Module 2C
Introduction to Systems Modeling: How to Build the Moose Model

Stage 1: Starting with Births

- Open Vensim. If a previous model appears, under the File menu, select New Model.
- If the Model Settings window opens, enter these values, then click OK.
  - INITIAL TIME = 0
  - FINAL TIME = 50
  - TIME STEP = 1
  - Units for Time: Year
  - Integration Type: Euler
- There are two very important icons on the menu bar – the hand and the pacman. The hand is the icon to use when you want to browse, move or resize the model. The pacman is used to delete a mistake. The pacman doesn’t ask for confirmation of the delete – it assumes that you mean what you say.
- To build the model shown below
  - Click and release on the Box icon, click in the white space, type Moose Population in the rectangle that appears, hit Enter. Use the tiny circle in the lower right hand corner of the box to adjust the box size so the words are easy to read.
  - Click and release on the Rate icon. Move to the left of the Moose Population box, click and release, move the mouse into the Moose Population box, click and release again. In the rectangle that appears, type Moose Births and hit Enter.
  - Click and release on the Variable icon. Move under the Moose Births rate, click and release, and type births per moose in the rectangle that appears. Hit Enter.
o Click and release on the **Arrow** icon. Move the mouse over the words ‘births per moose’ and click and release. Then move the mouse over the words ‘Moose Births’, and click and release. A blue arrow should appear. The head of the arrow should be pointing to Moose Births.
o Using the same action, connect Moose Population to Moose Births with a blue arrow.
o You can make the blue arrows curve by pulling on the tiny circle attached to each arrow.

**Putting the math in the model**

Click on the \( Y=x^2 \) button. Notice that all variables are shaded in black. That means we haven’t given Vensim any numbers yet.

- Click on the box called Moose Population. Enter 100 in the Initial Value box and your window should look like the one below.
- Note that Vensim has filled in for you that Moose Population is the Integral of Moose Births. If your students are taking calculus, you can tell them Vensim is solving differential equations numerically. For the rest of the world, you can simply say that Vensim will be adding Moose Births to the Moose Population to get next year’s Moose Population.
- Note that there is a Units box where you can type the appropriate units for the variable being measured.
- Note the Comment box for documentation.
- We will go over the other boxes when we do other variables. Click OK to close the window.

- Click on births per moose and enter 0.5. Also enter the values seen below for Minimum Value, Maximum Value, and Increment. These will be used for the slider bars you will see later.
- Click OK to close the window.
Click on Moose Births and enter births per moose*Moose Population by clicking on the names in the Variables box and the symbol * on the keypad or on your keyboard.

Click OK to close the window.

**Running the Model**

- **Run** the model by clicking on the green running man next to the white box that says Current. If a dialogue box appears saying “Dataset Current already exists. Do you want to overwrite it?”, click on Yes.

- To see the output, click on Moose Population, then click on the **Graph** icon on the left sidebar. A graph will appear showing that there are over 60 billion moose at the end of 50 years.

- To see a table of values, click on the **Table Time Down** icon on the left sidebar.

**Reflection Questions**

1. Look carefully at the first four values under Moose Population. Do they agree with the numbers calculated by the class and recorded on the chart earlier?

- **Run AutoSim** the model by clicking on the green running man with horizontal bars to the right of the other green man. Note the mini-graphs that appear in Moose Population and Moose Births. Use the slider bars to vary the births per moose.
• **Reflection Question**
  2. What kind of growth does this model illustrate?
  3. How would you simulate zero population growth with this model?
• Click the Stop Sign to return the model to its original state.
Stage 2: Adding Deaths

- Add the new components to the model.

  **Caution:** The rate called Moose Deaths must be drawn so it points away from Moose Population. That will tell the model to subtract deaths. Therefore, when you click and release the Rate icon, your first click in the model space should be inside the Moose Population box. Then move the mouse to the right and click again.

  Review the directions on page 1 to add the **Variable** moose death fraction and the two **arrows**.

- Click on the \( Y=x^2 \) button to add data the new parts of the model. Note that the Moose Population Box darkens, showing that you must click on the box to look at the new equation inside. You should see Moose Births – Moose Deaths inside the integral box. This means that every year, births will be added and deaths will be subtracted. Click OK to close the window.

- When you click on moose death fraction, ask yourself what fraction of moose should die each year. Enter that value in the text box. Set the Minimum Value, Maximum Value, and Increment in the window also. What bounds will you choose for the moose death fraction?

- Now input the equation for Moose Deaths just as you input the equation for Moose Births.

**Run AutoSim**, using the scroll bars to manipulate the moose death fraction.

- **Reflection Question**
  4. How could you simulate a declining moose population with this model?
Stage 3: Making a Custom Graph

Step 1
Click on the Control Panel icon at the far right end of the top bar to open this window.

Step 2
Click on the Graphs tab. Then click on New.

Step 3
Follow the steps below to make the top window to the right look like the window below it.

- Enter a Title – this will allow you to identify this graph. I suggest Population.
- Unless we say otherwise, the X-Axis will represent Time and it will go from 0 to 50 as it was set in our model.
- To tell the model what to graph on the Y-Axis, click inside the first variable box. Click on the Sel button, then select Moose Population from the list shown. Click OK.
- To be sure the Y-axis starts at 0, type 0 in the Y-min box.
- To be sure the graph plot is visible in a projection display, type 3 in the LineW box.
- Your window should now look like the bottom window to the right.
- Close the window by clicking on OK at the bottom of the window.
**Step 4**
You should see the Control Panel window open on your screen with Population in the white space.

Click Display and you should see a graph of the Moose Population like the one below.

**Step 5**
Close the graph window and then the control panel to return to the model. To attach the graph to the white space, click on the Input Output Object. Click in the model white space to bring forth a window.

**Step 6**
Click in the circle by Output Custom Graph. Then use the drop-down menu at the bottom of the box to select the name of the graph you wish to display (Population). Click OK and a graph box will appear on the screen. You may resize it by dragging on the small circle in the lower right-hand corner of the box. Run the model to make the graph appear.
Stage 4: Making a Custom Table

**Step 1**
Click on the Control Panel icon at the far right end of the top bar to open this window.

**Step 2**
Click on the Graphs tab. Then click on New.

**Step 3**
In the window shown below, click on the As Table button at the bottom center of the window.

**Step 4**
In the new window,
- Enter a Title different from the one selected for the graph - I suggest Population Table.
- Click on the Variable box. In the window that appears, select Moose Population and click OK. Notice that Moose Population now appears in the white text box next to Variable. Click the Add button on the right to move Moose Population into the Table Content box.
- Click in the Running down box to get a vertical display of numbers.
- Type 13 in both Cell Width boxes: First and rest.

The window should look like this:

- Close the window by clicking on OK at the bottom of the window.
Step 5
You should see the Control Panel window open on your screen with Population and Population_Table in the white space. Click on Population_Table to highlight it (if it isn’t already highlighted).

Then click Display. You should see a table of values like the one below.

<table>
<thead>
<tr>
<th>Time (Year)</th>
<th>Moose Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>1</td>
<td>140</td>
</tr>
<tr>
<td>2</td>
<td>196</td>
</tr>
<tr>
<td>3</td>
<td>274.4</td>
</tr>
<tr>
<td>4</td>
<td>384.16</td>
</tr>
<tr>
<td>5</td>
<td>537.82</td>
</tr>
<tr>
<td>6</td>
<td>752.95</td>
</tr>
<tr>
<td>7</td>
<td>1,054</td>
</tr>
<tr>
<td>8</td>
<td>1,476</td>
</tr>
</tbody>
</table>

Step 6
Close the table window and then the control panel to return to the model. To attach the table to the white space, click on the Input Output Object. Click in the model white space to bring forth a window.

Step 7
Click in the circle by Output Custom Graph. Then use the drop-down menu at the bottom of the box to select the object you wish to display (Population_Table). Click OK and a table box will appear on the screen. You may resize it by dragging on the small circle in the lower right-hand corner of the box. Run the model to make the table appear.