



Altair

HyperWorks

Altair MotionView 2019 Tutorials

MV-3010: Optimization using MotionView - HyperStudy

MV-3010: Optimization using MotionView - HyperStudy

In this tutorial you will,

- Perform an optimization study in the MotionView-HyperStudy environment
- Compare the baseline and optimized models

Theory

In general, an optimization problem consists of:

- The design constraints
- The objective function
- The design variables

Design variables change during optimization. The design variables always have a certain range within which they can be modified. Typical examples of design variables are thickness of shell elements, shape vectors, and masses.

The changes in the design variables cause some change in model responses. Such responses can become either objective function or design constraints. Examples of such responses include displacements and forces.

The response to be minimized or maximized becomes the objective function, while the rest of the responses that need to be within a certain tolerance range become constraints. Only one response can be defined as objective function.

HyperStudy can be used to set-up and perform an optimization study on a MotionView model. You can also use HyperStudy to perform optimization studies involving both linear and non-linear CAE analysis as well as perform optimization of mathematical equations using Templex. HyperStudy creates the input parameter files using Templex and provides iterative changes to them during the optimization process. HyperStudy uses HyperOpt (a general purpose, wrap around software) as the optimization engine to perform optimization, in conjunction with both linear and non-linear CAE analysis software. HyperOpt uses a robust sequential response surface methodology for optimization.


The files needed for this tutorial are `hs.mdl`, `target_toe.csv` (used in tutorial *MV-3000*); `Setup.xml` saved in tutorial *MV-3000* and the `nom_run` folder created in tutorial *MV-3000*.

These files should be in the `<working-directory>` that was used in tutorial *MV-3000*.

Note: If you copy the `Setup.xml` file from the above location, the path in the `<Folder>` tag in the file needs to be edited to point to your `<Working directory>`.

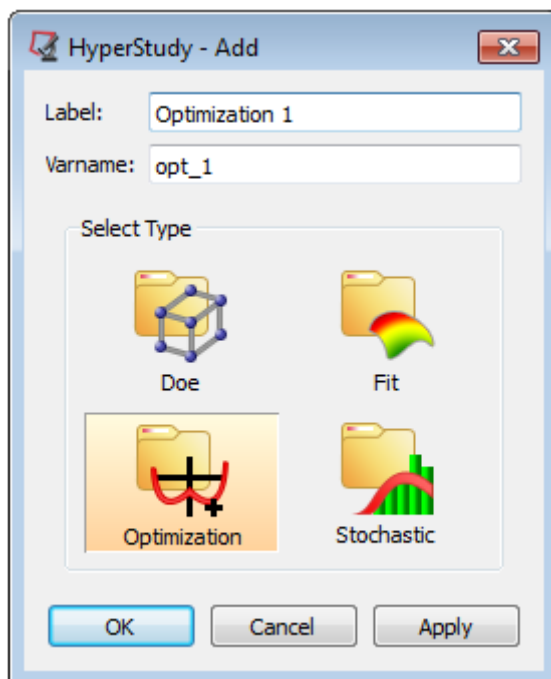
In the following steps you will perform an optimization study on a front SLA suspension model and determine the optimum coordinate positions of the inner and outer tie-rod points while trying to achieve a target toe curve. The baseline model will then be compared with the optimized model.

Step 1 Optimization Study.

1. Start a new MotionView session.
2. Open the model `hs.mdl`, located in <working directory>.
3. Review the model and the toe-curve output request.
4. From the **SolverMode** menu make sure that **MotionSolve** is selected.
5. From the **Applications** menu, launch **HyperStudy**.
6. Click on open file icon,  , browse to your study directory and select `Setup.xml` file created during the MV-3000 tutorial.
7. Add a new optimization study:
 - Right-click in the Explorer Browser area and from the context menu, click **Add Approach** to launch the **HyperStudy - Add** dialog box.

Or

- From the **Edit** menu bar, click the **Add Approach** icon,  , to launch the **HyperStudy - Add** dialog box.



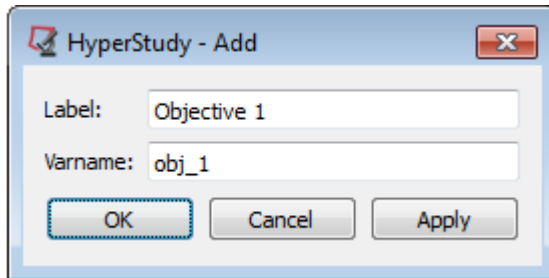
- Under **Select Type**, select **Optimization**.
- Accept the default label and variable name and click **OK**.
- The Optimization tree displays in the explorer with name `Optimization_1`.
- Click **Next** to go to the **Select design variables**.

- In the **Define design variables** panel, verify that all the design variables are checked.

This panel displays all the variables and their upper and lower bounds.

- Click **Next** to go to the **Select responses**.

– Click  to launch the **HyperStudy - Add Objective** dialog box.



Accept the default label and variable names and click **OK**.

In this exercise, minimize the **Sum of Squared Error** response function to obtain optimum values for the design parameters: the Y and Z coordinate positions of the inner and outer tie-rod points.

- Check to make sure that the type is set as **Minimize** from the drop-down menu.
- Check to make sure that the **Evaluate From** option is set to **Solver**.

Objectives										
+ Add Objective - Remove Objective										
	Active	Label	Varname	Type	Apply On	Evaluate From	Target Value	Weighted Sum	Reference Value	Comment
1	<input checked="" type="checkbox"/>	Objective_1	obj_1	Minimize	Sum of Squ...	SOLVER	1.0000000		1.0000000	...

- We will not have any constraints and unused responses in our design, so click **Apply** and then click **Next** to go to **Specifications**.

Accept the default **Optimization Engine: Adaptive Response Surface Method** and click **Apply** and **Next**. The Maximum iterations and Convergence criteria are specified in the same dialog.

- Click **Apply** and **Next** to go to **Evaluate**.
- Click **Evaluate Tasks** to start the optimization.

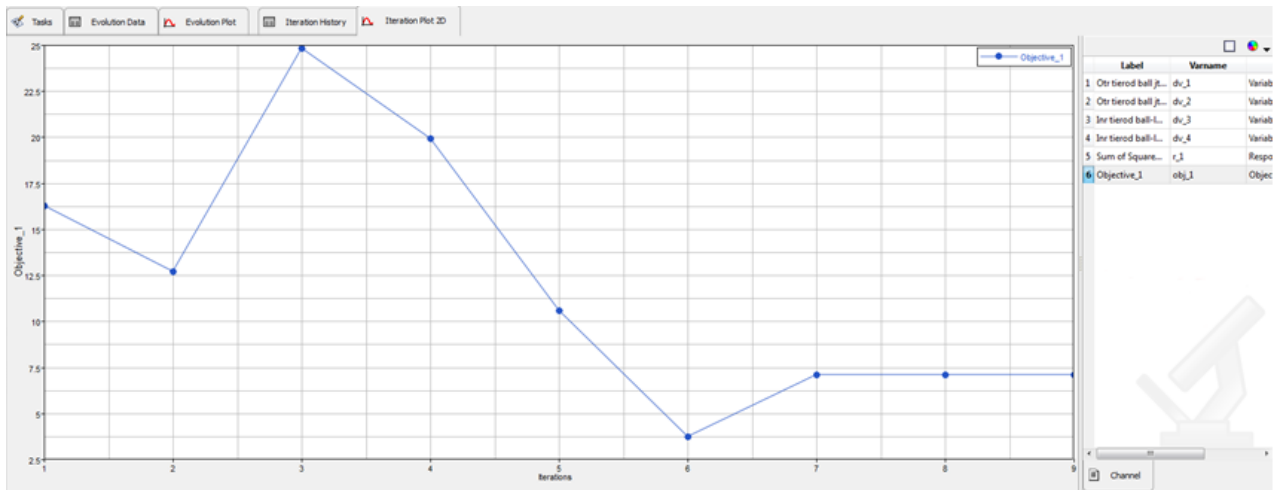
MotionSolve is launched sequentially and the HyperOpt engine attempts to find a solution to the problem.

Once the optimization is complete, an **Iteration table** is created with status of each run. The present study took nine iterations to achieve the target. Browse through the other tabs of this page to get more understanding of the iteration history.

- Click on the **Iteration Plot 2D** tab.

- From the list on the right side of the GUI, select the Objective function named `Objective_1`.

This plots the objective function value against the iterations.



Optimization history plot

In this panel, you can see the plots variations in the values of the objectives, constraints, design variables, and responses during different design iterations. The **Iteration History Table** displays the same data in a tabular format.

Note that in this study, iteration 6 is the optimal configuration.

Save your study to <working directory> as `Study_2.xml`.

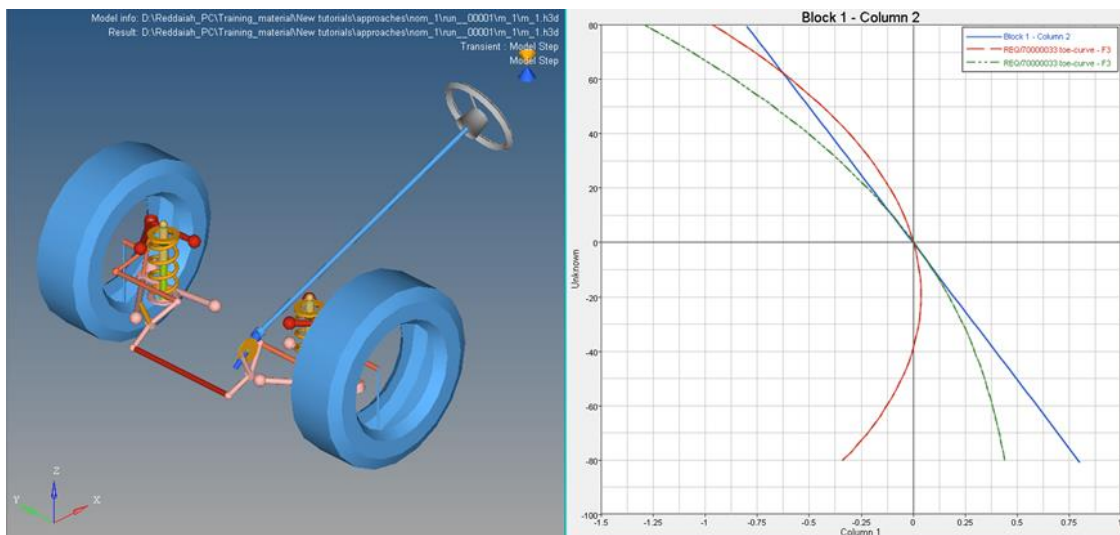
- Close the HyperStudy.

Step 2: Comparing the Baseline and Optimized Models.

- Add a Page to your **MotionView** session.
- From the **Select application** drop-down menu, select **HyperView**.
- Load the animation file <working directory>\approaches\nom_1\run__00001\m_1\m_1.h3d using the **Load Model** panel.
- Click the **Page Layout** icon on the toolbar and select the two-window layout.
- In the second window, switch to **HyperGraph**.
- Click the **Build Plots** icon on the toolbar.
- Use the **Build Plots** file browser and select the file `target_toe.csv`, located in the <working directory>.
- For **X-axis** data, select:
 - Type** = Unknown
 - Request** = Block 1
 - Component** = Column 1

9. For **Y-axis** data, select:
 - Type** = Unknown
 - Request** = Block 1
 - Component** = Column 2
10. Click **Apply**.
11. Using the file browser on the **Build Plots** panel, select the file <working directory>\approaches\nom_1\run__0001\m_1\m_1.abf
12. For **X-axis** data, select:
 - Type** = Expressions
 - Request** = REQ/70000033 toe-curve
 - Component** = F2
13. For **Y-axis** data, select:
 - Type** = Expressions
 - Request** = REQ/70000033 toe-curve
 - Component** = F3
14. Click **Apply**.
15. Plot another curve from the file
 <working directory>\approaches\opt_1\run__00006\m_1\m_1.abf using steps 11-14

You should end up with a session looking like the one shown below. Notice the optimized toe-curve.



Optimization results

You may also overlay the animation of the optimal configuration (run 6) over the nominal run. Notice the toe angle differences.

Save the session as `opt_toe.mvw`.