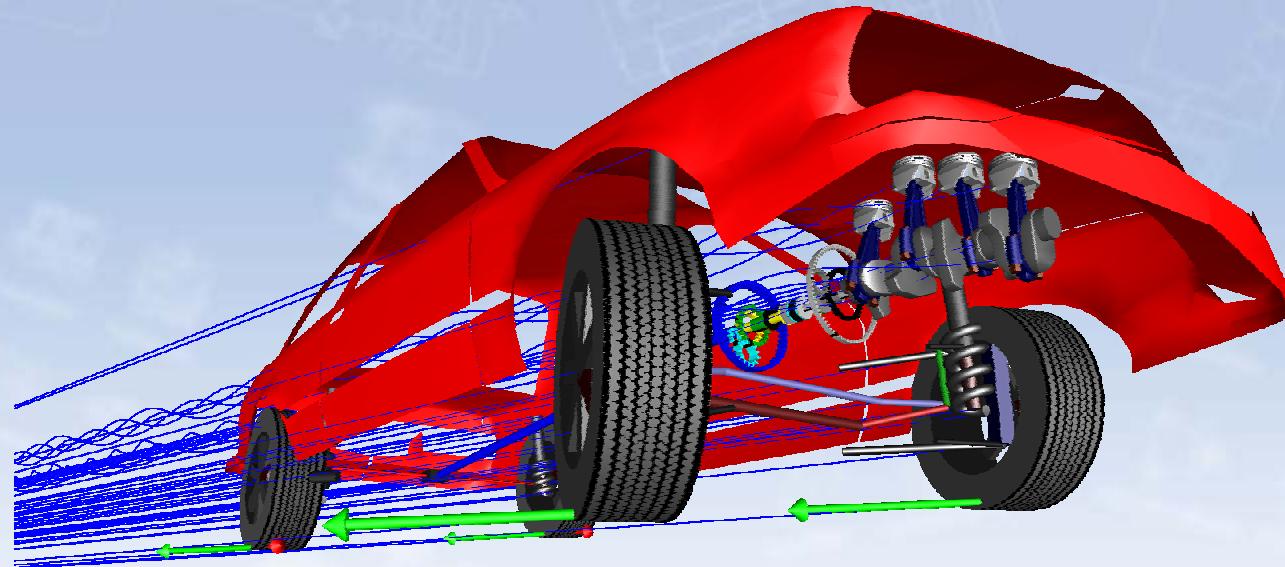


# Dymola 6

*Dynasim AB, Lund*



# Highlights in Dymola 6

**Model Calibration**

**Design Optimization**

**Model Experimentation**

**3D Visualization**

**User Designed dialogs**

**New scripting facilities**

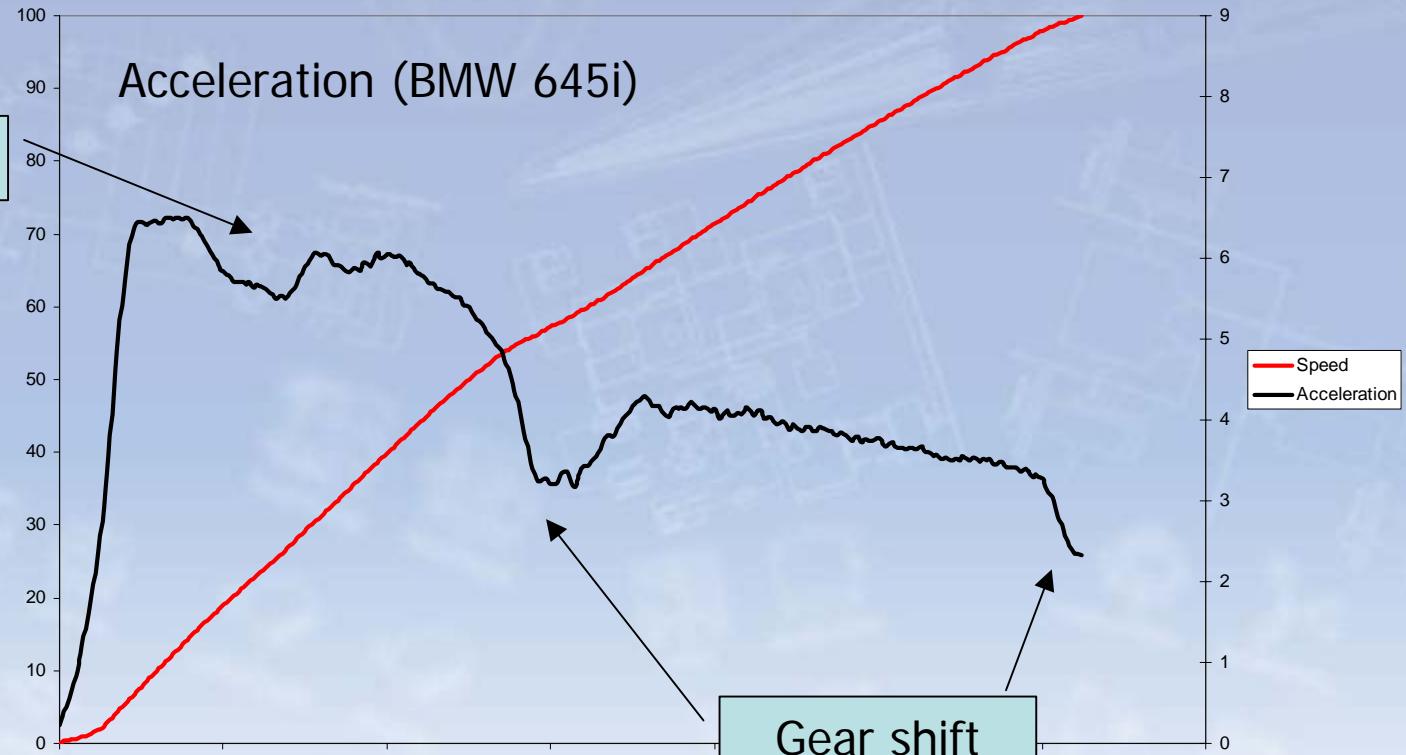
**Model management**



# Model Calibration

Determine unknown model parameters from transient measurements.

Anti spin control



Source: Auto Mobil, Issue 2, 2005



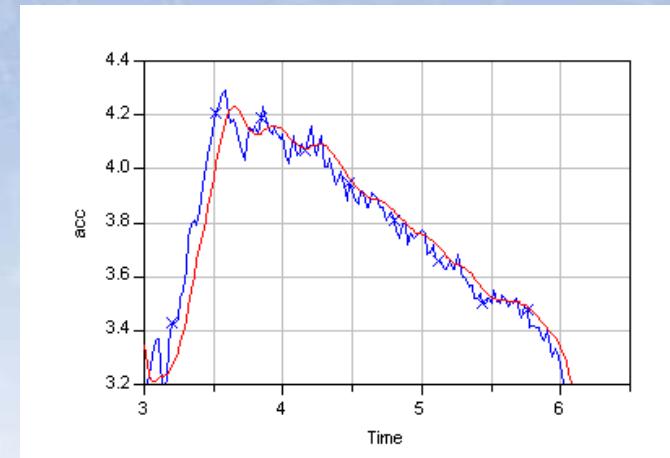
# Measurement data

- CSV files
- Matlab 4 mat files

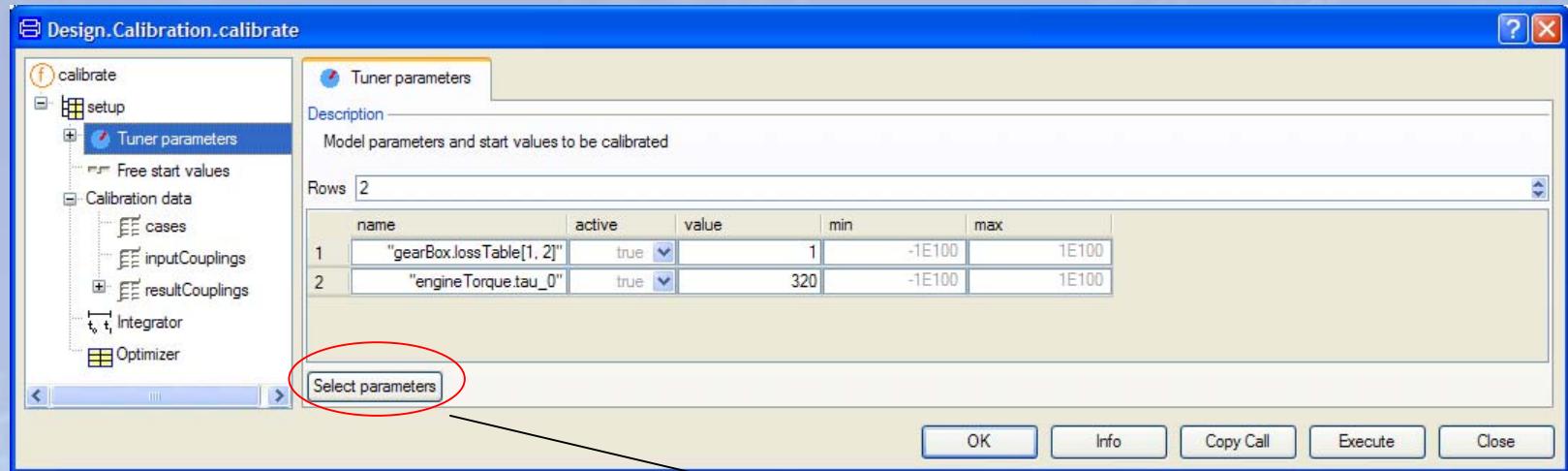
	A	B	C	D
1	time	speed	dist	acc
2	0	0	0	0.22
3	0.02	0.2	0	0.33
191	3.78	68.1	37.84	4.14
192	3.8	68.4	38.22	4.16
193	3.82	68.7	38.6	4.13

## Preprocessing data

- Detrending data
- Filter design and denoising
- Limitating data

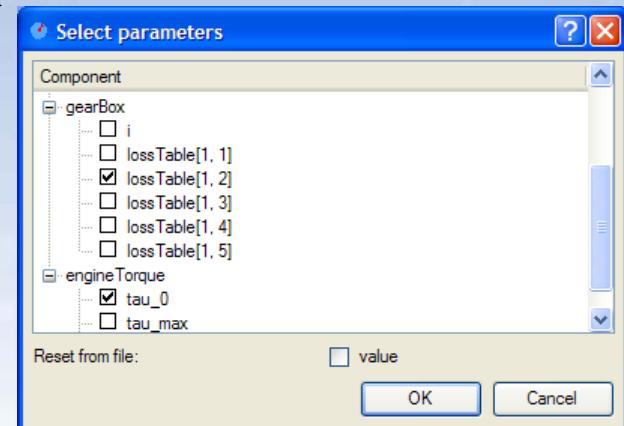


# Easy setup



Dialog with model, and data browsers to specify

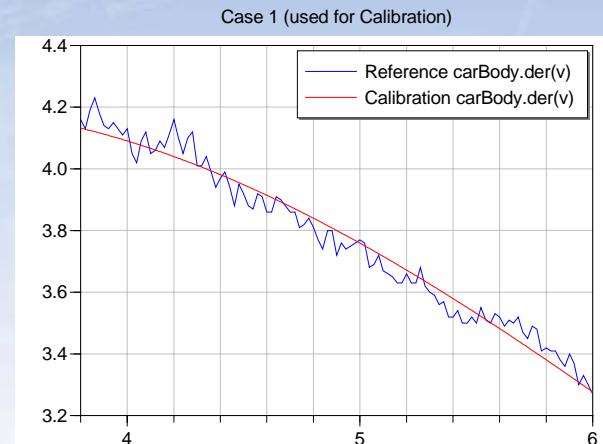
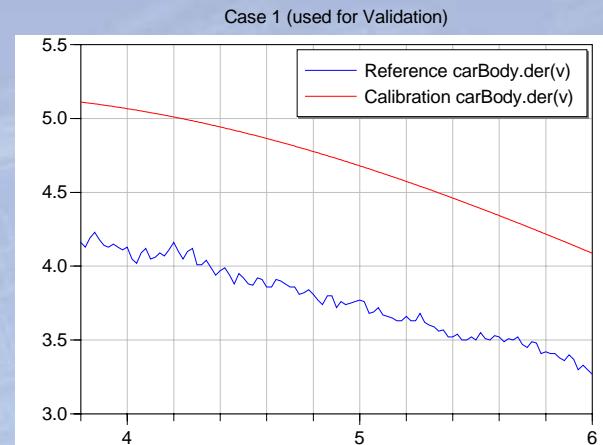
- Tuners (parameters or initial values)
- Measurement files
- Couplings between model and measurements
- Case dependent parameters and initial values



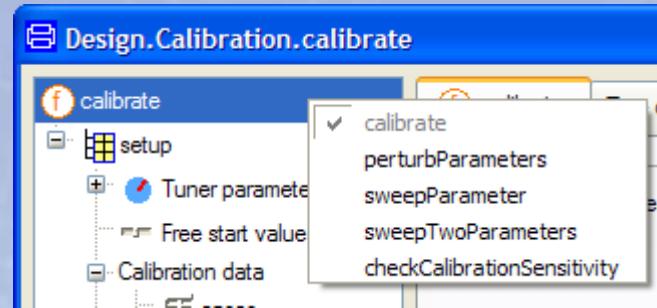
# Example: BMW 645i acceleration

Nominal model: No losses,  
Efficiency = 1

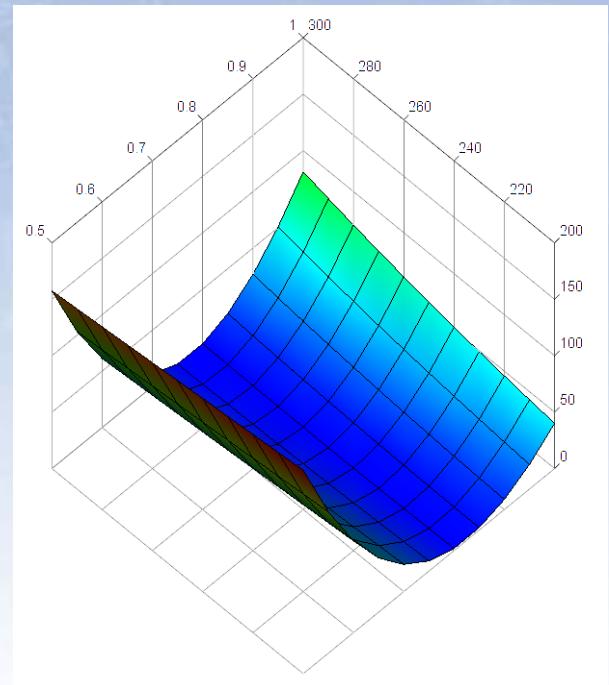
Tuning  
Efficiency: 0.80



# Similar operations with the same setup



- Calibration
- Validation
- Sensitivity analysis
- Parameter sweeping
- Checking calibration sensitivity



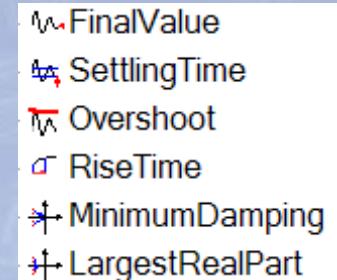
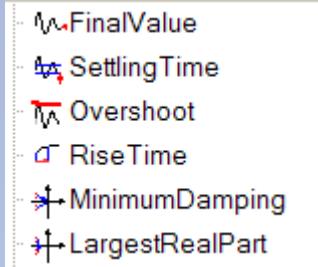
# Design Optimization

Tune parameters of device or controller  
to improve system dynamics

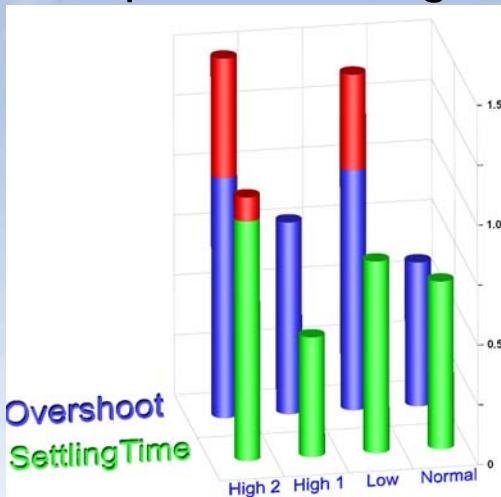


# Criteria

- multiple criteria and constraints

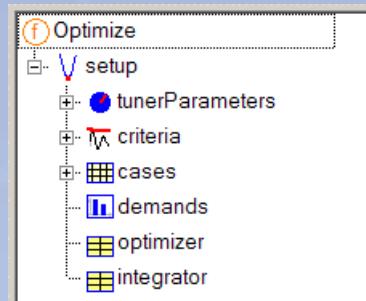


- multiple cases (e.g. different operating points)



- demand values to indicate trade-off

# Setup Dialogs



Optimize

**TunerParameter**

Description  
Model parameters to be optimized (same value for all cases)

Rows 3

	name	active	Value	min	max	autoScale
1	"kp2"	true	2	0.01	20	true
2	"ks2"	true	1	0.01	10	true
3	"Ts2"	true	0.1	0.001	1	true

Tuners

**Cases**

Rows 4

	Case	Active	startAngle2	startAngle3	endAngle2	endAngle3	mLoad
1	"High 1"	true	90	0	0	0	15
2	"Low 1"	true	90	-90	0	-90	0
3	"High 2"	true	0	90	30	90	15
4	"Low 2"	true	0	0	30	0	0

Cases

**Criterion**

Description  
Data defining one criterion for all cases

Rows 2

	active	name	criteria
1	true	"axisCriteria.overshoot.y"	FinalValue()
2	true	"axisCriteria.settlingTime.y"	FinalValue()

A dropdown menu is open over the 'FinalValue()' entry in the second row, showing a list of options: FinalValue, SettlingTime, Overshoot, RiseTime, MeanValue, MeanSquare, MaximumDev, IntegratedDev, and IntegratedSqr.

Criteria

**Demand**

Rows 4

	axisCriteria.overshoot.y	axisCriteria.settlingTime.y
High 1	0.003	0.3
Low 1	0.003	0.3
High 2	0.003	0.3
Low 2	0.003	0.3

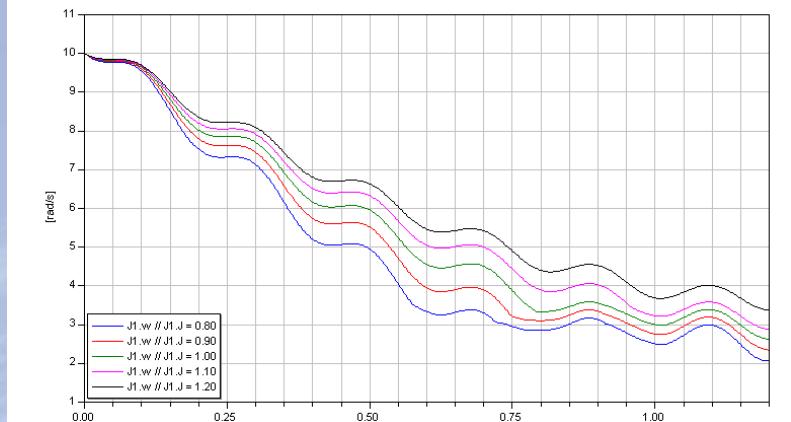
Demands



# Model Experimentation

How sensitive to parameter variations is a model?

Parameter sweeping and perturbation



$J_1.w$  when varying  $J_1.J$  from 0.8 to 1.2

Design.Experimentation.sweepTwoParameters

① sweepTwoParameters

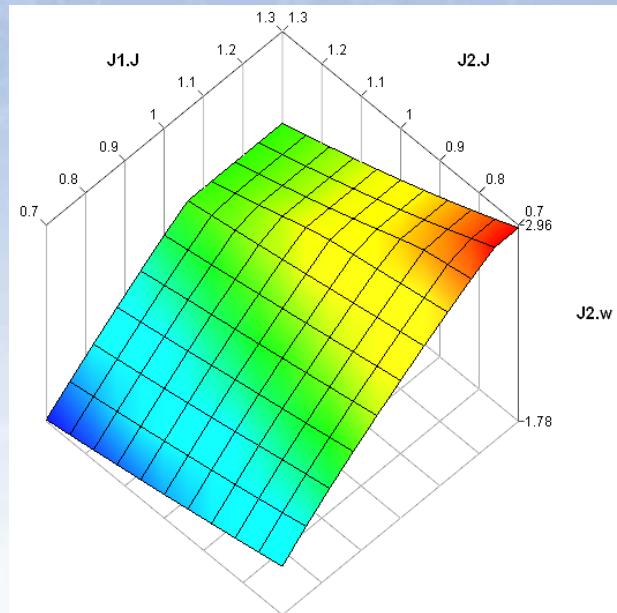
dependencyParameters

Description

Model parameters to be calibrated

Rows 2

name	Sweeping Values
"J1.J"	Design.Internal.Equidistantgrid(0.7, 1.3)
"J2.J"	Design.Internal.Equidistantgrid(0.7, 1.3)



$J_2.w$  against  $J_1.J$  and  $J_2.J$  at  $t = 1.2$



# Monte Carlo Analysis

Design.Experimentation.MonteCarloAnalysis

uncertainParameters

Description  
Model parameters to be calibrated

Rows 1

Name	minimum	maximum	Random Distribution
J1.J	-1e100	1e100	randomNormal(...)

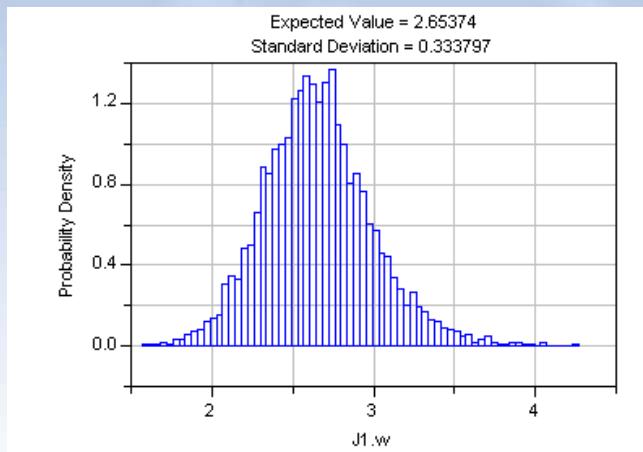
Select OK Info Copy Call Execute

randomNormal Distributions

randomNormal

Inputs  
Mean Value: 1 Standard Deviation: 0.1

OK Info Close



Gaussian variation  
of J1.J in Clutch model

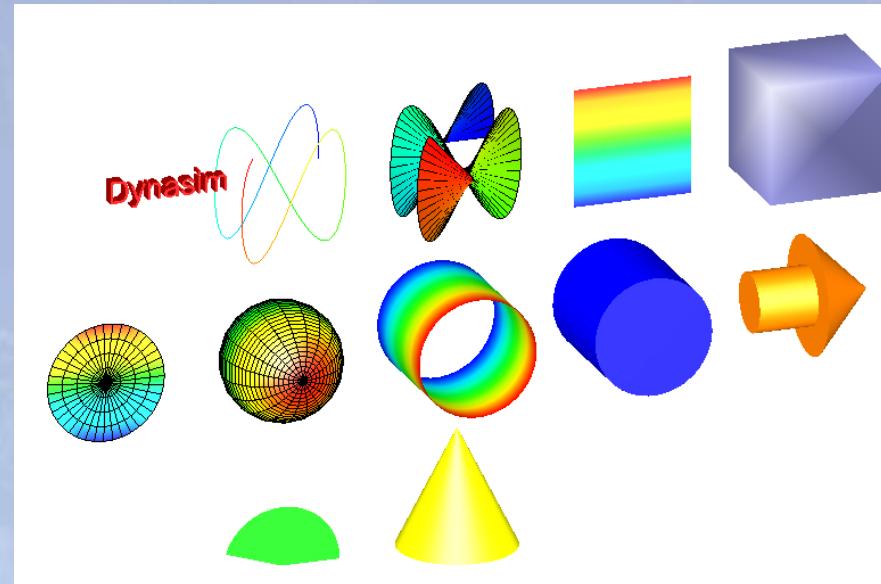
Random Distribution  
Observed in variable

J4.w at time 1.2 s

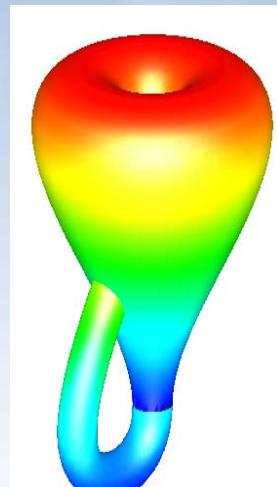


# Visualize 3D

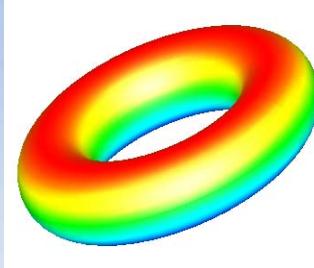
Graphical Primitives  
2D and 3D Text



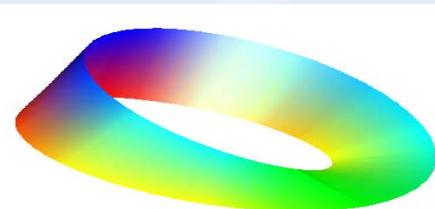
Parametric Surfaces



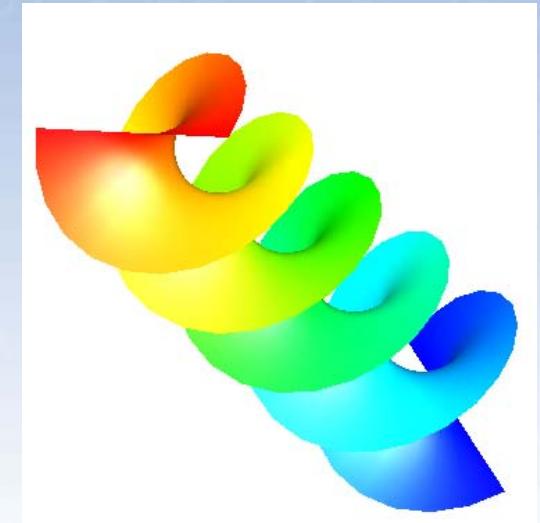
Klein Bottle



Torus



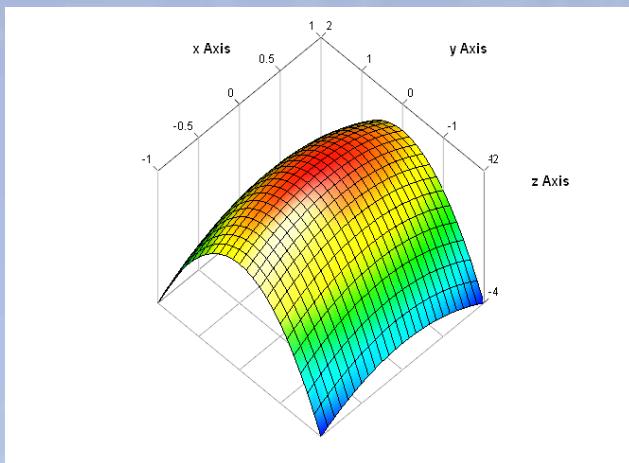
Moebius Band



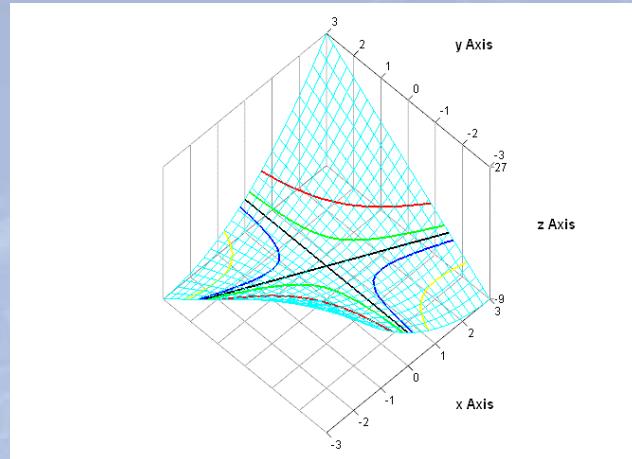
Helix



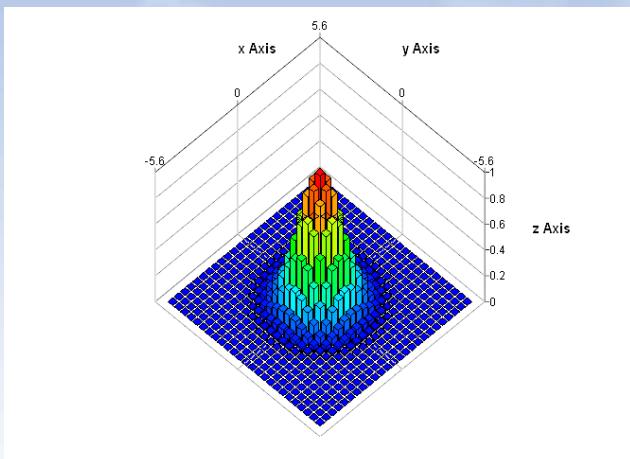
# Types of plots



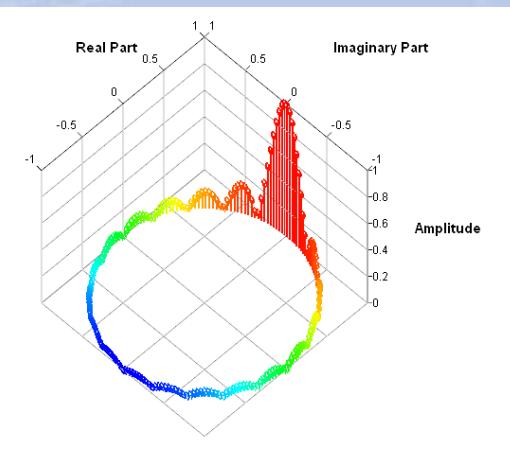
Parametric Surfaces



Level Curves



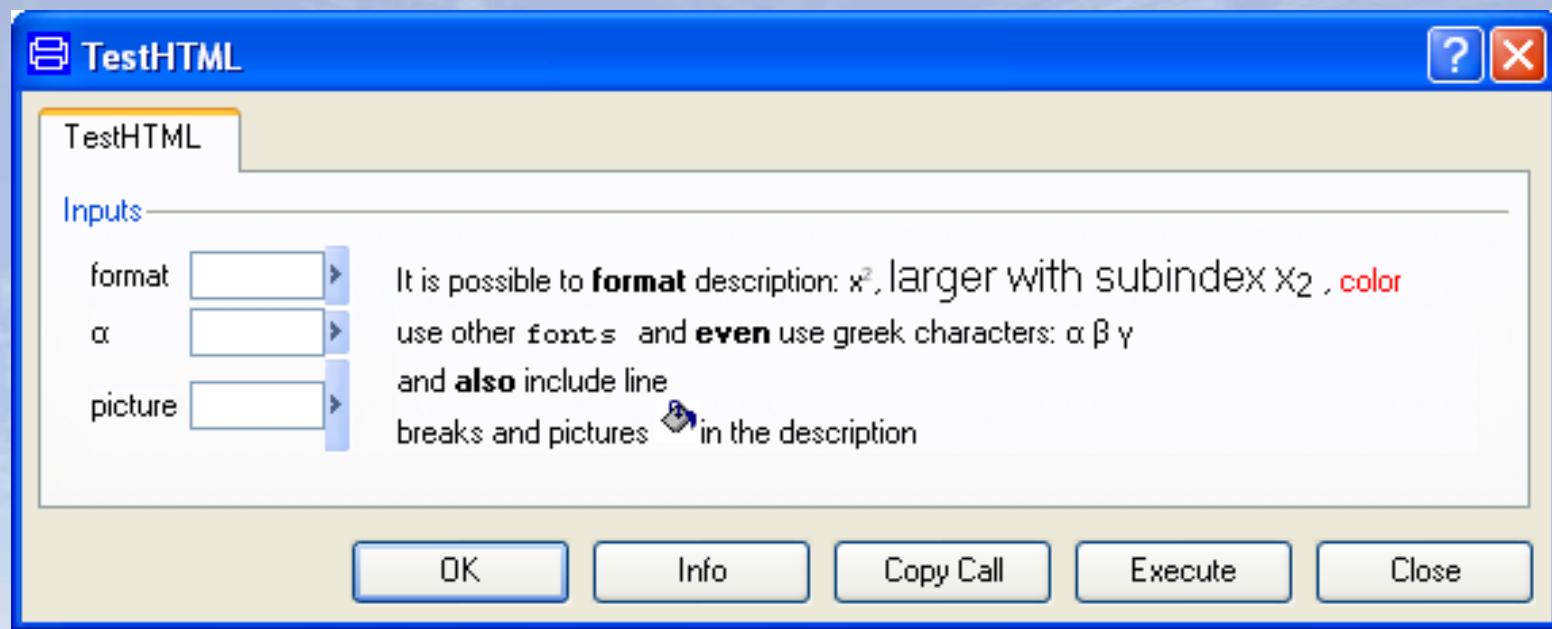
Bar Graphs



Stem Diagram



# Customizable User Interfaces

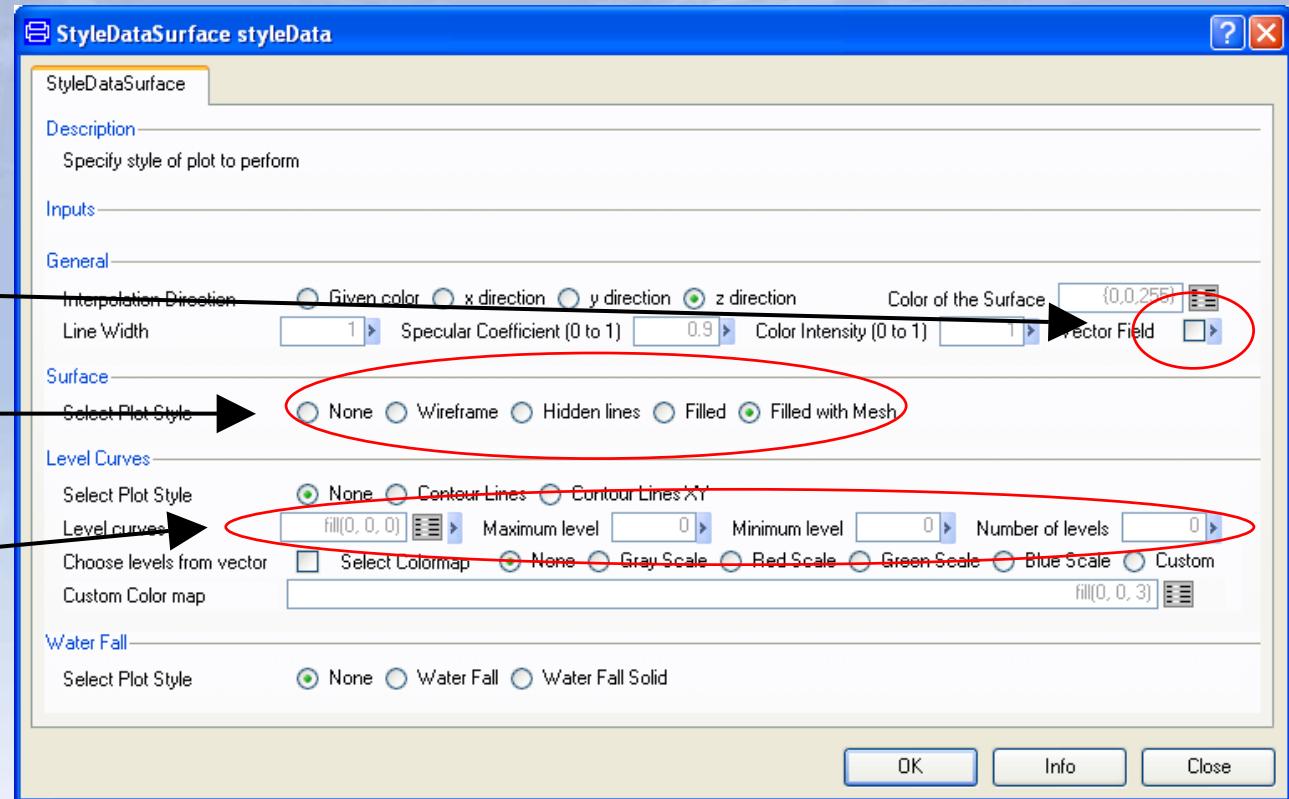


Flexible text formating in HTML

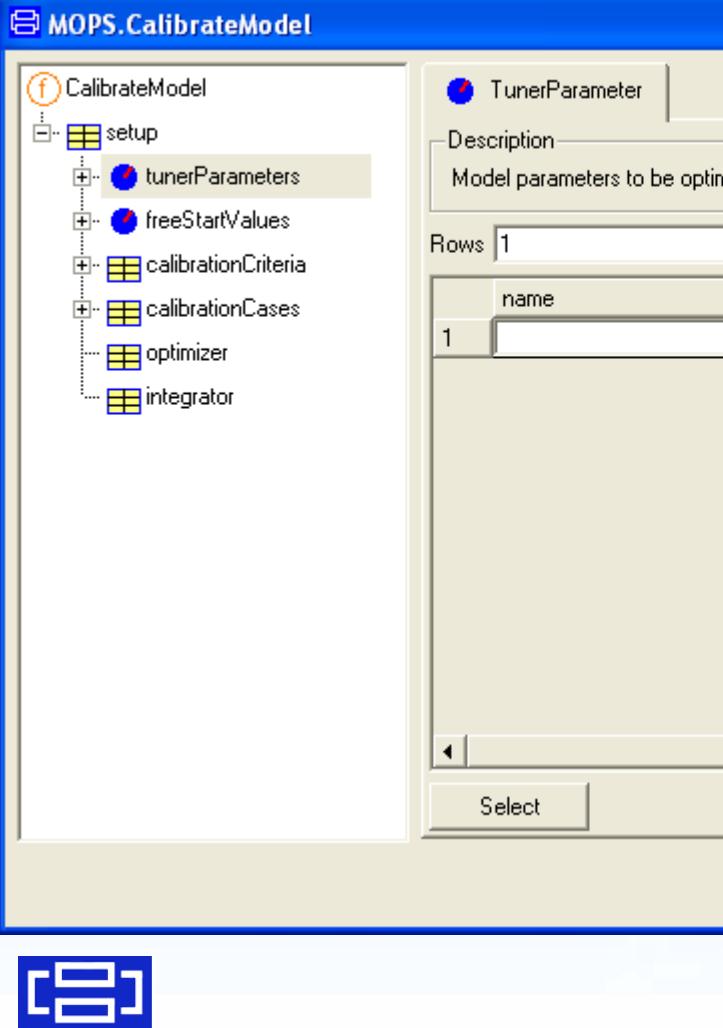


# Flexible Layout

- Check Box
- Radio Buttons
- Vertical Layout



# Nested Dialogs – Tree Browser

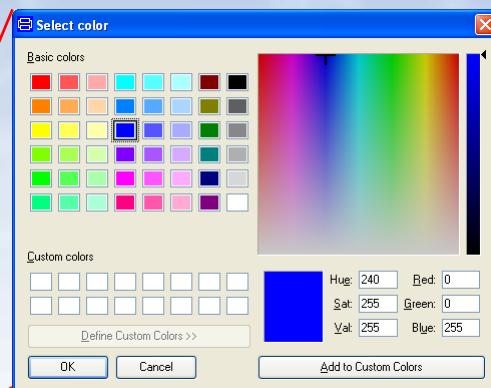
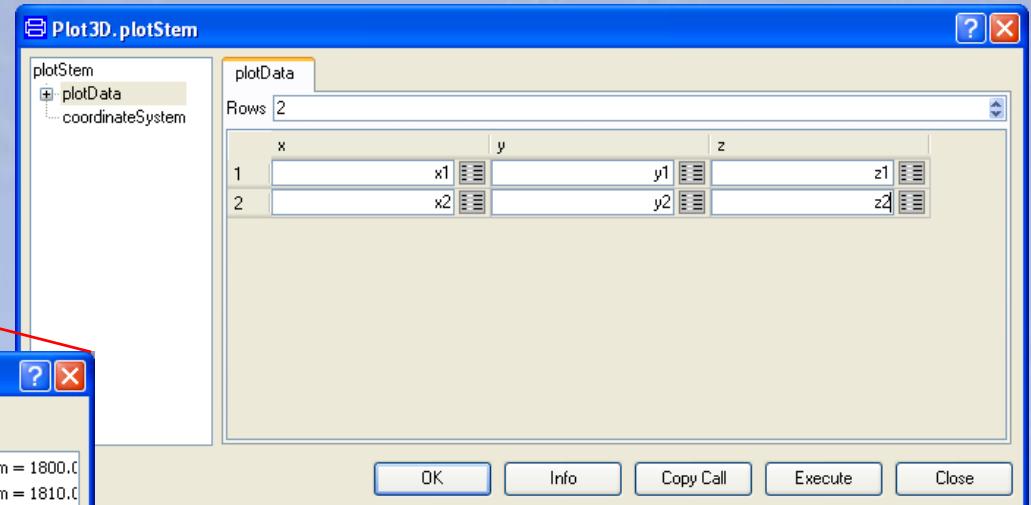
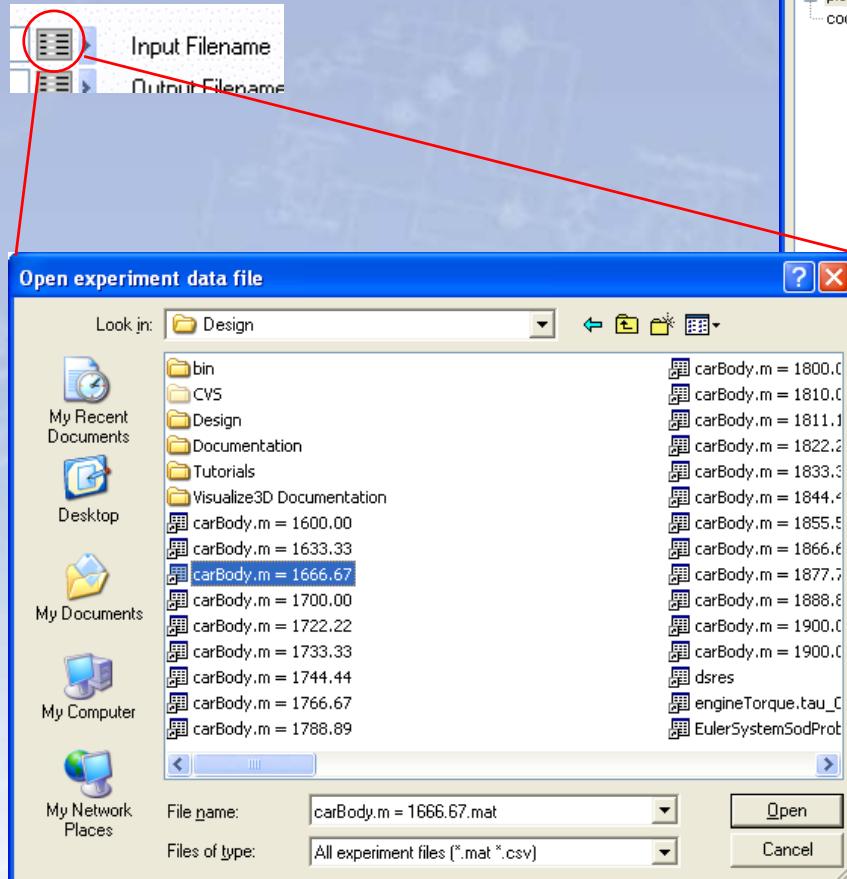


```
function CalibrateModel
    "Calibrate model to measured data"
    input ModelCalibrationSetup setup;
    ...
end CalibrateModel;

record ModelCalibrationSetup
    String Model;
    TunerParameter tunerParameters[ : ];
    ...
    Optimizer optimizer;
    Integrator integrator;
end ModelCalibrationSetup;

record TunerParameter
    "Model parameter to be optimized . . ."
    String name= "" "Full name of . . .";
    Boolean active=true "true, if . . .";
    ...
end TunerParameter;
```

# Specialized Dialogs



Color of the Surface



# Version Control

- Maintain revision history of model files
- Supports two common external tools
  - Concurrent Version System (CVS)
  - Subversion (SVN)
- Additional support in Dymola
  - Map from class name to file name
  - Reload files after “update” from repository



# Encryption

- Protection of intellectual property
  - Distribute libraries with hidden parts
  - Allow parameterization with user models
  - Fine control of what is visible or concealed
- Encryption stores file in binary format
- Scrambling removes proprietary data and structure



# Model Dependency

- Show how package depends on used classes
- Links in HTML documentation

These classes have been referenced in this package.

Class	Referenced From
<a href="#">Plot3D</a>	<a href="#">sweepTwoParameters</a>
<a href="#">Design.Internal.Records.MatCsvFileName</a>	<a href="#">dataPreprocessing</a>
<a href="#">Design.Internal.Records.MatCsvFileNameOut</a>	<a href="#">dataPreprocessing</a>
<a href="#">Design.Internal.Records.ModelCalibrationSetup</a>	<a href="#">calibrate</a> , <a href="#">checkCalibrationSensitivity</a> , <a href="#">perturbParameters</a> , <a href="#">sweepParameter</a> , <a href="#">sweepTwoParameters</a>
<a href="#">Design.Internal.Records.PerturbationParameter</a>	<a href="#">perturbParameters</a>
<a href="#">Design.Internal.Records.PreprocessingSignal</a>	<a href="#">dataPreprocessing</a>
<a href="#">Modelica.Utilities.Streams</a>	<a href="#">dataPreprocessing</a>
<a href="#">Modelica.Utilities.Streams.print</a>	<a href="#">checkCalibrationSensitivity</a> , <a href="#">sweepTwoParameters</a>
<a href="#">Modelica.Utilities.Strings</a>	<a href="#">checkCalibrationSensitivity</a> , <a href="#">perturbParameters</a> , <a href="#">sweepTwoParameters</a>
<a href="#">Modelica_LinearSystems</a>	<a href="#">dataPreprocessing</a>

