RAMDO
HyperStudy & OptiStruct
Example

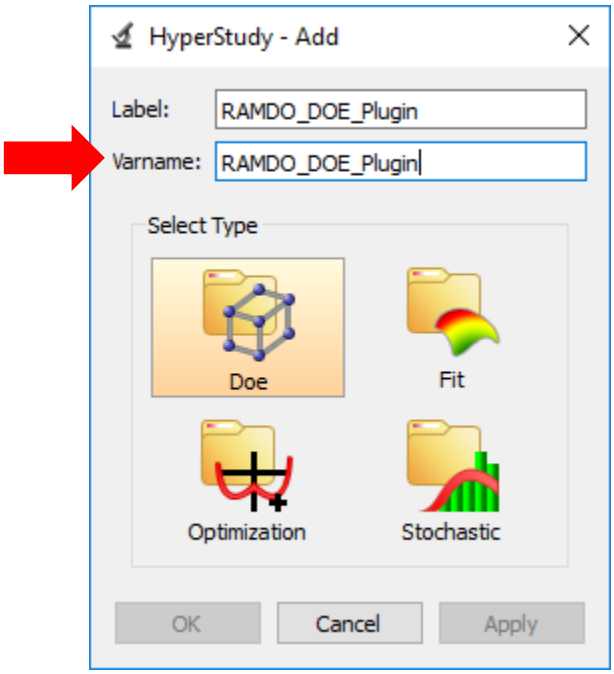
Contents

HyperStudy Model Setup

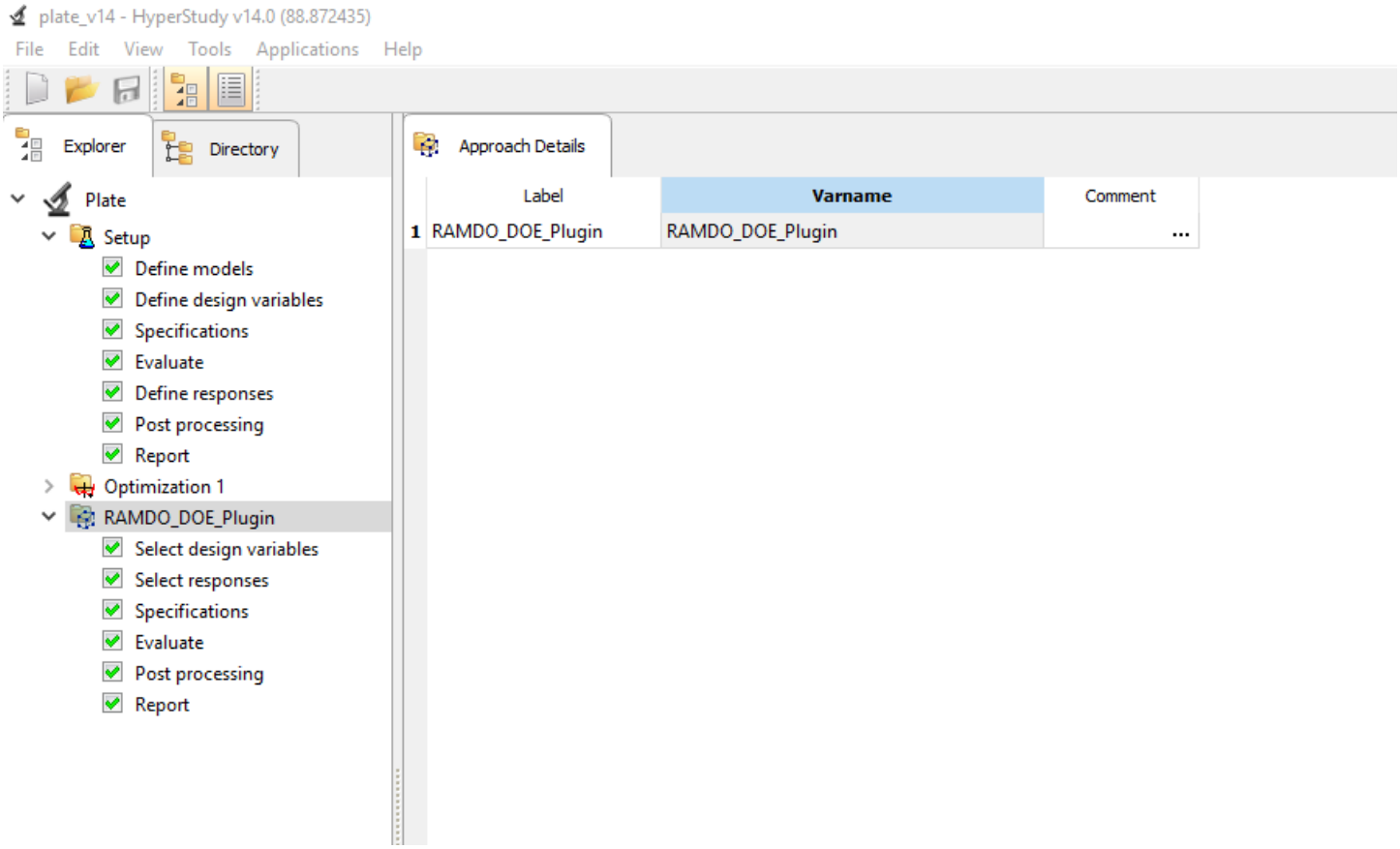
The first step to using HyperStudy with RAMDO is to setup the HyperStudy model to use a DOE Approach to connect to RAMDO. It is assumed that the user is familiar with how to setup a HyperStudy model. This example only provides the details specific for using HyperStudy with RAMDO.

Instructions

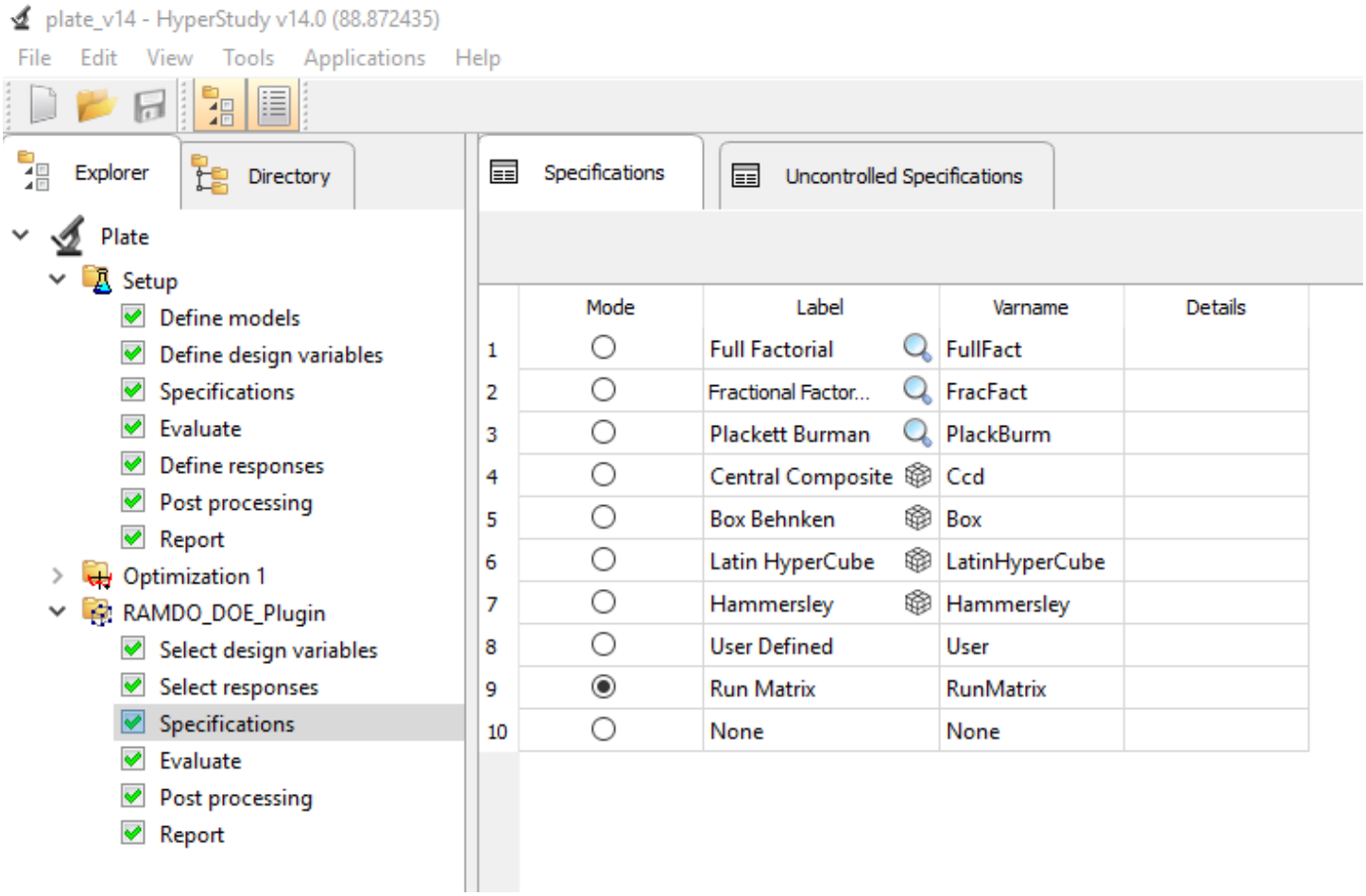
1. Following the typical process, create a HyperStudy model that links to the OptiStruct model.
2. Add a DOE Approach to the HyperStudy model.
    a. The Varname for the approach needs to be named RAMDO_DOE_Plugin
        i. This is DOE approach is how RAMDO is linked to HyperStudy. Thus, setting the variable name correctly is critical.



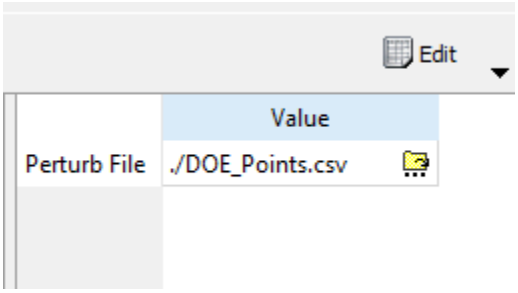
3. Note that in RAMDO all variables defined in the HyperStudy model are used, even if defined as in active in HyperStudy. Thus, the HyperStudy model should only include the variables that are to be used in RAMDO. In a future release the active state of the variable will imported into RAMDO.
4. The HyperStudy DOE approach should show the Varname as in the figure below.



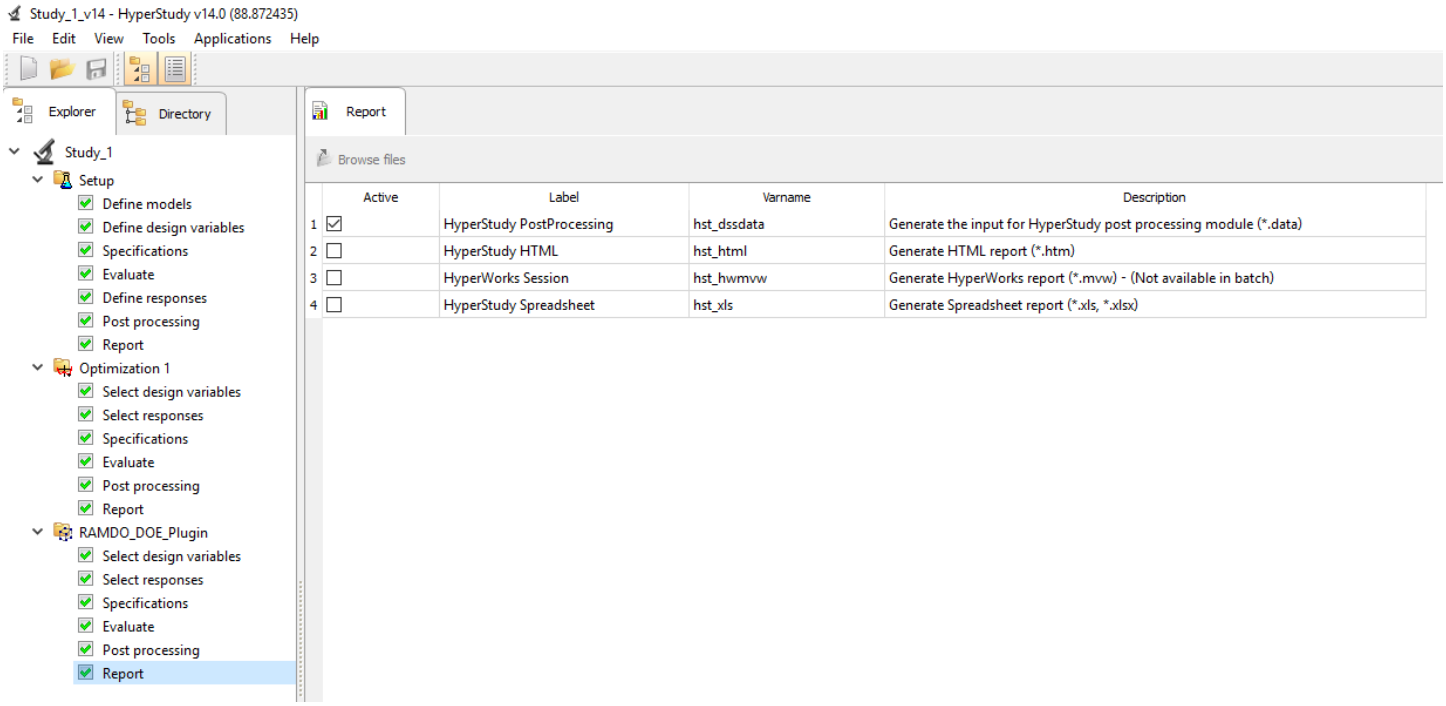
5. The Specifications node in the RAMDO_DOE_Plugin (DOE approach) needs to be configured as a Run Matrix as shown in the figure below.



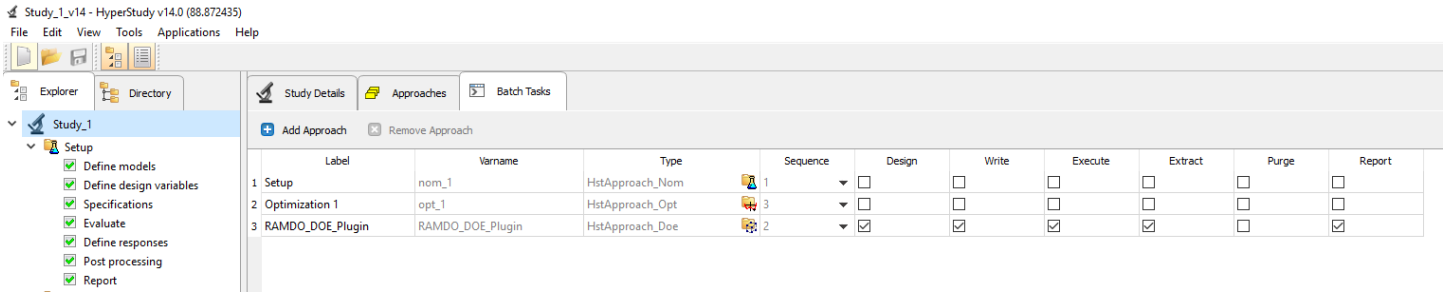
6. The Perturb File Value for the Run Matrix can be set to any CSV in any location.
    a. RAMDO will use the same name for the CSV file when it runs HyperStudy. It will not modify the original CSV. RAMDO creates a new CSV file in a new location when running HyperStudy.



7. On the Report node of the RAMDO_DOE_Plugin make sure the HyperStudy PostProcessing is checked as shown in the figure below.



8. The final step is going to select the Study in the tree and go to the Batch Tasks tab.
    a. For each listed approach in the list, uncheck all the checkboxes that are not required. Note that this is required, because when RAMDO runs HyperStudy in batch mode to evaluate the DOE, it will run every step for every approach that is checked. Thus, if an Optimization approach is checked, HyperStudy will run the full optimization approach in addition to the RAMDO_DOE_Plugin approach.
        i. Note, this does allow for linking multiple approaches together. Therefore, if multiple approaches need to run, in order, to evaluate the RAMDO_DOE_Plugin approach, then the HyperStudy model can be setup accordingly.
9. Save the HyperStudy model.
    a. Make a note of where the HyperStudy file is saved, so that in RAMDO you can browse to the HyperStudy file and find the HyperStudy XML file.
10. After setting up the HyperStudy model, proceed to start RAMDO and follow the example below.

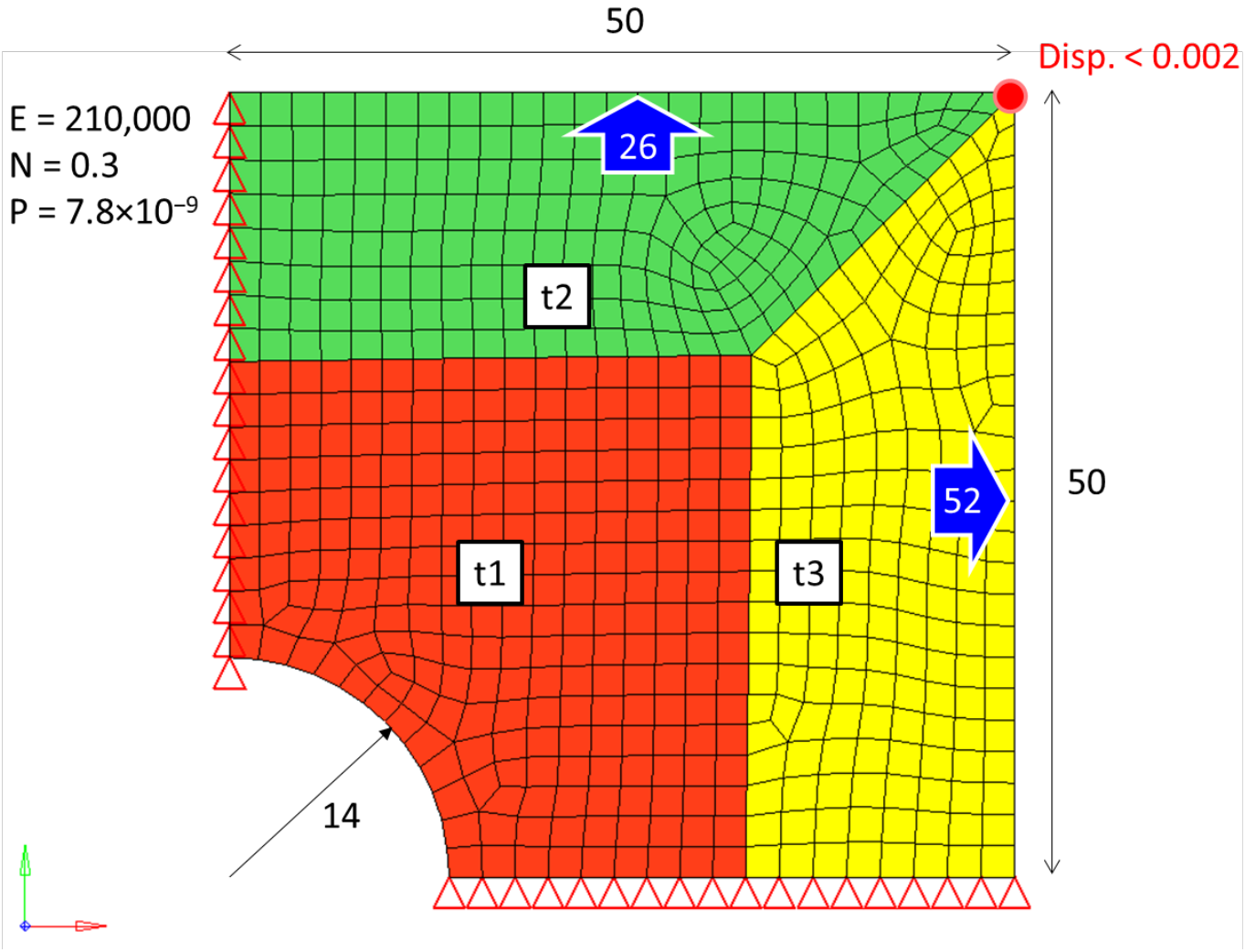


Note

The HyperStudy model can be setup to connect to any simulation solver.

HyperStudy & OptiStruct Plate Example

Problem Formulation



$Cost(\mathbf{d}) = mass\ of\ plate$
$G_1(\mathbf{X}) = Displacement\ of\ top\ right\ corner \leq 0.002$

Lower Bounds of Design $\mathbf{d} = [0.05, 0.05, 0.05]$
Upper Bounds of Design $\mathbf{d} = [0.15, \quad 0.15, 0.15]$

Initial Design $\mathbf{d}_{initial} = [0.096, 0.15, 0.082]$
Target Reliablity $= 95\%$

Random Variable	Marginal Distribution	Mean	Variance	Type
$t1$	Normal	d_1	0.3^2	Design Variable
$t2$	Normal	d_2	0.3^2	Design Variable
$t3$	Normal	d_2	0.3^2	Design Variable

Problem Definition

The plate example is a simple FE model that uses HyperStudy and OptiStruct in connection with RAMDO. There are three thickness variables. The objective is to minimize the mass of the plate and the constraint is the top right corner of the plate should have a displacement less than 0.002.

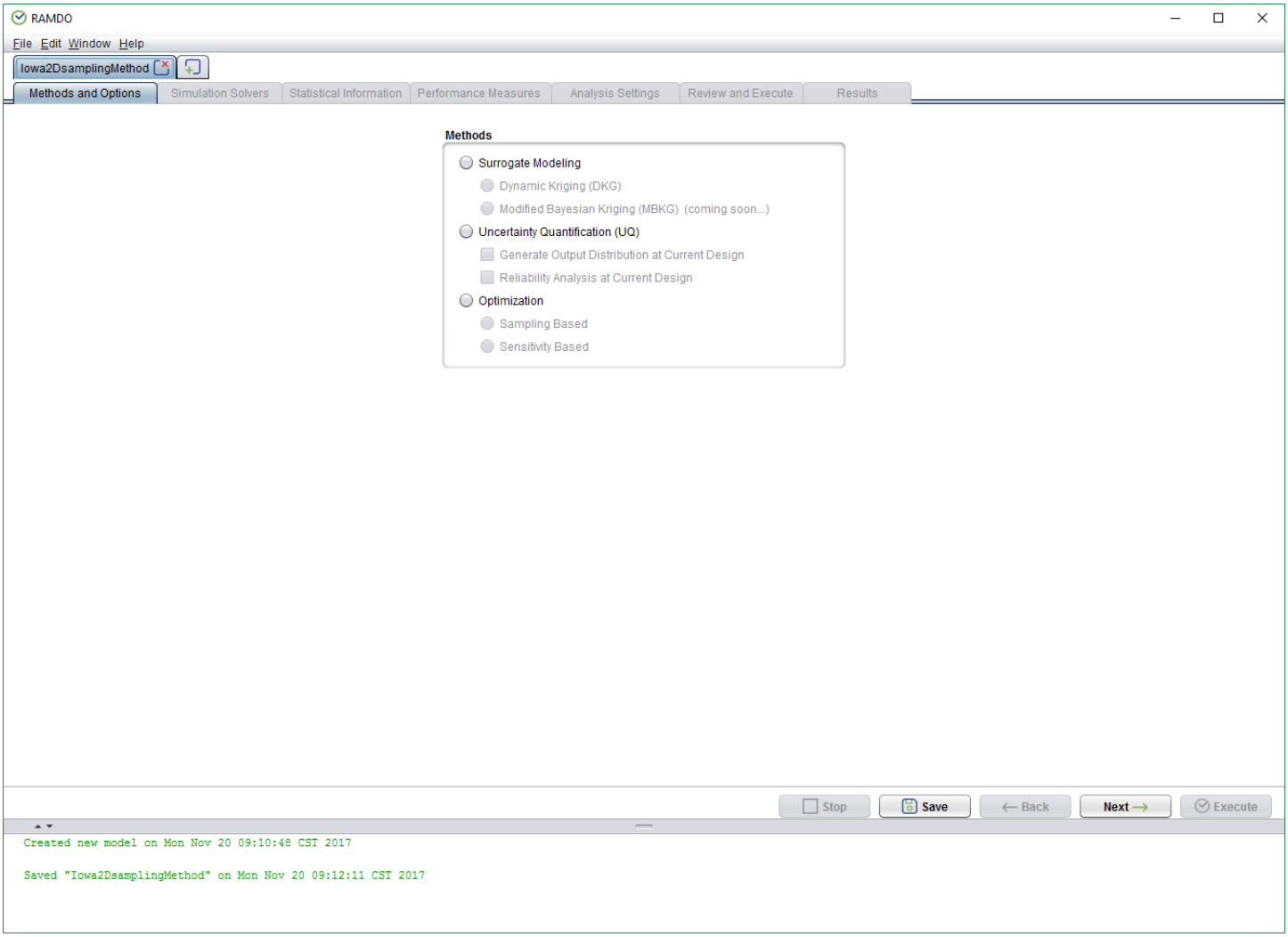
Instructions

Follow the following steps to set up and run the HyperStudy & OptiStruct Plate Example tutorial. This example will show to use HyperStudy and an existing HyperStudy model as the Simulation Solver in RAMDO. In this example OptiStruct is used as the FEA solver.

The basic process follow is RAMDO, launches HyperStudy, which in turn runs the OptiStruct simulations. HyperStudy then extracts the results from the OptiStruct simulations.

Methods and Options

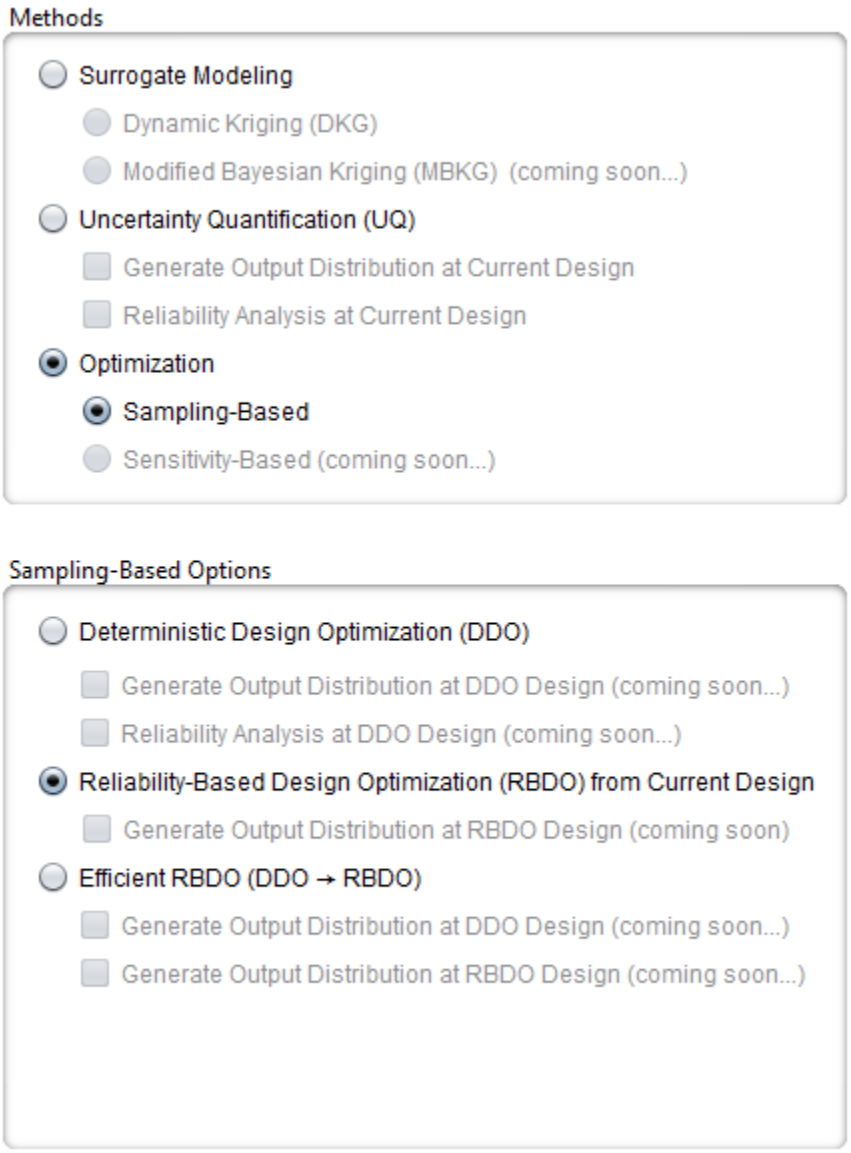
Filling out the Methods and Options page.



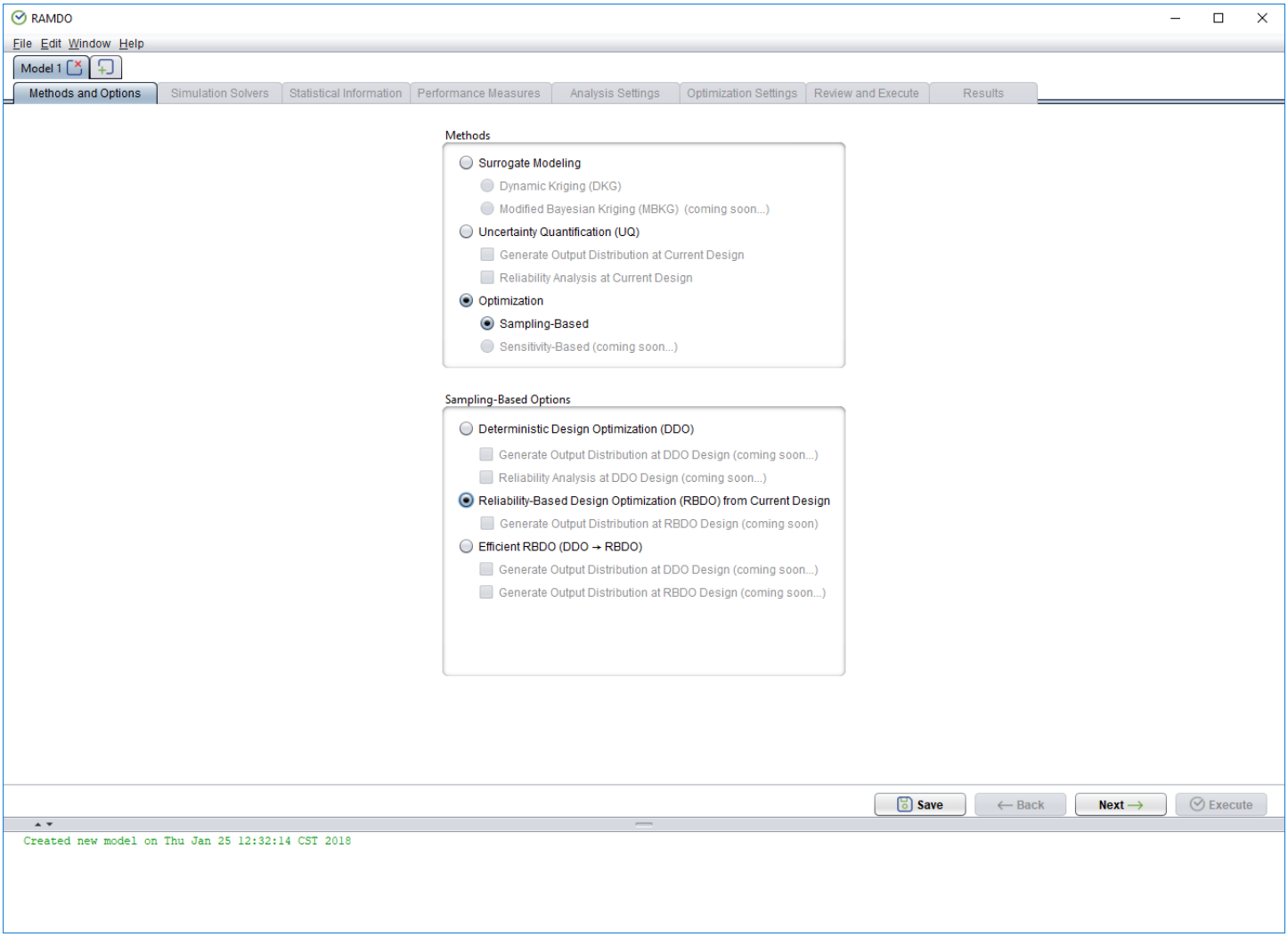
To fill out the Methods and Options form do the following:

1. Under the Method section select the **Optimization** and **Sampling-Based** methods.

2. Under the Sampling Based Options section select the **Reliability-Based Design Optimization (RBDO) from Current Design** option.



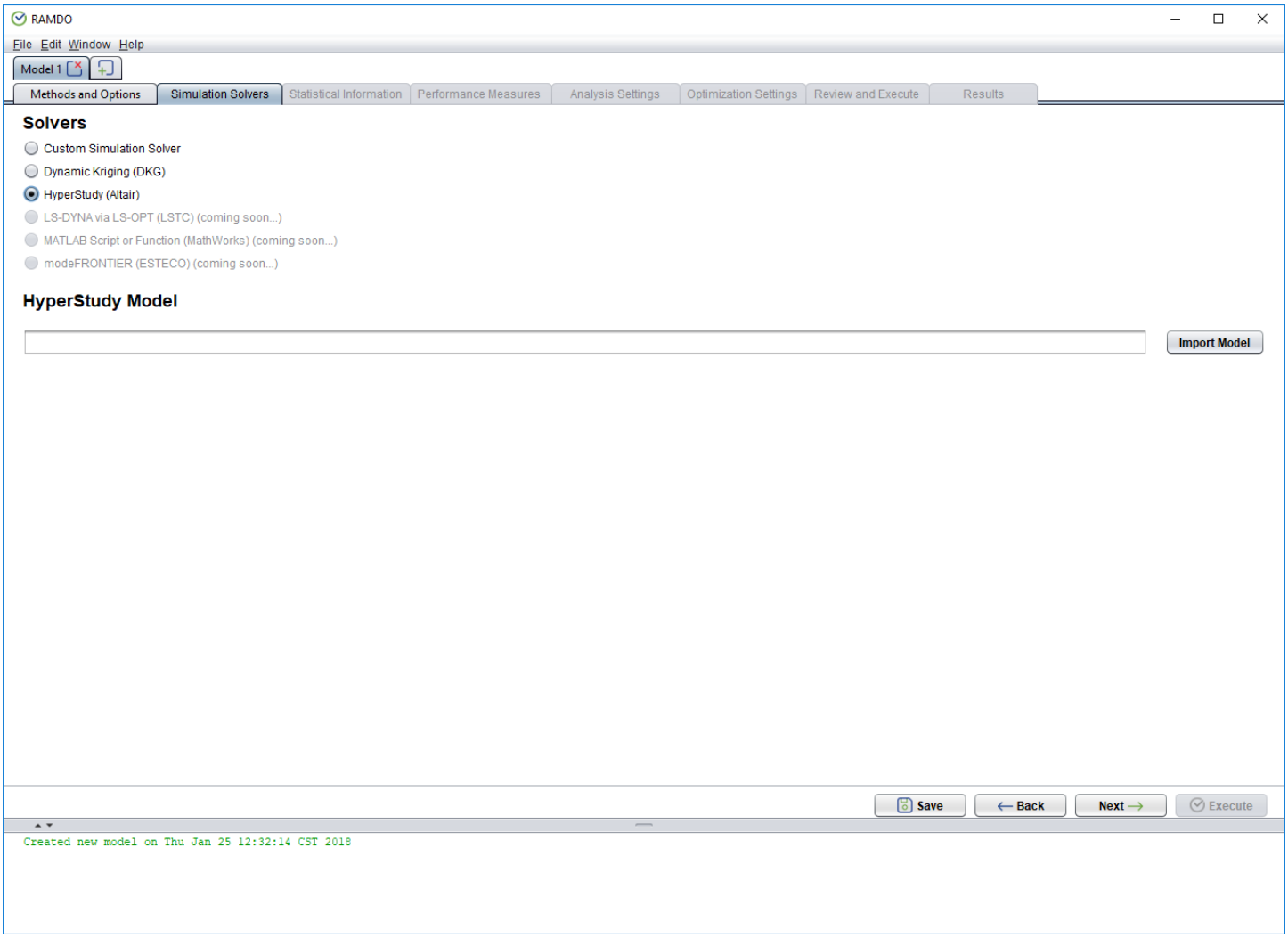
3. You should see the following in the figure below.



4. Click the **Next** button to continue to the next page.

Simulation Solvers

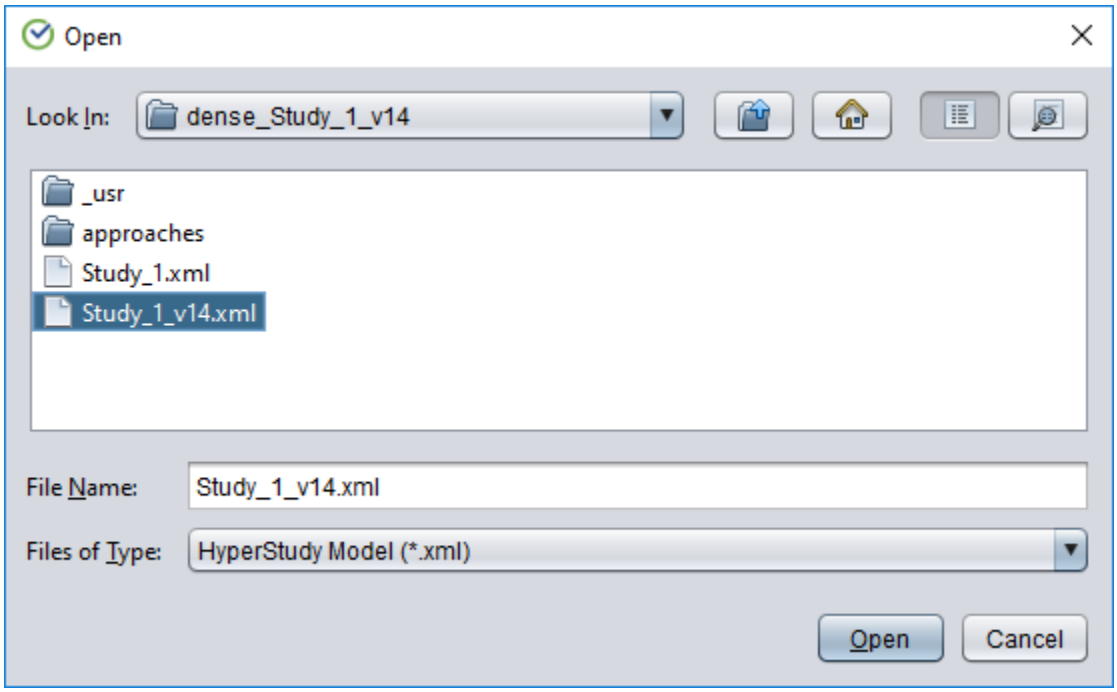
Filling out the Simulation Solvers page.



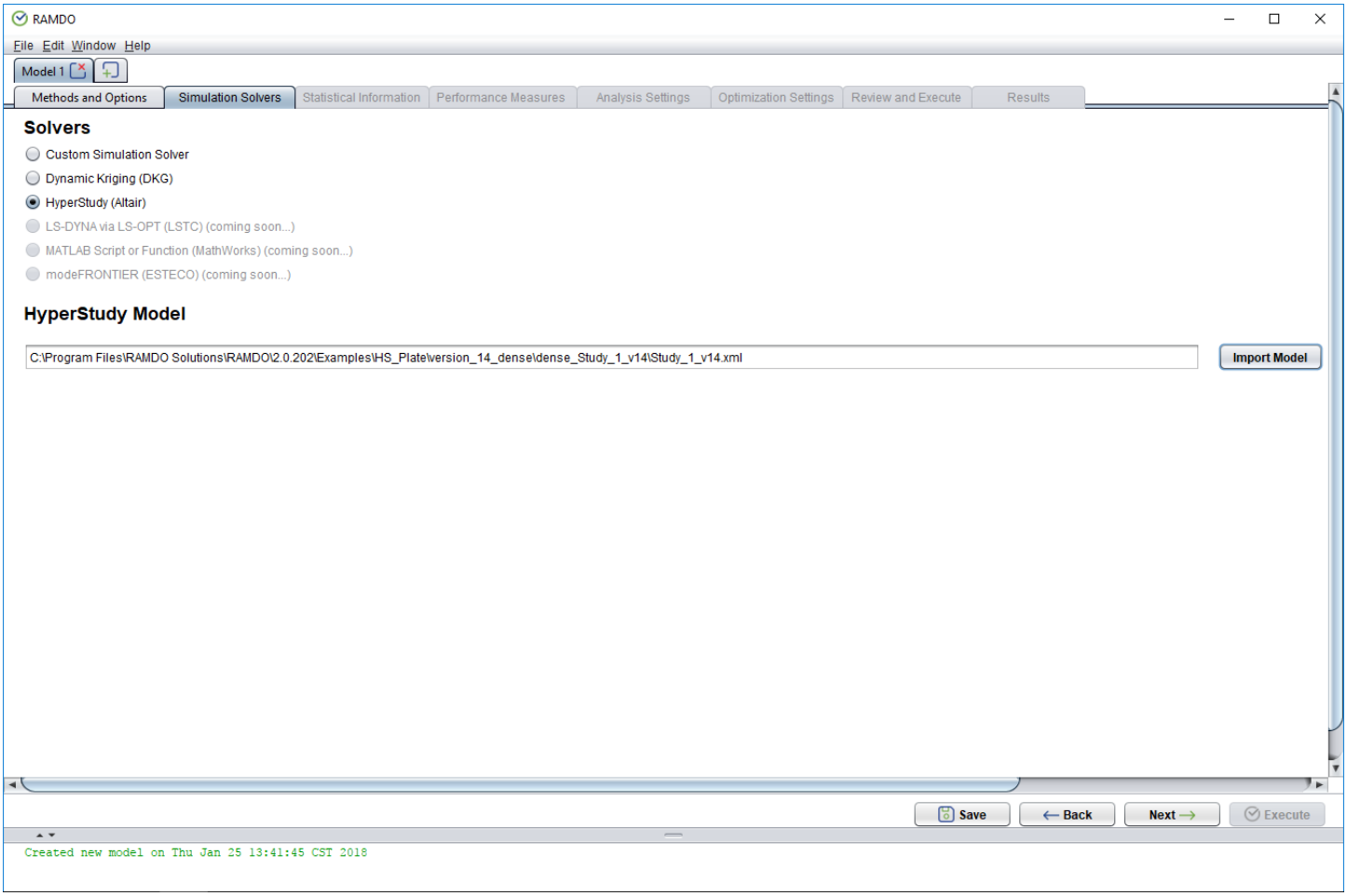
To fill out Simulation Solvers form do the following:

1. Select the **HyperStudy (Altair)** option.

2. Upload the solver:
   a) Click the **Import Model** button to choose the solver file.
   b) Browse to the installation location of RAMDO and find the **'plate_v14.xml'** HyperStudy file in the **'dense_Study_1_v14'** folder in the **'Examples'** folder in the RAMDO program folder.
   c) Click the **Open** button to import the HyperStudy model.



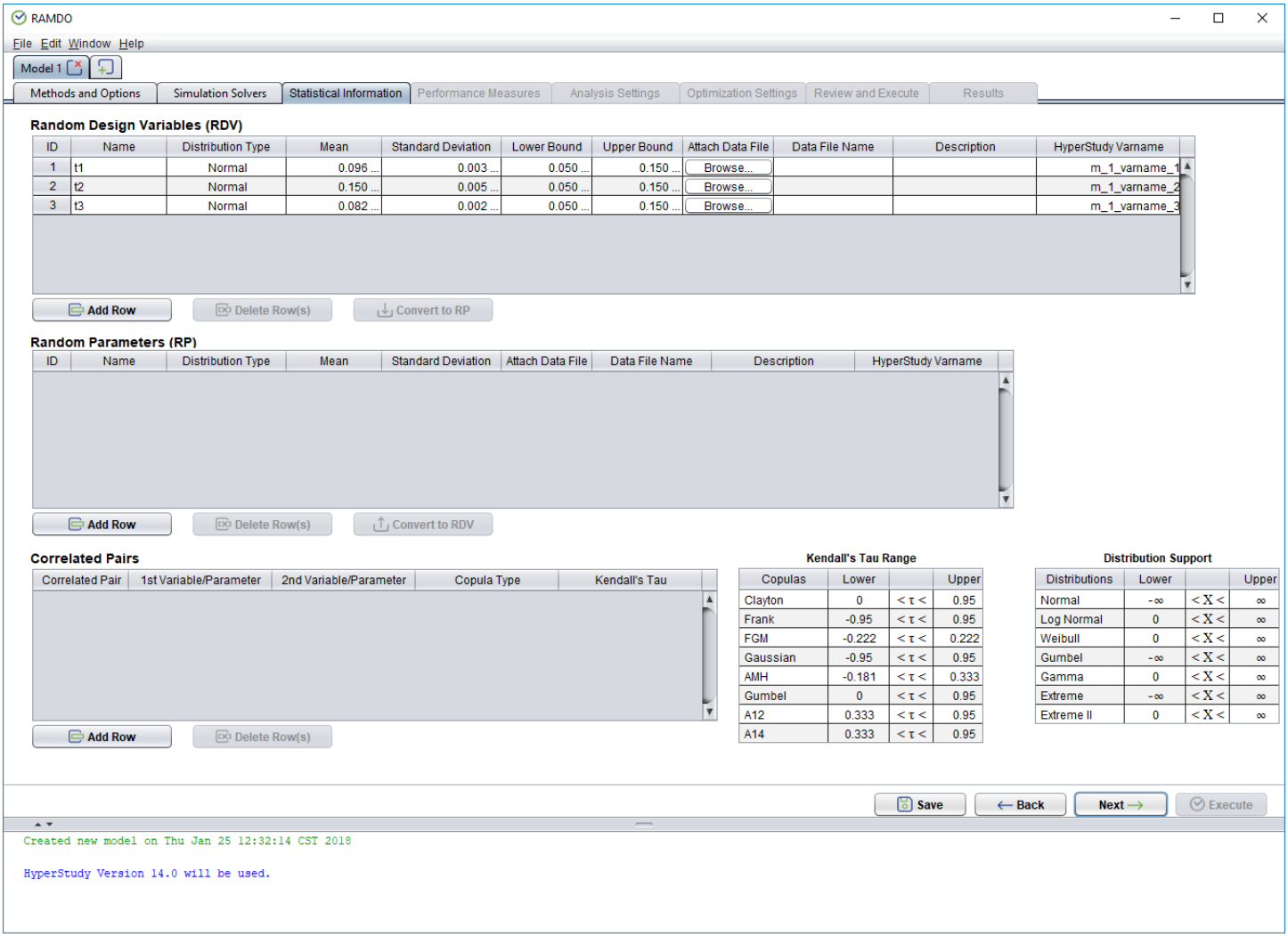
3. You should see the following in the figure below.



4. Click the **Next** button to continue to the next page.

Statistical Information

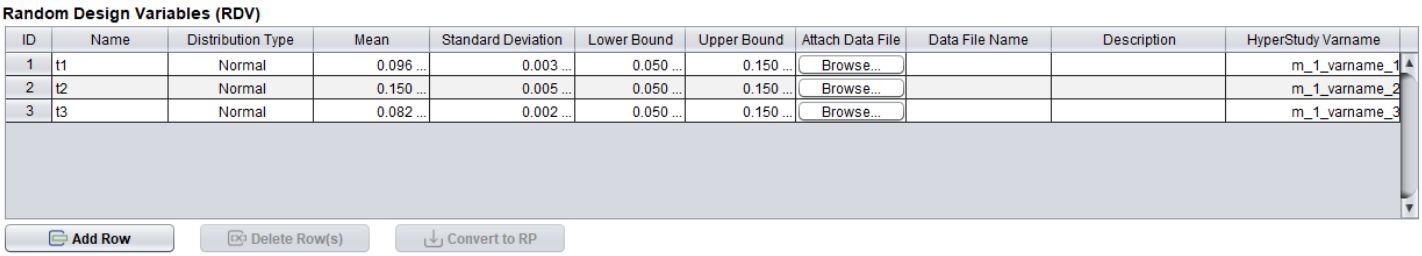
Importing the HyperStudy model adds the variables defined in the HyperStudy model to Random Design Variables (RDV) table in RAMDO. The HyperStudy variable name is shown in the last column of the table to provide a reference back to the variable as defined in HyperStudy.



Review the Statistical Information:

Random Design Variable Table

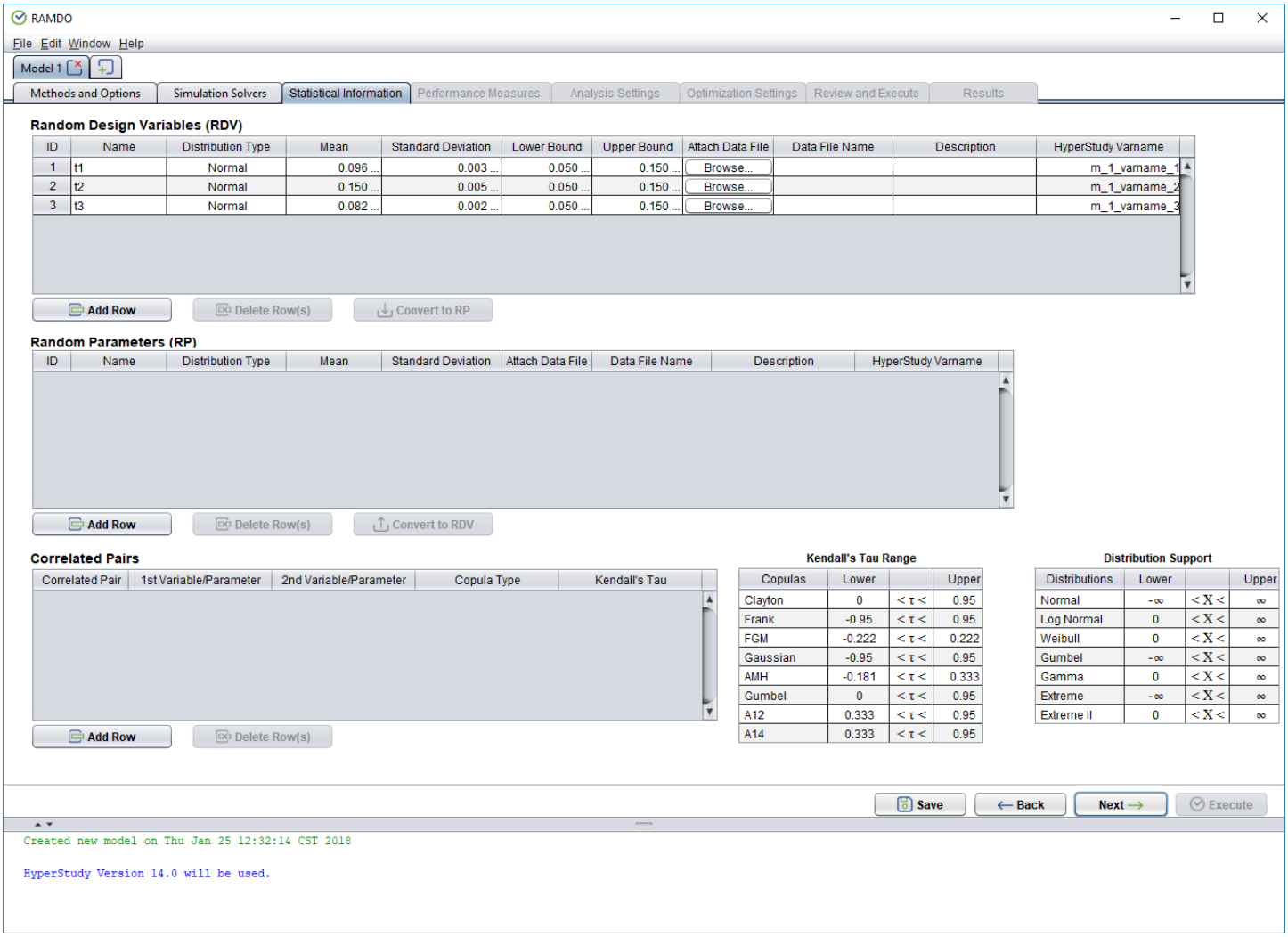
The table should look like the table in the figure below.



Note (Random Design Variable Description)

The Description column is for user convenience. The user can enter any description of the random design variable they want. This is so that when a model is opened later the user can remember what are the random design variables in the problem.

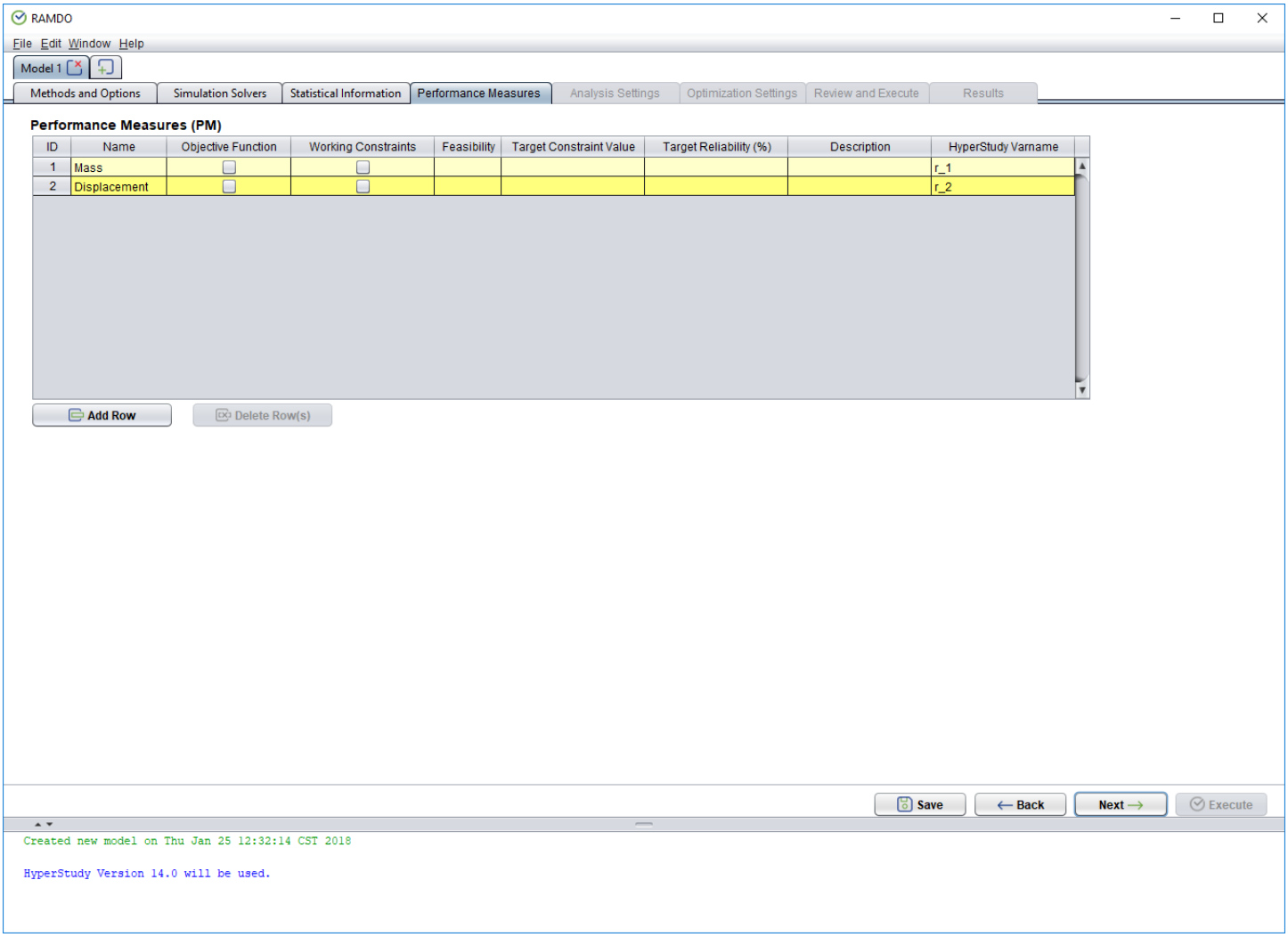
1. The RAMDO window should now look like the window in the figure below.



2. Click the **Next** button to continue to the next page.

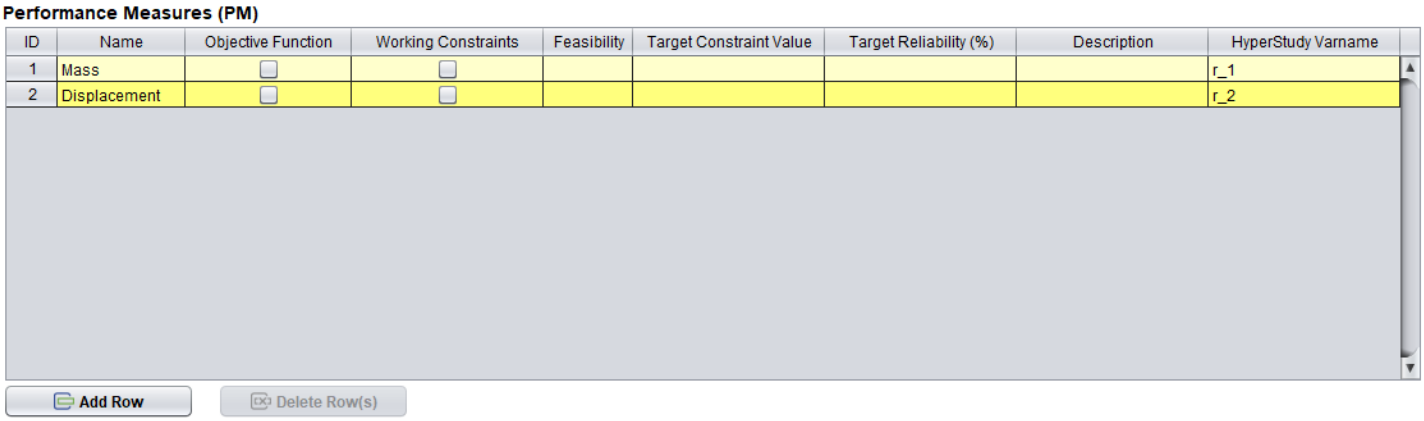
Performance Measures

Filling out the Performance Measures page.



To fill out the Performance Measures page do the following:

1. Responses defined in the HyperStudy model are imported into the Performance Measure Information table. The last column of the table shows the HyperStudy name of the response, this is for a reference back to the original HyperStudy model.

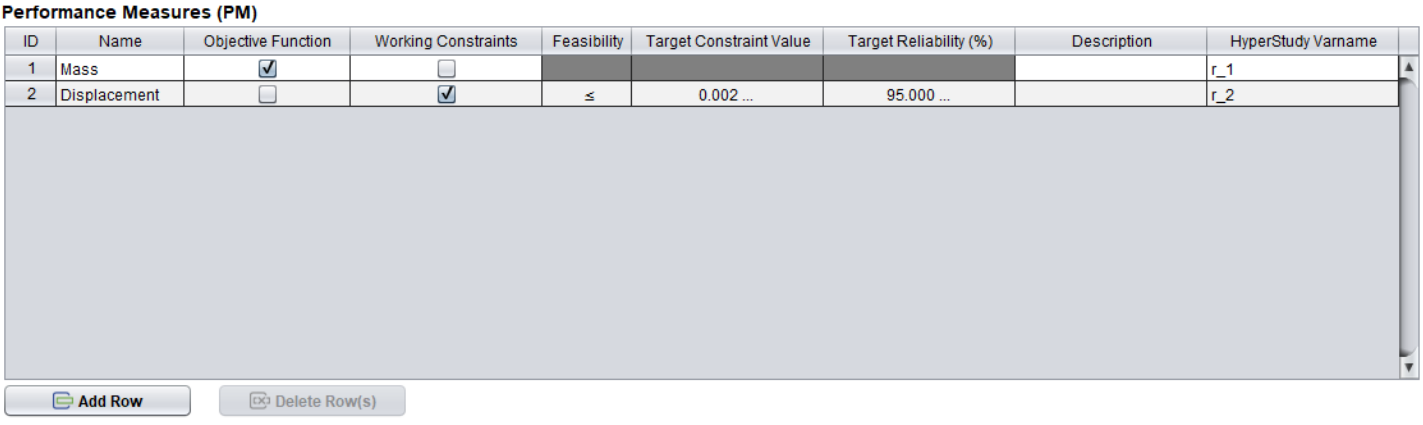


2. Fill out the table with the following.

Performance Measures Table

ID	Name	Objective Function	Constraints	Feasibility	Target Constraint Value	Target Reliability	Description
1	Mass	x					Cost Function
2	Displacement		x	≤	0.002	95	Constraint

The table should look like the table in the figure below.



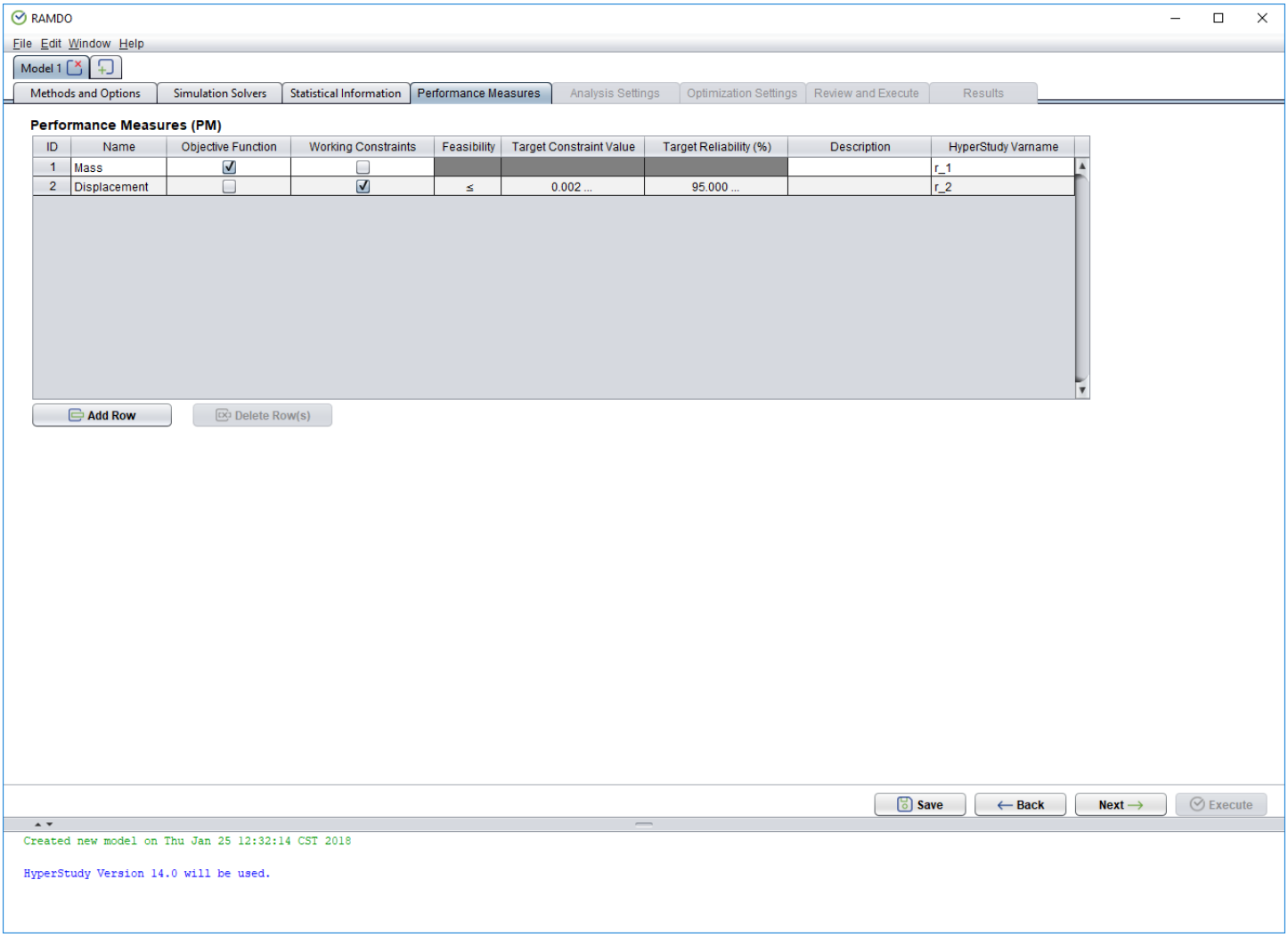
Note (Inequality Sign)

The inequality sign defines if the constraint value should be less than or greater than the allowable/target value defined. In the above figure, the inequality sign is < and the allowable/target value is 0. This means that the constraint would be defined as $g < 0$, where g is the constraint value.

Note (Performance Measure Description)

The Description column is for user convenience. The user can enter any description of the performance measure they want. This is so that when a model is opened later the user can remember what the performance measures are for the problem.

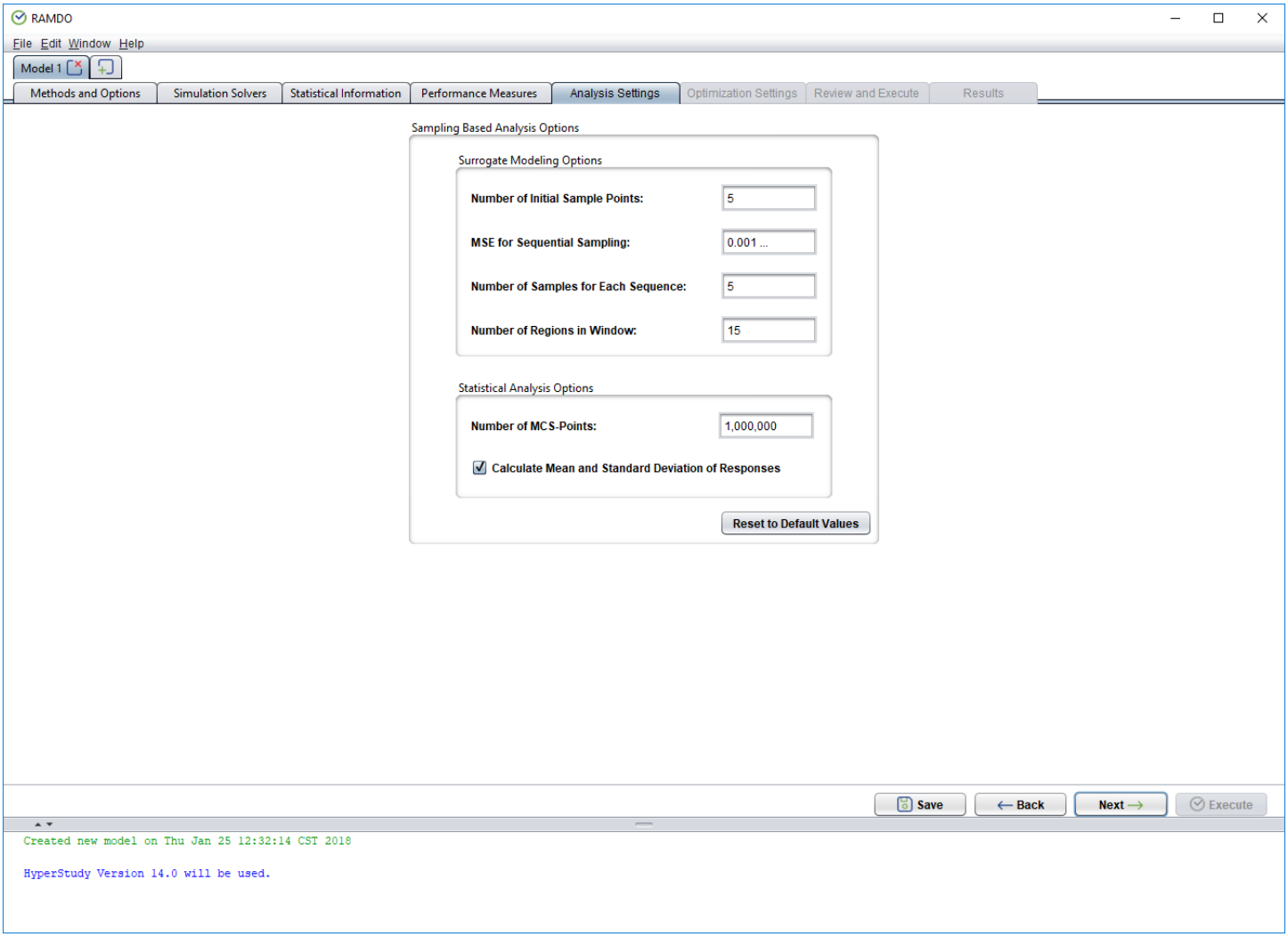
3. You should see the following in the figure below.



4. Click the **Next** button to continue to the next page.

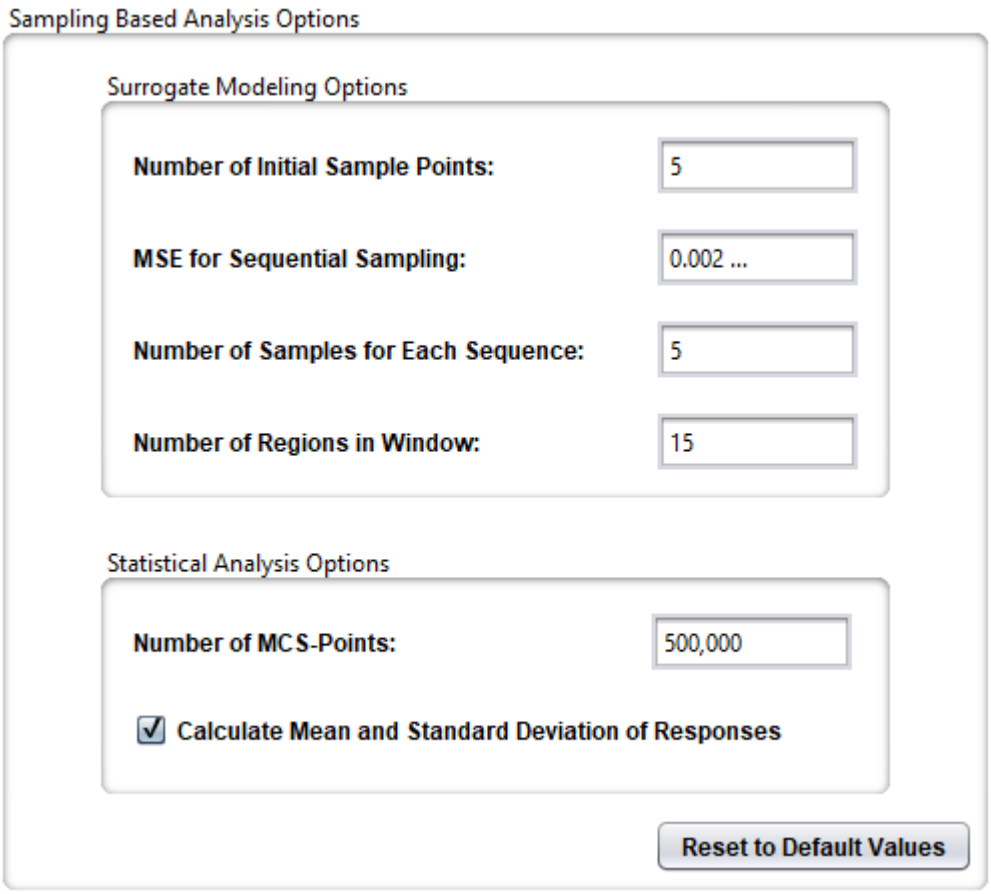
Analysis Settings

Filling out the Analysis Settings page.



To fill out the Analysis Settings page do the following:

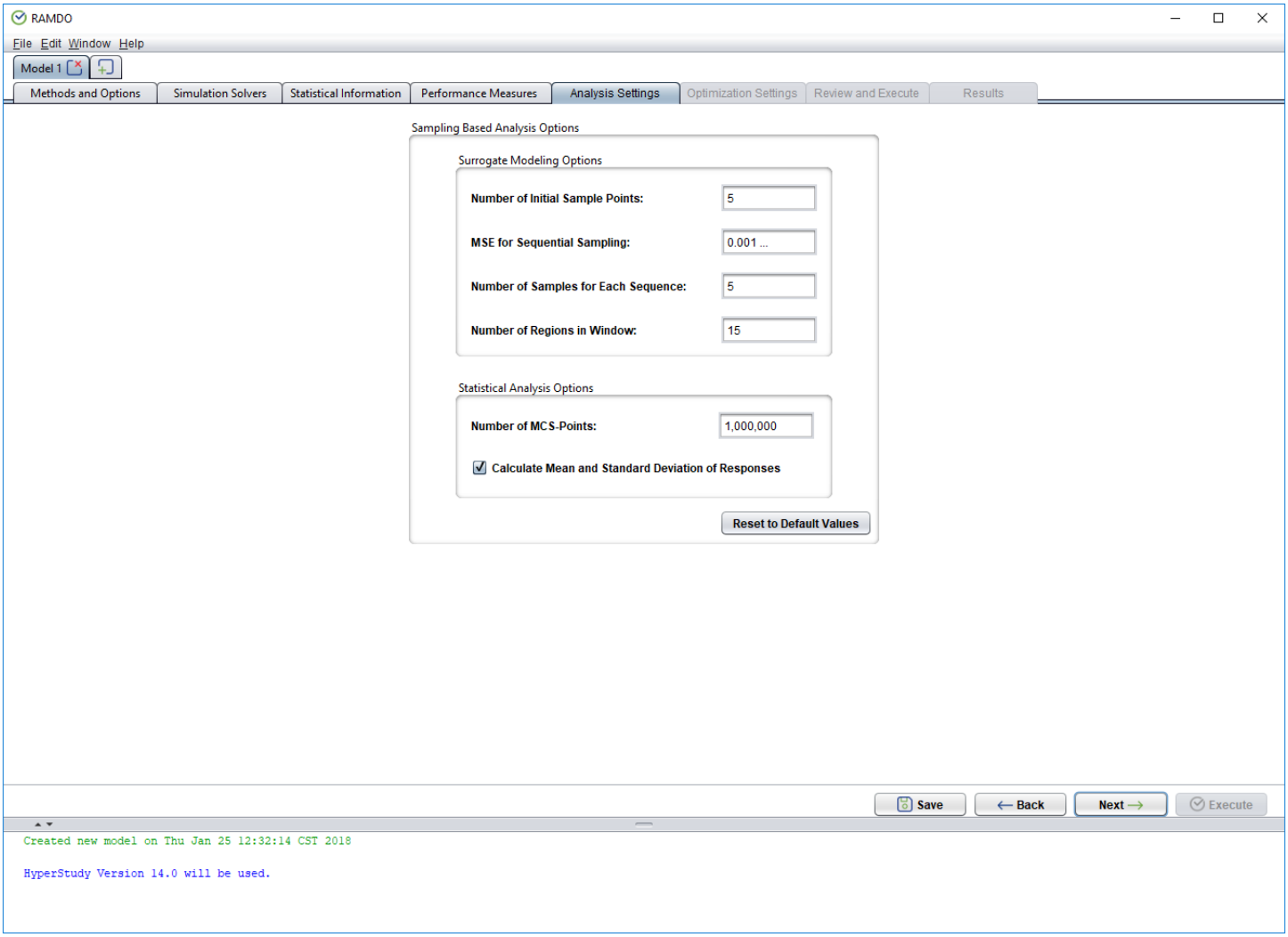
1. The default options can be used for this example.



Note

The Users can set their own values or use the default values.

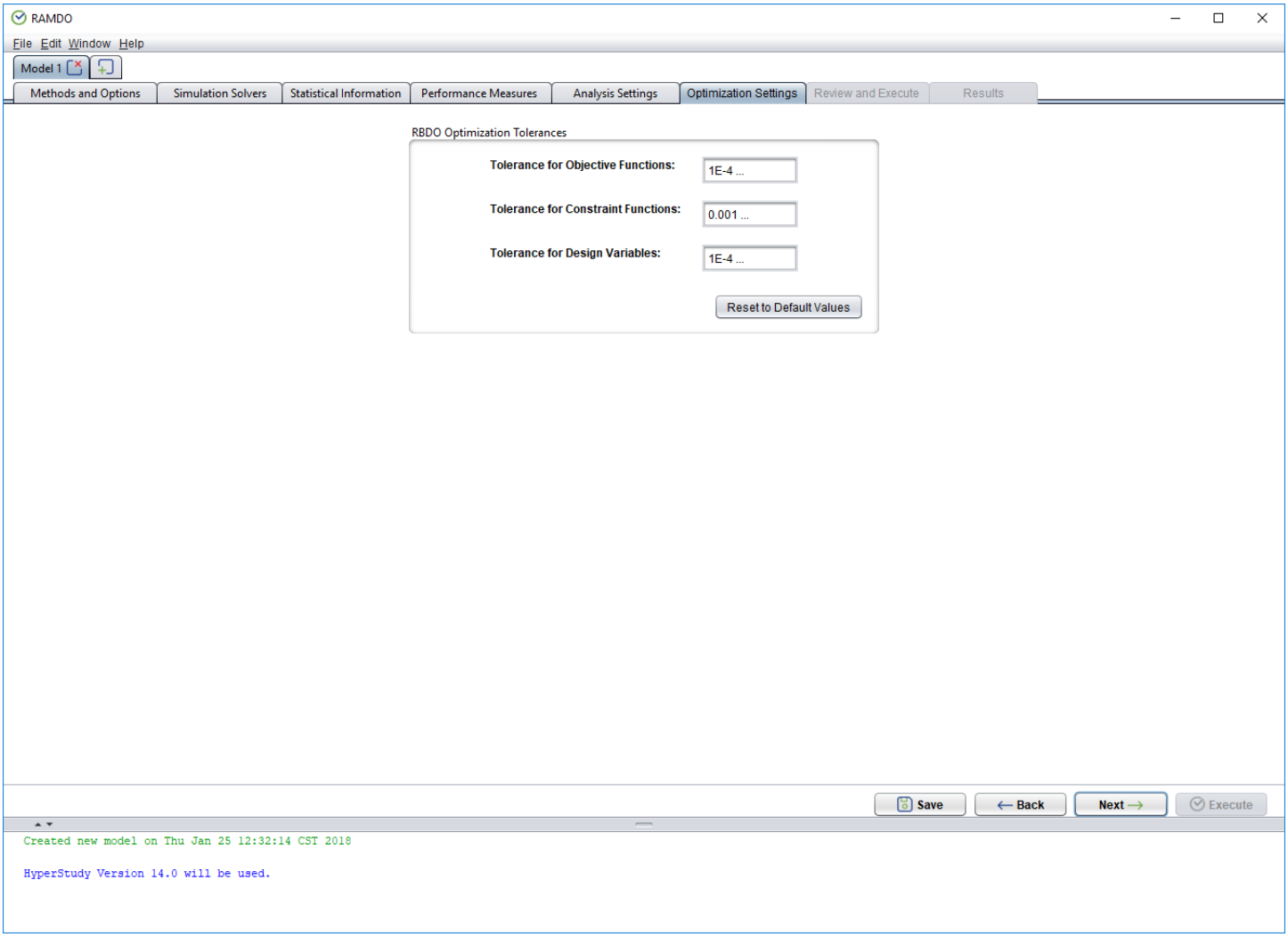
2. You should see the following in the figure below.



3. Click the **Next** button to continue to the next page.

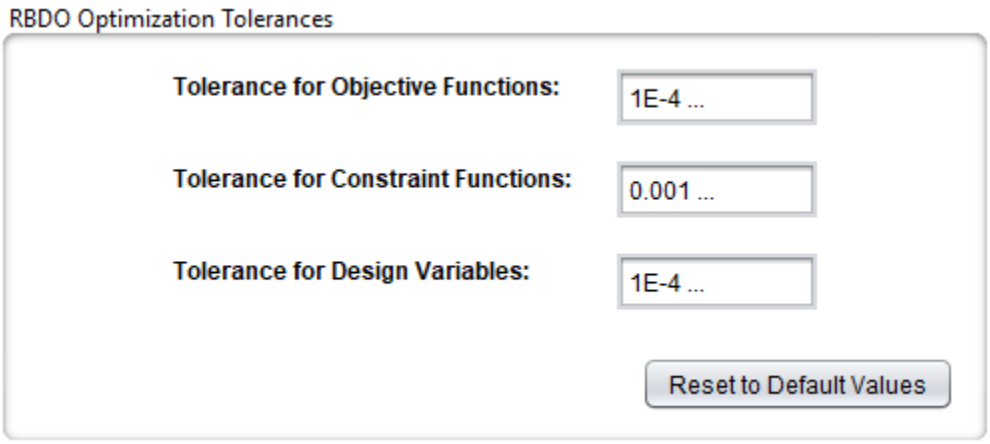
Optimization Settings

Filling out the Optimization Settings page.



To fill out the Optimization Settings page do the following:

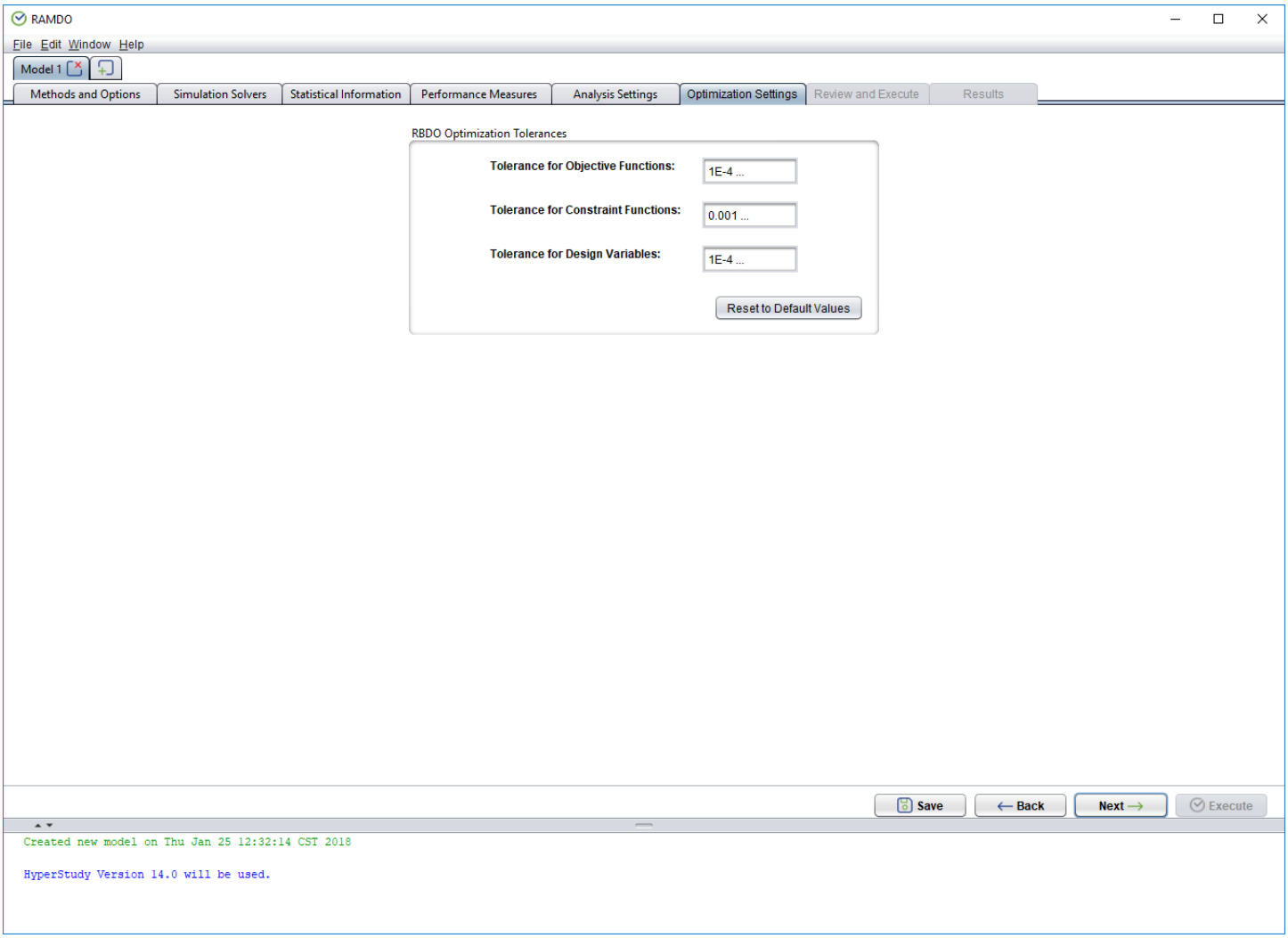
1. The default tolerances can be used for this example.



Note

Users can set their own values or use the default values.

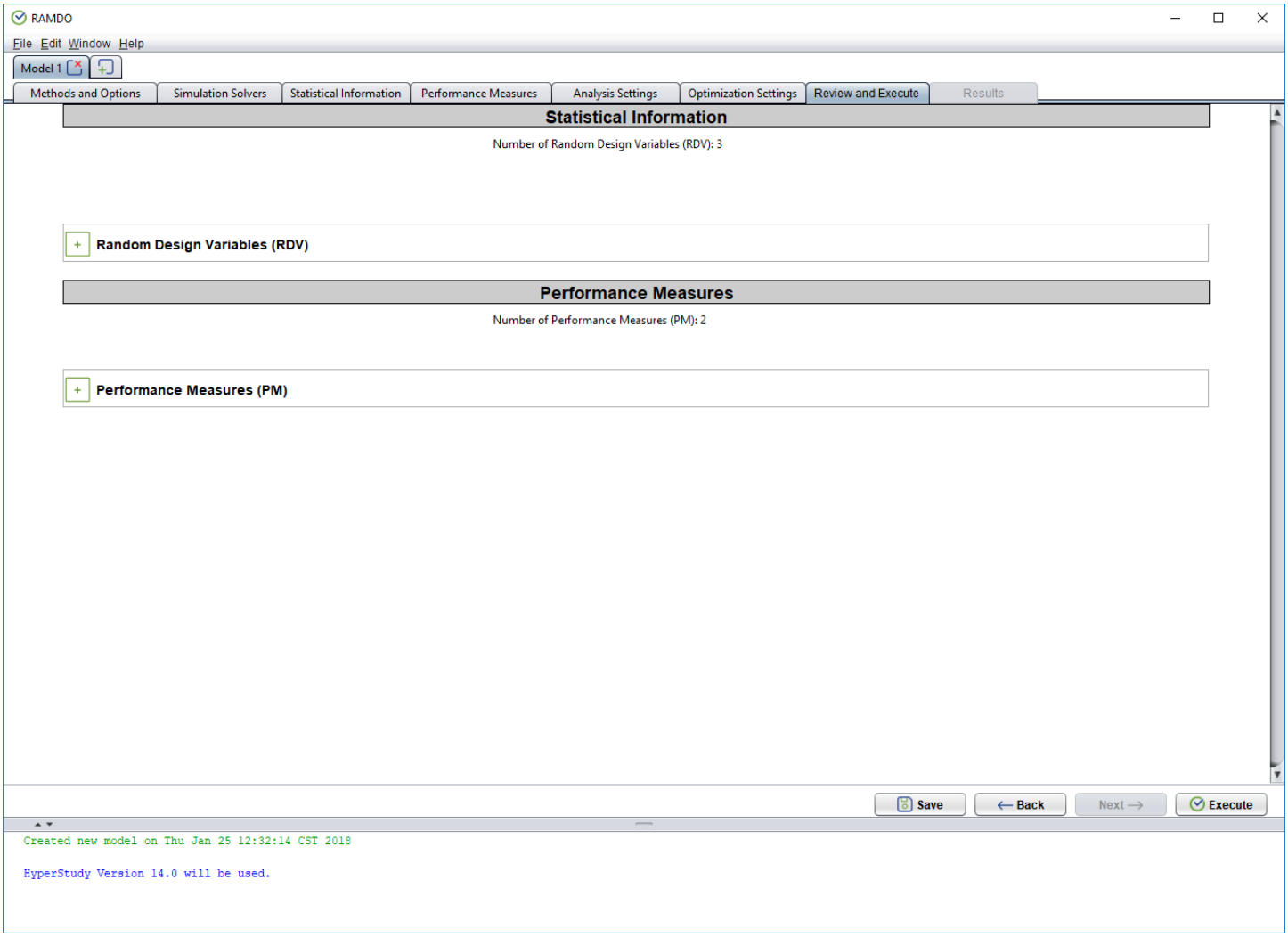
2. You should see the following in the figure below.



3. Click the **Next** button to continue to the next page.

Review and Execute

Viewing the Review and Execute page.



To use the Review and Execute page you can do the following:

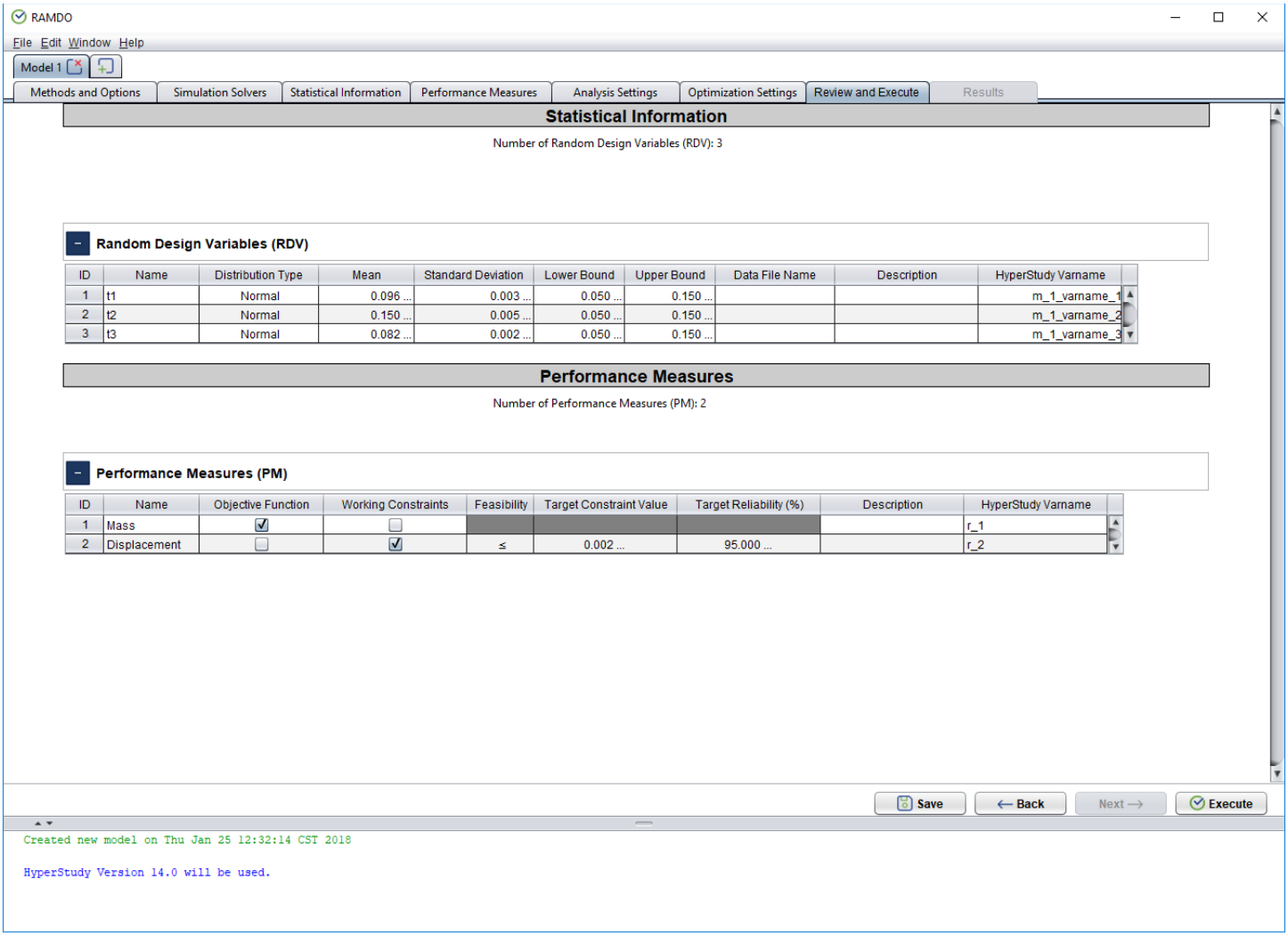
1. Click the [+] icon to expand the drop-down to display the tables you want to view.

2. Click the [−] icon to collapse the drop-down.

3. Review the tables to make sure they are correct. Go back and edit them if needed.

4. You should see the following in the figure below if all the drop downs are expanded.

5. Click the **Save** button to save the model.

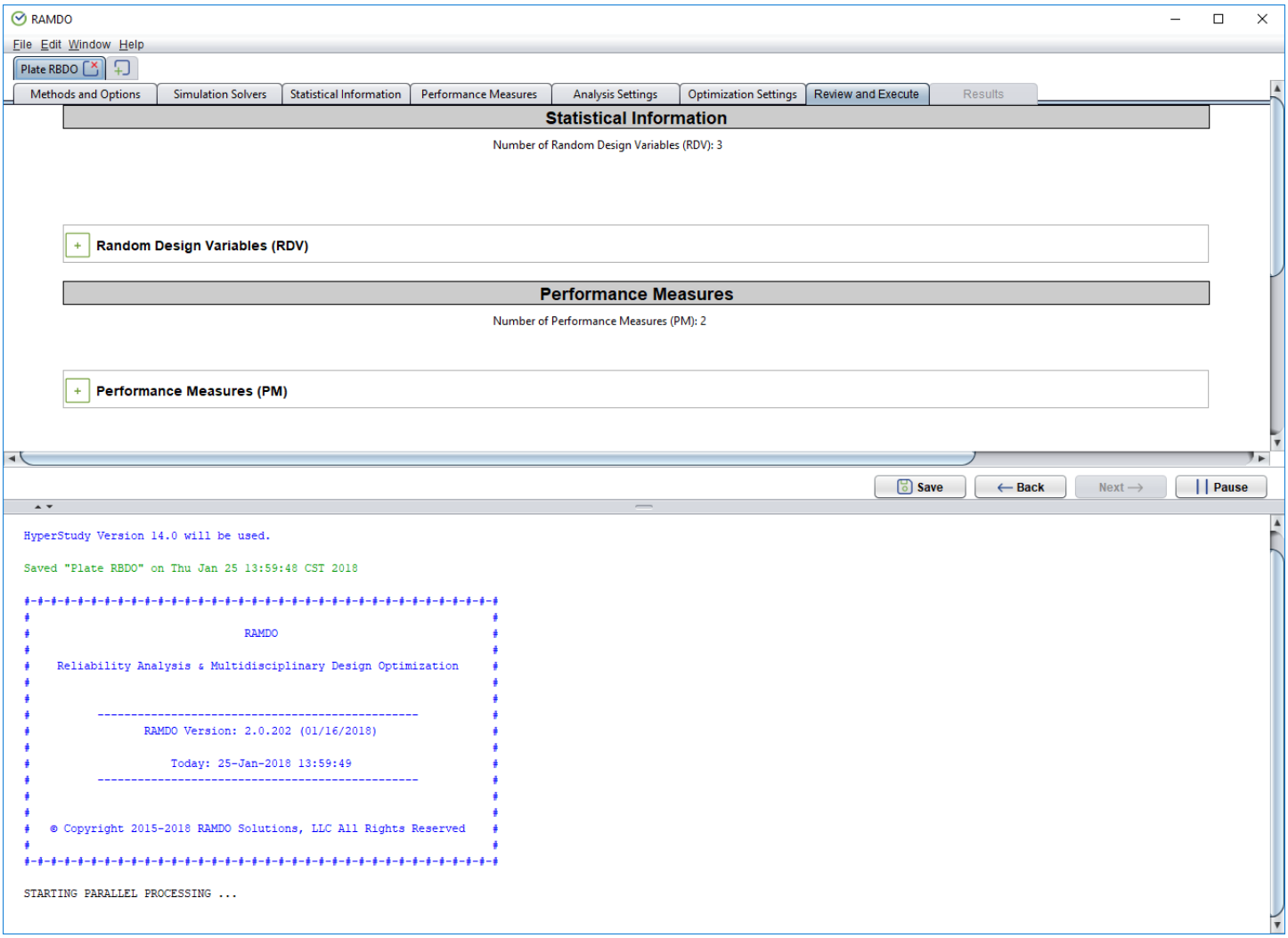


1. Click the **Execute** button to execute the simulation of the model.

Note

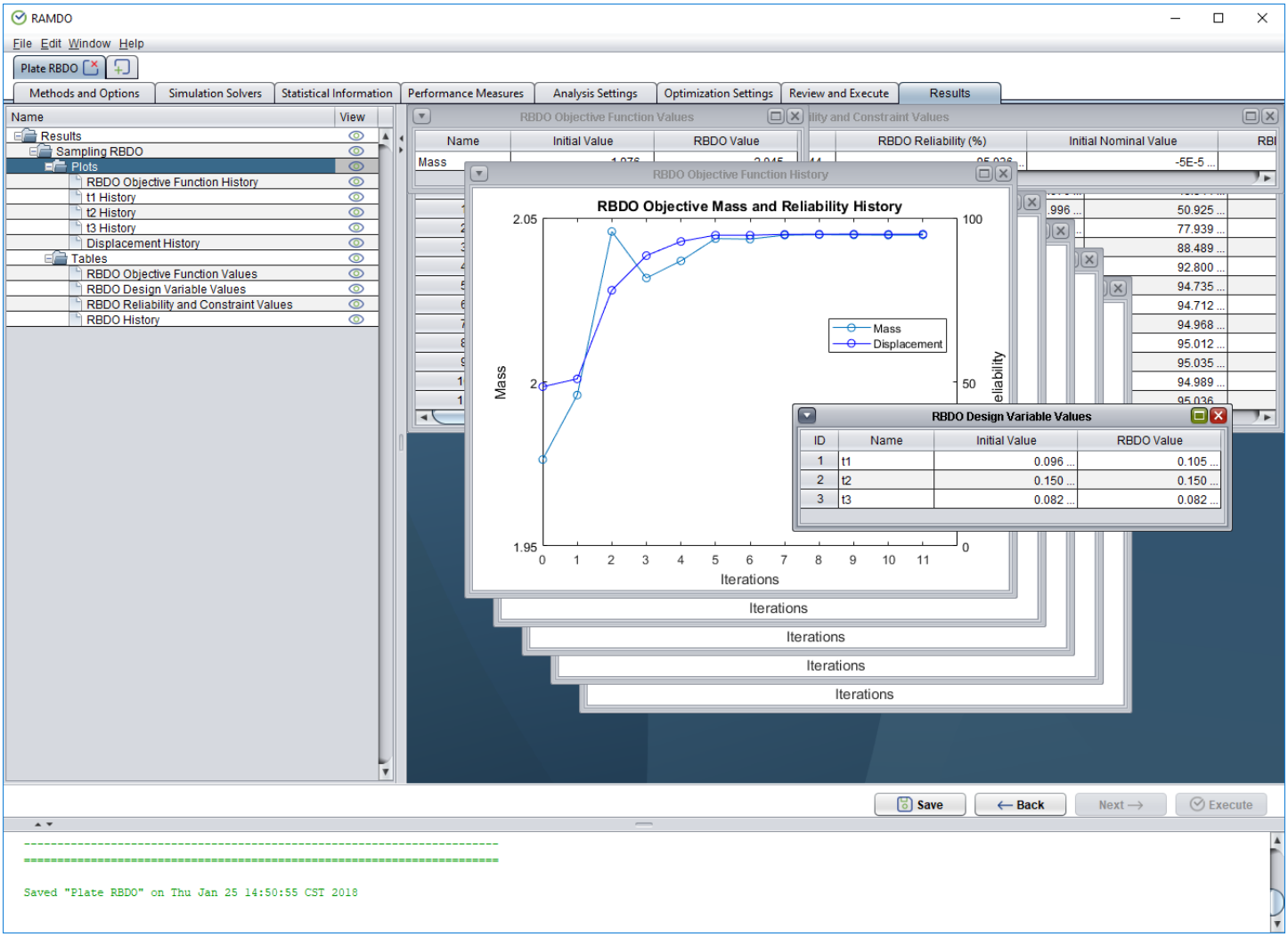
As shown in the log window it will take a few minutes before you will see the RBDO code start and for information to appear in the log window. This normal so please be patient.

2. The output of the simulation will be printed in the output window. Once the model is finished simulating then the Results page will be shown.



Results

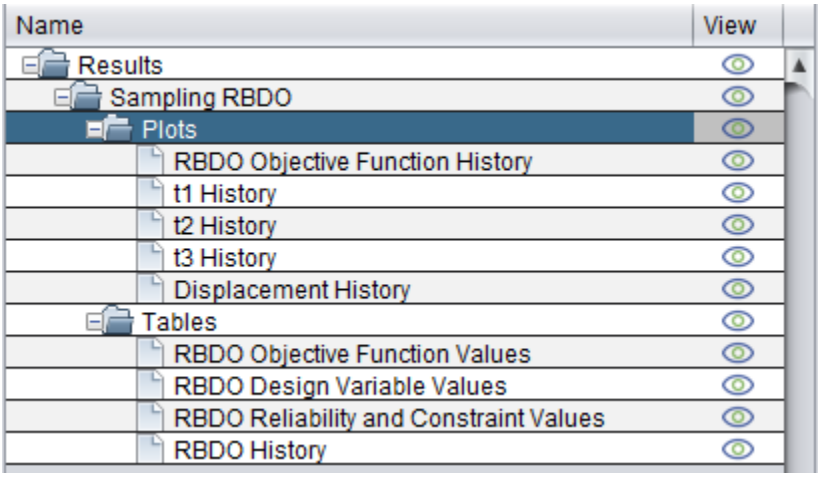
Viewing the Results page.



Navigation Table Tree

To use the navigation table tree, make sure it is visible on the page. Change the view of the table tree by dragging right or left the split pane bar or by clicking the right arrow to expand or left arrow to collapse.
To collapse or expand the navigation table tree click the collapse icon and expand icon button arrows respectively.

The “Name” column is the name of the results or result types. The “View” column is the current view state of the internal frames of the plots and tables if they are visible or hidden. The visible icon means the item is visible and the hidden icon means the item is hidden. To change the viewing state of the plots and tables on the navigation tree table, double-click on the desired item or grouping of items to toggle the view.



Result Frames

The result windows behave like normal desktop windows. They can be resized and dragged around.

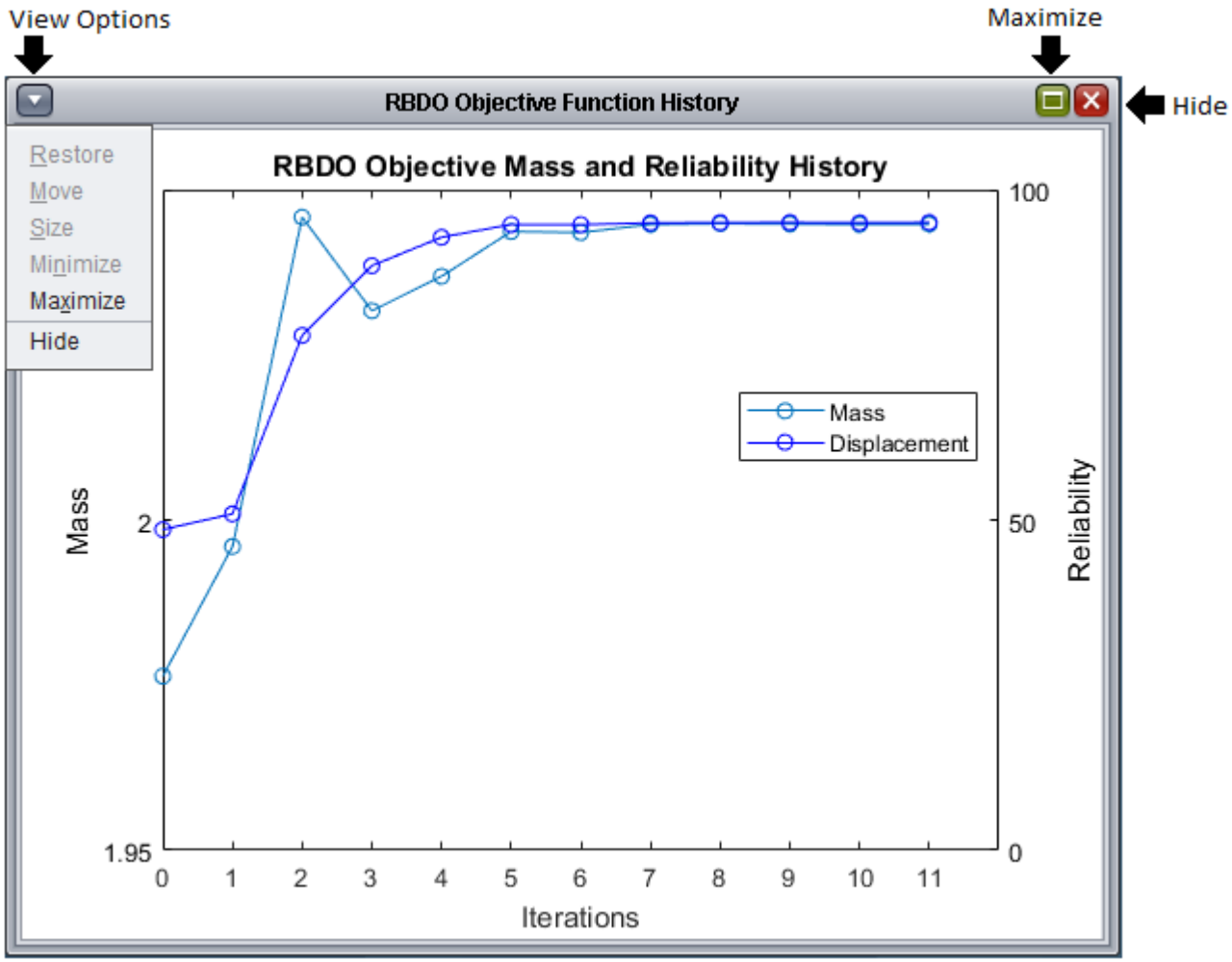
To expand a window to fit the result's desktop, click the Expand button in the top right-hand corner.

To restore a window to its last size after it has been expanded, click the Restore button in the top right-hand corner.

To show an individual result window, double-click on the window's corresponding name or single-click on the view icon in the navigation tree table. Or do the same actions on a group of tables, plots, or results to hide or show them all at once.

To hide an individual result window, click the Hide button in the top right-hand corner.

Click the View Options button in the top left-hand corner to use all the viewing options.



The Results

Note

The results in the table may vary a little from the ones shown in the table below. This is to be expected being a sampling-based RBDO method using surrogate models is used for analysis.

RBDO Objective Function Values

Name	Initial Value	RBDO Value
Mass	1.976 ...	2.045 ...

RBDO Design Variable Values

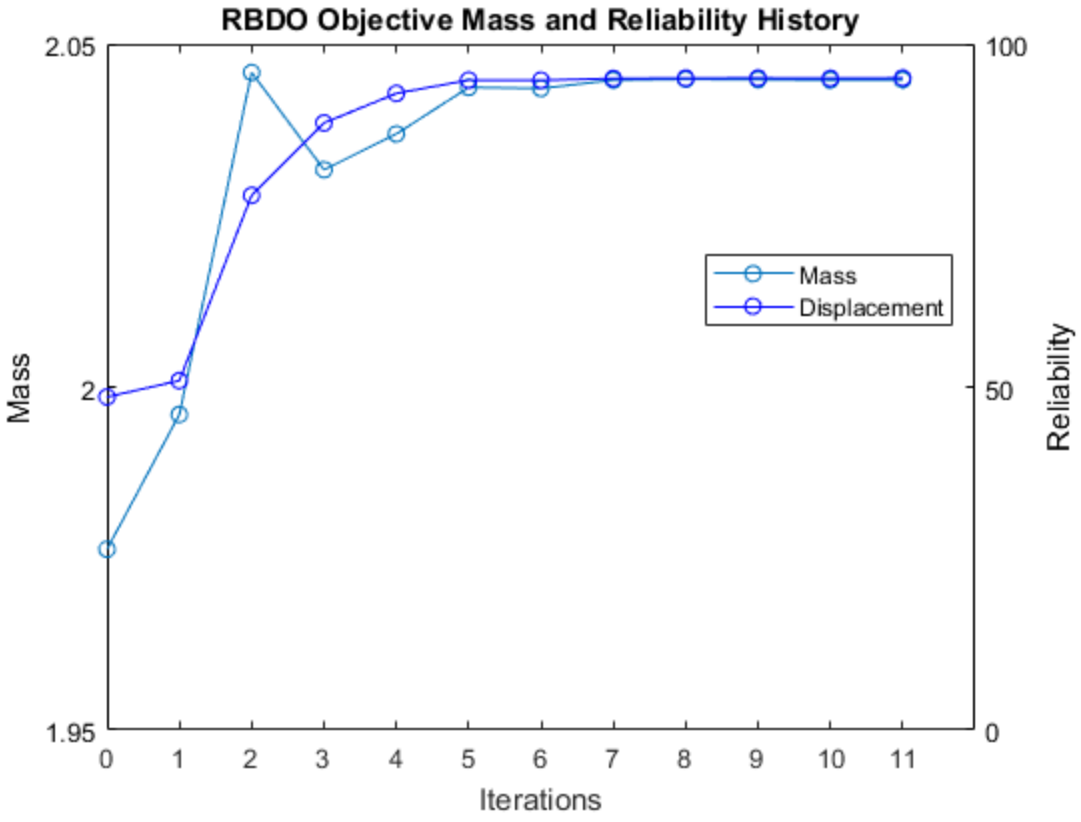
ID	Name	Initial Value	RBDO Value
1	t1	0.096 ...	0.105 ...
2	t2	0.150 ...	0.150 ...
3	t3	0.082 ...	0.082 ...

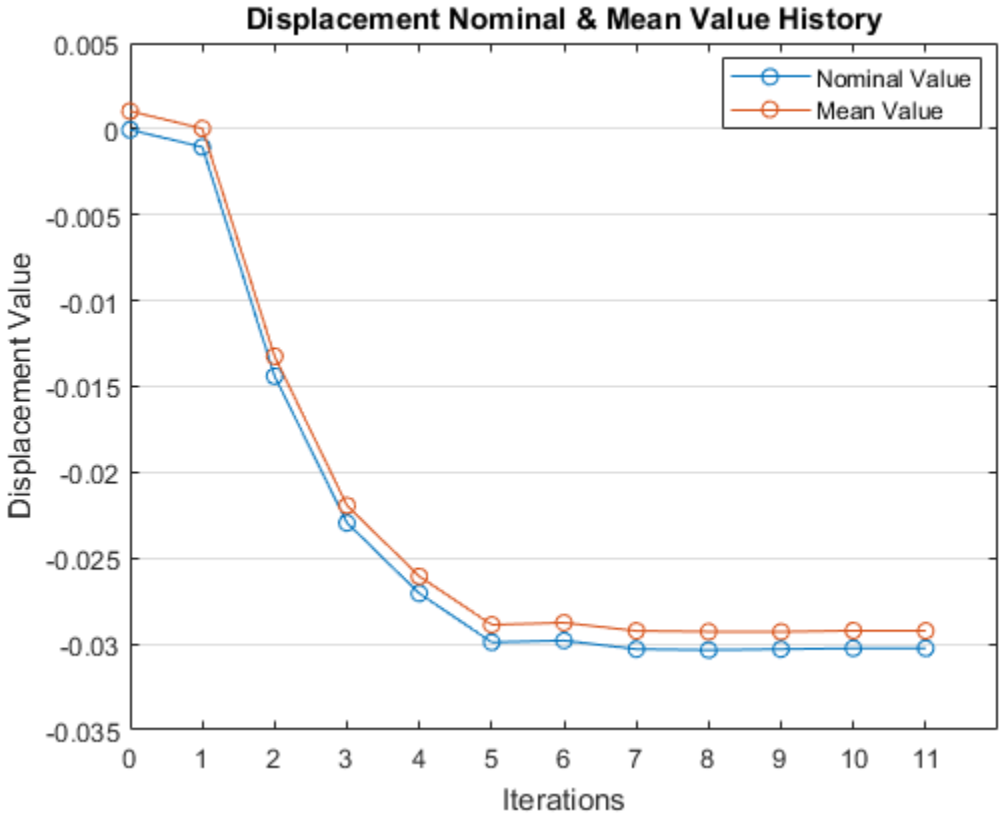
RBDO Reliability and Constraint Values

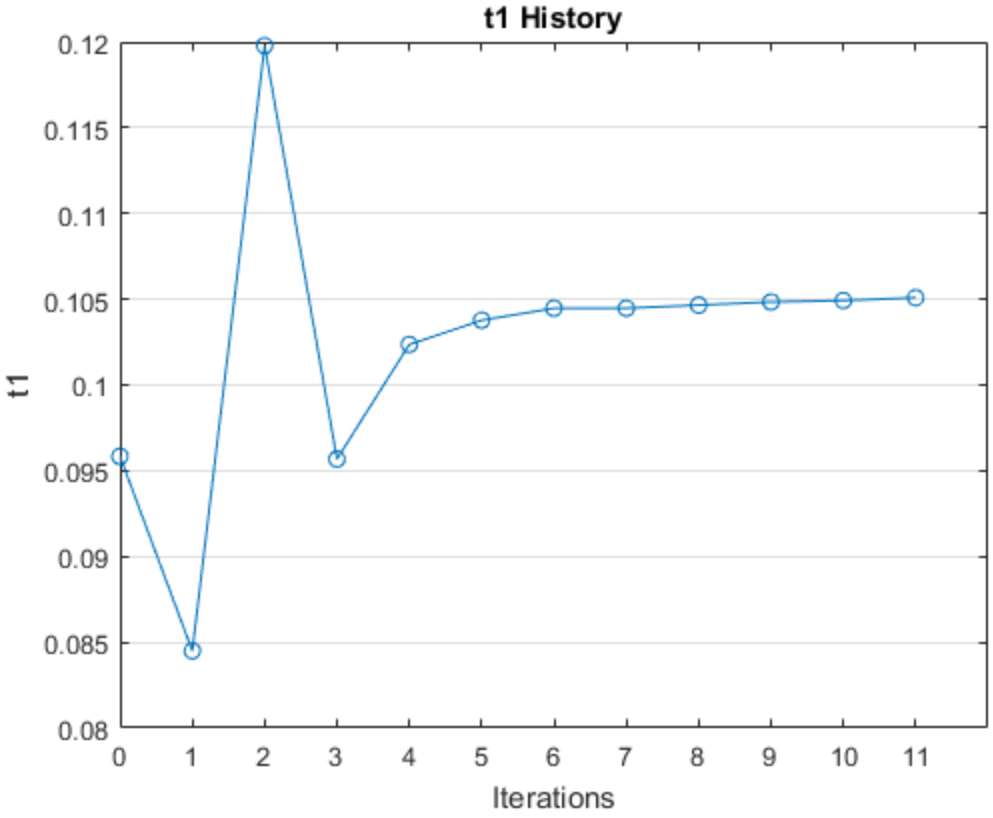
ID	Name	Initial Reliability (%)	RBDO Reliability (%)	Initial Nominal Value	RBDO Nominal Value	Initial Mean Value	RBDO Mean Value
1	Displacement	48.544 ...	95.036 ...	-5E-5 ...	-0.030 ...	0.001 ...	-0.029 ...

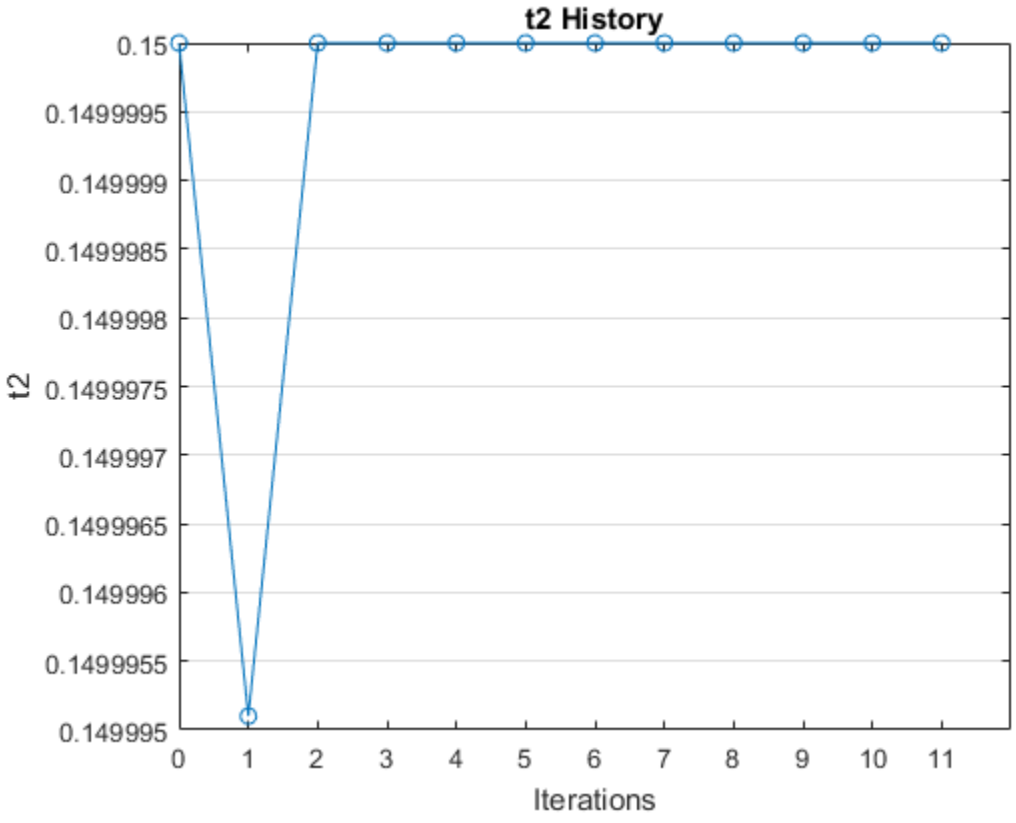
RBDO History

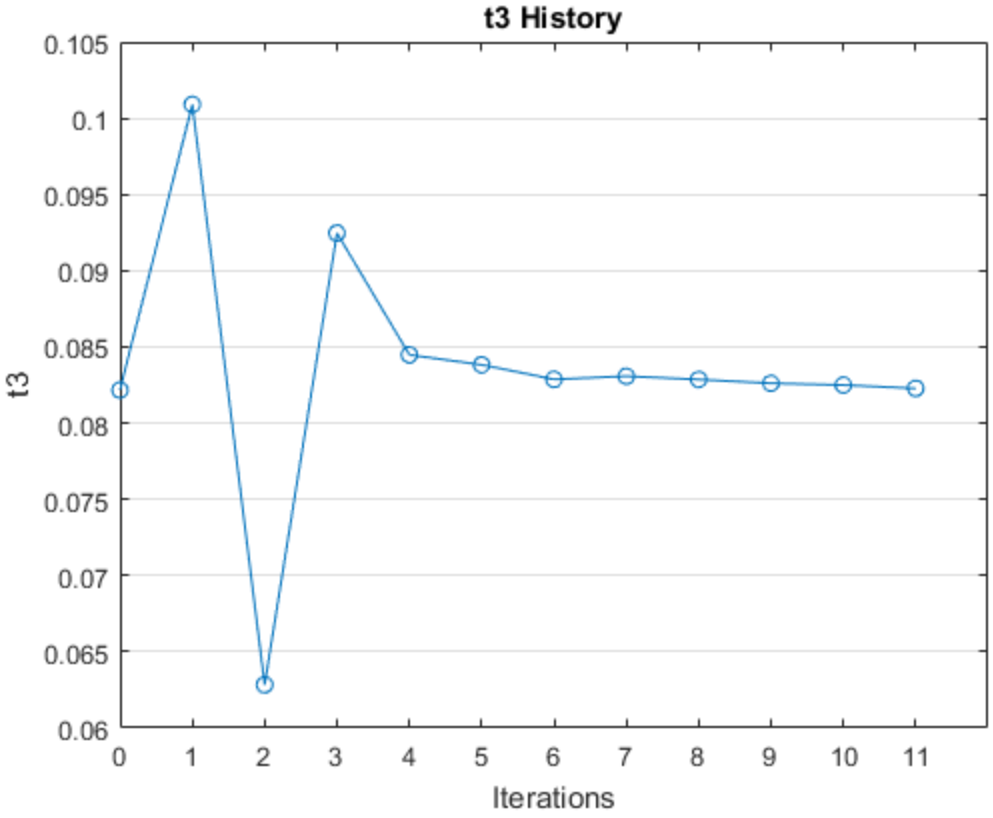
Iteration	t1	t2	t3	Mass	Displacement Reliabilit...	Displacement Nominal	Displacement Mean
0	0.096 ...	0.150 ...	0.082 ...	1.976 ...	48.544 ...	-5E-5 ...	0.001 ...
1	0.084 ...	0.150 ...	0.101 ...	1.996 ...	50.925 ...	-0.001 ...	2.561E-5 ...
2	0.120 ...	0.150 ...	0.063 ...	2.046 ...	77.939 ...	-0.014 ...	-0.013 ...
3	0.096 ...	0.150 ...	0.092 ...	2.032 ...	88.489 ...	-0.023 ...	-0.022 ...
4	0.102 ...	0.150 ...	0.084 ...	2.037 ...	92.800 ...	-0.027 ...	-0.026 ...
5	0.104 ...	0.150 ...	0.084 ...	2.044 ...	94.735 ...	-0.030 ...	-0.029 ...
6	0.104 ...	0.150 ...	0.083 ...	2.044 ...	94.712 ...	-0.030 ...	-0.029 ...
7	0.104 ...	0.150 ...	0.083 ...	2.045 ...	94.968 ...	-0.030 ...	-0.029 ...
8	0.105 ...	0.150 ...	0.083 ...	2.045 ...	95.012 ...	-0.030 ...	-0.029 ...
9	0.105 ...	0.150 ...	0.083 ...	2.045 ...	95.035 ...	-0.030 ...	-0.029 ...
10	0.105 ...	0.150 ...	0.082 ...	2.045 ...	94.989 ...	-0.030 ...	-0.029 ...
11	0.105 ...	0.150 ...	0.082 ...	2.045 ...	95.036 ...	-0.030 ...	-0.029 ...


RBDO Objective Mass and Reliability History
Mass
Displacement
Mass
Reliability
Iterations
2.05
2
1.95
100
50
0
0 1 2 3 4 5 6 7 8 9 10 11


Displacement Nominal & Mean Value History
Nominal Value
Mean Value
Displacement Value
Iterations
0.005
0
-0.005
-0.01
-0.015
-0.02
-0.025
-0.03
-0.035
0 1 2 3 4 5 6 7 8 9 10 11


t1 History
t1
Iterations
0.12
0.115
0.11
0.105
0.1
0.095
0.09
0.085
0.08
0
1
2
3
4
5
6
7
8
9
10
11


t2 History
t2
Iterations
0.15
0.1499995
0.149999
0.1499985
0.149998
0.1499975
0.149997
0.1499965
0.149996
0.1499955
0.149995
0
1
2
3
4
5
6
7
8
9
10
11


t3 History
0.105
0.1
0.095
0.09
0.085
0.08
0.075
0.07
0.065
0.06
t3
0
1
2
3
4
5
6
7
8
9
10
11
Iterations