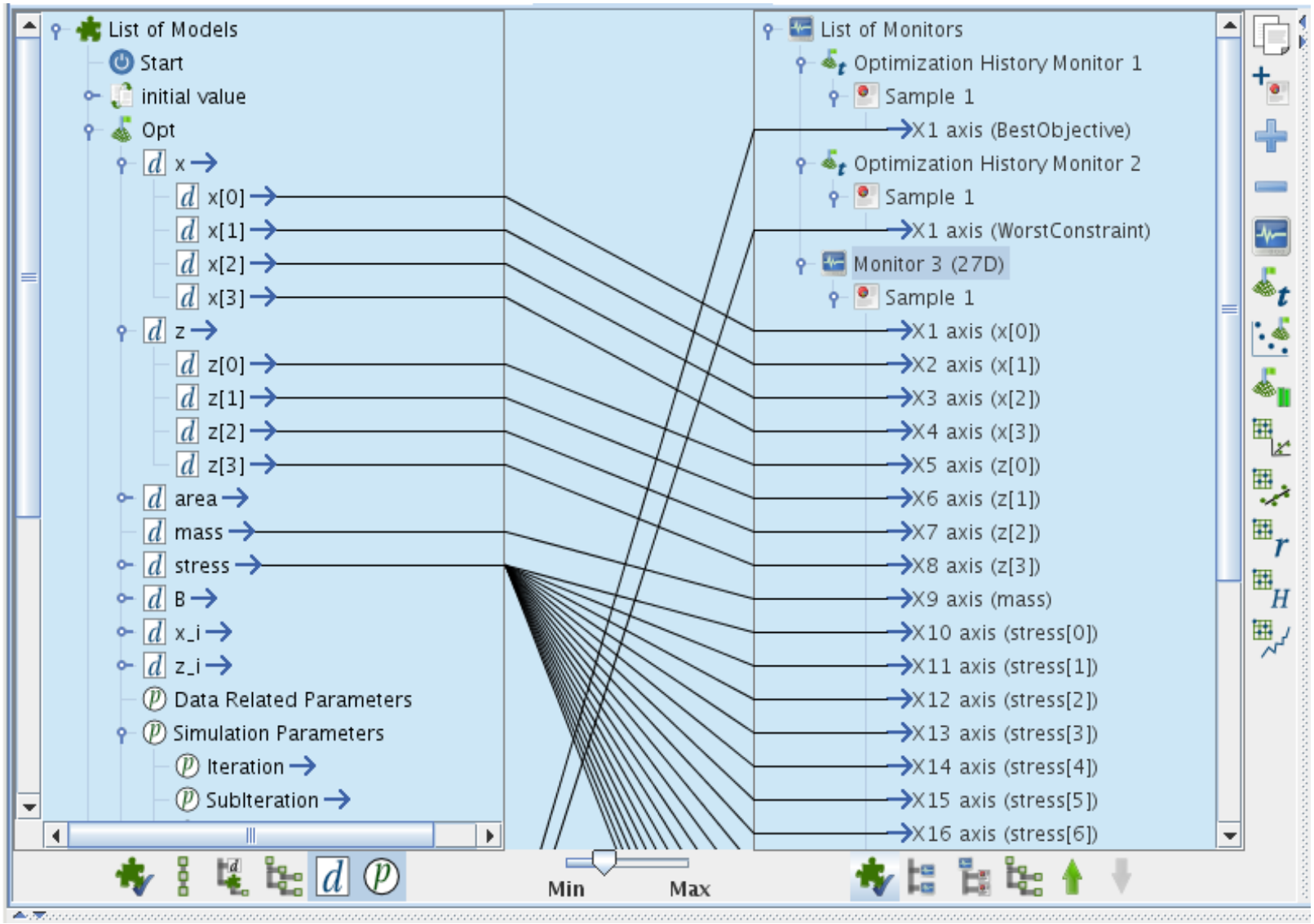


- Red octagon: enabled breakpoint
- Green circle: disabled breakpoint
- Red octagon with cross: active breakpoint

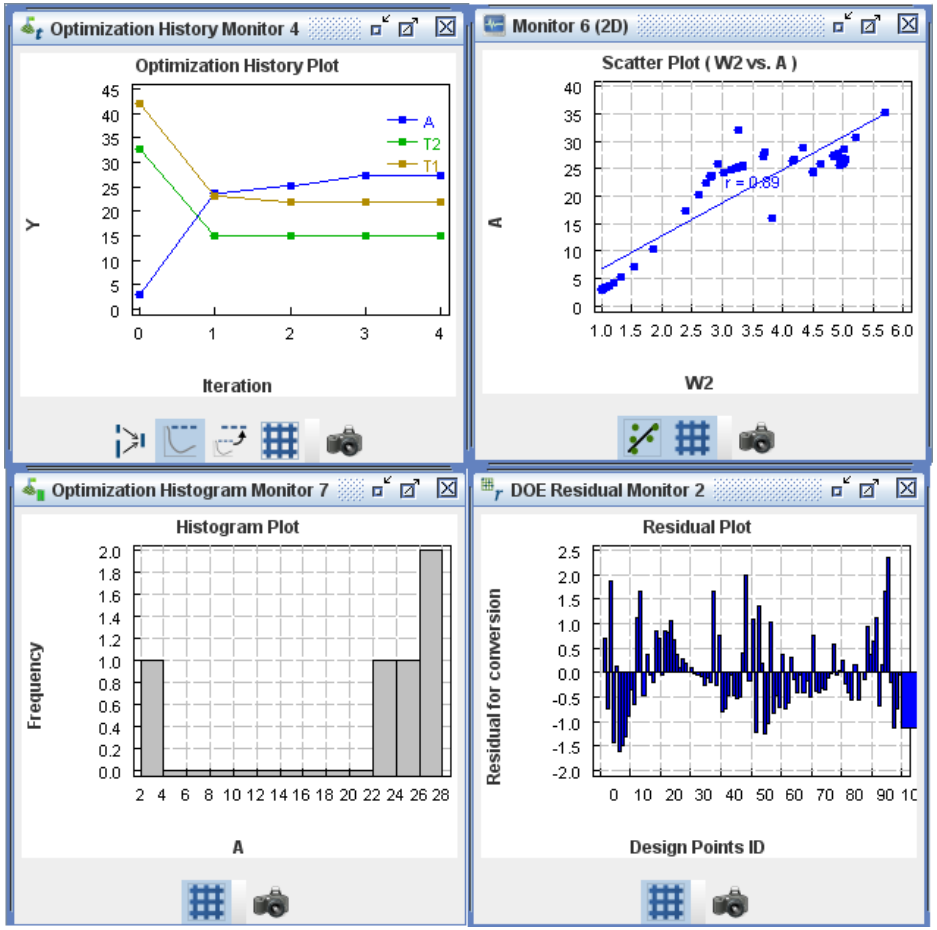
Simulation Monitors

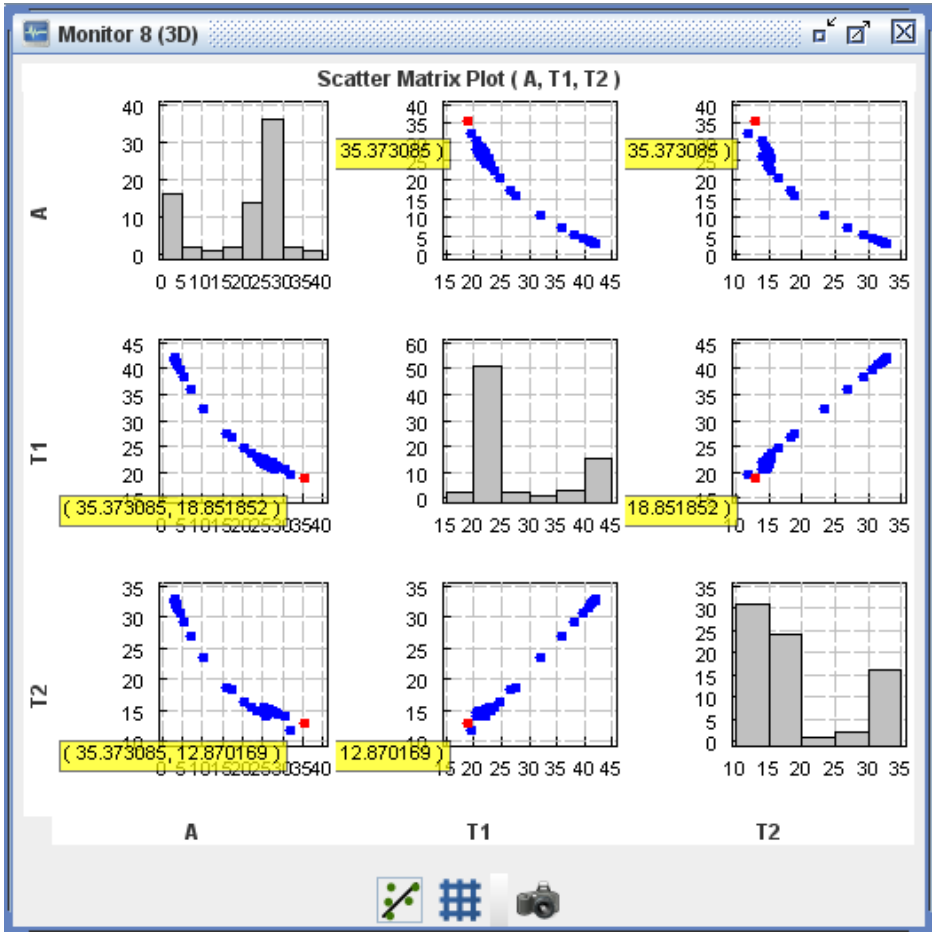
- Real-time monitoring of simulation data
- Visualization plots, tables, animations, etc.
- Simulation monitors can be added/edited before, during, or after a simulation run
- Any number and types of monitors can be added
- Do not interfere with model execution

Simulation Monitors



Simulation Monitors

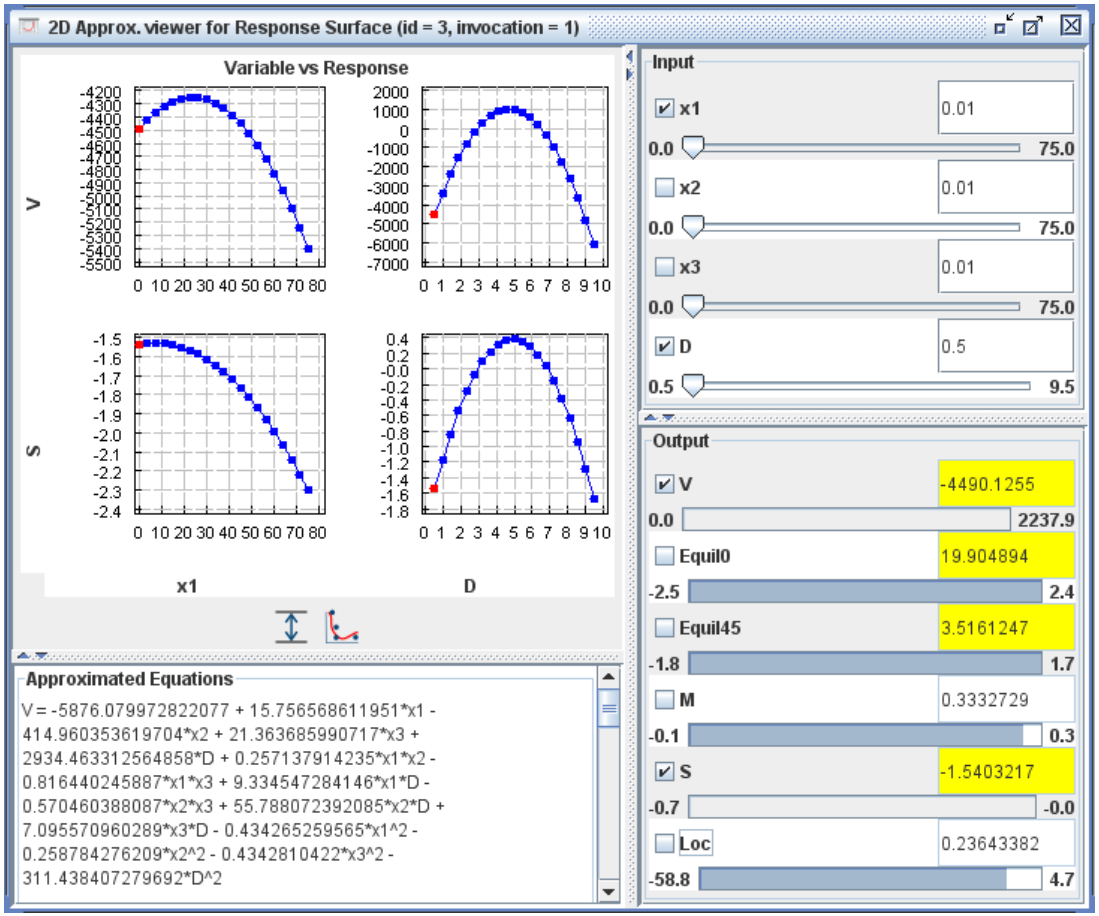




Post Processing

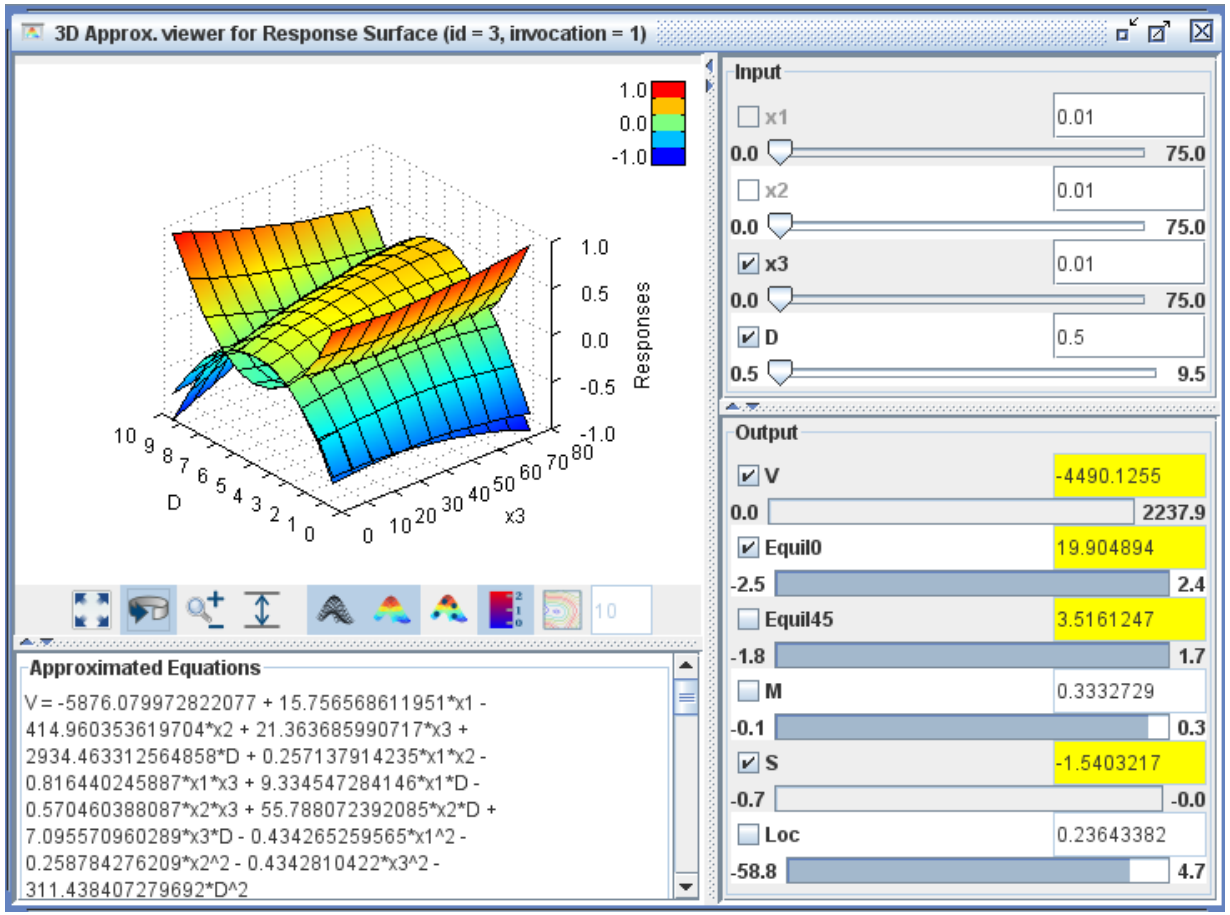
- Performed only after a component's execution has finished
- Summary reports, design point tables, visualization plots etc.
- Interactive visualization tools (e.g. Approximation viewer for DOE)
- Extract/store simulation data – a flexible and intuitive interface to choose the data to extract

Post Processing



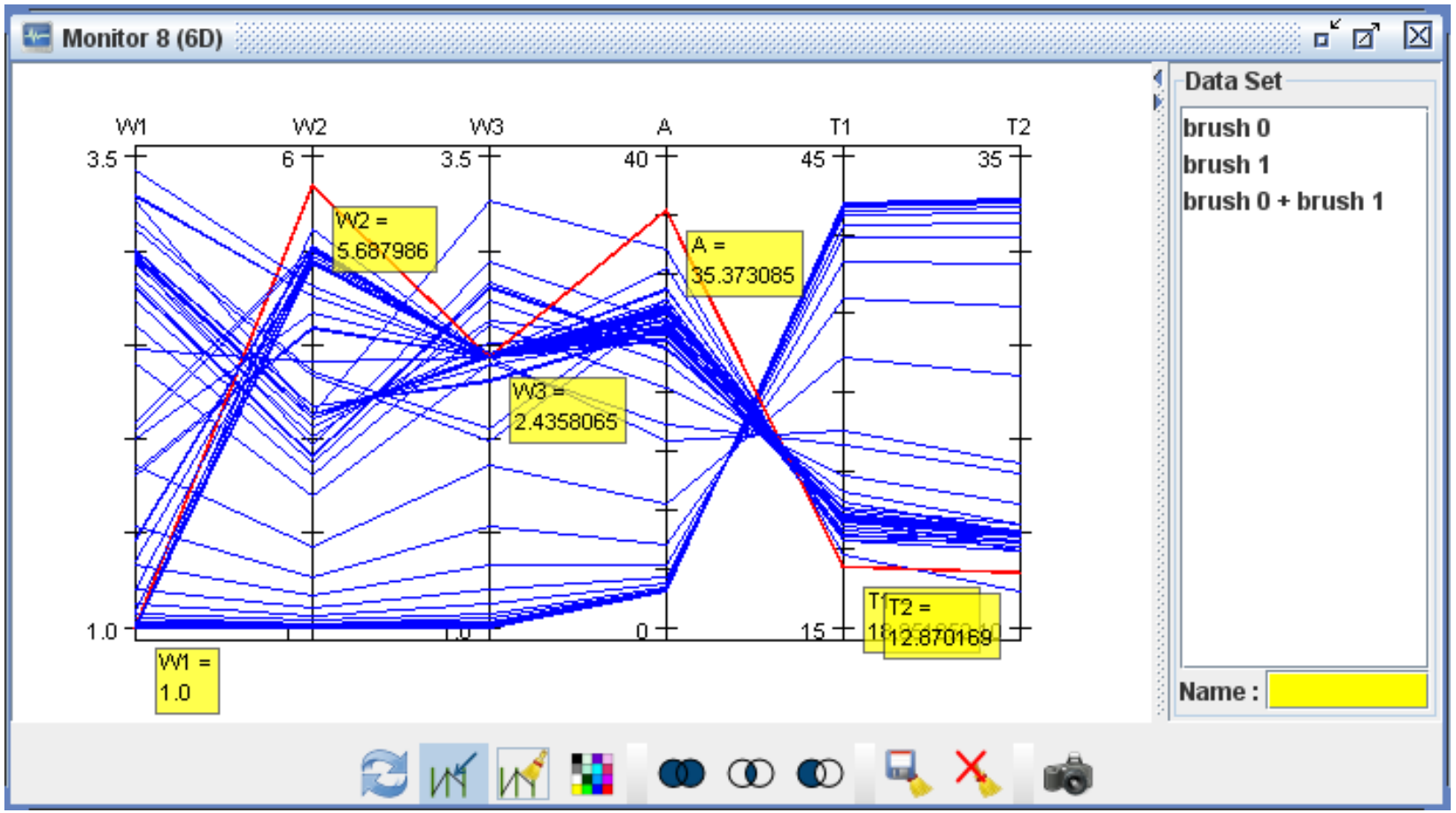
Approximation Viewer

Post Processing



Approximation Viewer

Post Processing

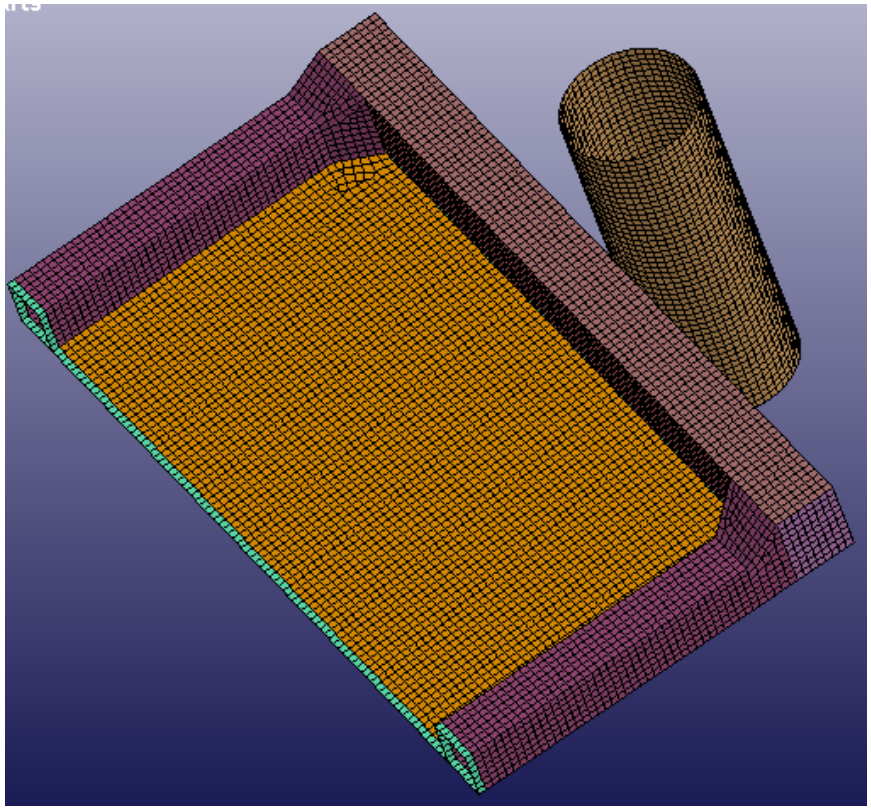


Parallel Plots

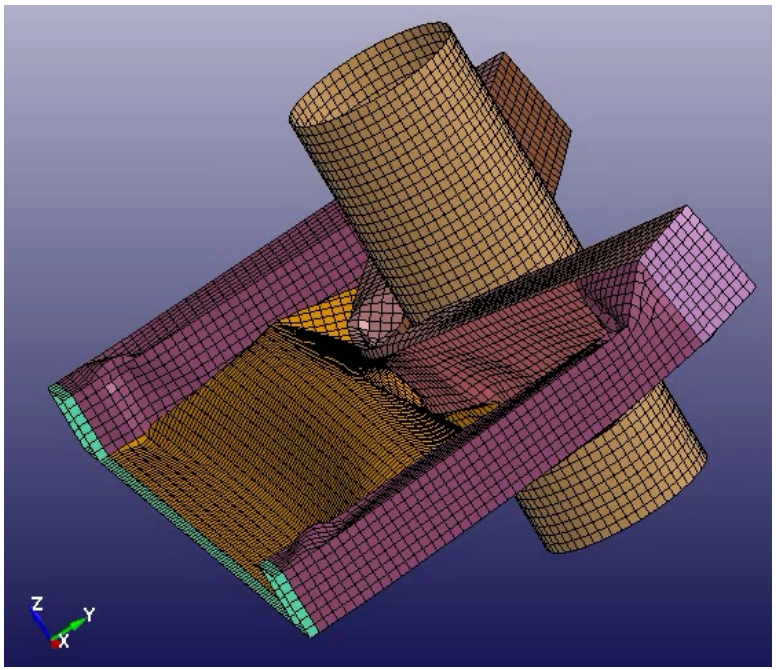
Examples

Barrier Design Example

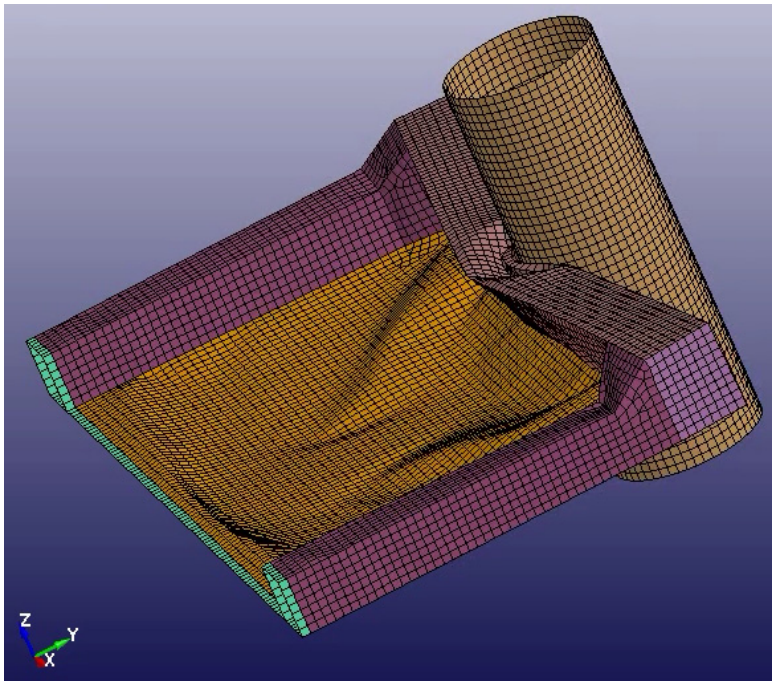
- Desired: lightest structure for specified deformation
- Minimize mass subject to deflection constraints
- LS-DYNA used for analysis



Barrier Design Example



Initial (infeasible) design
Mass = 8.83 kg
Deflection = 486.28 mm

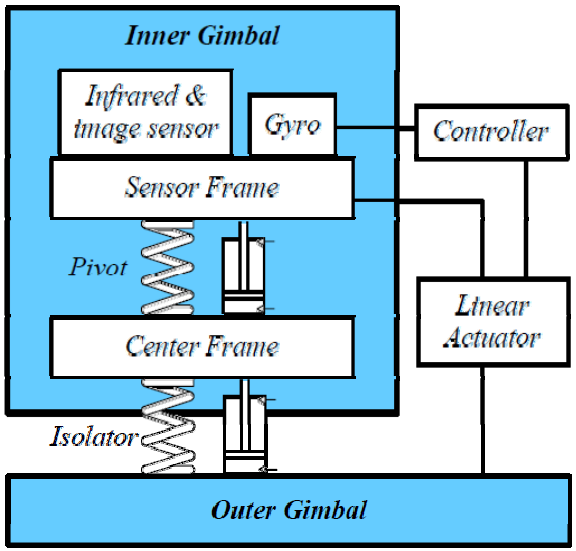


Final optimized (feasible) design
Mass = 17.19 kg
Deflection = 129.86 mm

Dynamic Balancing of Gimbaled Assembly

- **Gimbal: An electro-optical system on which image sensors are mounted**

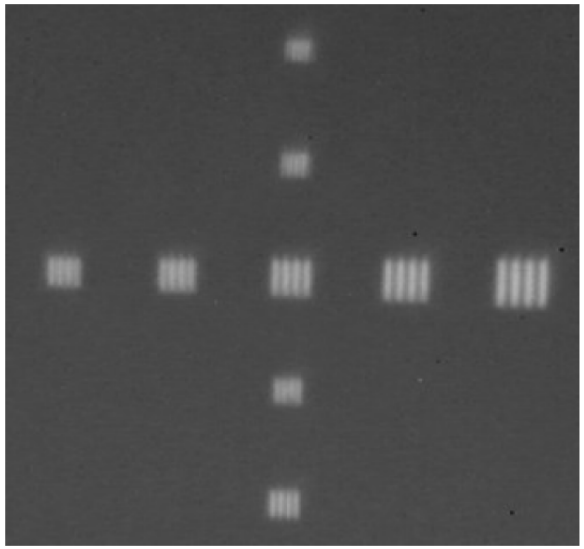
- Objective: Maintain the line-of-sight with stability and precision irrespective of the motion/vibration of the support on which the Gimbal is mounted
- Multi-axial dynamic balancing performed



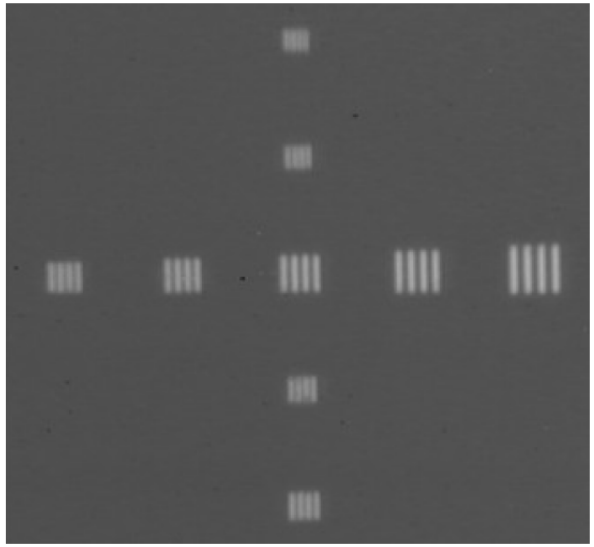
Dynamic Balancing of Gimbaled Assembly

- **Results**
  - **95% reduction in unbalance about *y*-axis**
  - **90% reduction in unbalance about *z*-axis**

Image obtained from the sensor mounted on the Gimbal



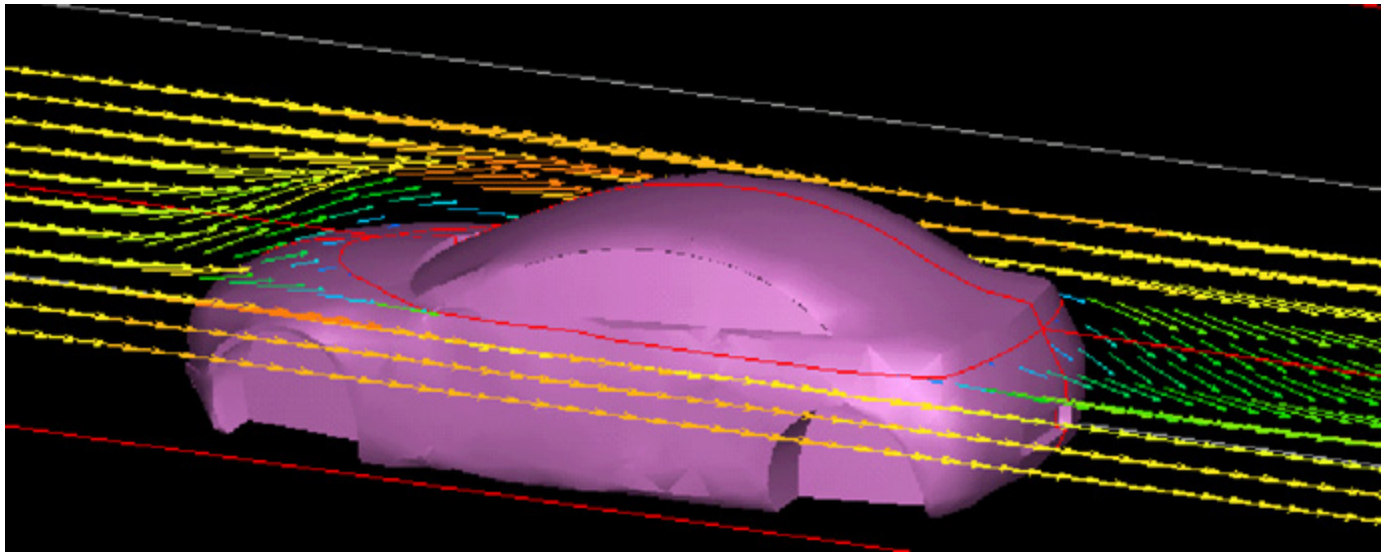
Initial



Optimal

Shape Design of an Automobile

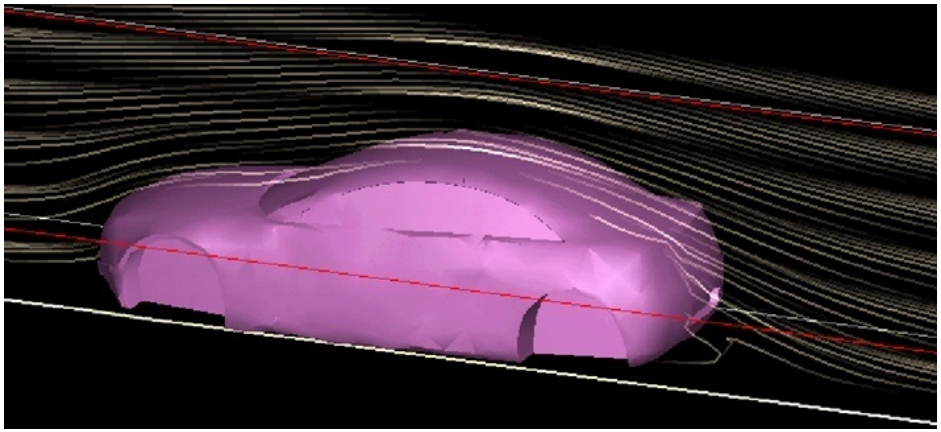
- **Design objective: Minimize the coefficient of drag C_d**
- **VisualDOC coupled to a CFD model of the car**

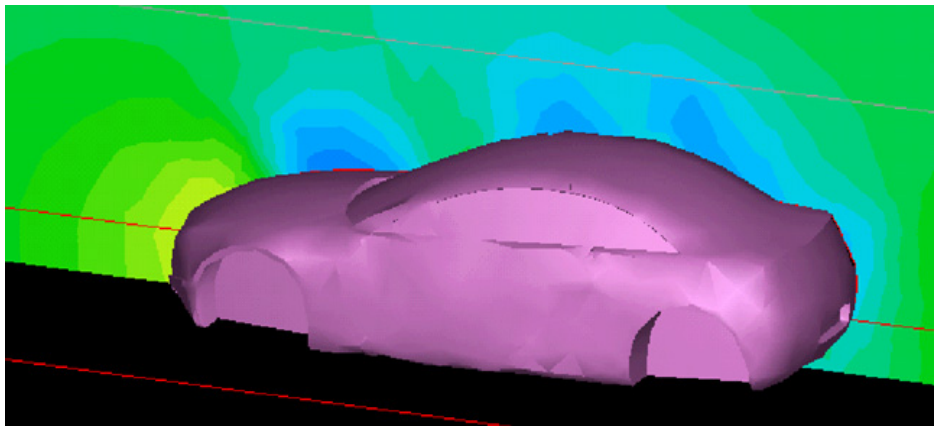


Vehicle details removed

Shape Design of an Automobile

- Response surface approximation (RSA) based optimization done in VisualDOC
- **14.3%** improvement in Coefficient of Drag C_d





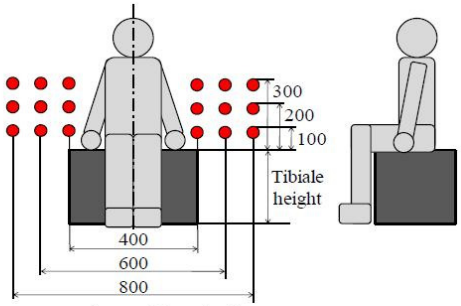
Vehicle details removed

Design of Ergonomic Hand-Rails

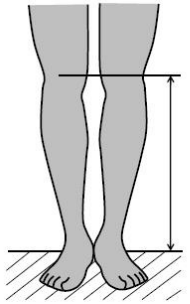
- **Multi-objective optimization of hand-rails for Sit-to-Stand movement**
- **Experimental verification with live subjects**
- **Minimize the muscle load**
  - **Optimization results verified using surface electromyograms**

Design of Ergonomic Hand-Rails

- Determined that a trade-off exists between the muscle load of triceps brachii and tibialis interior

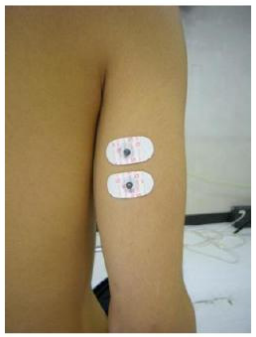


Location of handrail


Tibiale height

- The lower the position of the hand-rails, the lower the muscle load


(a) Anterior deltoid


(b) Triceps brachii


(c) Rectus femoris


(d) Tibialis anterior

Thank You

Questions/Comments?

For more information visit:

http://www.vrand.com/visualdoc.html

Email: visualdoc.support@vrand.com