Sweeping Parameters in Dymola 2019 FD01

Few models are simulated only once. In fact, running several simulations with different parameters and comparing the results is one of the most fundamental user tasks.

Automated model experimentation has been supported by Dymola in the past, but it has been a somewhat hidden feature and – frankly speaking – a bit awkward to use.

In Dymola 2019 FD01 a modern user interface has been implemented, that allows the user to drag-and-drop variables that will be used to sweep and to visualize the results.

Introduction

Experimentation, meaning running several simulations with different parameter values or initial conditions has been supported in three ways in Dymola.

▶ Interactively setting values in the variable browser and then running the simulation.

▶ Scripting parameter settings in Dymola. This can also be done from an external program, for example, a Python script.

▶ Calling functions in the Design.Experimentation library to perform parameter sweeps.

The latter has been a somewhat hidden and awkward feature in Dymola, using a dialog to select variables and setting up the simulation parameters.

New in Dymola 2019 FD01 is a modern user interface to the functions that make basic parameter sweeps. The key advantages are

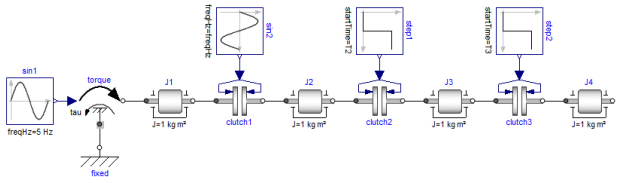
▶ Experiment setup is done by dragging suitable variables from the variable browser to a new window.

▶ Easy selection of which parameters or initial conditions will be varied during the sweep, and which variables will be plotted.

▶ Simulation settings are taken from the usual simulation setup.

Setting up such a sweep generates a script command that calls functions in Design.Experimentation, which means that it can be easily saved for future use.

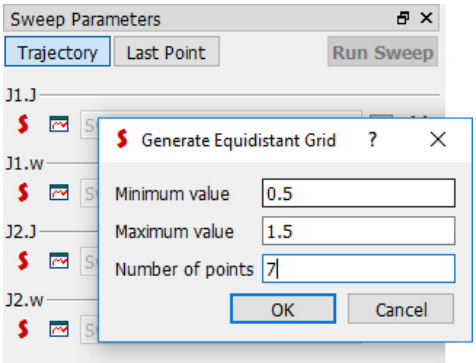
As a prototypical example, let us experiment with the CoupledClutches example from Modelica Standard Library and study the effects of varying the inertias of J1 and J2.



Setting up the sweep

Pressing the stylized "S" button in the simulation toolbar opens the Sweep Parameters window.

To set up the sweep we first drag sweep and plot variables into the sweep window. Second, we setup the range and number of points to sweep and select the variables to plot.

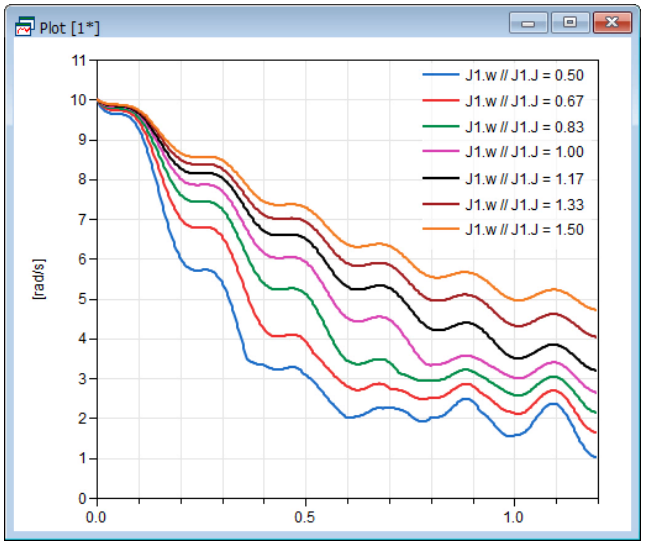


The dialog produces a call to the linspace function, but it is also possible to define a vector of parameter values with other Modelica constructs, such as, `0.5:0.2:1.5` or an array of values `{0.5, 0.8, 1.5}`.

The two buttons on the left side are used to select variables for sweeping or for plotting. It is possible to drag more variables to the dialog and quickly change sweep or plot variables.

Plot trajectory

In the first experiment, we will study the impact of changing the inertia of the first rotating mass in our system. We do that by sweeping one parameter (J1.J) and plotting the time trajectories of the rotational speed J1.w for each sweep value.

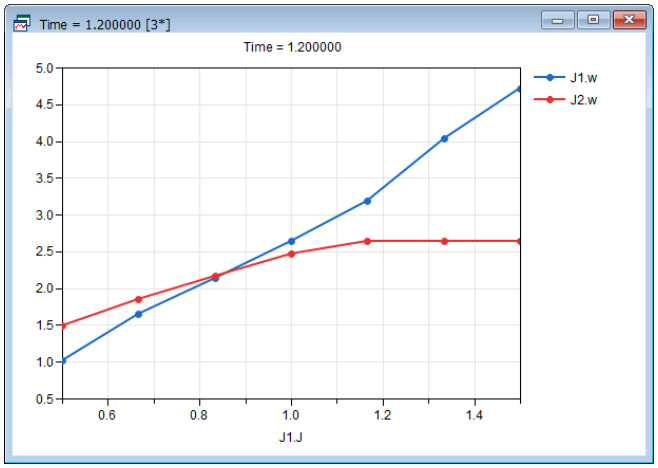


It should be noted that trajectory plotting only supports sweeping one parameter at a time, but several variables can be plotted.

With smaller inertias, we observe some irregular oscillations at the end, but smoother behavior and higher speed with increasing inertia.

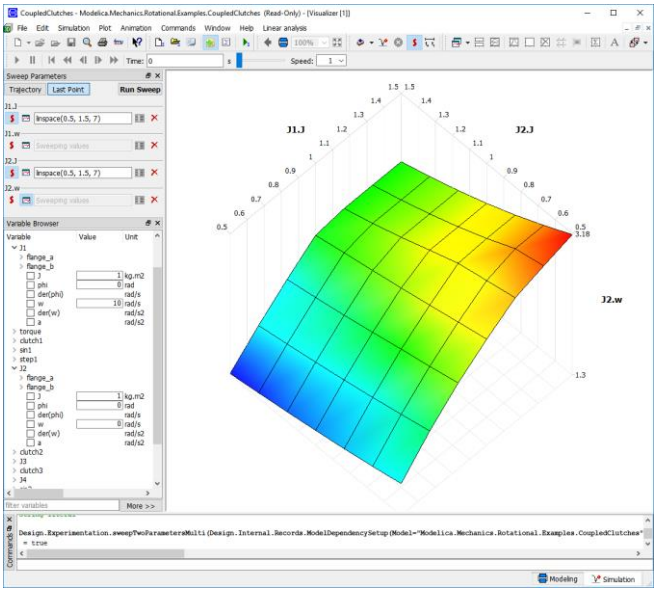
Plot last point

In the second experiment, we will sweep the same parameter, but plot only the last points of the two variables J1.w and J2.w, i.e. their values at the end of simulation. The sweep parameter J1.J is used as the horizontal axis.



Plot surface

Finally, we sweep two parameters for all combinations and plot the surface created by the last points of each simulation. Here we chose to plot just one of the variables for clarity.



The surface plot can be zoomed and rotated as needed. Color is used to highlight the variation of the plotted variable.

To plot J1.w instead of J2.w, we just click on the corresponding plot buttons and run the sweep again.

Conclusion

Basic model experimentation is now much more convenient Dymola. A modern user interface allows you to drag-and-drop variables for experimentation, and a variety of plots is easily generated.