9. Using Wolfram SystemModeler to teach concepts in Unit 3 VCE Systems Engineering

This video demonstrates how to use *Wolfram SystemModeler* to link inputs to outputs when creating an integrated and controlled system using the Systems engineering design process. It also discusses the factors that will influence the creation and use of an integrated and controlled system. In addition the video provides advice how to demonstrate this understanding in a record of achievement for school-based assessment

Transcript

**Colin:** [00:00:21] In this video, we're going to look at linking an input to an output. An important part of this site design that students need to be able demonstrate in their portfolio with a record of evidence.

**Colin:** [00:00:35] So, so we start off by opening up a new class, giving it a name that makes sense. In this case, I'll call it LightDetect1. And I'm going to save that under the same name, making sure I'm saving it on the Wolfram Mathematica. That's all saved. I pull across, first of all, an Arduino. Which we'll put on top here and I'll just enlarge it. I didn't need to go to my pins. And I'm going to have an analog input. This is going to be reading information from a voltage divider network, which will build fairly soon. And then we need a digital output, put on the other side here.

**Colin:** [00:01:23] So that's the basics of the connection to the Arduino. What we now need to do is have some logic to process the information coming in from the voltage divider network. So in order to do that, we need to go to my Modelica. So I'm just going to collapse the model plug and open up Modelica and we're going into the blocks. Blocks is where all the logic blocks are found. So in the logic blocks, I need to find an 'and' statement. So I'm going to go to logical 'and' I'll pull that across.

**Colin:** [00:02:00] What we're going to try to determine in this experiment is whether the light level, or the voltage is acting as a proxy for light level, falls between two values, and it will eliminate LED appropriately. So we need an 'and' statement in order for us to be able to measure whether something is greater than or less than another value.

**Colin:** [00:02:18] So I have my 'and' block there. I'll enlarge that. The next thing we need is a greater than and less than. I'm going to pull across a greater than block enlarge that and now a less than. There are also blocks that are greater than equal to and less than equal to, and so on. So there are the blocks there. And the next thing I need is some value that I can compare these voltage inputs from the voltage divider network.

**Colin:** [00:02:58] So I need to go to I'm staying in blocks, but now I need to go to sources. And as I scroll down sources, we need two constant sources. That's constant source number one and constant source number two and I'm enlarging those as well.

**Colin:** [00:03:19] So those are all the components we need. Now, the next thing to do is to wire this up. So we'll go to the wiring lock here and we'll connect the output to the Arduino and the the Arduino to an input. There we go.

**Colin:** [00:03:39] The next thing we have to do is to, first of all, connect the input, the analog input from the voltage divider network, to both of our logic blocks. The greater than and less than compareters. I'm going to take a wire from there and I'm going to take it right across and put it into this side with the blue triangle is. And you can see that the wiring is automatically adjusted to show that it's connected. You got the bold cross, so that's connected. I need to also connect this to the other logical statement. And there it is, the less than. So those two are now connected.

**Colin:** [00:04:21] Now, the next thing to do is I need to connect the thing that these inputs are being compared to to these constant voltage sources. So I connect from this port to the voltage source, which is there, you can see the cross has become bolded and I connect this one in a similar fashion.

**Colin:** [00:04:45] Now I've got two outputs. Now this circuit, at the moment, looks a bit confusing, but there's nothing to stop us from highlighting any of these blocks and turning them around, if it helps us make better sense of what's going on. Everything changes dynamically. So I'll do the same to this one here. So things seem to be a bit easier to follow now. And this 'and' statement, I'll do the same to that. Could even say the text of the blocks that describes their function also rotates. So I'll connect now, each of these to the 'and', order doesn't matter. And then the 'and' will go to the output. So now I've connected the circuit. So let's validate. And it's completed successfully, so we know the circuit is connected.

**Colin:** [00:05:49] The next thing we need to do now is to actually build the physical circuit. So we're building a voltage divided network. For a voltage divided network we need the following components, an LDR, a 10k resistor, various connecting wires and an LED to act as our output.

**Colin:** [00:06:20] We'll connect the LED first. We'll connect it to PIN number eight. So it's easy for me to locate as far as a pin is concerned. So I connect long leg into the output of the PIN, PIN number eight, and then not connect the other end of the LED to ground, on this board is down on this block here. You can see there's an old code in there making a flash when we put the new program in. It'll change.

**Colin:** [00:06:47] We'll need to build our voltage divider network. So here's my LDR and I'm going to connect it to a point on the board. Doesn't matter where it goes. There it is. And I need to connect that in series with the resistor, the 10k resistor. So I make sure that the LDR and the 10k resistor share a connection and then I plug the other end of the resistor into another part of the circuit.

**Colin:** [00:07:19] The next thing to make this voltage divider network work, is I need to have a source of voltage in one end and ground in the other. So I'm going to put five volts from the Arduino board in one end. And ground in the other end.

**Colin:** [00:07:46] And then finally, where the LDR and the resistor connect in series, that junction, I'm going to put a wire in place. That's effectively going to be the reading from the voltage divider network. And I'm going to plug that into A zero port, input port of the Arduino. The A zero port being the analog port.

**Colin:** [00:08:10] So now I've got my circuit all built up. The next thing to do now is to go and check all my components and give them the appropriate values. So, for the Arduino, I need to click on that. Making sure I got the right icon. There we go. Click on it. And we remember that we need to pick a comm port and if we click this editing icon, it will tell us where the Arduino is connected in this case comm three. We can press Okay and it will sign that comm to the Arduino.

**Colin:** [00:08:45] The next thing we need to do is to go to the analog input. Now, there's a slight quirk with the SystemModeler in that it doesn't label analog inputs as aA zero through to A five. What it does is it assigns a number beyond 13 to those ports. A0 corresponds to PIN 14. But if we click on the icon here, you can see that under the pin, under parameters for PIN, there's a editing icon there. We can click on that. And you can type in 14 for A0.A0.

**Colin:** [00:09:30] The next thing we need to do is to look at the output and we connected that to PIN number eight. So we'll put 8 for that output there. So if connected those two.

**Colin:** [00:09:41] The next thing for us to do is to assign logic values to these two here, these constants sources. Now we want to know whether something is greater than a value and less than another value. So we'll try some values and see what happens. For this one here, I'm going to put a value of one. And for this other one here, I'm going to put a value two.

**Colin:** [00:10:12] Now, before I simulate, there a couple of values, I need to change and one is to do with the output here. The inpu. So the input has to be scaled. The Arduino has a couple of inbuilt voltage suppliers. One is zero to three point three volts, and the other one to zero to five volts. So we need to scroll down for our input here and you'll see there's a scaling section of two fields. Minimum value, we'll put zero. Maximum value, in this case, using five volt rails, so five volts in there. Once we've done that, we then just go and re select our values for the greater than and the less than what we would like to do is have the LED turn on when the voltage from the voltage divider network, acting as a proxy for light level, is above 1 volt and below 2 volts. So you can see that's what I've changed in these two fields here. Now we can go to simulate. It's just building the experiment.

**Colin:** [00:11:26] Now we need to keep our good habits here. We have to go to settings and make sure that we set the settings to synchronize with real time, which is what we have here. And I've also kept the experiment to 20 seconds. And the reason is that the scaling horizontally will allow a much more clear graph for the students to use.

**Colin:** [00:11:50] The next thing I want to do is go to my plot. And in plot, the things I'm looking at, are the analog input and the digital output. Because what I'd like to see is what happens as the light levels change, therefore the voltage and the voltage divider network changes and the digital response to that.

**Colin:** [00:12:10] So we'll set the simulation to go. I'll just close this window here and hit it start. You'll notice L.E.D. will turn on to at the appropriate times. Just press those again so the graph knows.

**Colin:** [00:12:28] So as I change the light levels, you can see on the screen the digital output is changing and the LED is coming on at the same time. The students can take a screenshot of this and they can annotate both traces. In this case, the top blue traces is looking at light levels. And they can see the digital response, the orange trace in response to that.

**Colin:** [00:12:50] This is very good evidence of successful integration of mechanical and electronic components of their projects.