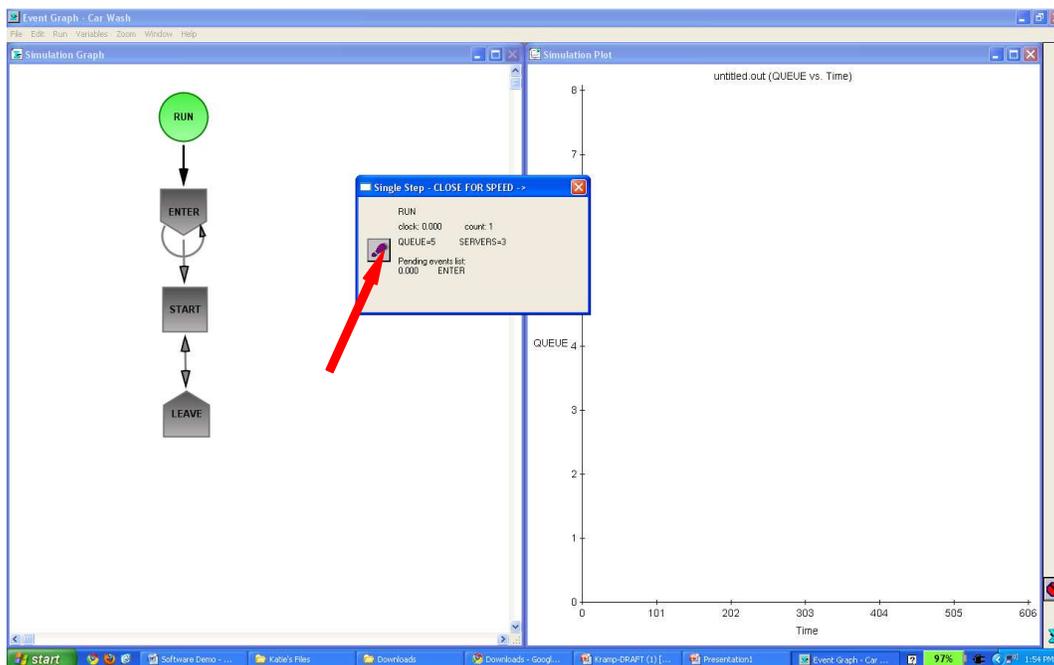


Example Models in SIGMA - CARWASH

- 1) The quickest way to learn SIGMA is to open a sample model that comes with the program, and run it to understand what is going on. The nice thing about SIGMA is that you can execute your simulation step-by-step and see what happens. I will start with a simple car wash which will appear in your documents folder once you have downloaded the program (My Documents\Sigma Models\A Car Wash\Car Wash.mod).
- 2) Press F5 to start running the simulation. Note that more run settings are available in the Run Tab -> Options dialogue box, but we will use the defaults for now.

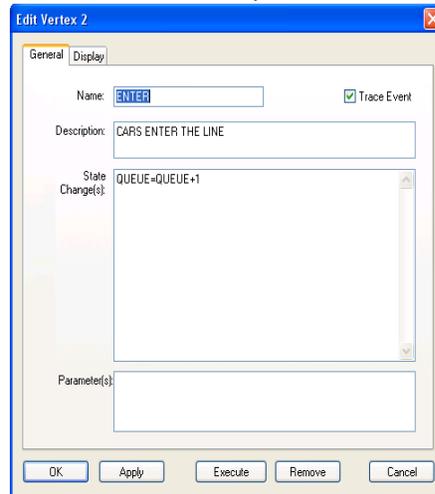
You will see a set of axes appear which is set initially to Queue Length versus Time. The clock is currently at 0 and an ENTER event is immediately scheduled (RUN simply initiates the run and is always executed first). Pressing the footprint icon will advance the simulation clock to the time of the next event on your events list.



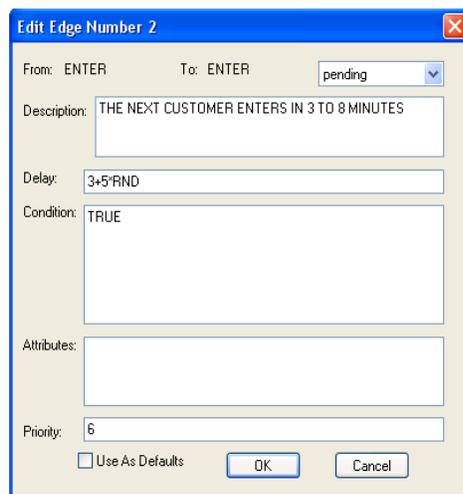
Once the ENTER event is executed, we see that another ENTER is scheduled as well as an immediate START event since all 3 carwashes are initially idle. START will schedule a LEAVE for 21.679 minutes later and that also goes on the events list. Keep single-stepping until you are sure you understand the pattern. As you go, you will also see data appear on the output plot. This single-step mode is extremely useful as a debugging tool for your model.

You can close the Single Step dialogue box to finish the full run and see the final output as well as the trace file. Notice that as you click in each window, the main toolbar will change so that you can only access options and settings relevant to that window.

- 3) Sigma models are built using vertices, which model events, and edges, which model the relationships between events. Let's take a look at the 'enter' event by double clicking on the node called 'Enter'. You can see that this event models the arrival of cars to the carwash. The description says 'CARS ENTER THE LINE'. The state change is $QUEUE=QUEUE+1$, indicating that every time this event occurs the queue of waiting cars is incremented by one.



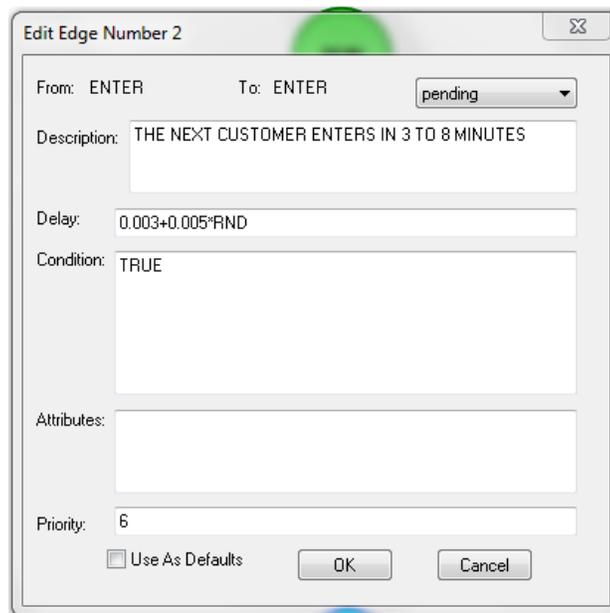
- 4) Now let's take a look at an edge, which is used to schedule events. Double click on the edge going from the ENTER event we just looked at, back to the ENTER event. This is called a 'self-scheduling' event. It models the arrival of the next customer to the carwash, which will occur between 3 and 8 minutes later. The delay, $3+5*RND$ indicates the length of time between customer arrivals. Finally, the condition simply says 'TRUE', indicating one ENTER event will always schedule another ENTER event.



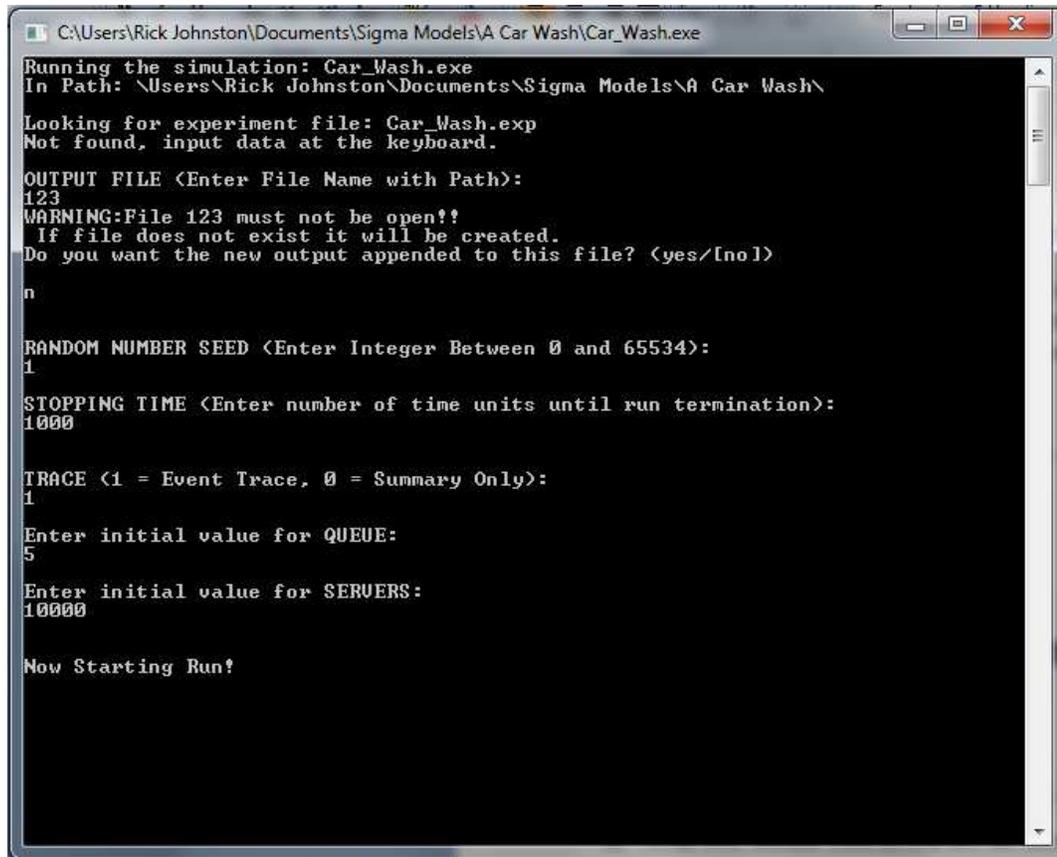


5) Now I want to mention some other details that may be useful to you. When building your own model, click the middle icon in the right-hand toolbar to create vertices and edges. Right-clicking will toggle between the simple selection tool and the model building tool. To delete a vertex, make sure you press Delete, not Backspace. Another thing to note is that when you start building your own model, all vertices will be circles. To change their shape as in Car Wash, click the Display tab in the vertex dialogue box and choose square, pentagon, or any other shape.

- 6) As I mentioned before, you can edit your model while it runs and see the changes immediately. This is something unique to SIGMA. Press F5 again, close the Single Step box and double click on the graph to allow you to show different data or to show the same data in a different way. Here we will show a histogram. Click OK and observe how the histogram changes as the run progresses.
- 7) Close the histogram plot. The carwash model we've just looked at is the simplest possible example of a carwash with only three servers. Let's see the power and speed of SIGMA by changing the number of servers to 10000 using Run Options.
- 8) We will also change the inter-arrival time to very short ($0.003+0.005*RND$ minutes). To do this, double click on the arc we were looking at earlier, going from and to the ENTER event. Change the inter-arrival delay to $0.003+0.005*RND$. An arrival event will occur more than once a second.



- 9) We're going to run this model in Fast mode, which will open the output in another window. Click Run > Fast, then enter the values for the output.



```
C:\Users\Rick Johnston\Documents\Sigma Models\A Car Wash\Car_Wash.exe
Running the simulation: Car_Wash.exe
In Path: \Users\Rick Johnston\Documents\Sigma Models\A Car Wash\
Looking for experiment file: Car_Wash.exp
Not found, input data at the keyboard.
OUTPUT FILE <Enter File Name with Path>:
123
WARNING:File 123 must not be open!!
If file does not exist it will be created.
Do you want the new output appended to this file? <yes/[no]>
n
RANDOM NUMBER SEED <Enter Integer Between 0 and 65534>:
1
STOPPING TIME <Enter number of time units until run termination>:
1000
TRACE <1 = Event Trace, 0 = Summary Only>:
1
Enter initial value for QUEUE:
5
Enter initial value for SERVERS:
10000
Now Starting Run?
```

- 10) Once this model has completed, the outputs will be stored in the filename you specified. Notice that the model has completed 1000 minutes, or around 17 hours of simulation time very quickly. The output file relating to this simulation is also very large – over 181,000 cars got washed during this day. Using SIGMA in this high speed mode is useful for doing advanced analysis or integrating your simulation with other toolsets. You can open the output file in Excel or some other toolset like Matlab for further analysis.