



VisualDOC Software

Current Features and Capabilities

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Presentation Outline



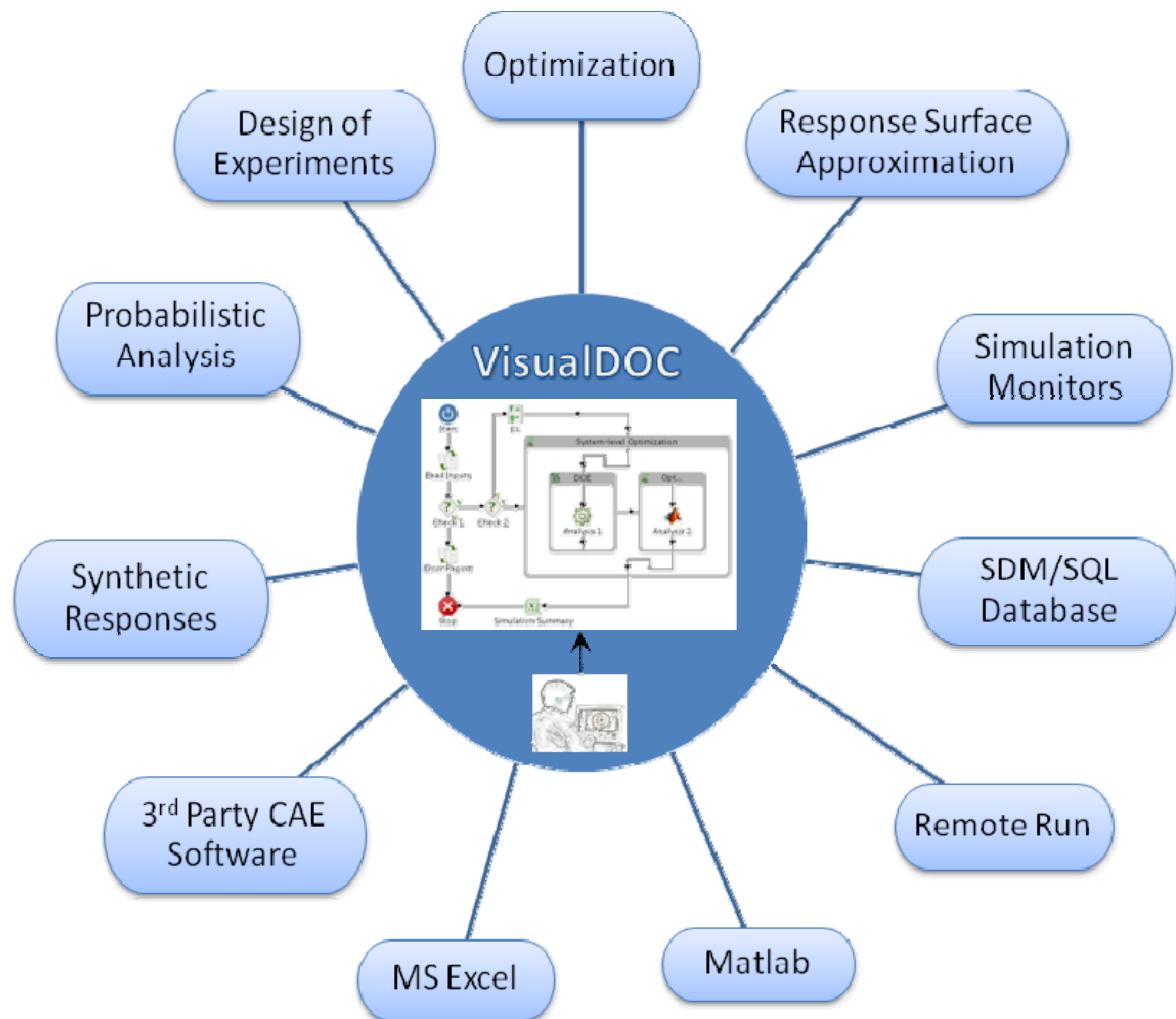
- **What is VisualDOC**
- **VisualDOC Evolution / History**
- **Features and Capabilities**
- **Some Examples**

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



Evolution of VisualDOC



Design Modules

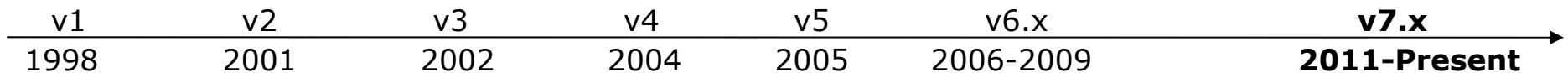
DOT RSA DOE	User-supplied gradients New DOE designs	BIGDOT GA PSO	Probabilistic optimization Monte Carlo MVA	Discrete RSA	Combinatorial Multi-objective Discrete DOE	Multi-level OPT, DOE, RSM, Probabilistic, ... Full MDO capability
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Process Integration

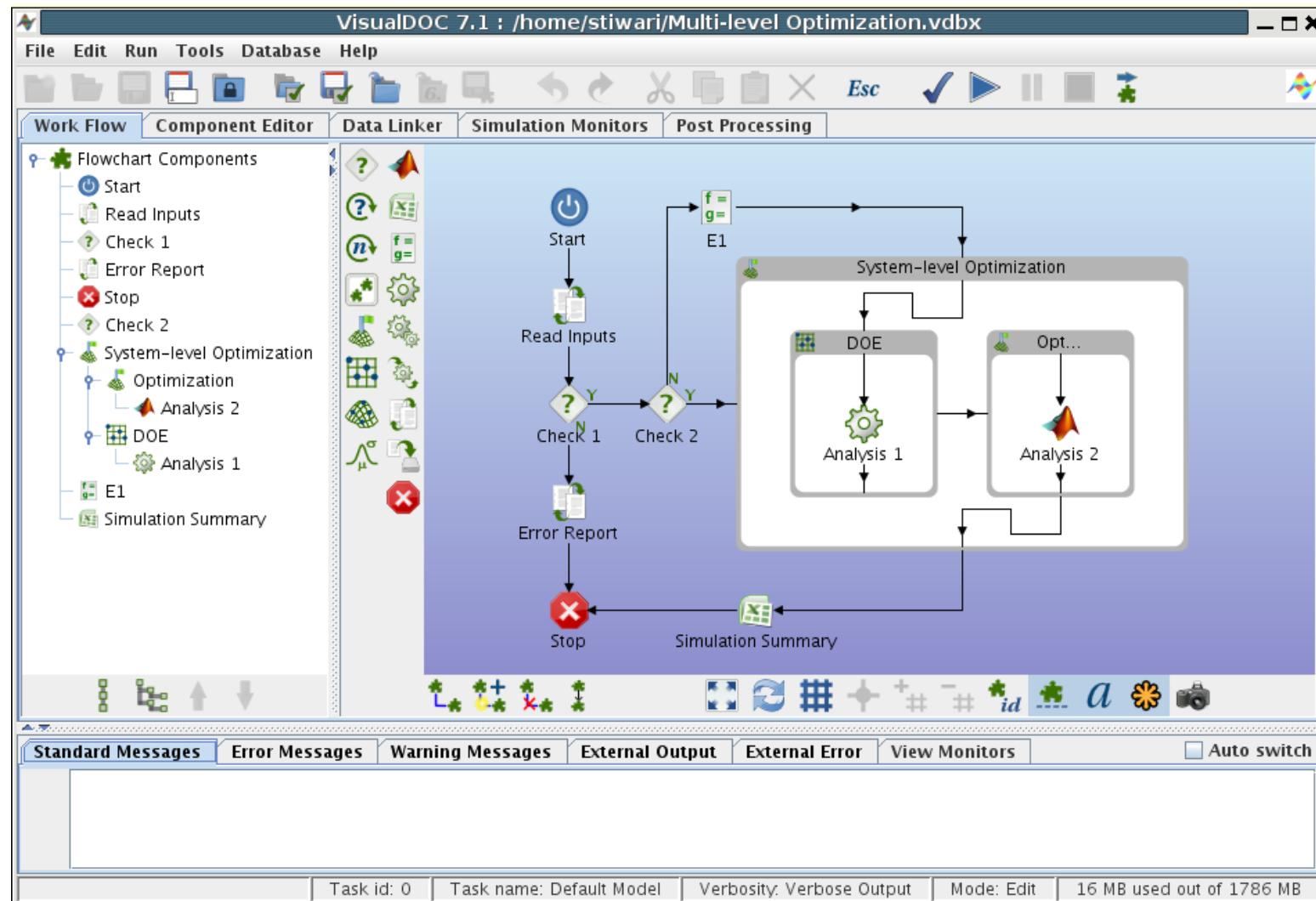
Standalone program	VisualScript Text file interface API	If stat. Excel ADAMS LS-DYNA	Loop Matlab Array element	Shared library	Synthetic functions Morpher	Workflow Components Auto data/connect/link Full parameterization
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Design Environment

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
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VisualDOC Interface



VisualDOC Setup

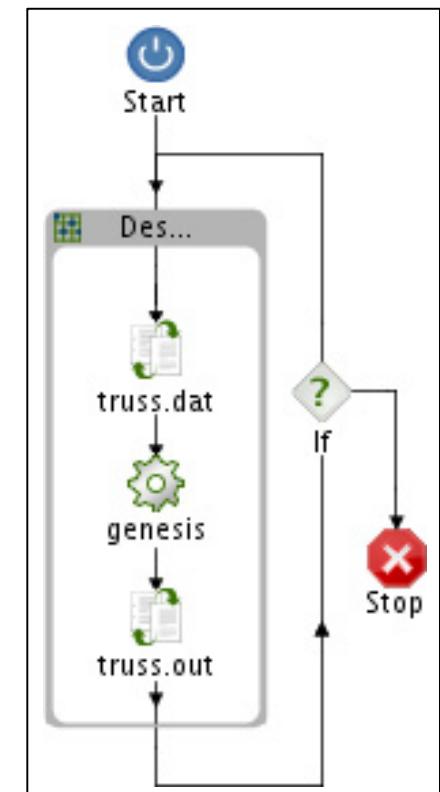


- **Define the VisualDOC Model**
 - **Setup the workflow components**
 - **Components are designed to perform specific tasks**
- **Data definition**
 - **Define the data for each component**
- **Data Linking**
 - **Define the flow/transfer of data between components**
- **Validate and Run**

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



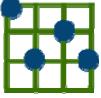
Flow Control Components



-  **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	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	-200.0
x[0]	Input	Scalar	Real	None	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	-200.0
x[1]	Input	Scalar	Real	None	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	-200.0
x[2]	Input	Scalar	Real	None	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	-200.0
x[3]	Input	Scalar	Real	None	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	-200.0
z	Input	Vector	Real	None	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	-200.0
area	Input	Vector	Real	None	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
area[0]	Input	Scalar	Real	None	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	5.0
area[1]	Input	Scalar	Real	None	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	10.0
area[2]	Input	Scalar	Real	None	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	0.5
area[3]	Input	Scalar	Real	None	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1.0
mass	Output	Scalar	Real	None	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
stress	Output	Vector	Real	None	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	-18000.0
B	Output	Vector	Real	None	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	-7.854E6
v_i	Input/Output	Vector	Real	None	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

Selected Data: area

Toolbar icons: +, clipboard, grid, arrows, matrix, p, d, d.

Component Editors



File Definition

Template file /home/stiwari/vrand/vdov7.0/examples/TenBarTrussGenesis/D015.out.tpl

```

123456789*123456789*123456789*123456789*123456789*123456789*123456789

214          F O R C E S   I N   R O D   E L E M E N T S
215
216
217      ROD ID      FORCE-A      FORCE-B
218
219      1      2.000000E+04    2.000000E+04
220      2      -2.828427E+04   -2.828427E+04
221      3      -2.000000E+04   2.000000E+04
222      4      2.000000E+04    5.656854E+04
223      5      5.656854E+04   5.656854E+04
224      6      -6.000000E+04   -6.000000E+04
225      7      -6.000000E+04   -6.000000E+04
226      8      6.000000E+04    6.000000E+04
227      9      8.485281E+04   8.485281E+04
228     10      -1.200000E+05   -1.200000E+05
229     11      -8.000000E+04   -8.000000E+04
230     12      1.200000E+05   1.200000E+05
231     13      1.131371E+05   1.131371E+05
232     14      -2.000000E+05   -2.000000E+05
233     15      1.000000E+05   -1.000000E+05
234     16      2.000000E+05   2.000000E+05
235     17      1.414214E+05   1.414214E+05

```

Extract

Name: force
Relative Line Number: 4

Format Specification

Free Format	<input checked="" type="checkbox"/> Use Array <input type="checkbox"/> Consecutive
Separator: (SPACE),(TAB)	Array Length: 18
Field Number: 2	Array Offset: 1
Maximum Width:	

File I/O

Optimizer Gradient Based Optimization

Constrained Method

- Modified Method of Feasible Direction (MMFD)
- Sequential Quadratic Programming (SQP)
- Sequential Linear Programming (SLP)
- Sequential Unconstrained Optimization (BIGDOT)

Unconstrained Method

- Broydon-Fletcher-Goldfarb-Shanno (BFGS)
- Fletcher-Reeves Method
- Sequential Unconstrained Optimization (BIGDOT)

Gradient

Gradient Calculation: Forward Difference

Relative Finite Difference Step Size: 1.0E-3

Absolute Finite Difference Step Size: 1.0E-4

Stopping Criteria

Relative Objective Convergence: 1.0E-3

Absolute Objective Convergence: 1.0E-6

Maximum Number of Iterations: 100

Iterations for Convergence: 2

Show Advanced Options

Defaults

Optimization

GENESIS Component Editor



Analysis Workflow

- 2 tenbar.dat.tpl
- 3 C:\Program Files\VRAND\bin\genesis.exe
- 4 tenbar.out.tpl

File Path: tenbar.dat
Current Path: C:\Users\Phani Adduri\Desktop\Demo\doc\tenbar_mat1_topology\tenbar

Template File: tenbar.dat.tpl

Parsed Data

Name	Value	Use
PROD_MID		<input type="checkbox"/>
PROD_AREA		<input checked="" type="checkbox"/>
MAT1_E		<input checked="" type="checkbox"/>
MAT1_G		<input type="checkbox"/>
MAT1_NU		<input type="checkbox"/>
MAT1_RHO		<input checked="" type="checkbox"/>

Data Filter: ALL

Analysis Configuration

Local Analysis Program Definition: Absolute

File Path Type: Relative to Analysis Working Dir

File Path: C:\Program Files\VRAND\bin\genes...

Current Path: C:\Program Files\VRAND\bin\genes...

Analysis Options

Program Arguments: tenbar.dat

Valid Return Code: 0

Time Out (seconds): 0

Extract Return Code as output

Terminate task execution if return code is invalid

Test **Stop**

Analysis Workflow

- 2 tenbar.dat.tpl
- 3 C:\Program Files\VRAND\bin\genesis.exe
- 4 tenbar.out.tpl

File Path: tenbar.out
Current Path: C:\Users\Phani Adduri\Desktop\Demo\doc\tenbar_mat1_topology\tenbar.out

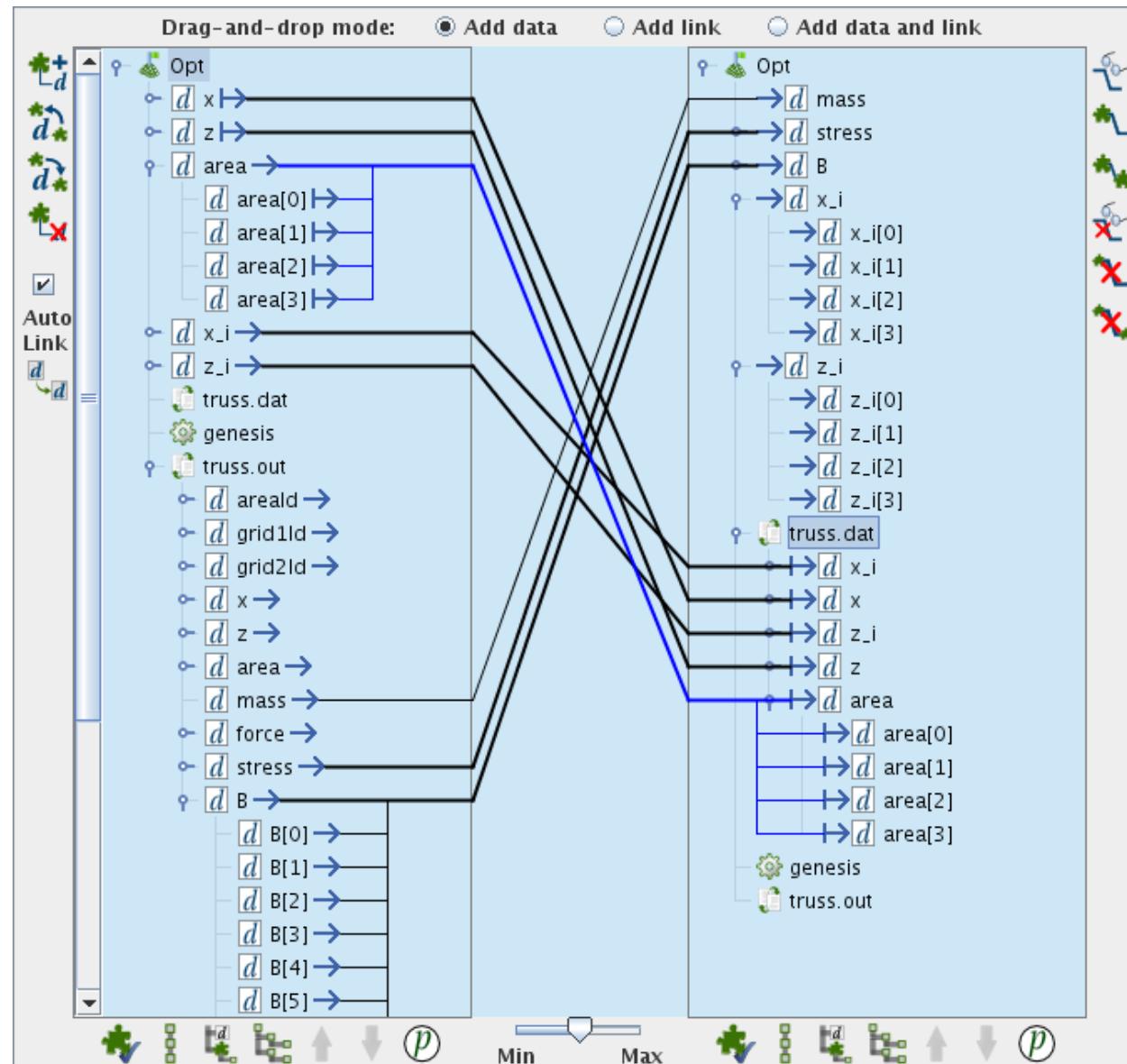
Template File: tenbar.out.tpl

Parsed Data

Data Filter: System Mass

Name	Value	Use
SystemMass		<input type="checkbox"/>
SystemMass_SYSTEM	817.649	<input checked="" type="checkbox"/>
StrainEnergy		<input type="checkbox"/>
StrainEnergy_Loadcase_1	3.149309E6	<input checked="" type="checkbox"/>

Data Linker



Model Execution

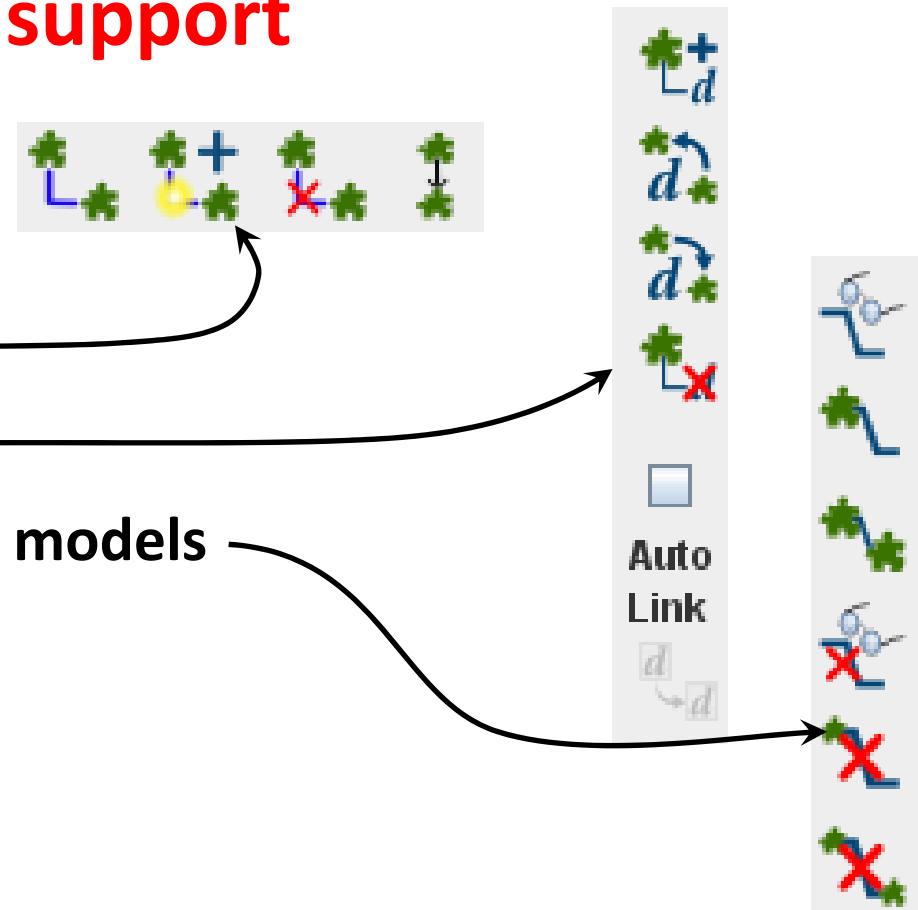


- **Real-time visual feedback** for model execution
- **Cyclic execution (conditional branching)** of sub-flows
- **Ability to reuse simulation data from previous runs**
- **Execute individual components or only part of a sub-flow**
- **Remote Run**
- **Parallel Execution**
- **Batch Execution**
- **Monitor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

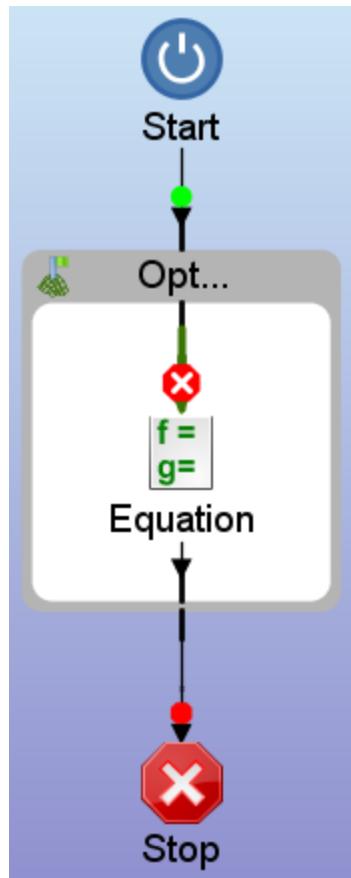


Advanced Capabilities



- 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



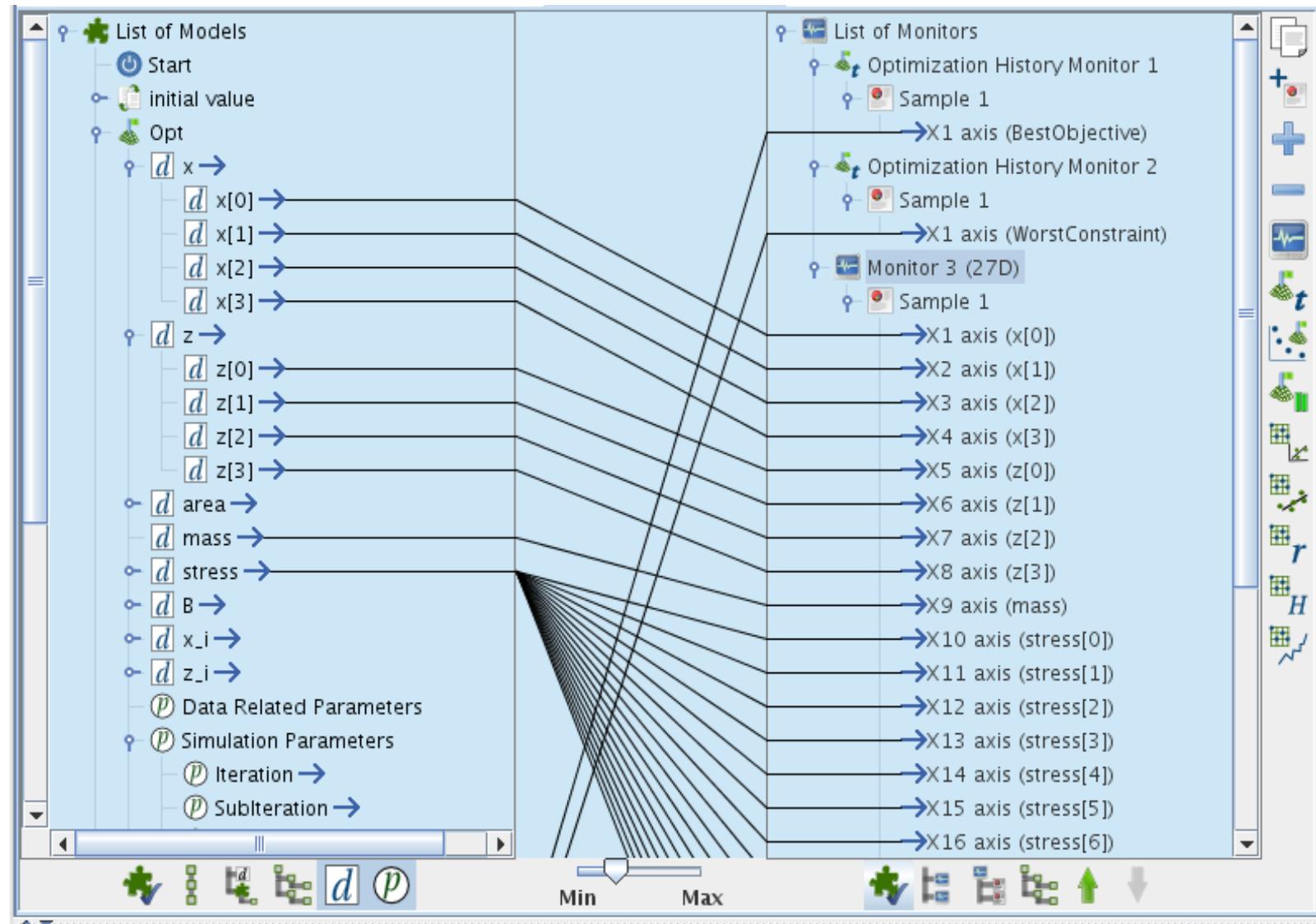
- Red octagon: enabled breakpoint
- Green circle: disabled breakpoint
- Red octagon with cross: active breakpoint

Simulation Monitors

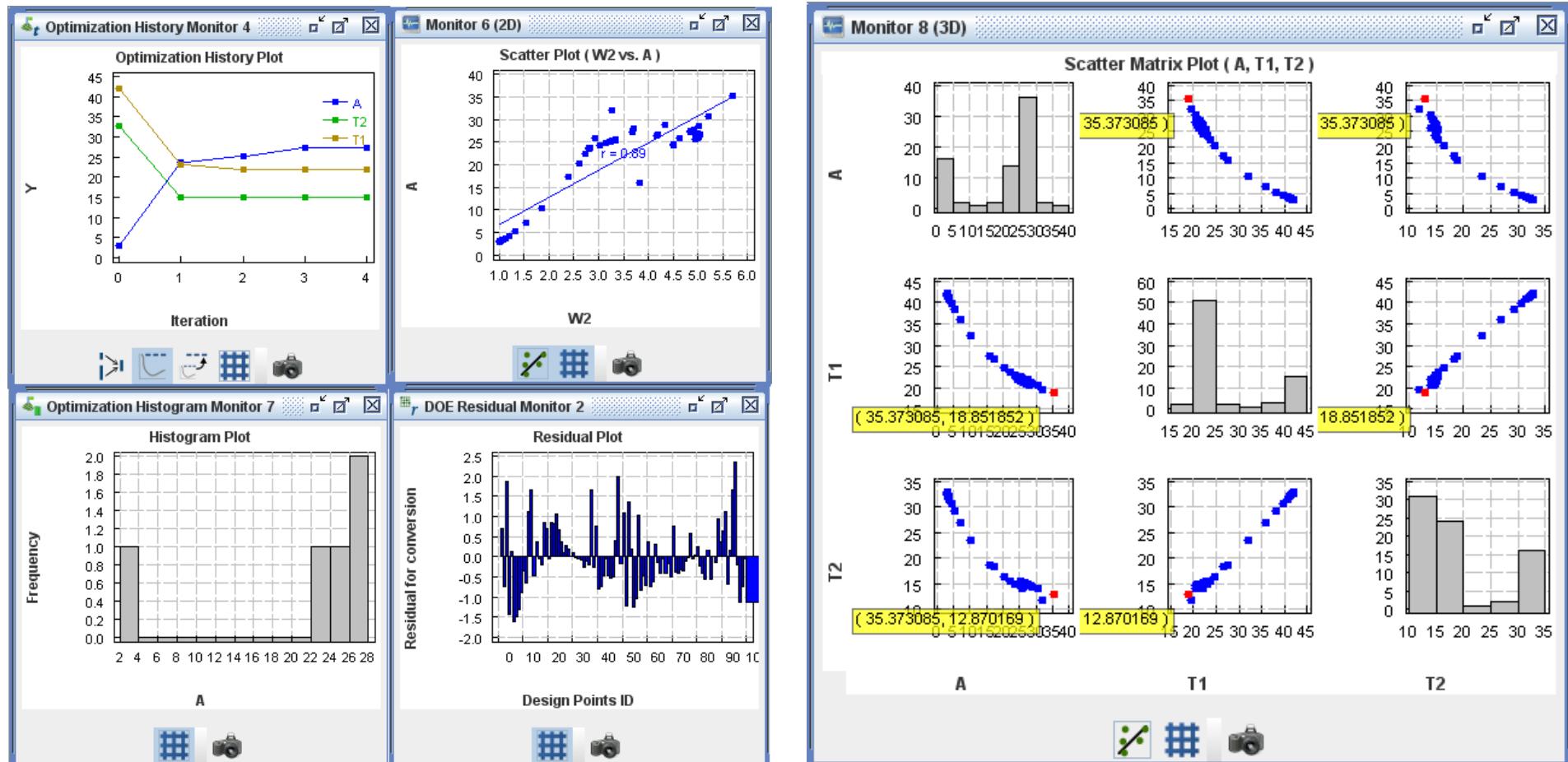


- Real-time monitoring of simulation data
- Visualization plots, tables, animations, etc.
- Simulation monitors can be added/edited before, during, or after a simulation run
- Any number and types of monitors can be added
- Do not interfere with model execution

Simulation Monitors



Simulation Monitors

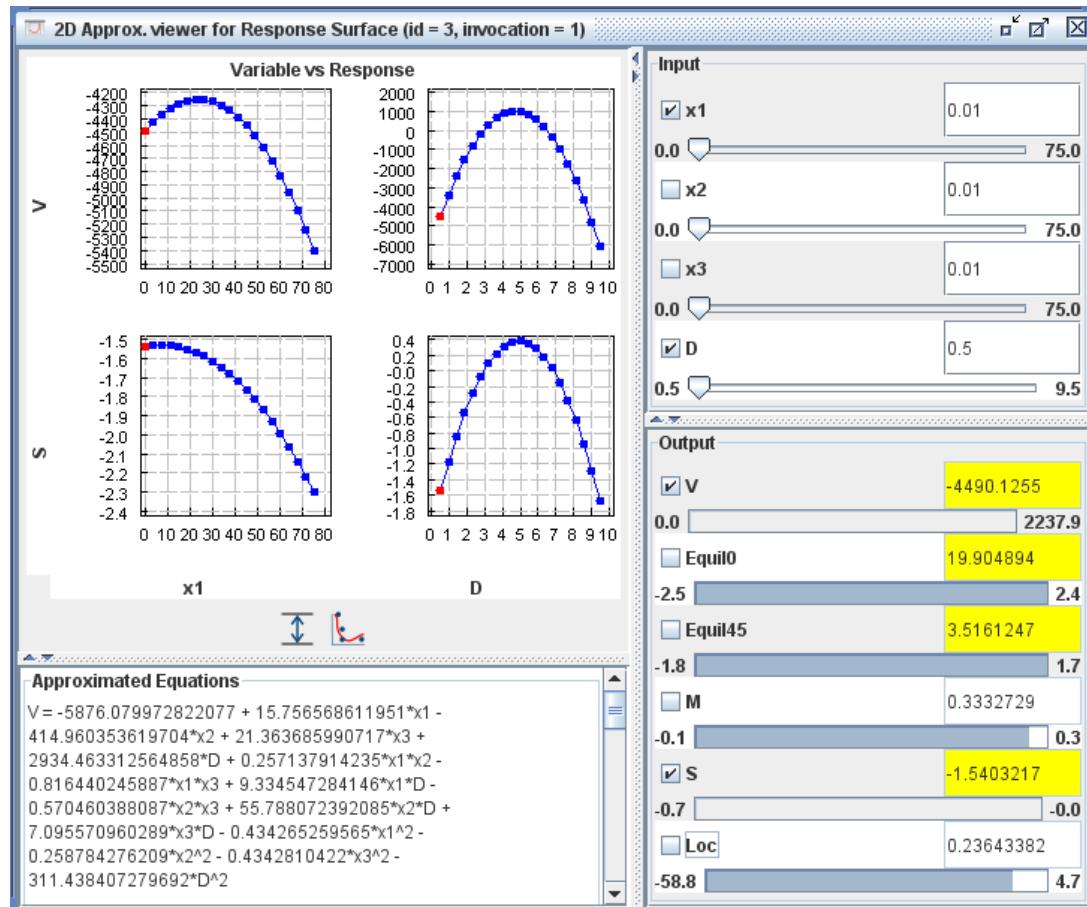


Post Processing



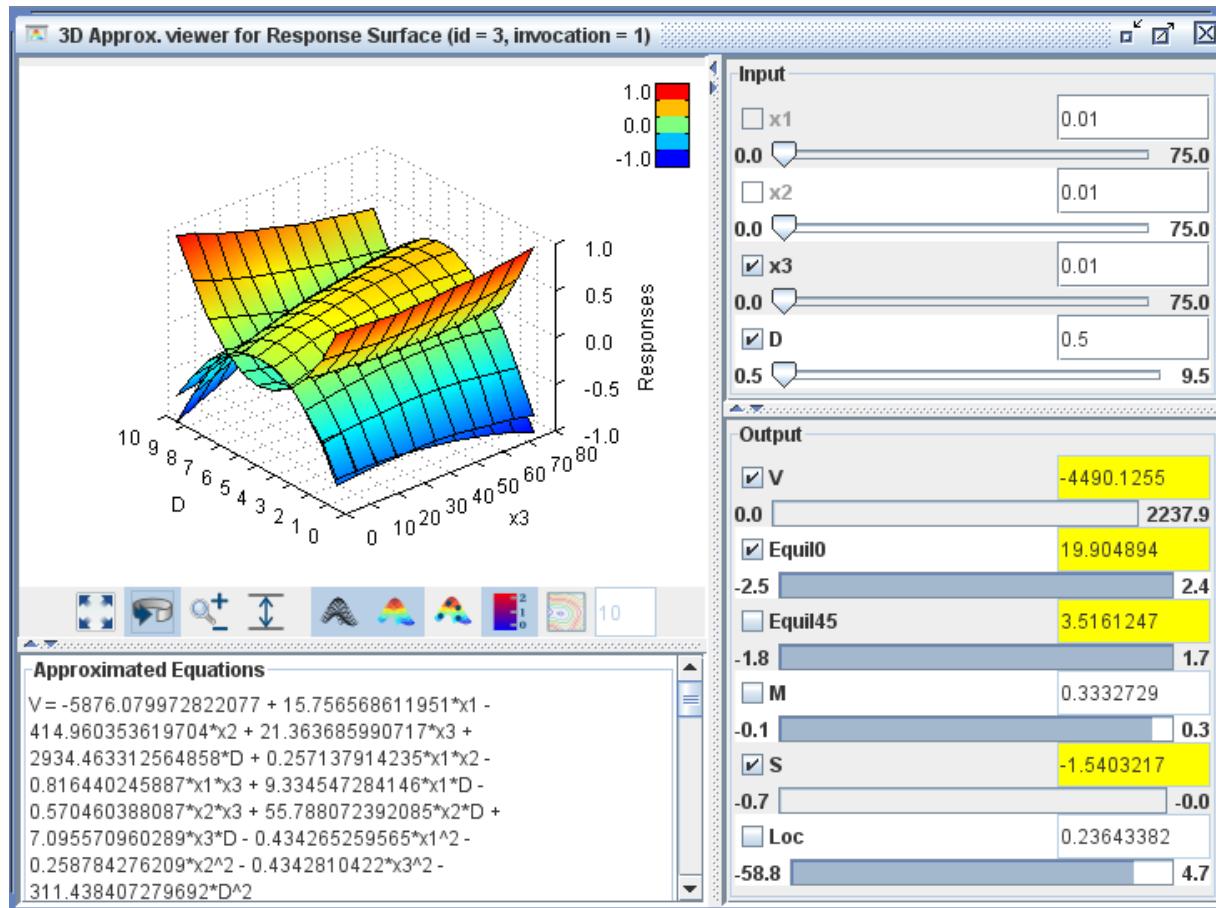
- Performed only after a component's execution has finished
- Summary reports, design point tables, visualization plots etc.
- Interactive visualization tools (e.g. Approximation viewer for DOE)
- Extract/store simulation data – a flexible and intuitive interface to choose the data to extract

Post Processing



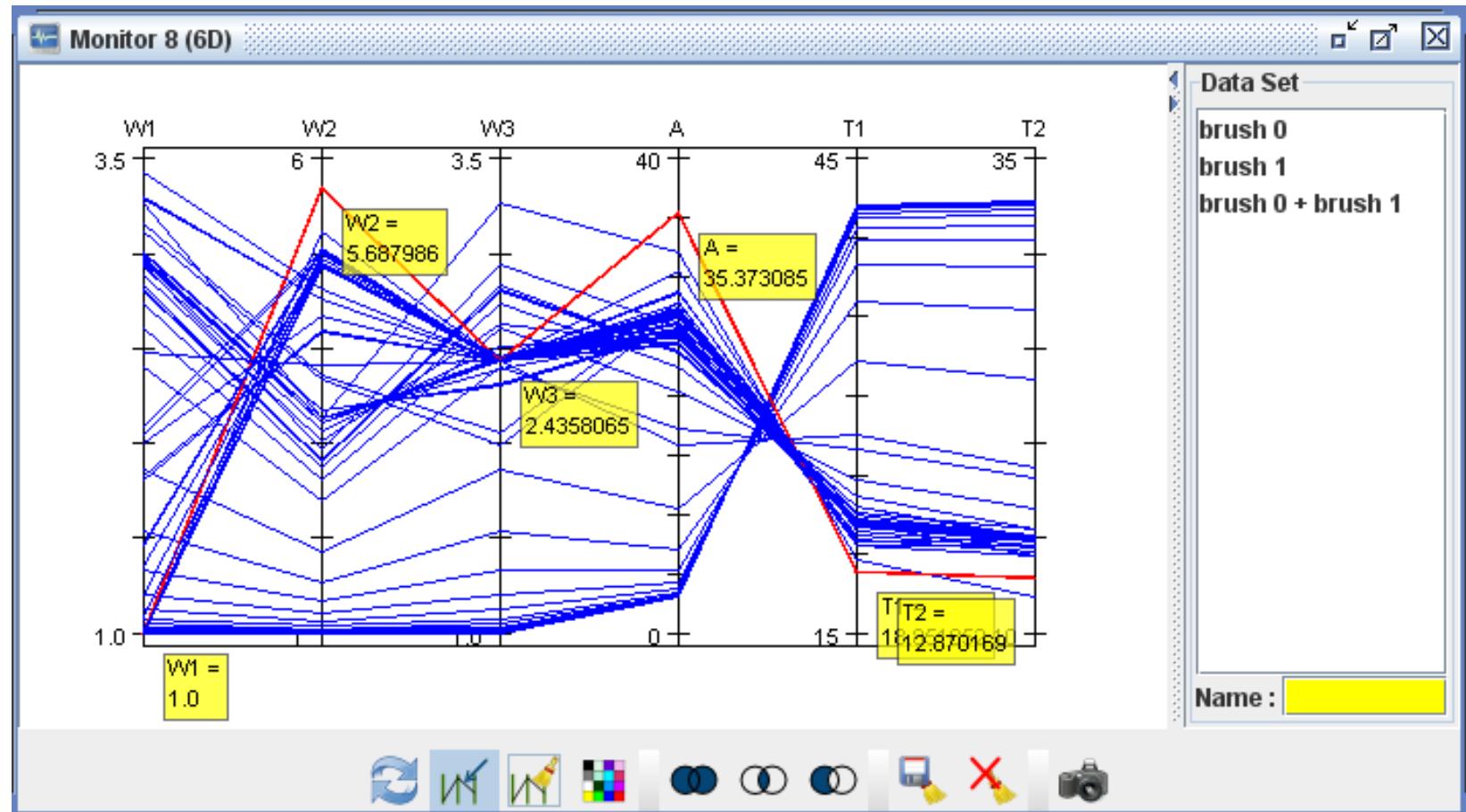
Approximation Viewer

Post Processing



Approximation Viewer

Post Processing



Parallel Plots

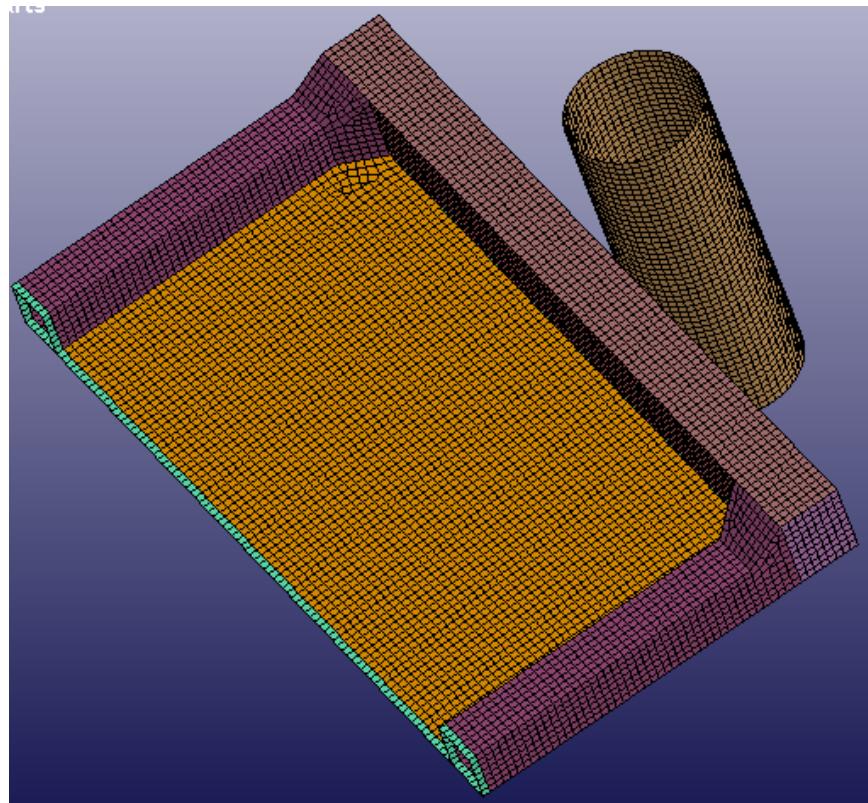


Examples

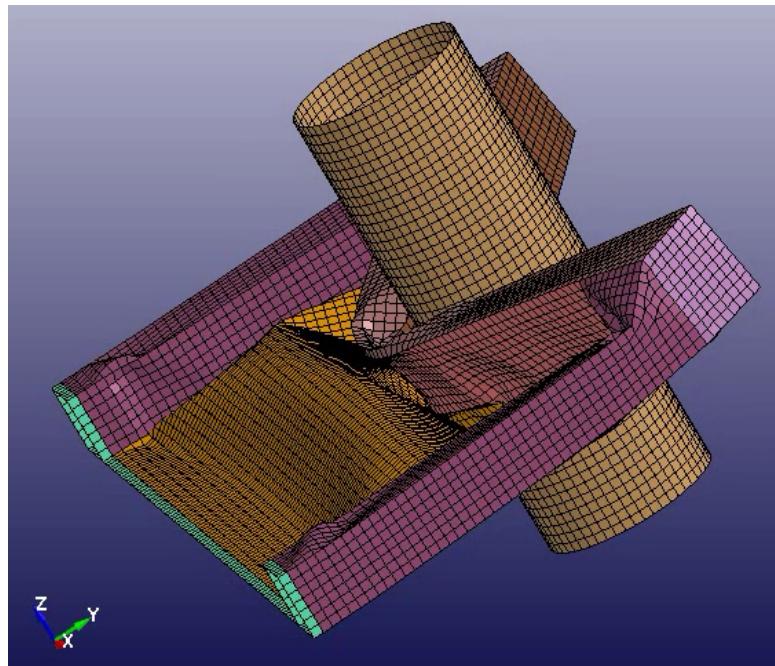
Barrier Design Example



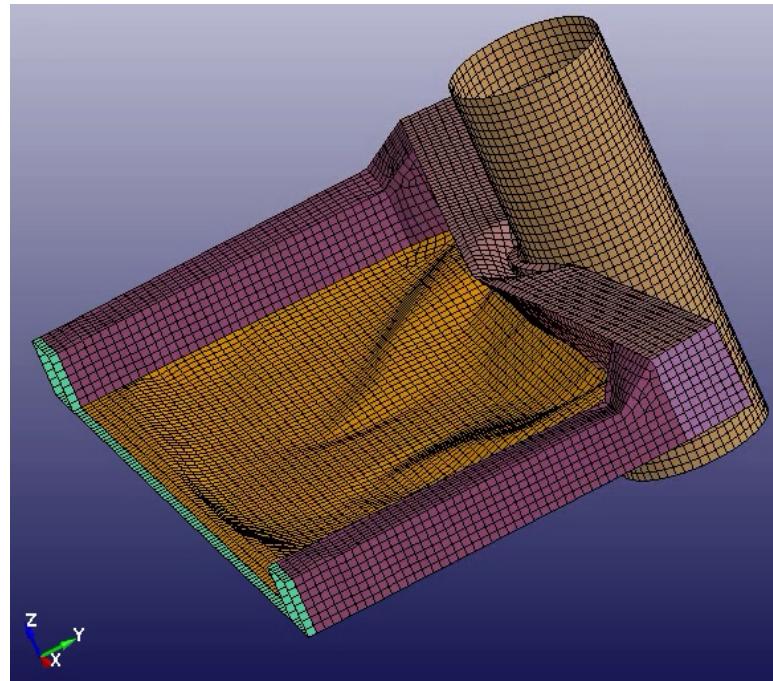
- Desired: lightest structure for specified deformation
- Minimize mass subject to deflection constraints
- LS-DYNA used for analysis



Barrier Design Example



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

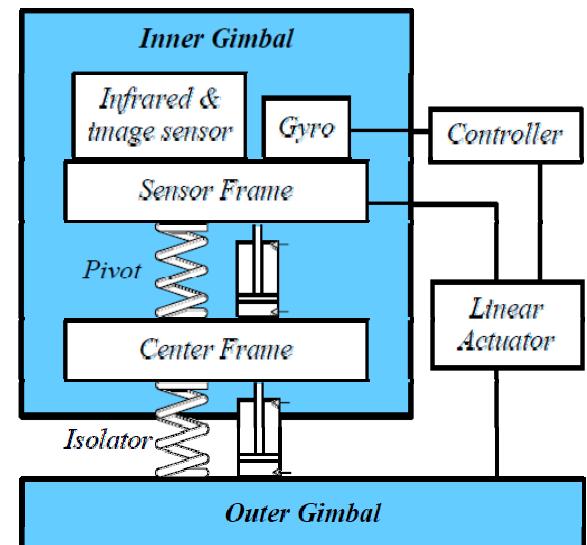


Final optimized (feasible) design
Mass = 17.19 kg
Deflection = 129.86 mm

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



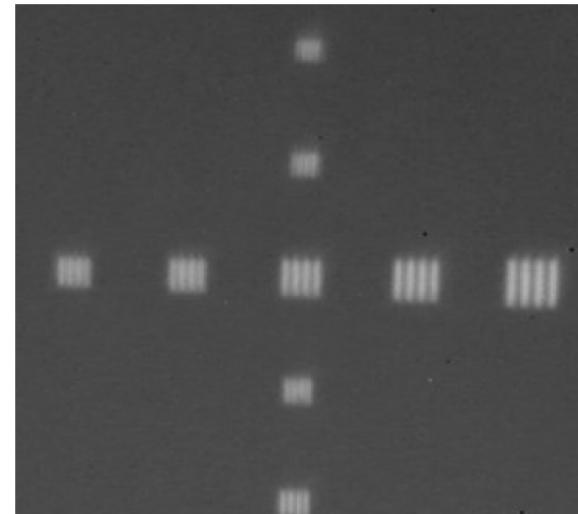
Dynamic Balancing of Gimbaled Assembly



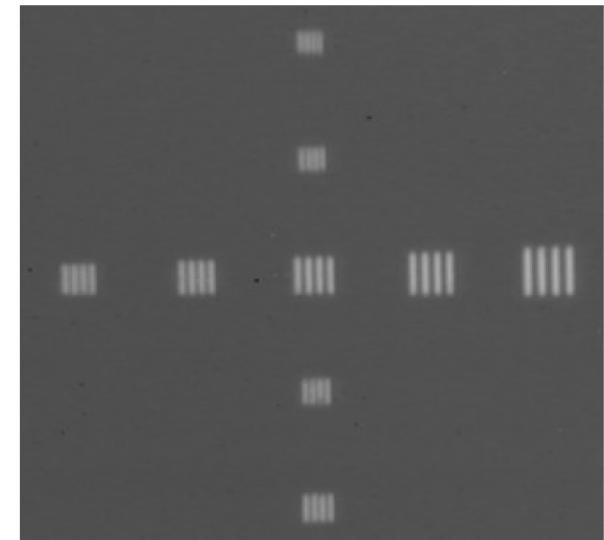
➤ Results

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

Image obtained
from the sensor
mounted on the
Gimbal



Initial

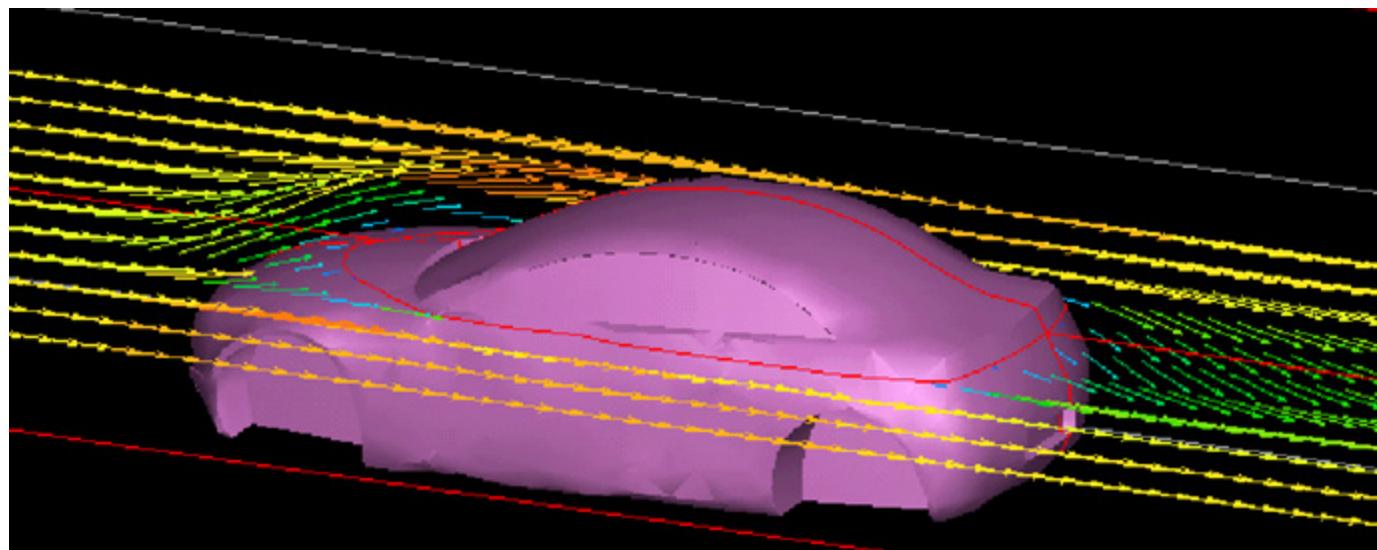


Optimal

Shape Design of an Automobile



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

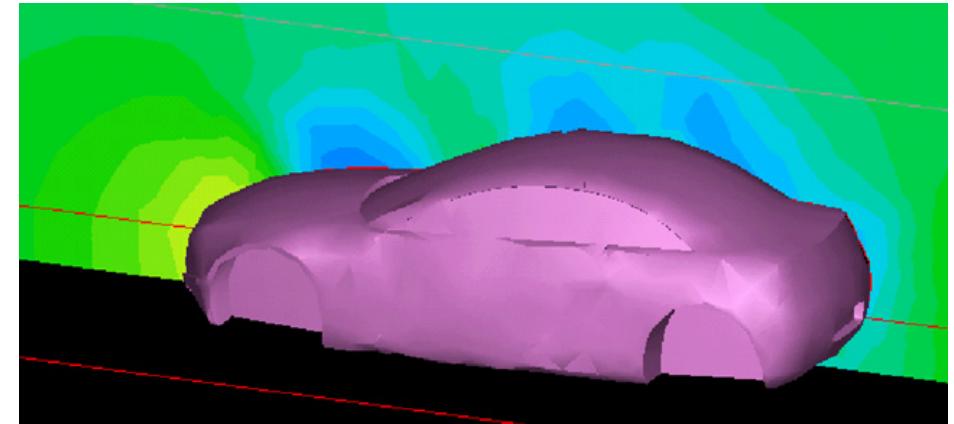
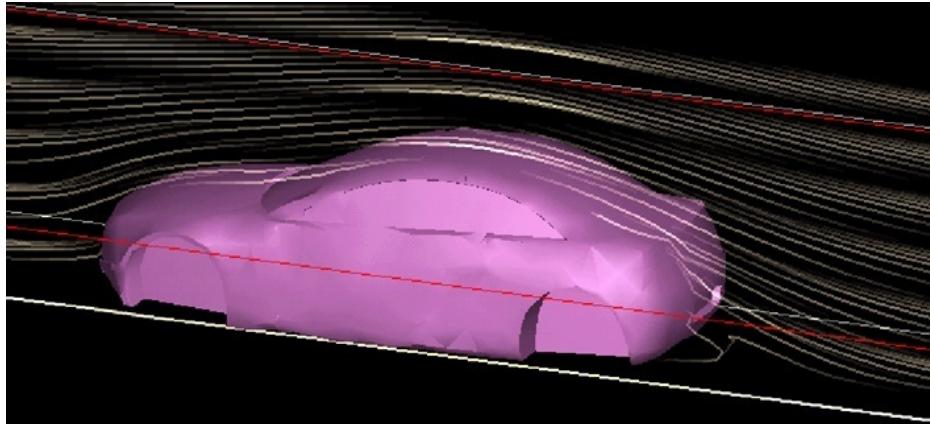


Vehicle details removed

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

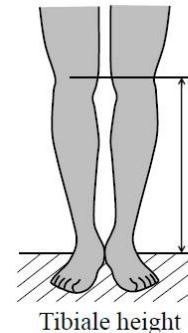
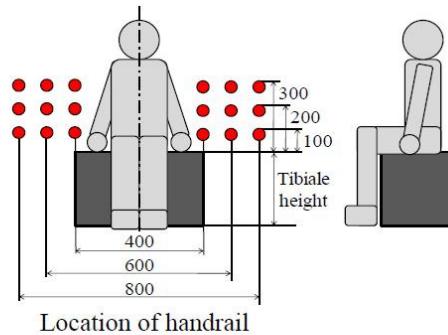


- **Multi-objective optimization of hand-rails for Sit-to-Stand movement**
- **Experimental verification with live subjects**
- **Minimize the muscle load**
 - Optimization results verified using surface electromyograms

Design of Ergonomic Hand-Rails



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



(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