Simulink SubSystems and Masking
April 22, 2008
http://jagger.me.berkeley.edu/~pack/e177

Copyright 2005-8, Andy Packard. This work is licensed under the Creative Commons Attribution-ShareAlike License. To view a copy of this license, visit http://creativecommons.org/licenses/by-sa/2.0/ or send a letter to Creative Commons, 559 Nathan Abbott Way, Stanford, California 94305, USA.

A (very simplified) car model
Consider a very simplified car model, modeling 1-dimensional motion on a straight (but perhaps hilly) road.

Writing down Newton’s law, assuming a simple proportionality model for Engine force (from throttle angle) and resistance (from speed) would give the differential equation model as

\[ m\ddot{v}(t) = Eu(t) - \alpha v(t) + d(t) \]

Simple car model in Simulink
For Simulink, we rewrite the original equation

\[ m\ddot{v}(t) = Eu(t) - \alpha v(t) + d(t) \]

as

\[ q(t) = \frac{1}{m} [Eu(t) - \alpha v(t) + d(t)] \]

\[ v(t) = v(0) + \int_0^t q(\tau) d\tau \]

and draw it using

– Summing junctions
– Gains
– Integrator
– InPorts, OutPorts

Simple car model in Simulink
Goal: Treat this as one entity, a “car”, with 4 parameters
– Initial speed (v(0))
– Engine Effectiveness (E)
– Drag Coefficient (\( \alpha \))
– Mass (m)

but, as shown, it is really many blocks. And, the parameters are all in different blocks. Two features to alleviate this:

– Subsystems
  – Group blocks (the constituent elements) into a single block (the subsystem)
– Masks
  – Create a new dialog box (the Mask Dialog) for a subsystem
  – Actual dialog entries of constituent elements are dependent on the dialog entries of the new dialog

Creating a subsystem
Within a model… Click and drag to select the blocks that will constitute the subsystem… They become selected…

Mission Accomplished Choose “Create Subsystem” from “Edit” menu…

Opening a subsystem
You can drill back down into a subsystem by double-clicking…

Another window opens, with all the details as before (now there are input and output ports too)…

But, to enter any values (mass, drag, engine effectiveness, etc), you have to open each block, and individually enter. For example, double-click on the 1/Mass gain block…

So, to the user, although the subsystem groups the blocks together, the 4 “properties” are still in separate places. Still need something else. Masks.
Component parameters from Mask Variables

Open each block, and enter a descriptive variable name in the appropriate parameter dialog box.

Creating and Editing the Mask

Select the Subsystem (single click)
Choose “Mask Subsystem” from “Edit”

The Mask Editor opens. This pane is for customizing the appearance of the block’s icon. We will not cover this here.

Click on the Parameters pane selector. That will be used to create the Dialog Box for the subsystem.

Mask Parameters

This pane defines the dialog box that user’s will interact with after double-clicking the block. We need to create 4 parameters. We will use editable text (as opposed to popups, etc).

Click Add button
Enter a Prompt, and a Variable Name. The expression that the user types in the dialog box will be evaluated, and a variable (of the defined name) will be created with that value

Add as many as you need
Rearrange/Remove with tools

What happens during Mask Initialization

When you start a simulation, initialization processes are carried out. For a Mask, this entails:

- Evaluate expressions in the MaskDialog box
  - expressions in Dialog Boxes are evaluated in Base Workspace, unless otherwise specified by the Workspace option in simset.
- Assign the resulting values to the Mask Dialog Variables (which “live” in the Mask Workspace of the block)
- Execute the Mask Initialization Code in the Mask Workspace, creating more variables in Mask Workspace.

At this point, the Mask Workspace consists of:

- the Mask Dialog Variables, and
- any variables defined by the Mask Initialization Code.

Then, the dialog boxes of the underlying blocks in the masked subsystem are evaluated. These are evaluated in the Mask Workspace, so that all Mask Variables are visible.

Mask Initialization

Enter code that must be run to convert the Mask Dialog Variables into the variable names that are entered in the dialog boxes of the blocks that make up the subsystem (the gain blocks, and the integrator). Could also do a lot of error checking…

Mask Documentation

The Documentation pane is where descriptive narrative is entered, as well as HTML code for the block “help”. Let’s just enter some text, and see what effect it has…

Mask Documentation
Masked subsystem’s behavior

Before masking the subsystem, double-clicking on the subsystem revealed the internal structure of the subsystem.

After masking, it simply opens the Mask Dialog box, as we have designed it.

Clean things up…

Select the subsystem, and choose “Look Under Mask” from “edit” to get back to the actual underlying structure. Edit the names of the input and output ports.

Now close that, and things are starting to look pretty professional.

Make a Library

Choose “File->New->Library” from any Simulink window.

Repeat. Add more blocks to Library.