

Chapter 4 – Basic Process Panel

4.1 Modules

We will use Sample Model 1 in Figure 4.1 and Sample Model 2 in Figure 4.19 to discuss both the Modules and Data Modules used from the Basic Process panel in this course.

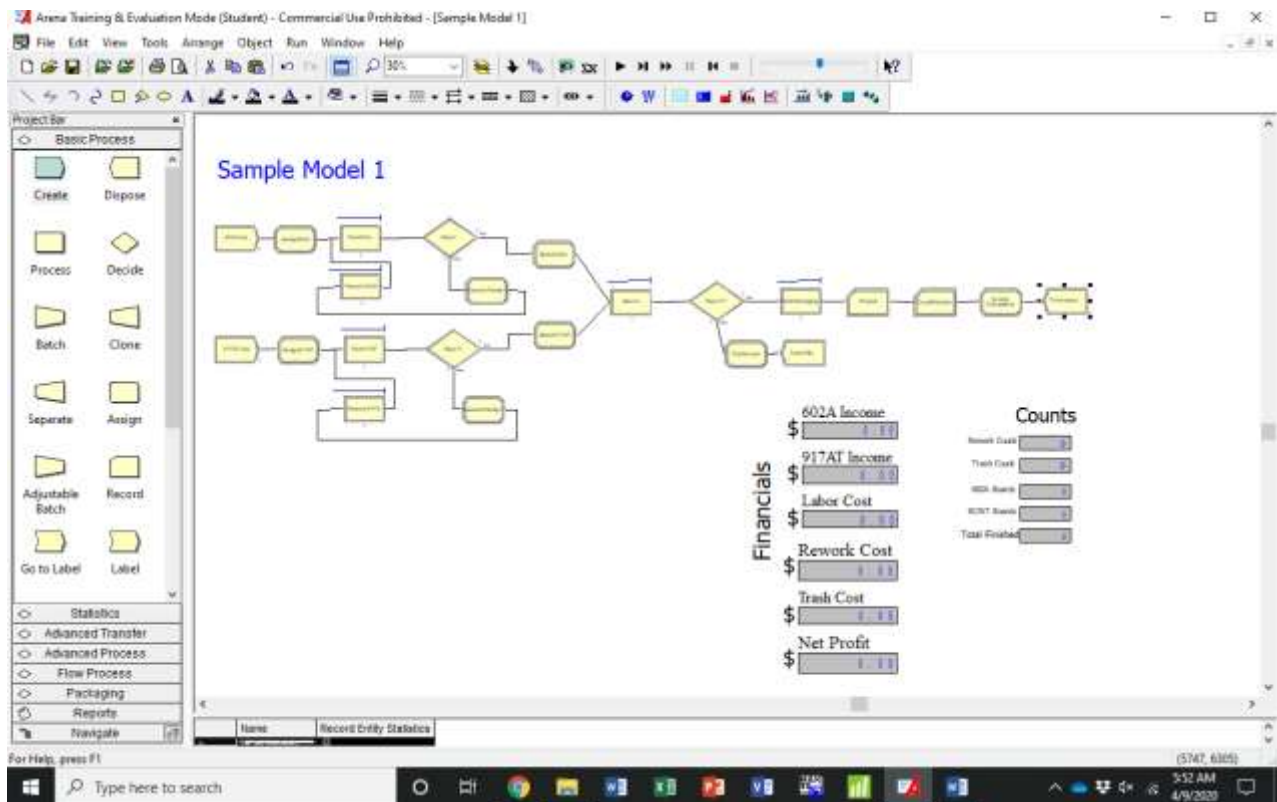


Figure 4.1. Sample Model 1.

4.1.1 The Create Flowchart Module

The Create module (see Figure 4.2) is the “birth” node for entity arrivals to the system from the outside.

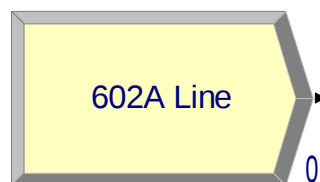


Figure 4.2. Create module.

Double-click it to open a dialog box like the one in Figure 4.3.

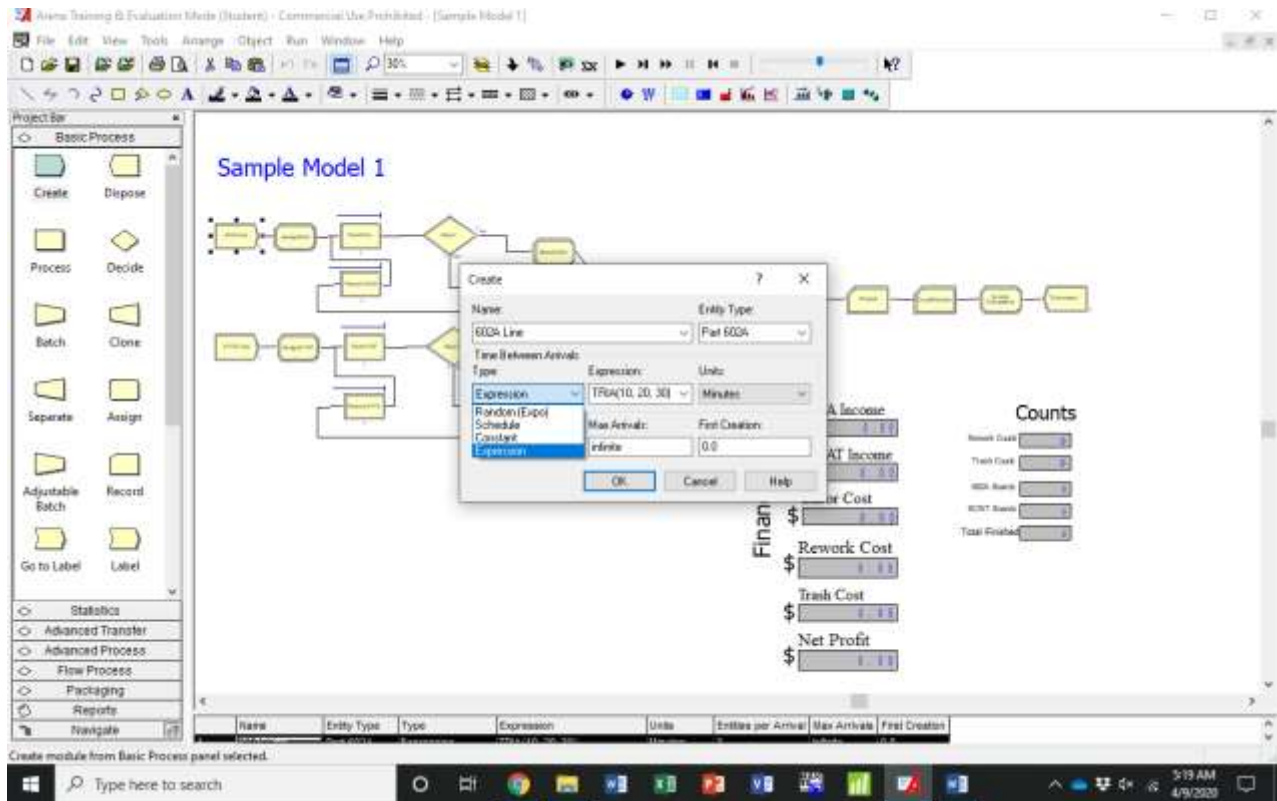


Figure 4.3. Dialog box for the Create module.

The dialog box contains fields for different kinds of information related to this particular module. In the Name field, you would type in a short descriptive name that will become the label for this Create module. In the Entity Type field, you would type in a descriptive entity name, such as a particular part name. In the Time Between Arrivals section, select the appropriate probability distribution from the Type drop-down menu. You will notice four choices: Random(Expo), Schedule, Constant, and Expression. Select Random(Expo) if the time between arrivals follows an exponential distribution. Select Schedule if the time between arrivals follows a certain schedule that you can build into Arena (i.e., incoming parts arrive between 7am and 8am). Select Constant if the time between arrivals follows a constant time, such as the time between arrivals is 2 minutes for all parts. Select Expression if the time between arrivals follows any other distribution. When you select an option, you will notice the Expression field in the middle of the dialog box will change (see Figure 4.4).

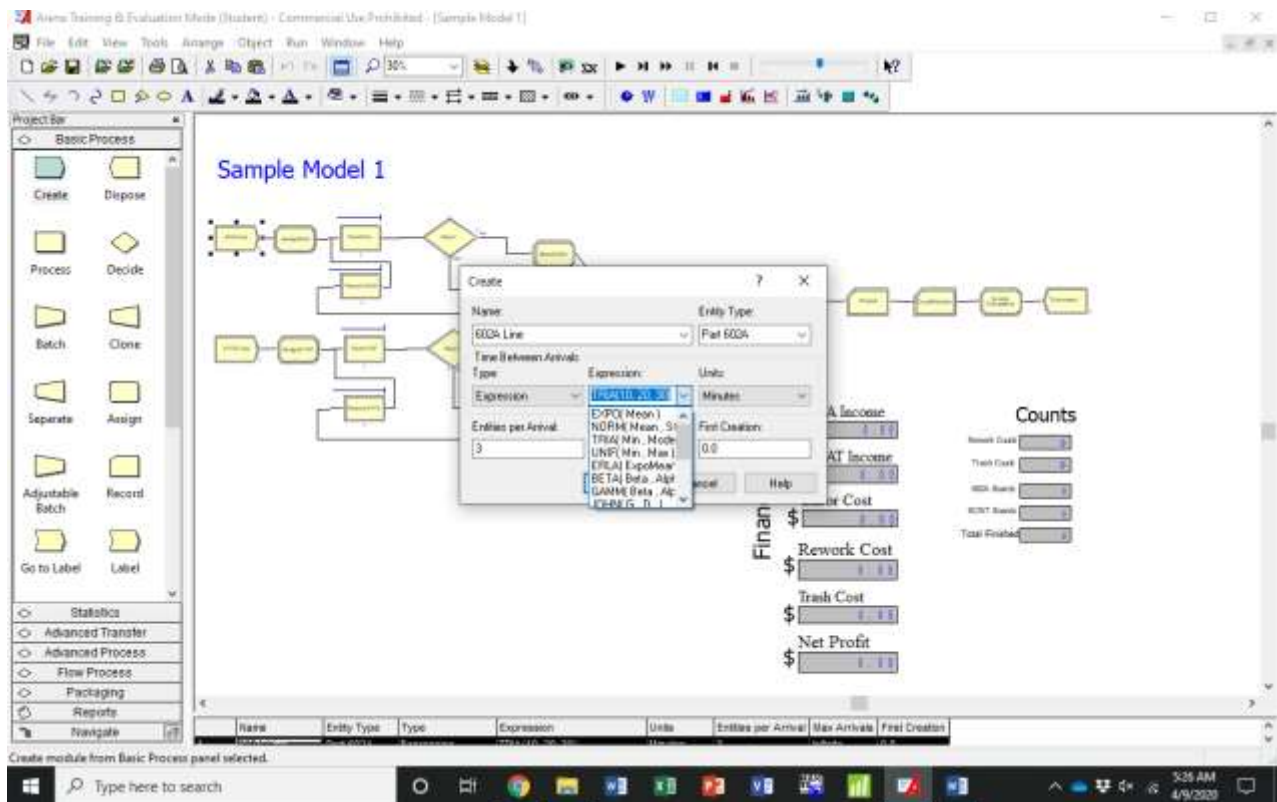


Figure 4.4. The Expression drop-down menu in the Create module.

You can select the appropriate distribution and manually enter the parameter values in parentheses to replace the text.

The Units field offers a drop-down menu in Figure 4.5. These are time units of measurements for arrivals. Select the appropriate choice of seconds, minutes, hours, or days.

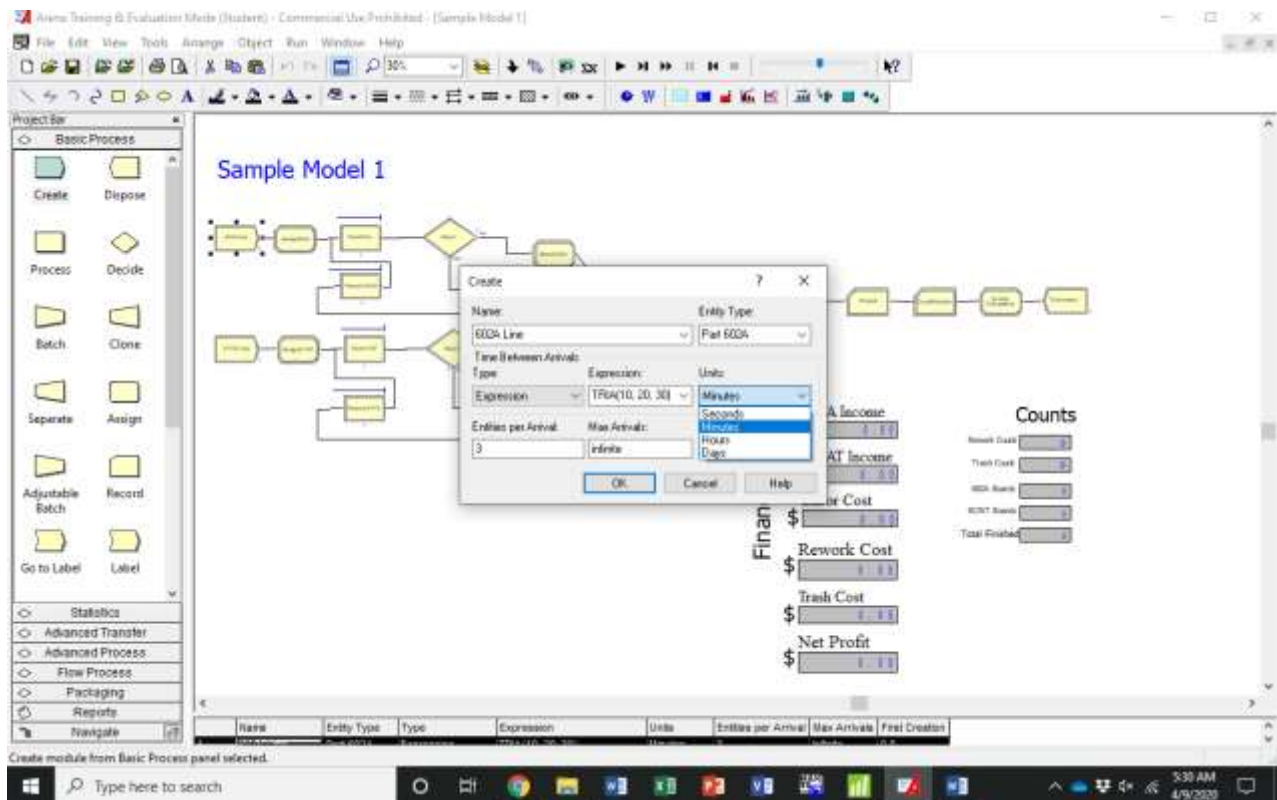


Figure 4.5. The Units drop-down menu in the Create module.

In the Entities per Arrival field, enter the number of entity arrivals at a time. Entities may arrive one at a time or in batches (i.e., batches of 5). In the Max Arrivals field, enter the maximum number of entity arrivals. If there is a cap like, say, no more than 10 arrivals, then enter the number 10. If there is no cap on the number of arrivals, then enter Infinite. The case in this field is non-sensitive to upper or lower case letters.

In the First Creation field, enter the time that the first part, or entity, is expected to enter the system (see Figure 4.6). If the first part is expected to enter the system as soon as the simulation begins, then enter the value of 0, or 0.0. If you want to build in a delay, such as the first part enters the system 5.5 minutes after the simulation begins, then enter 5.5 here. Be sure you selected Minutes in the Units field so that 5.5 in this example means 5.5 minutes.

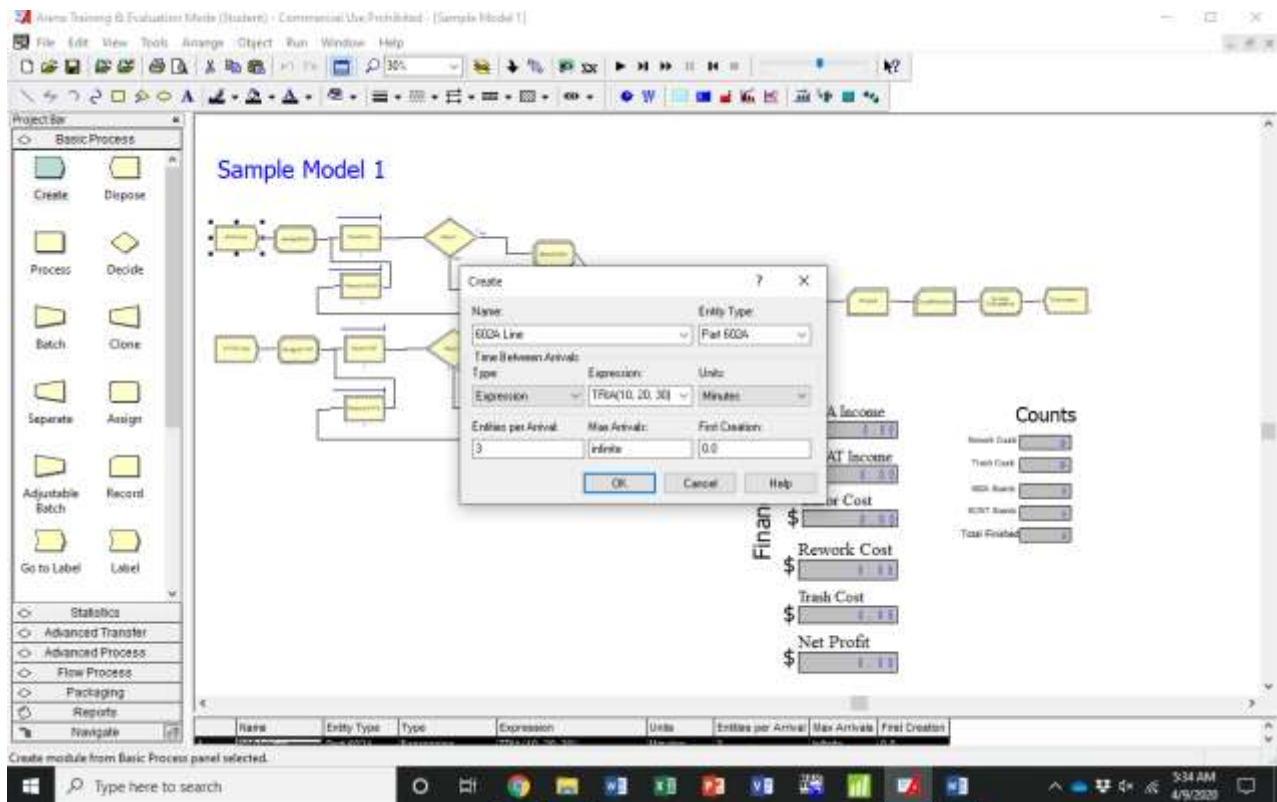


Figure 4.6. First Creation field in the Create module.

4.1.2. The Dispose Flowchart Module

The Dispose module (see Figure 4.7) represents the end of a trunkline of modules, such as a process or a decision, or the end of the modeled system.

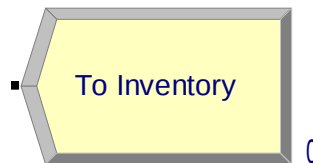


Figure 4.7. The Dispose module.

Double-click it to open the dialog box (see Figure 4.8).

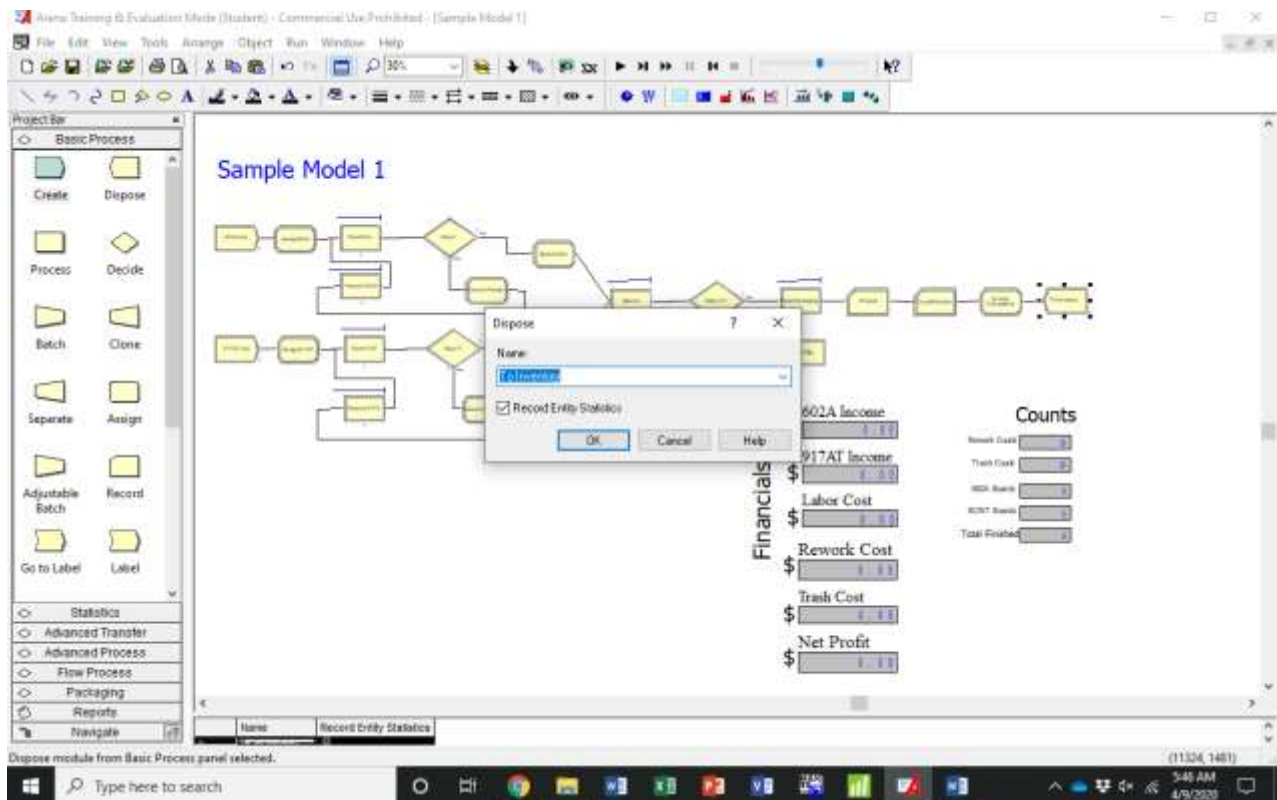


Figure 4.8. Dialog box for the Dispose module.

Simply enter a descriptive name in the Name field. This will become the label on the face of the Dispose module. Be sure the checkbox for Record Entity Statistics is checked for all modules so that Arena captures this information during the simulation run. This data will impact the results at the end of the simulation run in one of the output reports, such as the Category Overview report or the SIMAN Summary Report.

4.1.3 The Process Flowchart Module

The Process module in Figure 4.9 is used to describe a process, such as a value-added like Burn In or non-value-added process like Walking from point A to point B.

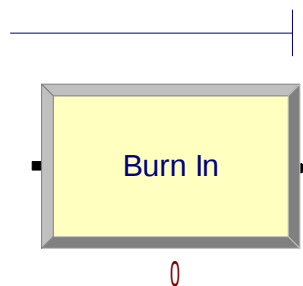
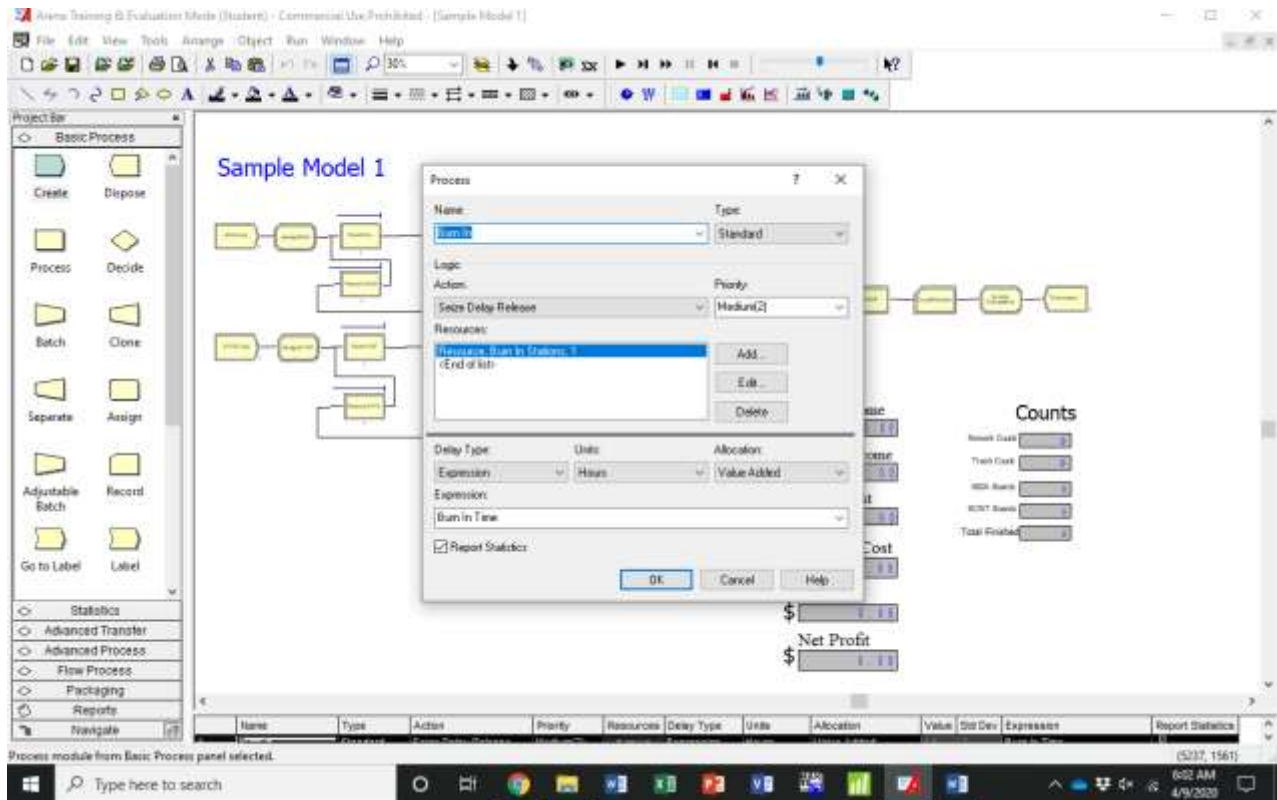


Figure 4.9. The Process module.

Double-click the Process module to open the dialog box (see Figure 4.10).

**Figure 4.10. Dialog box for the Process module.**

In the Name field, enter a descriptive name and this will become the label for this particular Process module. In the Type field, we have two options: Standard or Submodel. Select Standard if a submodel is not used in your model.

In the Logic section, we see four options for the Action field in Figure 4.11.

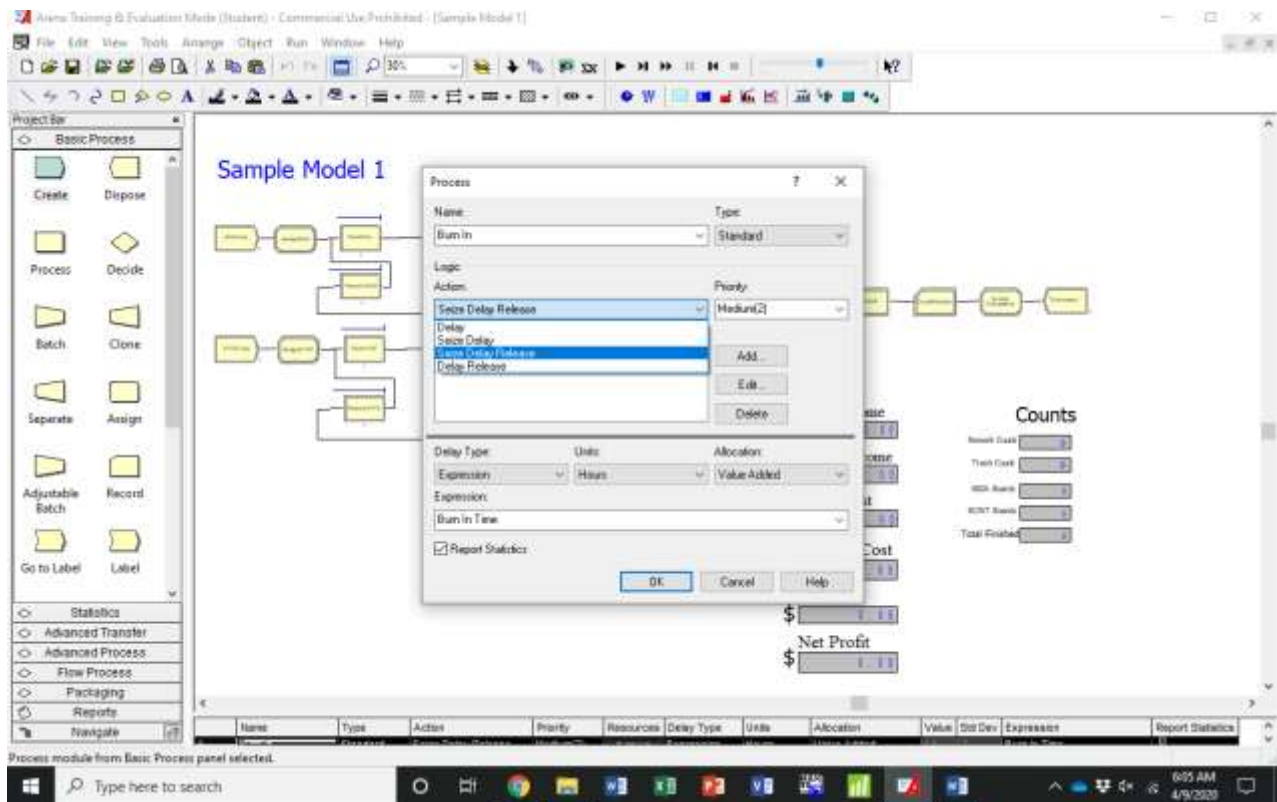


Figure 4.11. Four options in the Action field.

The Action selected pertains to the relationship between the entity and the resource, if any. The option Delay means that the entity is in a holding pattern of sorts. No activity is being performed on the entity. The Seize Delay option means that the entity has seized a resource an activity is being performed on the entity (the delay). The Seize Delay Release option means that the entity has seized a resource, an activity is being performed on the entity (the delay), and then the entity is released to continue on to the next destination. The Delay Release option means that the entity has an activity being performed on it and is then released to continue on to the next destination. Note that the selection of either Seize Delay or Seize Delay Release triggers two significant things: (1) it will automatically create a queue line above the Process module; and (2) we need to add at least one resource (see Figure 4.12).

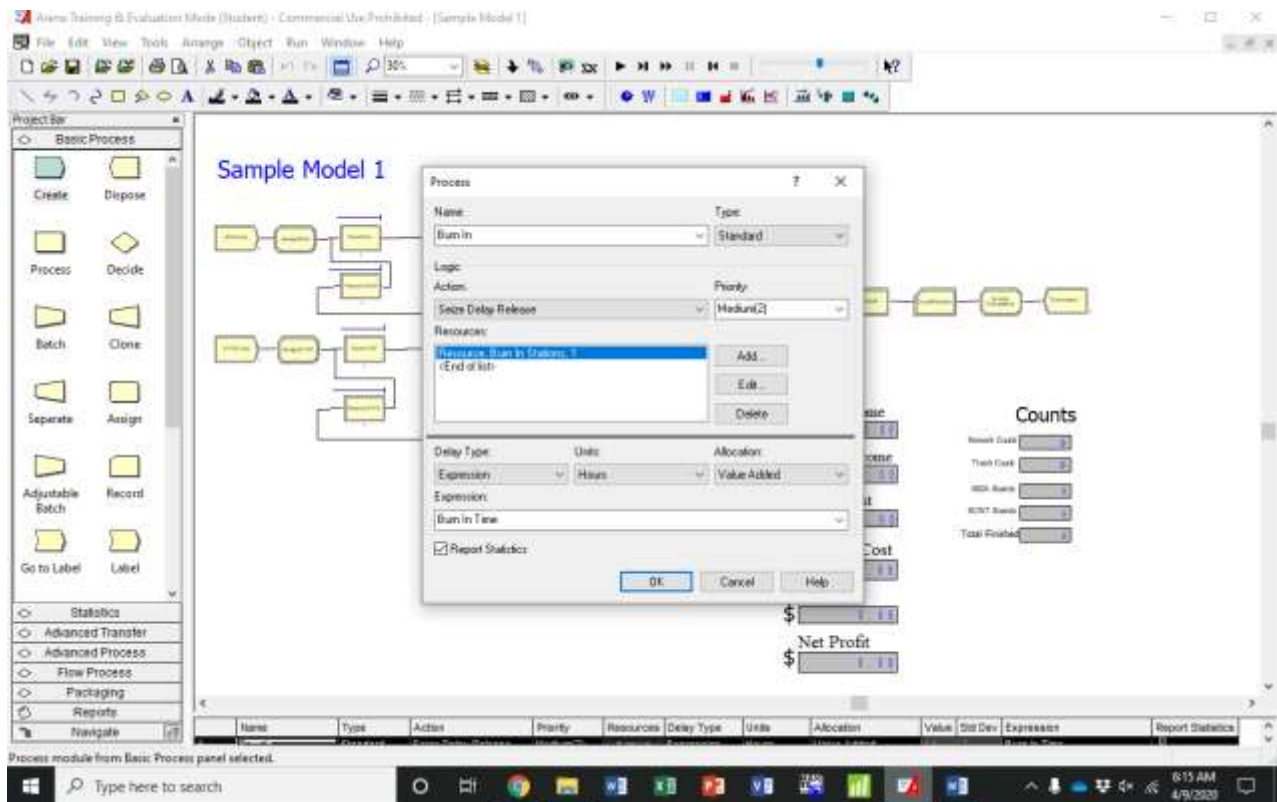


Figure 4.12. Burn In Station as a Resource.

To add a resource, click the Add button next to the Resources window (see Figure 4.13).

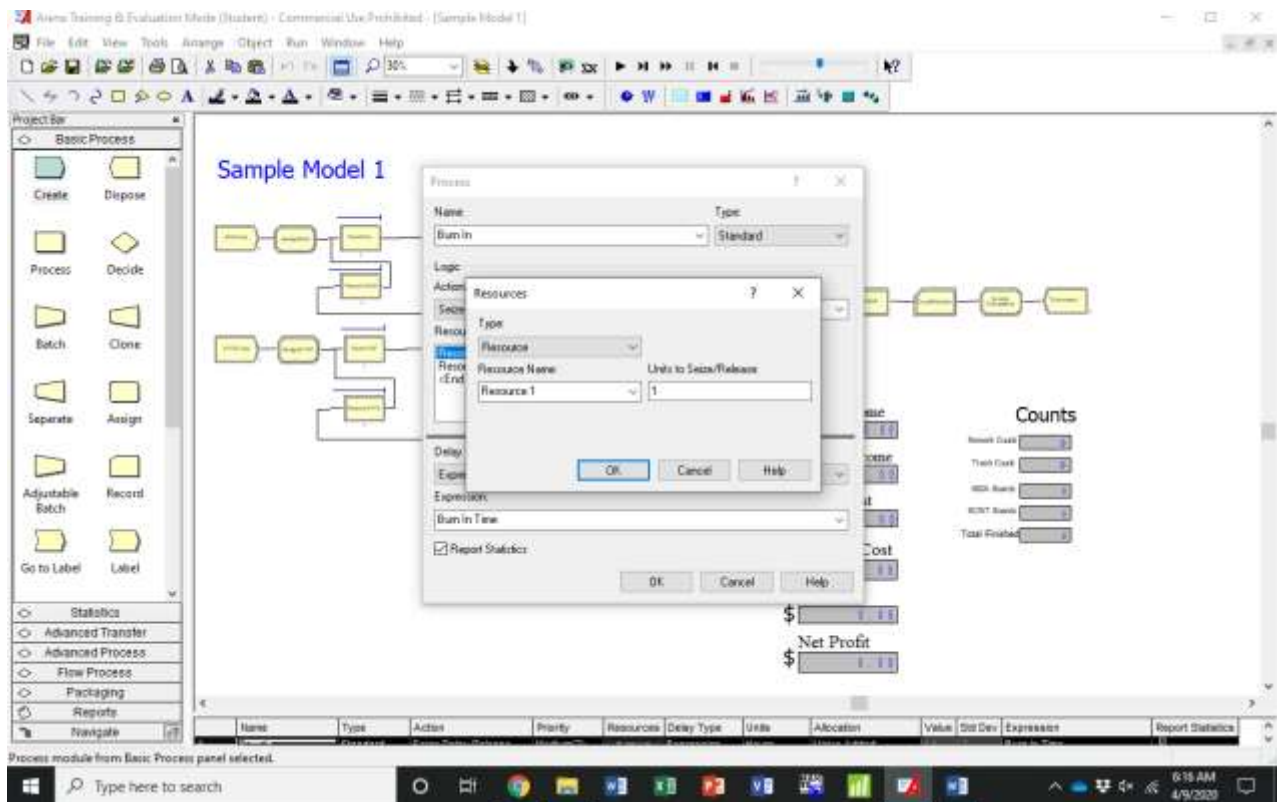


Figure 4.13. Resource dialog box to add Resources.

In the Type field, there are two options: (1) Resource; and (2) Sets. Select Resource if you want to add a machine, a person, or equipment. In the Resource Name field, enter the name of your resource. In the Units to Seize/Release field, select the Default value of 1 if you want one resource to work on each entity. The resource in this example is a Burn In machine so we want one Burn In machine to work on each entity. If we were to enter a different number here like, say, 5, then this means we need 5 Burn In machines to work on each entity. If your resource becomes a bottleneck operation and you need more than one resource to work on the shift (or day), then you would change the number of resources needed in the Resource data module, not in the dialog box in the Process module. For example, if you needed 5 Burn In machines on the shift but each Burn In machine works on only one entity, then change the fixed capacity to 5 in the Resource data module but keep retain the value of 1 in the Units to Seize/Release dialog box in the Process module.

There are three options in the Priority field: High (1); Medium (2), and Low (3). Select the appropriate priority.

The Delay Type section represents the processing time for the entity (see Figure 4.14).

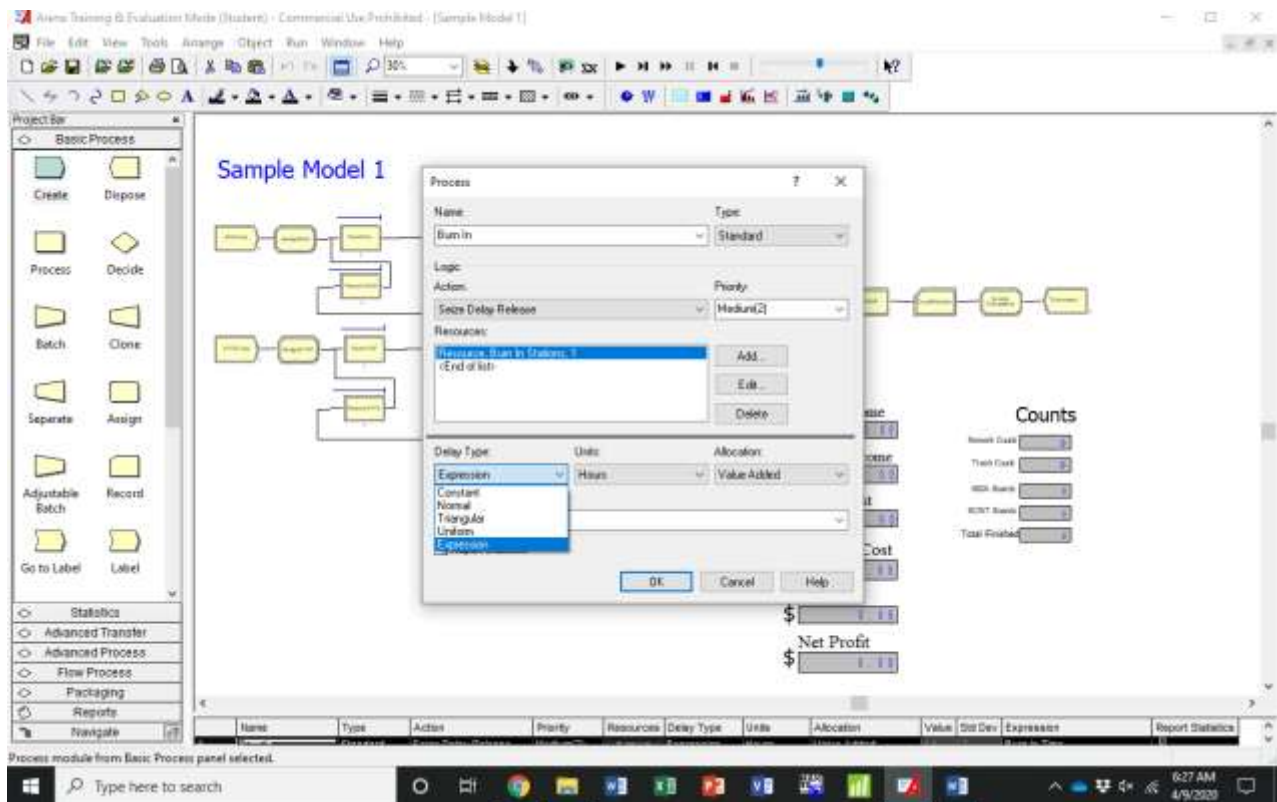


Figure 4.14. Expression drop-down menu for Delay Type.

The drop-down menu for Expression provides the choices of Constant, Normal, Triangular, Uniform, and Expression. Select Constant and enter the value in the appropriate time unit of measurement if the processing time is constant, such as a 30 second Stamping operation. Select Normal if the processing time follows a Normal distribution. Then enter the mean and standard deviation values. Select Triangular if the processing time follows a Triangular distribution. Then enter the minimum, most likely, and maximum values. Select Uniform if the processing time follows a Uniform distribution. Then enter the minimum and maximum values. Otherwise, select Expression (see Figure 4.15).

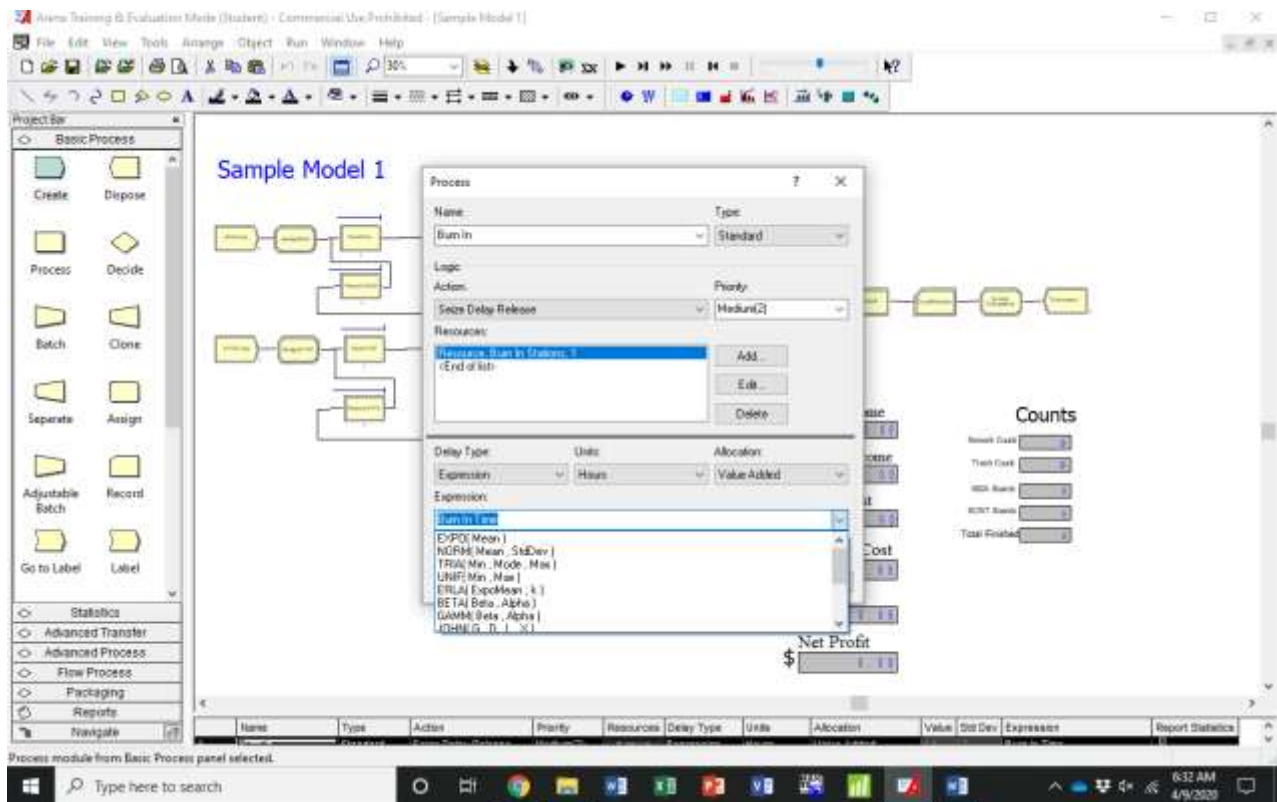


Figure 4.15. The Expression drop-down menu.

The Expression can be one of the probability distributions from the drop-down menu or it can be a label, such as Burn In Time that we see in Figure 4.15. If you select a probability distribution, then enter the appropriate parameter values. If you enter a label, such as in our example, then the processing time values will appear in preceding Assign modules but will be referenced by the Expression labeled Burn In Time. This technique is employed when different entities pass through the same Process module, but with different processing times.

Be sure to select the appropriate Units (seconds, minutes, hours, or days) and whether the Allocation field should be Value Added or Non-Value-Added.

4.1.4 The Decide Flowchart Module

The Decide module allows for decisions to be made. The entity will be routed in a certain direction depending on whether the decision takes on the value of True or False (see Figure 4.16).

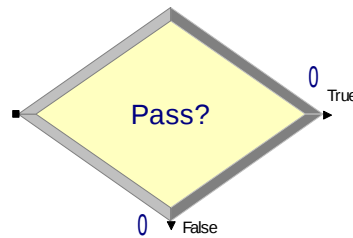


Figure 4.16. The Decide module.

Double-click to open the dialog box in the Decide module (see Figure 4.17).

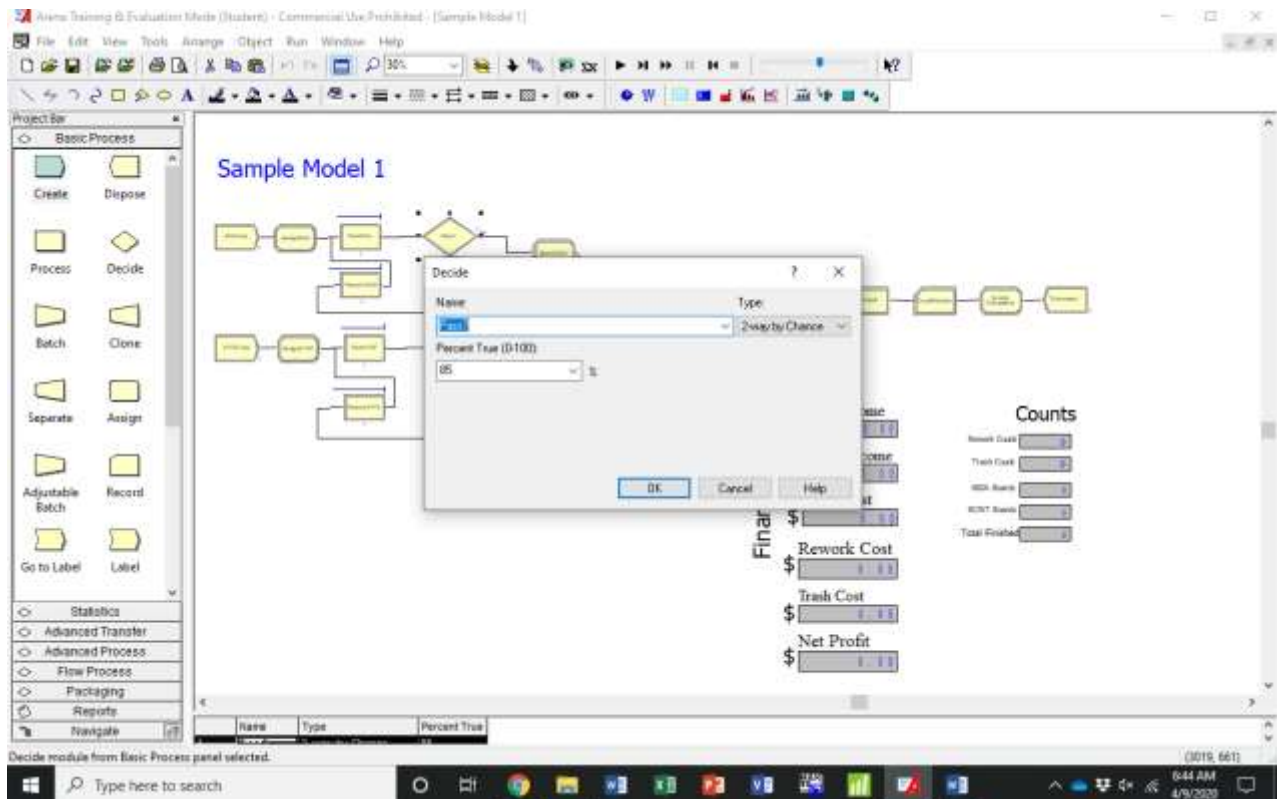


Figure 4.17. Dialog box for the Decide module.

Enter a descriptive name in the Name field. This will become the label on the face of the Decide module. In the Type field, we see four options in Figure 4.18.

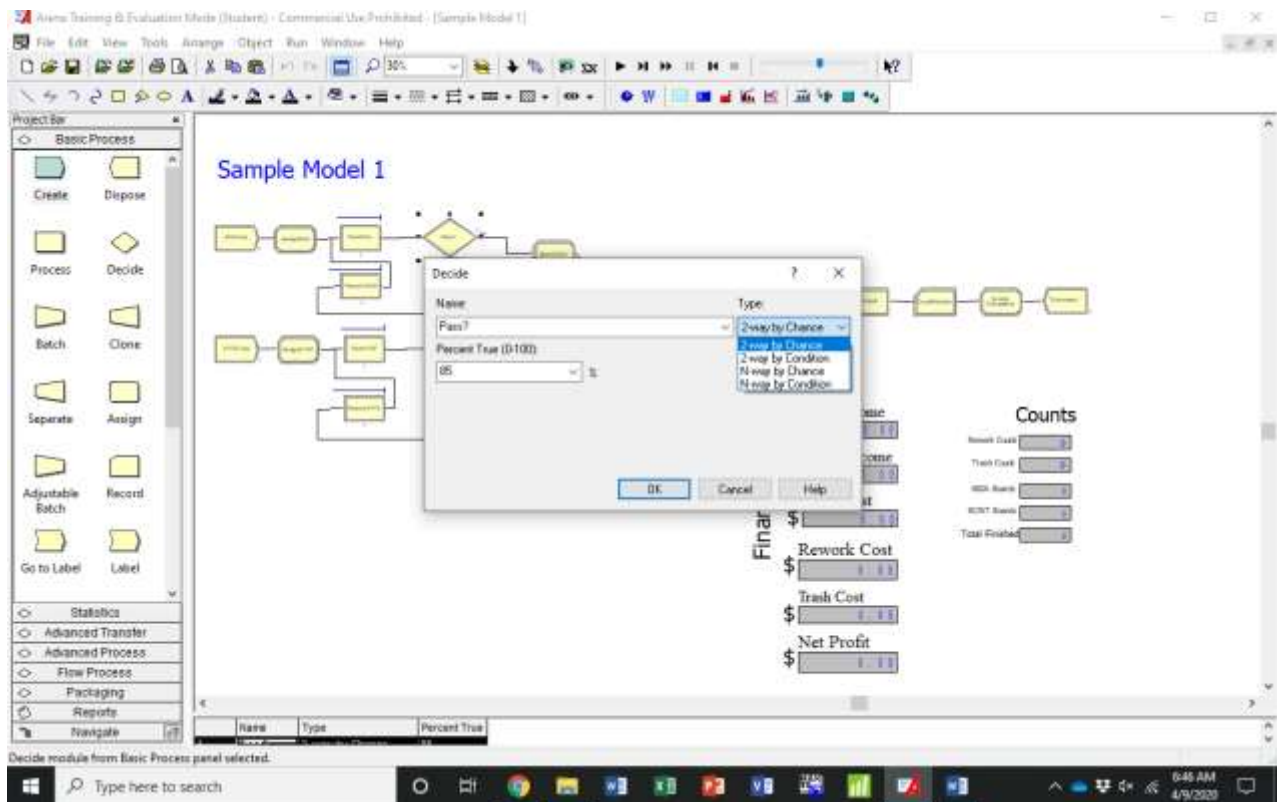


Figure 4.18. Four options in the Type drop-down menu.

Select 2-way by Chance if there are only two possible outcomes, such as Pass/Fail or Good/Bad. Select 2-way by Condition if there are only two possible outcomes based on a condition that you define. Select N-way by Chance or N-way by Condition if there are more than two possible outcomes for Chance or Condition. Enter the value for Percent True (anywhere from 0-100%) based on what you entered in the Name field. The True outcome will be routed one way and the False outcome will be routed another way. Note that the Percent True value must align with the Name of your Decide module so that the entity is correctly routed.

4.1.5 The Batch Flowchart Module

Sample Model 2 in Figure 4.19 is used to illustrate the Batch and Separate modules.

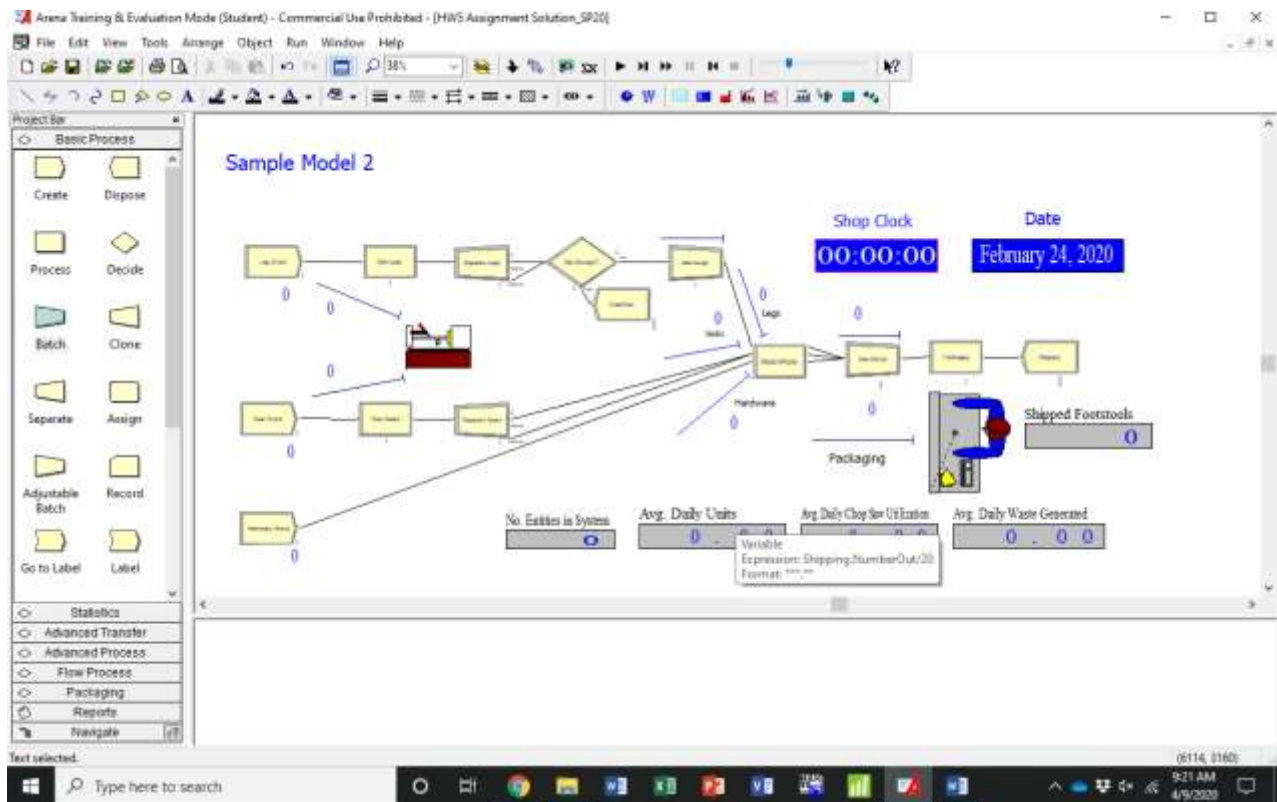


Figure 4.19. Sample Model 2 with Batch and Separate modules.

The Batch module (see Figure 4.20) is used to batch different entities into a “kit.”

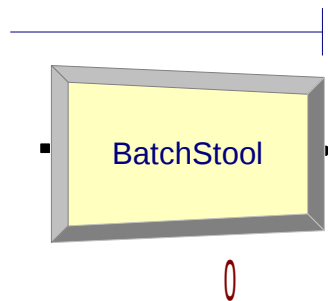


Figure 4.19. The Batch module

Double-click to open the dialog box for this Batch module (see Figure 4.20).

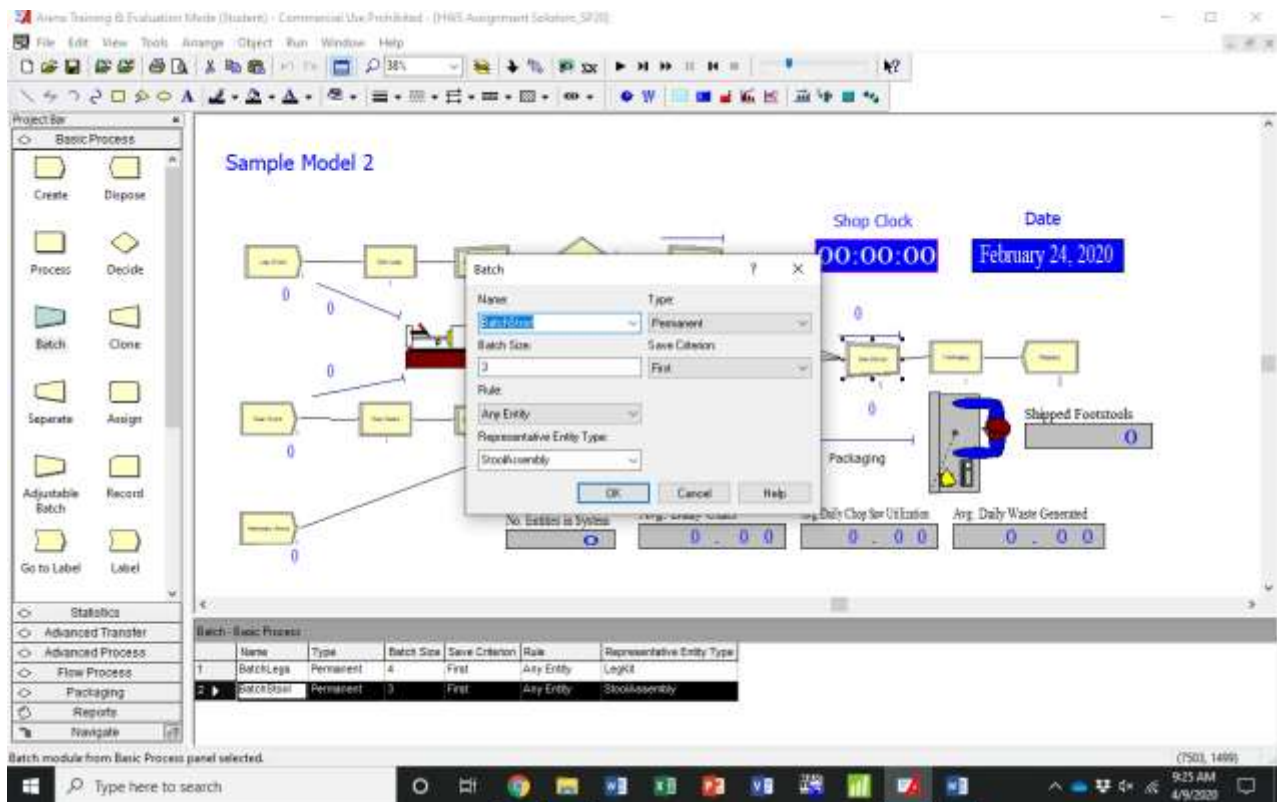


Figure 4.20. Dialog box for Batch module.

Enter a name in the Name field that will be used as the label for the Batch module. In the Type field, we have two options: (1) Permanent; and (2) Temporary. Make the appropriate selection. In the Batch Size field, enter the number of different entities needed to form a “kit.” In this example, three different entities (Leg Stock, Seat Stock, and Hardware) form a kit. In the Save Criterion field, you will see four options: First, Last, Sum, and Product. Select the appropriate option. For example, the option named First will group the first of all different entities in the respective queues into a kit. In the Rule field, you will see two options: Any Entity and By Attribute. If you are not using attributes to define entities, then select Any Entity. In the Representative Entity Type field, enter the name of the “kit.” This becomes a new entity in the model, in addition to the entities previously defined in all Create modules in the model. You will also note that a queue line is automatically created above the Batch module once you exit the completed dialog box.

4.1.6 The Separate Flowchart Module

An example of the Separate module from Sample Model 2 is shown in Figure 4.21.

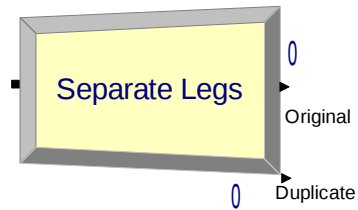


Figure 4.21. Separate module.

Double-click the Separate module to open the dialog box (see Figure 4.22).

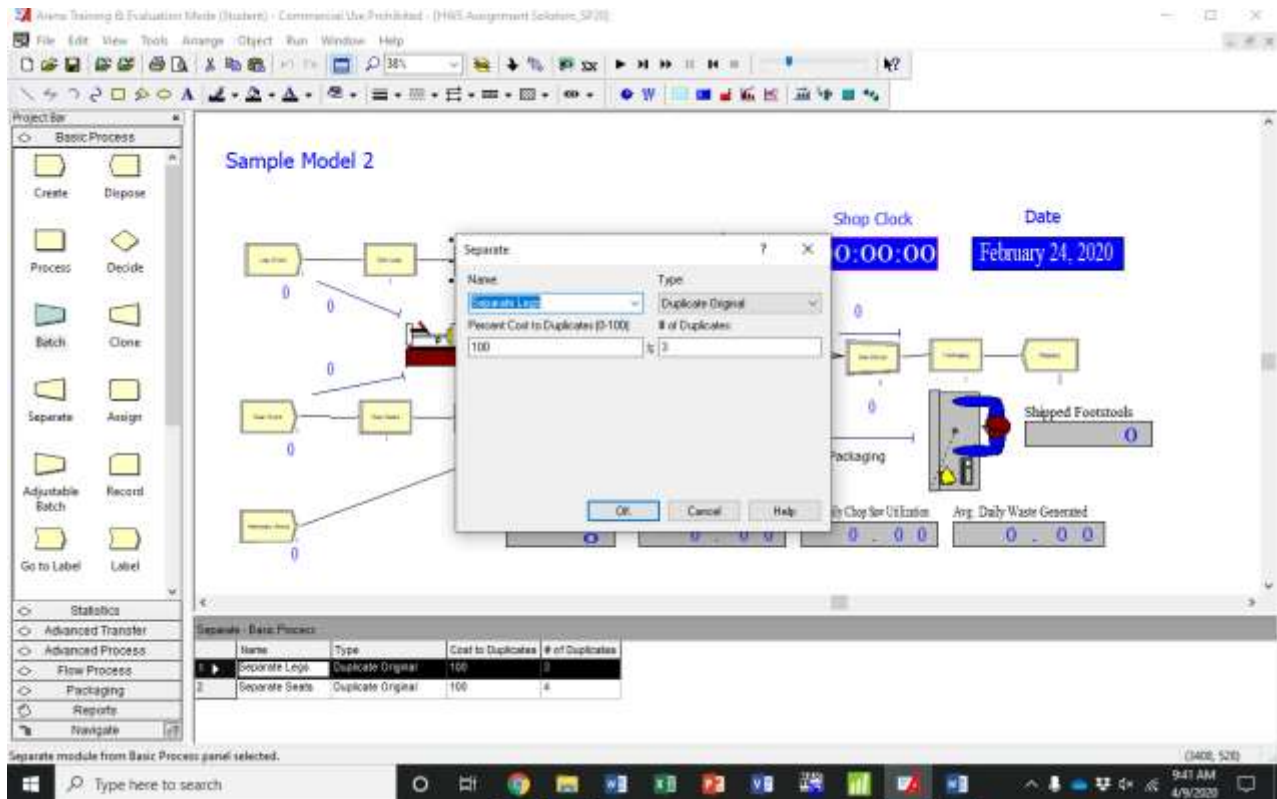


Figure 4.22. Dialog box for Separate module.

Enter a name in the Name field. This will become the label for the Separate module. In the Type field (see Figure 4.23), you will see two options: Split Existing Branch and Duplicate Original.

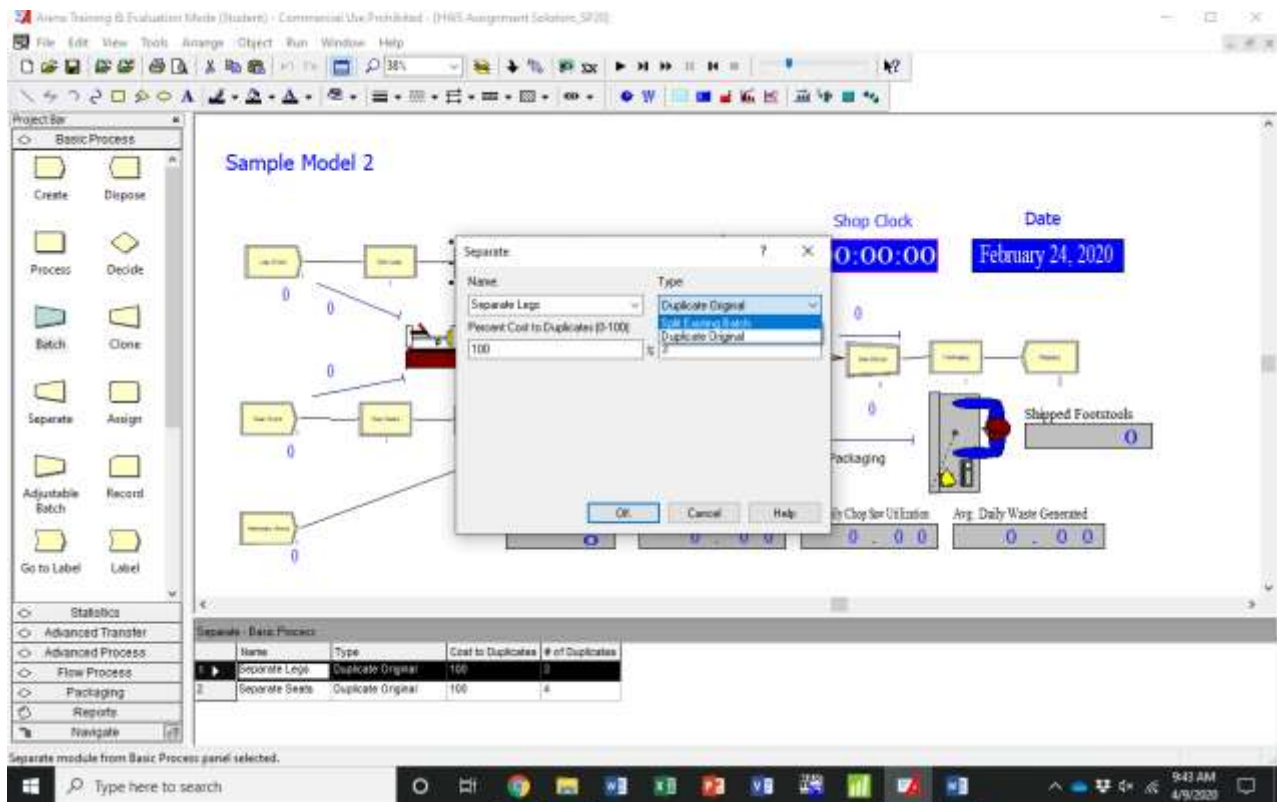


Figure 4.23. Dialog box for Type field in Separate module.

Select Split Existing Branch if you desire to break down a “bulk” unit into individual units. By selecting Split Existing Branch in Figure 4.24, the Member Attributes field will display a drop-down menu consisting of three options: Retain Original Entity Values, Take All Representative Values, and Take a Specific Entity Value. Make the appropriate selection.

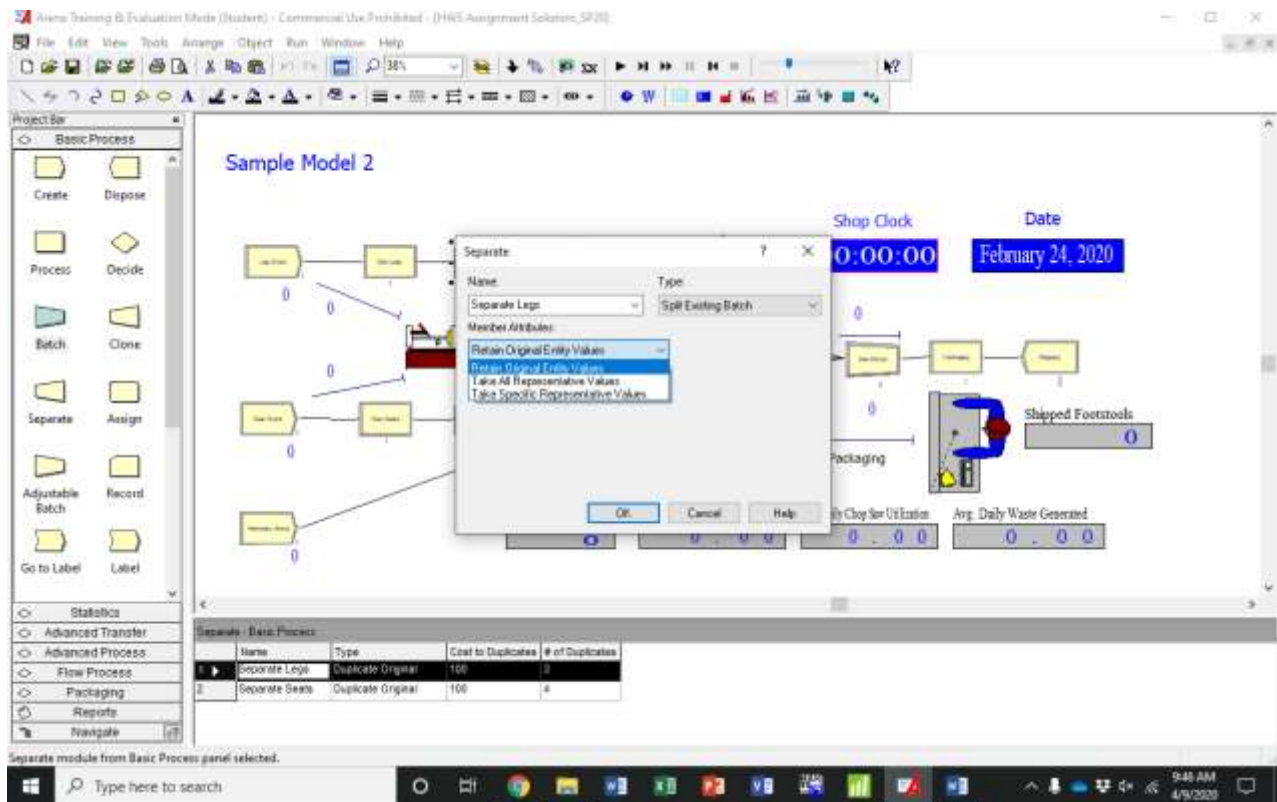


Figure 4.24. Dialog box for Split Existing Branch > Member Attributes field.

If you select Split Existing Branch > Retain Original Entity Values and the model crashes when running, change your selection to Duplicate Original. The model might crash due to short inter-arrival times of entities into the system. That is, entities are entering the system at a faster rate than can be processed. We would want to retain these inter-arrival times, rather than change them, because they represent the real scenario we are trying to model.

Select Duplicate Original if you desire to duplicate the original entity. Be sure to make connections from the Original and Duplicate output nodes to the next destination. In the Percent Cost to Duplicates field, enter 100, meaning duplicate 100% of the original entity. In the # of Duplicates field, enter the appropriate value. For example, if you are separating a piece of wood stock into four legs for a chair, then the Original value is 1 and the # of Duplicates is 3, which makes a total of 4 legs per chair.

4.1.6 The Record Flowchart Module

An example of the Record module from Sample Model 1 is shown in Figure 4.25.

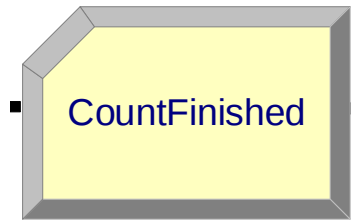


Figure 4.25. The Record module.

The Record module records statistics like throughput time (also known as cycle time) and counts of units.

Double-click to display the dialog box for the Record module as shown in Figure 4.26.

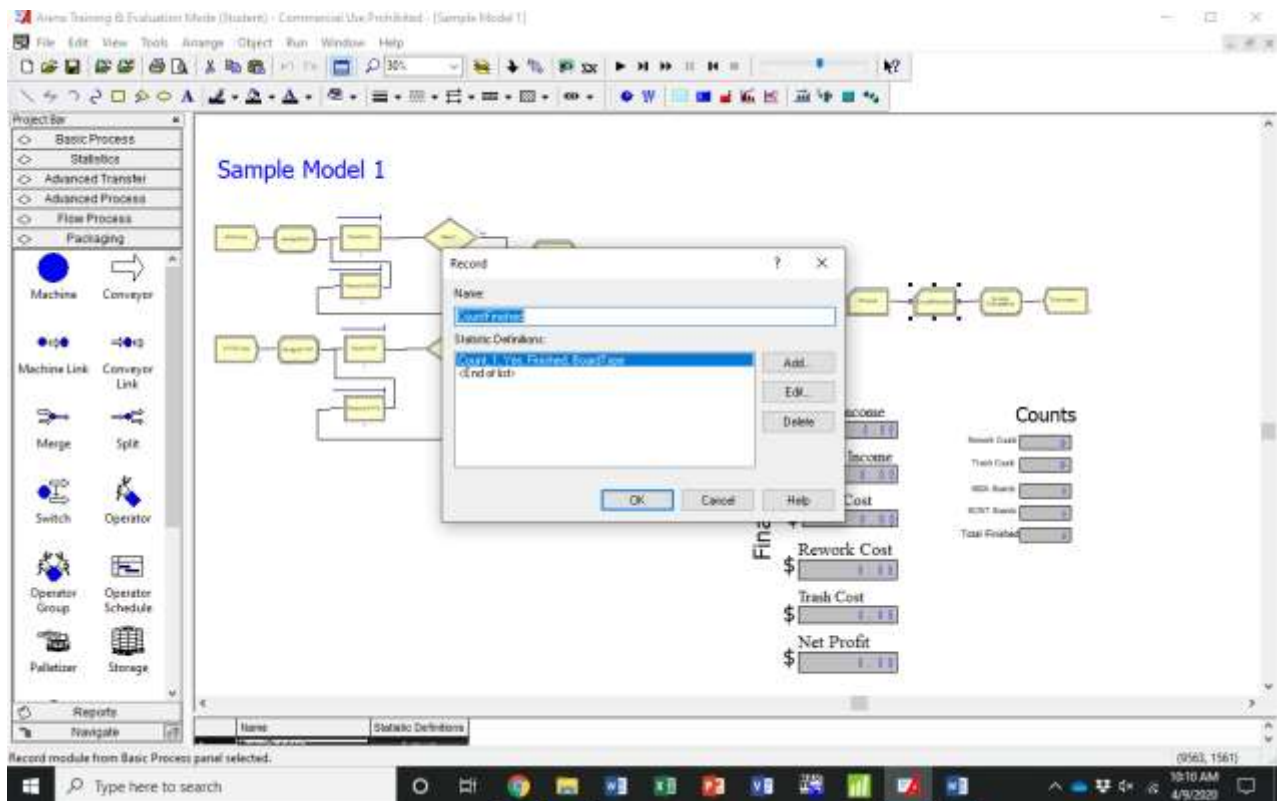


Figure 4.26. Dialog box for Record module.

Click the Add button to add a new statistic that you would like Arena to monitor (see Figure 4.27).

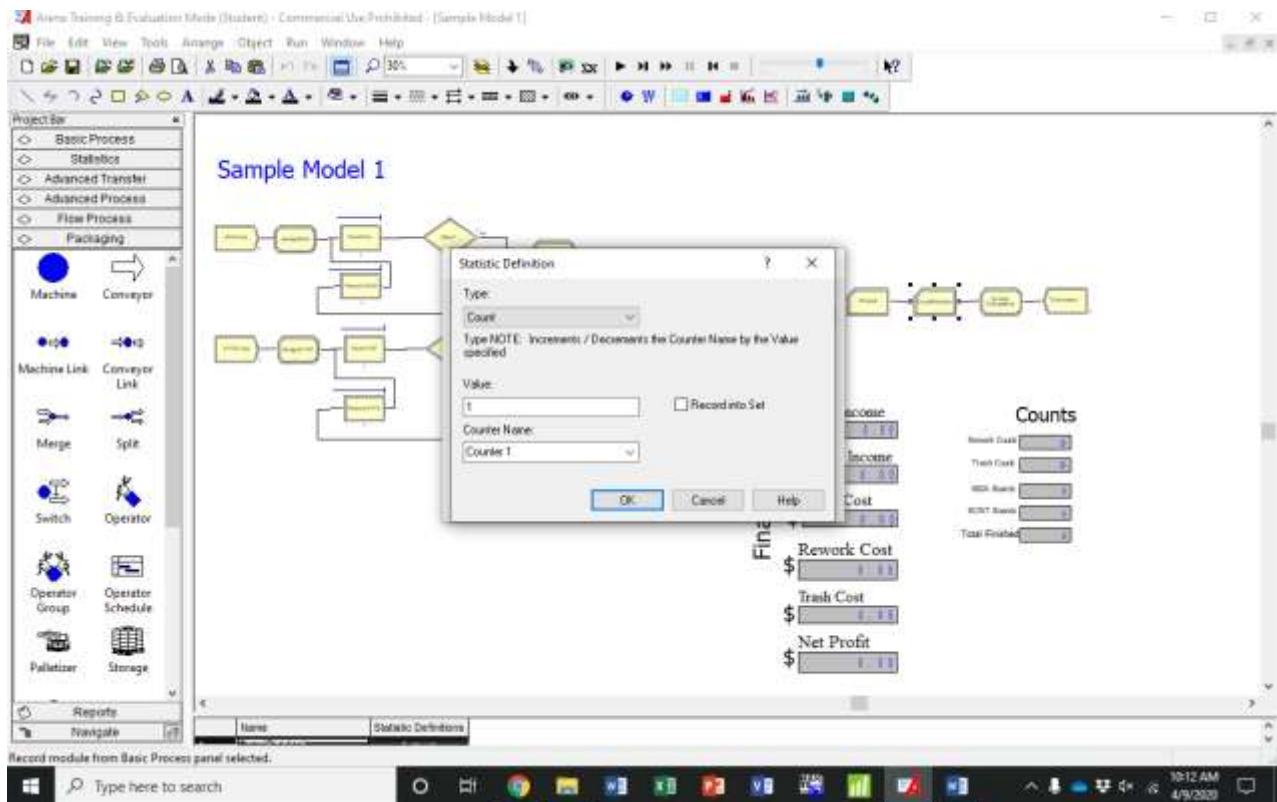


Figure 4.27. Statistic Definition dialog box for Record module.

In the Type field in Figure 4.28, a number of options are given, such as Count, Entity Statistics, Time Interval, Time Between, and Expression.

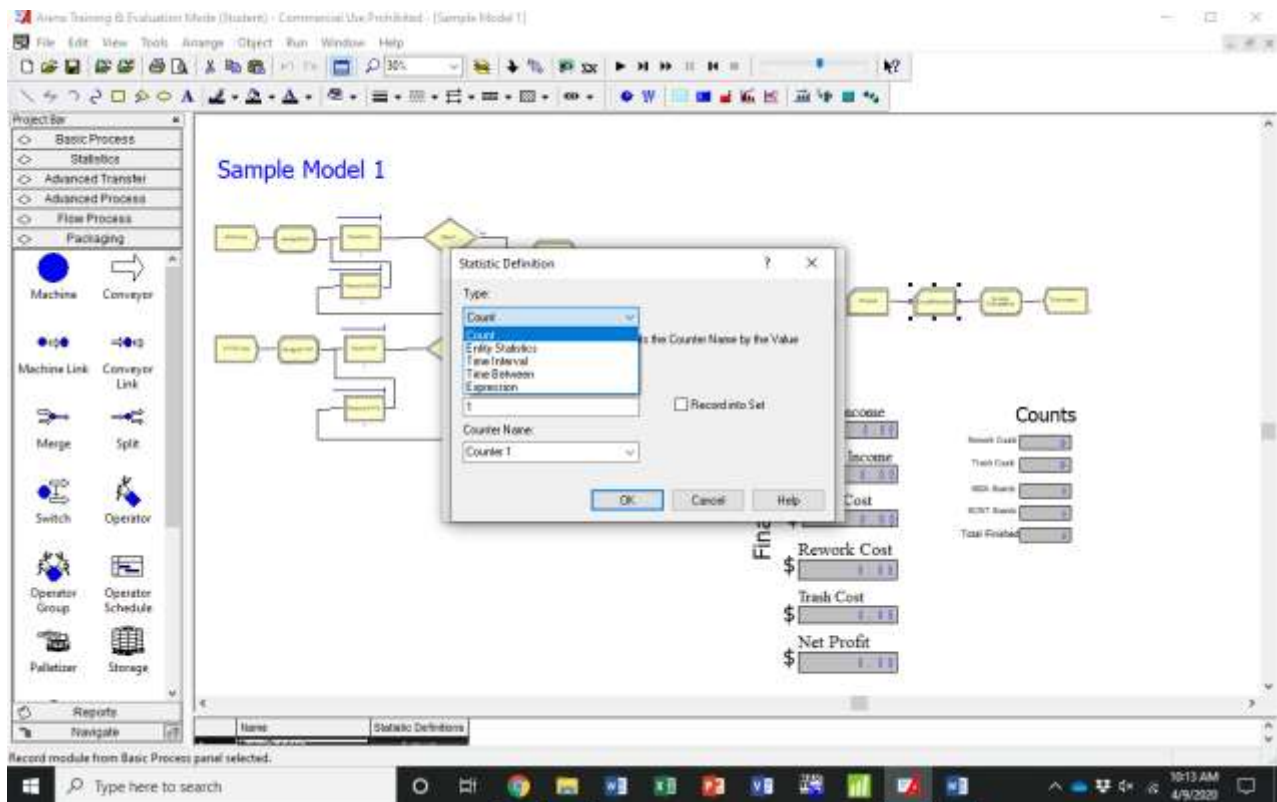


Figure 4.28. Type dialog box for Statistic Definition.

Select Count if you want Arena to Record a count of entities passing through a point in your model. Select Entity Statistics if you want Arena to Record throughput, time, and cost for the entity type of the active entity. Select Time Interval if you want Arena to record the cycle times of all entities. Select Time Between if you want Arena to record the difference between the current simulation time and the time the last entity executed this Record module for the Tally name specified. You would then have to specify the Tally name in the field given. Select Expression if you want Arena to Record the value specified for the Tally name specified. Here, you would have to enter a value and the Tally name. Also note that the analyst is given the option to checkmark the box marked Record into Set. This allows Arena to Record statistics into a Set by Set Index (a previously defined entity selected from the drop-down menu) defined by the analyst in the Sets data module. An example of a completed dialog box with Record into Set checkmarked is shown in Figure 4.29.

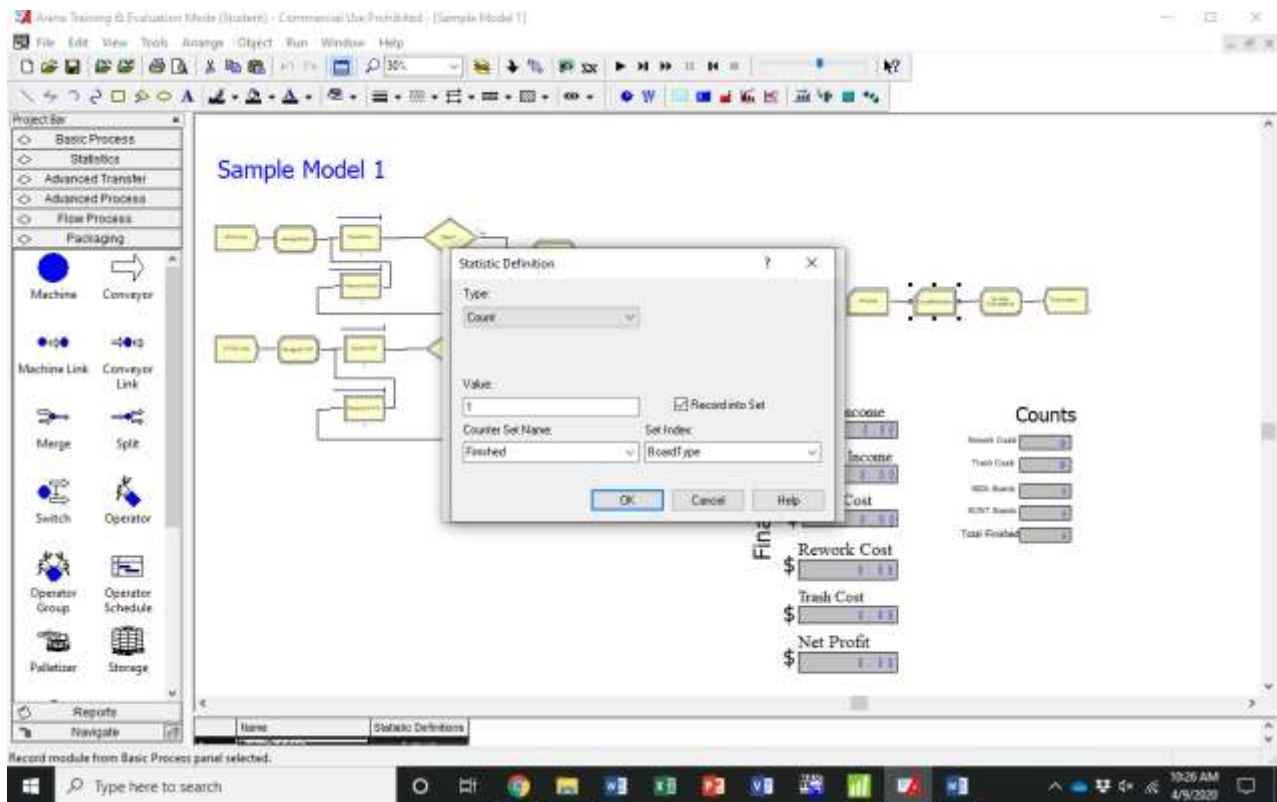


Figure 4.29. Completed dialog box with checkmarked Record into Set.

4.2 Data Modules

Data modules define the characteristics of various process elements, such as entities, resources, and queues. They can also be used to set up variables and other types of numerical values and expressions that pertain to the entire model. The icons for data modules look like small spreadsheets in the Project Bar below the Modules section. Data modules for the Basic Process panel include Attribute, Entity, Queue, Resource, Variable, Schedule, and Set. Other panels contain different sets of data modules.

Data modules exist “behind the scenes” and define different kinds of values, expressions, and conditions. To edit a data module, click on it in the Project Bar and it will automatically appear in the Spreadsheet view of the Model Window, below the Flowchart view. If the Flowchart view takes up the entire Model Window, move your cursor down to “grab” the top of the spreadsheet view and pull it up into view. Unlike Modules that may be used more than once in the Flowchart, there is only one of each type of data module in every model. Within each data module, however, there may be any number of rows that correspond to what is included in the model for that type of data module.

Flowchart and data modules in the model are related by the names for objects that they have in common, for example, queues, resources, entity types, and variables. Arena stores in memory the names of objects the analyst defines and then presents these names in a drop-down menu in the appropriate places in the flowchart and data modules. This helps the analyst to remember what you've named things and maintains consistency in the model development.

4.2.1 Attribute Data Module

By clicking on the Attribute data module in the Project Bar, the Attribute spreadsheet opens up at the bottom of the Model Window, as shown in Figure 4.30.

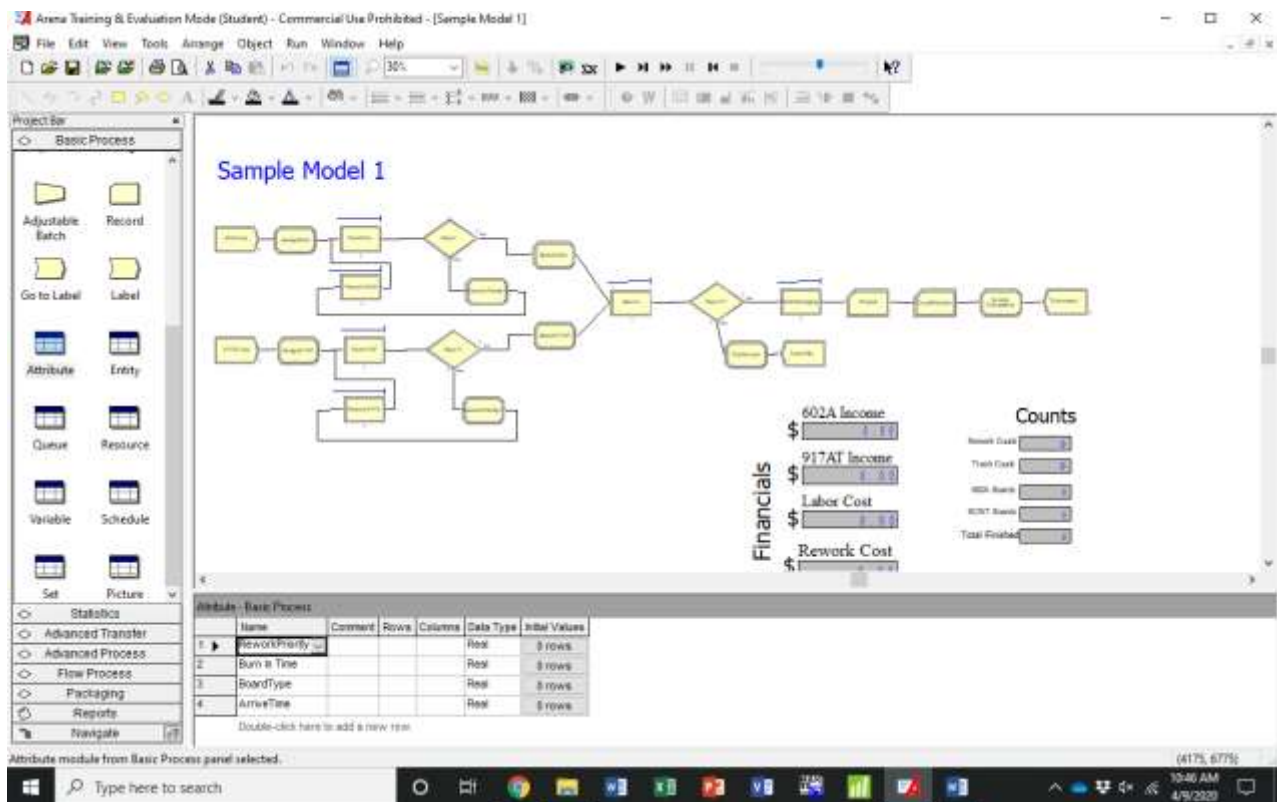


Figure 4.30. The Attribute data module.

In this example, we observe four rows in the Attribute data module, each row representing a different Attribute included in the model. In the Data Type column, we are given two options in the invisible drop-down arrow to the right of this field: Real and String. If you select String, double-click to add new attributes or select those you wish to edit. The value of the string attribute is assigned via the ReadWrite module. In most cases, the analyst would opt for Real to show real numbers rather than a string of numbers. In the Initial Values column, the Default is 0 rows. If an Attribute needed an initial value other than the value of 0, then click to add a row, then enter the initial value. If the Attribute's initial value is 0, then do nothing.

4.2.2 Entity Data Module

By clicking on the Entity data module in the Project Bar, the Entity spreadsheet opens up at the bottom of the Model Window, as shown in Figure 4.31.

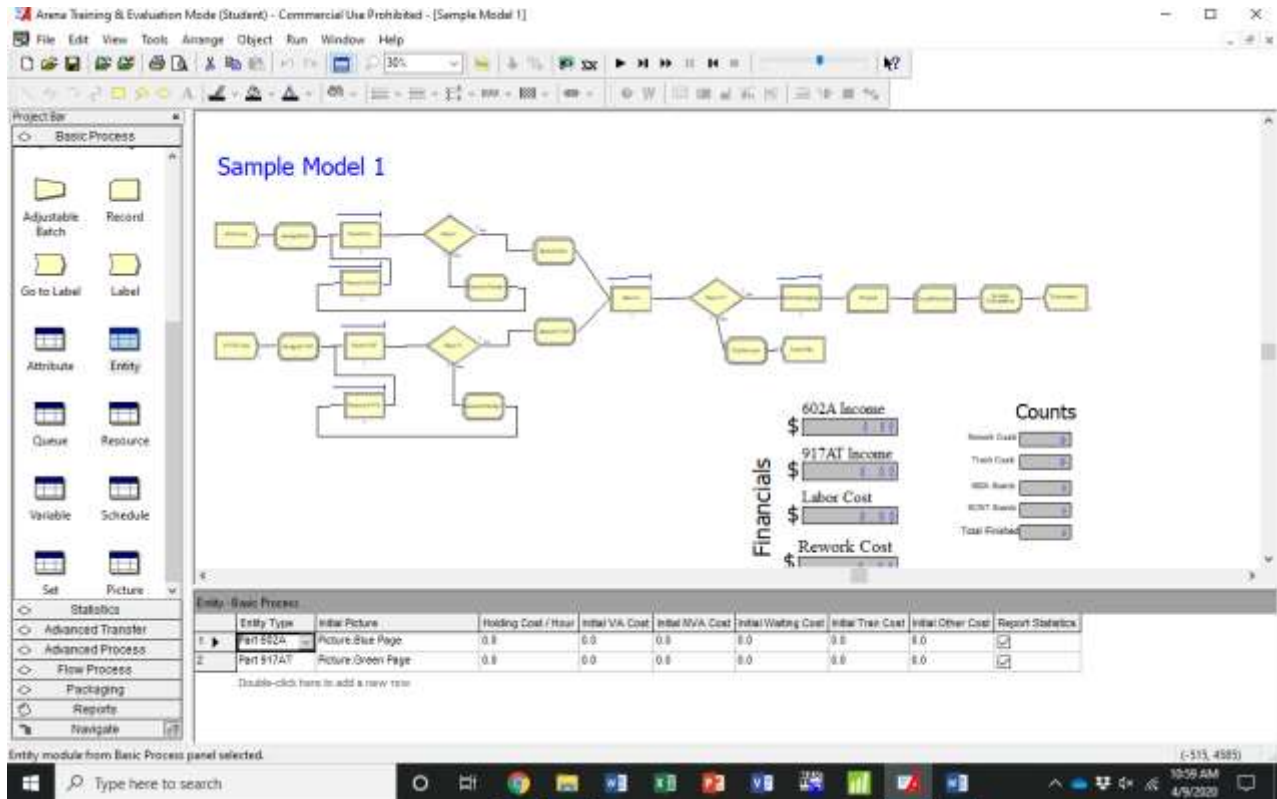


Figure 4.31. The Entity data module.

The Entity data module shows all entities currently in the model in the Entity Type column. Entities are typically added in the Create module; however, an entity can also be added in the Batch module by entering a new entity name. In the Initial Picture column, a drop-down menu exists that displays numerous entity pictures, arranged in alphabetical order as shown in Figure 4.32. Select an entity picture to represent the given entity. Initial cost values can be manually entered in the various cost columns, if appropriate.

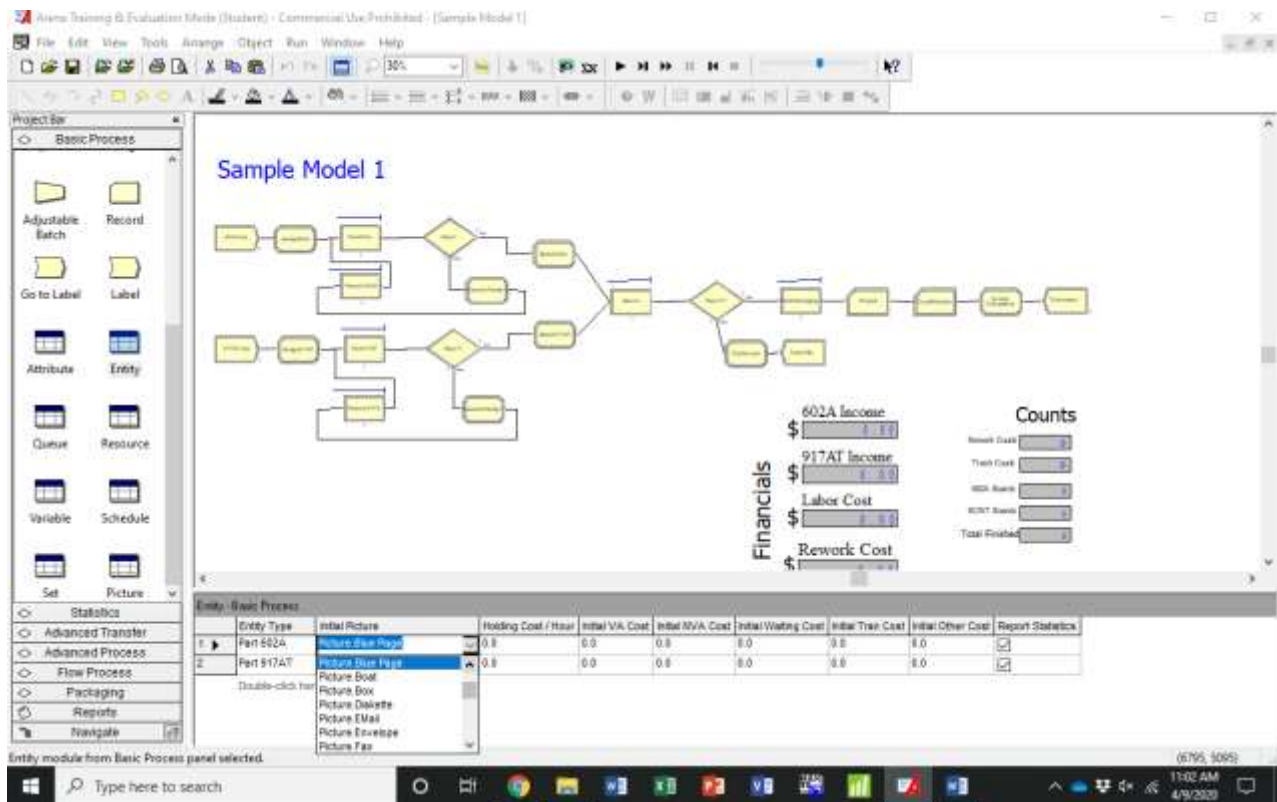


Figure 4.32. Drop-down menu for Initial Picture in the Entity data module spreadsheet view.

4.2.3 Queue Data Module

By clicking on the Queue data module in the Project Bar, the Queue spreadsheet opens up at the bottom of the Model Window, as shown in Figure 4.33.

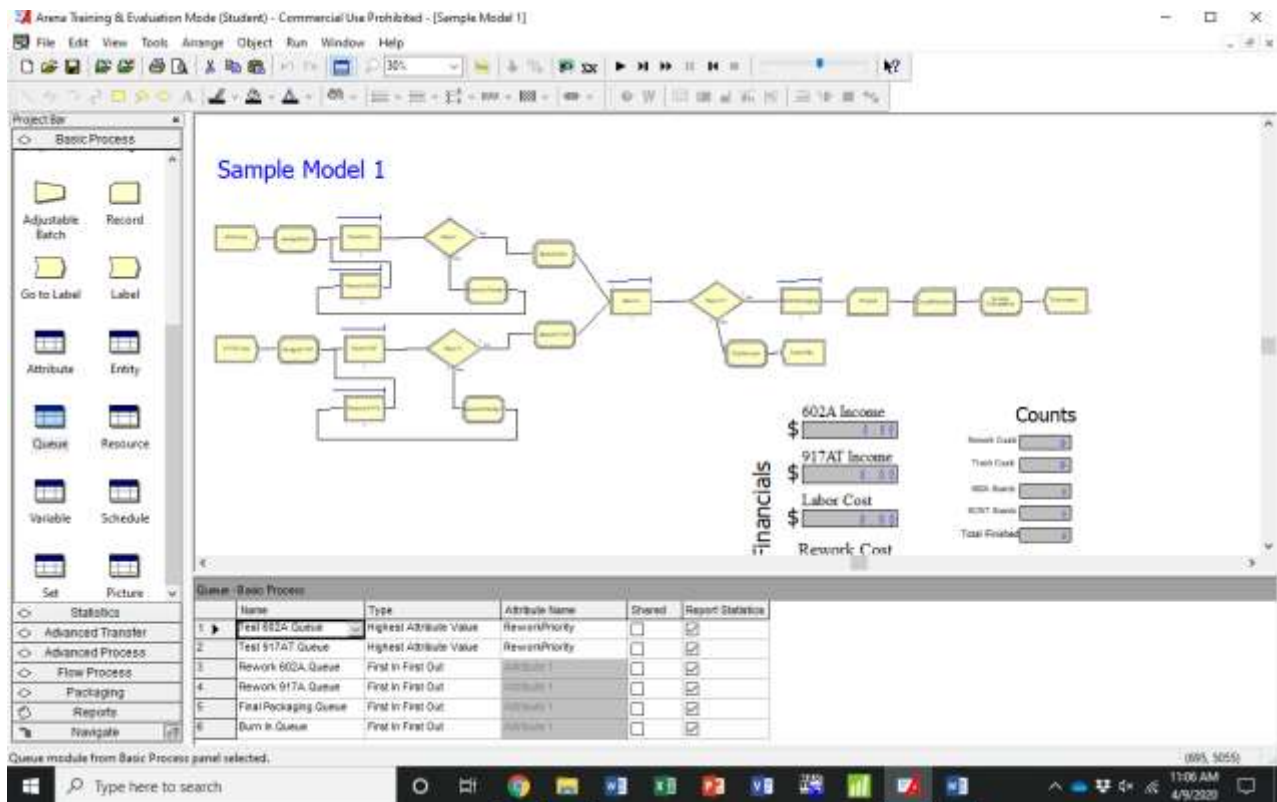


Figure 4.33. The Queue data module.

By clicking on the Queue data module, the Spreadsheet view displays rows for each queue in the model. In the Name column, we see the name of each queue, which follows the pattern of the name of a Process followed by a .queue. The Type column displays the priority rule used for each queue. A drop-down menu displays the following options for the analyst to select: First In First Out, Last In First Out, Lowest Attribute Value, and Highest Attribute Value. Select the appropriate priority rule for each queue. If Lowest Attribute Value or Highest Attribute Value is selected, then select the appropriate Attribute in the drop-down menu for the Attribute Name column. The selected Attribute would be a previously defined Attribute in the model that was stored in memory by Arena.

4.2.4 Resource Data Module

By clicking on the Resource data module in the Project Bar, the Resource spreadsheet opens up at the bottom of the Model Window, as shown in Figure 4.34.

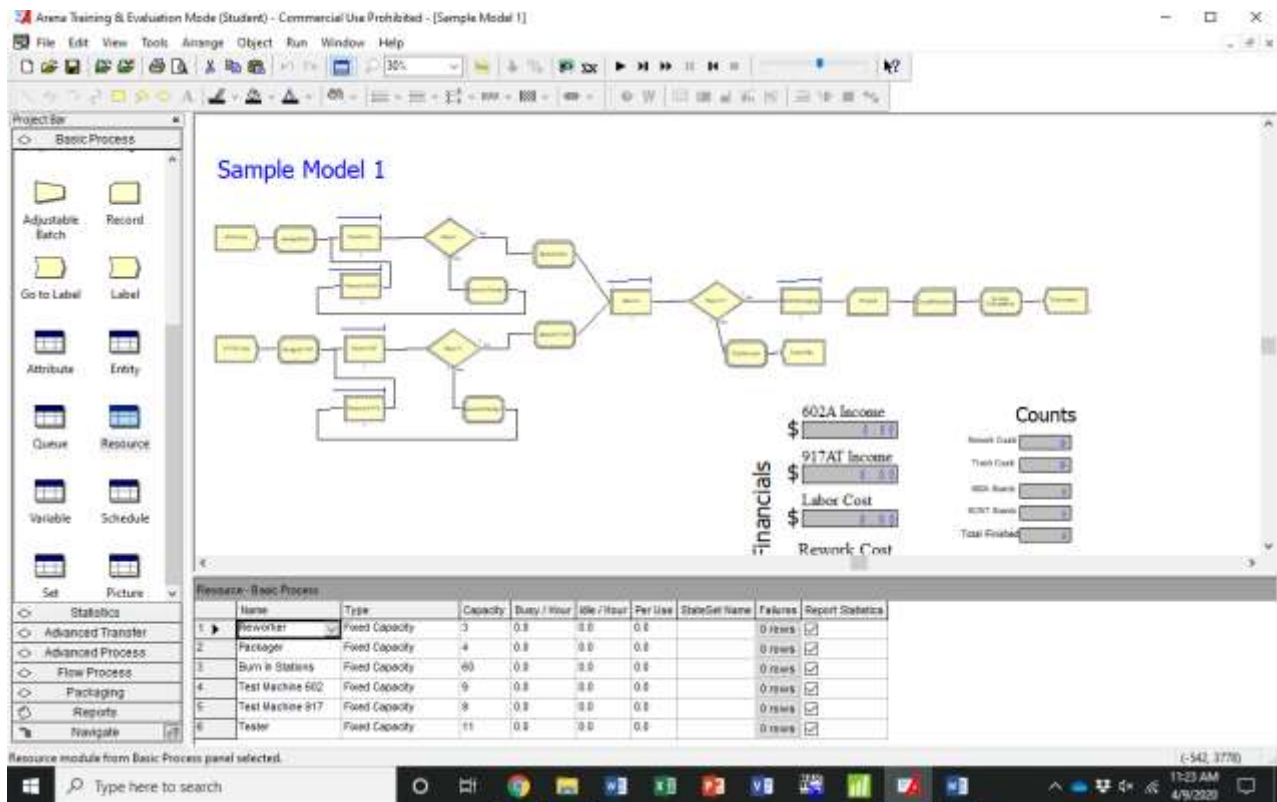


Figure 4.34. The Resource data module.

By clicking on the Resource data module, the Spreadsheet view displays rows for each resource in the model. The Name column displays all resources included in the model by row. In the Type column, there are two options in the invisible drop-down menu: Fixed Capacity and Schedule. Select Fixed Capacity if the analyst wants to edit the number of each resource in the model by changing the capacity value in the Capacity column. Select Schedule if the resource will be used based on some schedule to be further defined in the Schedule data module. For example, a forklift driver in the Receiving area might only unload incoming trucks between the hours of 7am-8am rather than all day long. Values for the number of each resource that are busy or idle per hour can be manually entered in the respective columns. The analyst can also build in a Failure for a given resource, such as a machine breakdown. Failures can be added by clicking to add a new row in the Failures column, then describing the type of Failure and the Failure Rule (Wait, Ignore, Preempt) that should be applied (see Figure 4.35).

The Wait option will wait until the in-process entities release their units of the resource before starting the actual capacity decrease. The Ignore option immediately decreases the resource capacity, ignoring the fact that the resource is currently allocated to an entity, but work (or processing) on the in-service entities continues unabated. The Preempt option attempts to preempt the last unit of the resource

seized by taking it away from the controlling entity. If the preempt is successful and a single unit of capacity is enough, then the capacity reduction begins immediately. If the preempt is unsuccessful or if more than one unit is needed, then the Ignore rule will be used for any remaining capacity.

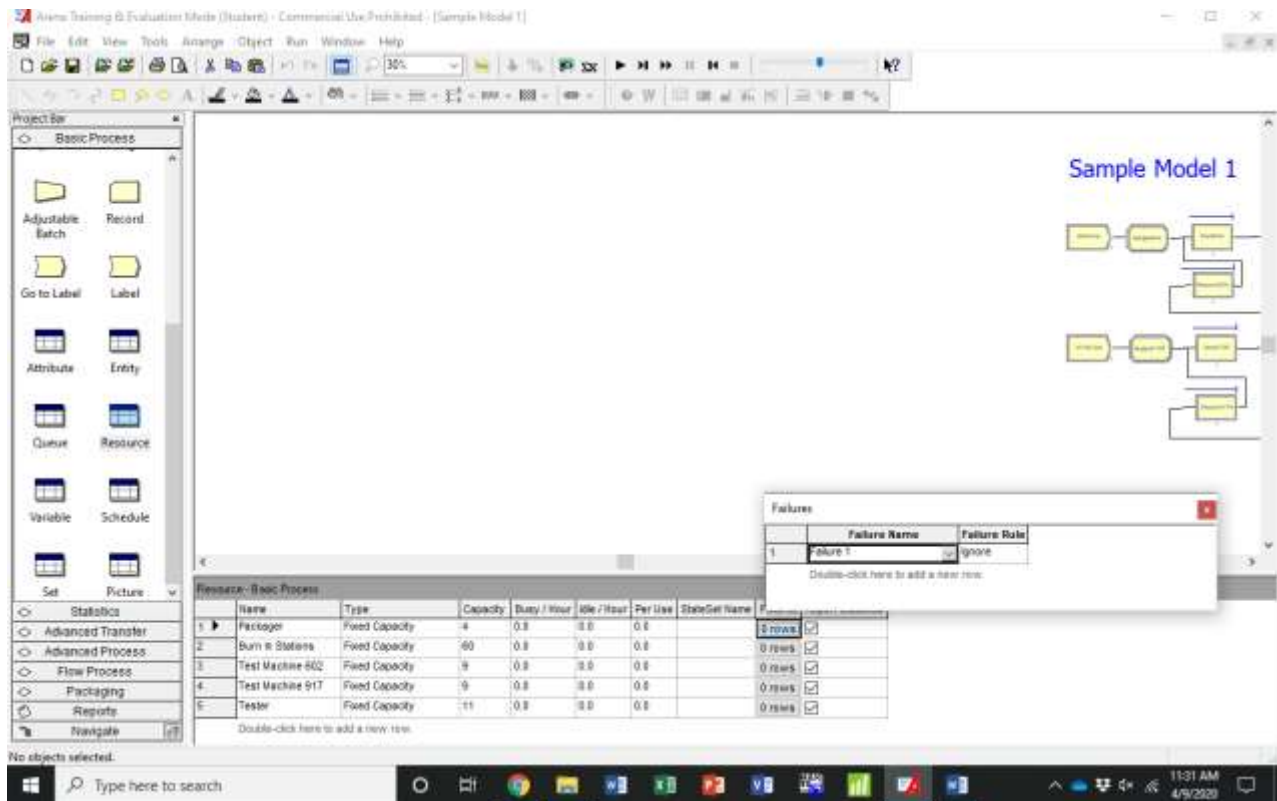


Figure 4.35. Building in a Failure for a given resource.

Additional information regarding failures can be entered in the Failure data module in the Advanced Process panel, as shown in Figure 4.36.

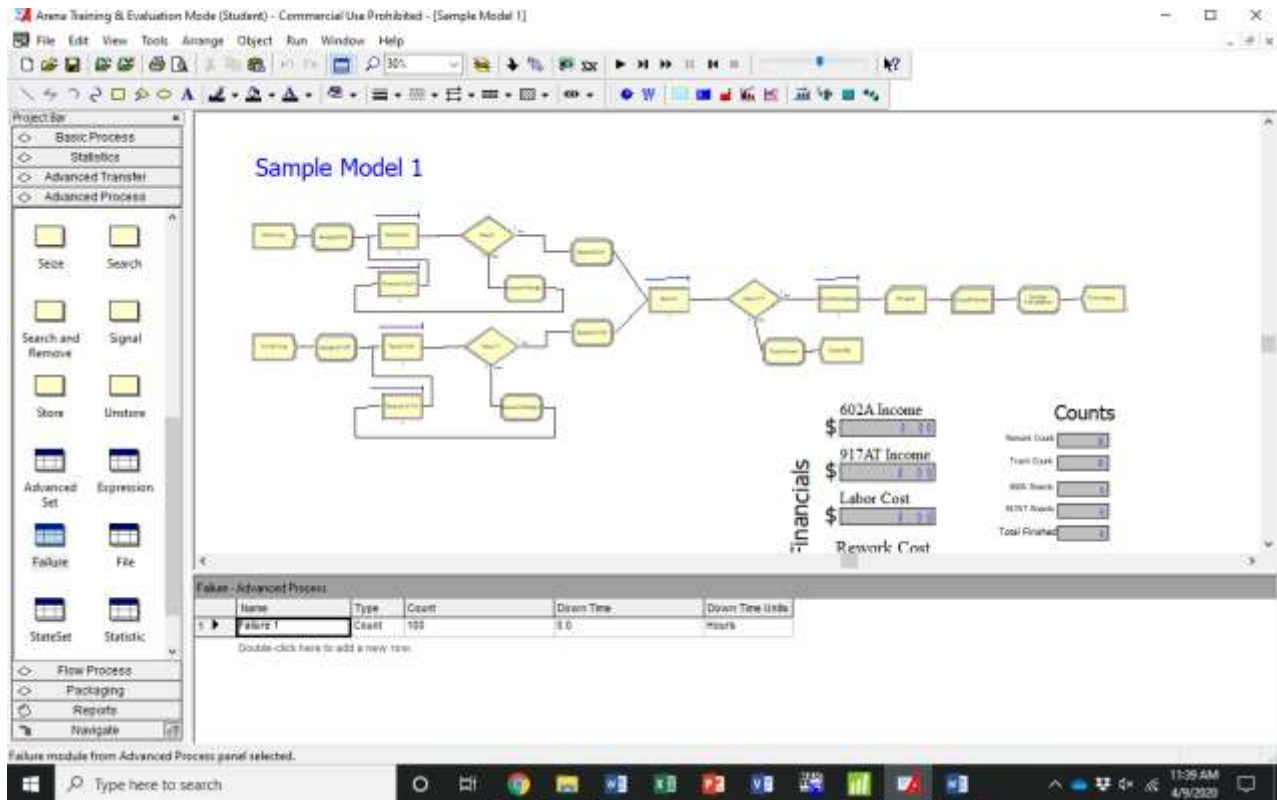


Figure 4.36. The Failure data module in the Advanced Process panel.

4.2.5 Variable Data Module

By clicking on the Variable data module in the Project Bar, the Variable spreadsheet opens up at the bottom of the Model Window, as shown in Figure 4.37.

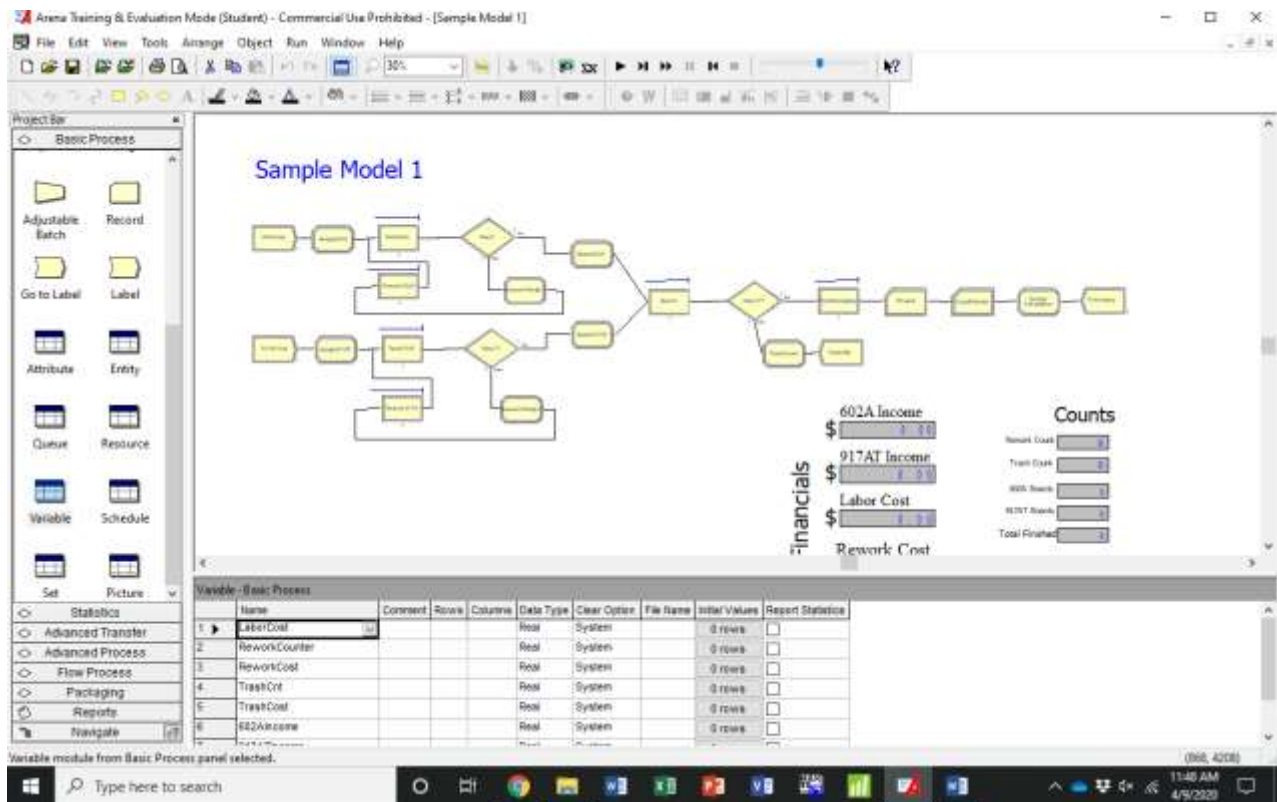


Figure 4.37. The Variable data module.

By clicking on the Variable data module, the Spreadsheet view displays rows for each variable in the model. The Name column displays all variables included in the model by row. In the Data Type column, there are two options in the invisible drop-down menu: Real and String. In the Clear Option column, three options are given: Statistics, System, and None, so the analyst can choose which option to clear. The analyst may manually enter initial values for each variable if it differs from zero. Else, the Default initial value is zero.

4.2.6 Schedule Data Module

By clicking on the Schedule data module in the Project Bar, the Schedule spreadsheet opens up at the bottom of the Model Window, as shown in Figure 4.38.

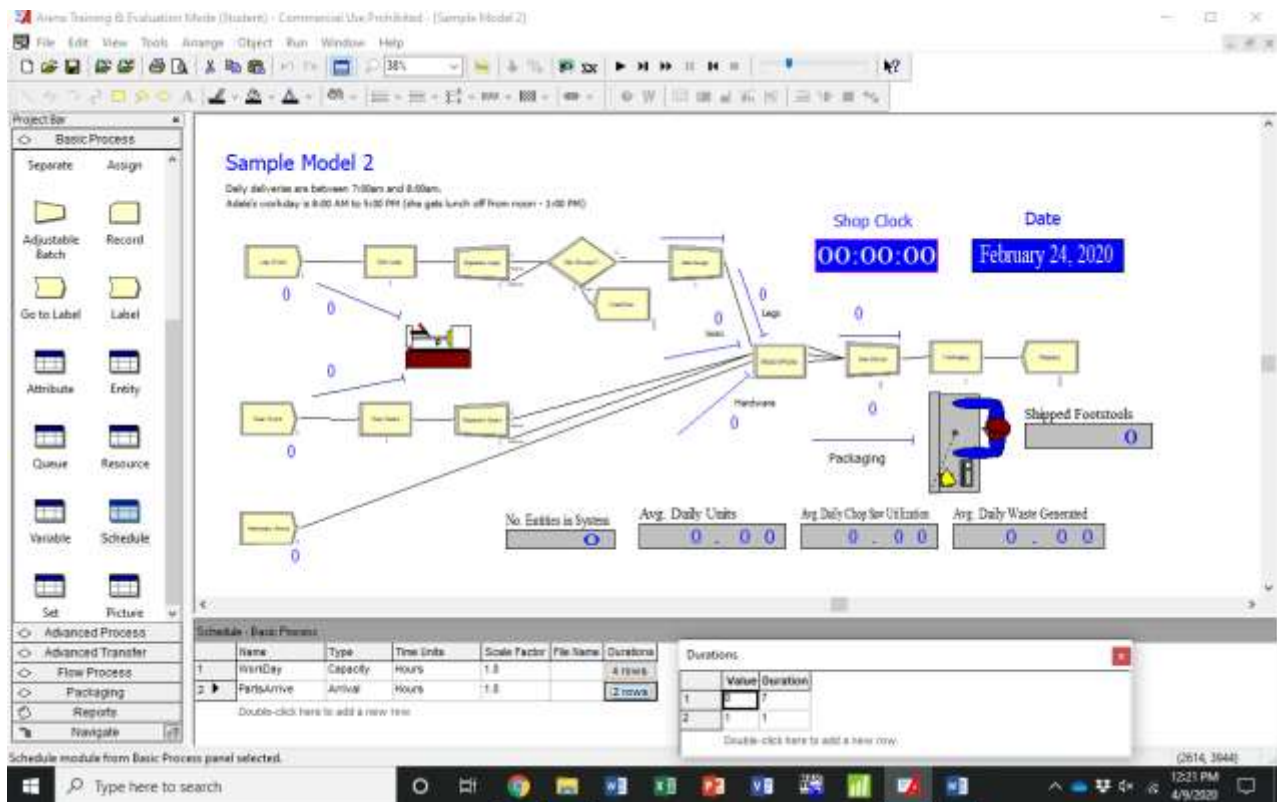


Figure 4.38. The Schedule data module.

By clicking on the Schedule data module, the Spreadsheet view displays rows for each type of schedule in the model. The Name column displays all schedules included in the model by row. In the Type column, we observe three options: Capacity, Arrival, and Other. Select Capacity or Arrival if a numerical value must be entered for Value and Durations in the Durations column.

For example, if Arrival is selected for a schedule named PartsArrive, the values in the Durations column would represent the number of resources needed in the Value column and the number of time periods (i.e., hours) needed in the Durations column. In Figure 4.38, the values in the Durations column for the schedule named PartsArrive is interpreted as zero resources are needed for the first 7 hours, then one resource is needed for the next hour, based on a 24-hour clock.

A similar logic applies if Capacity is selected. In Sample Model 2, Capacity represents the WorkDay hours when a resource is or is not needed based on a 24-hour clock.

4.2.7 Set Data Module

By clicking on the Set data module in the Project Bar, the Set spreadsheet opens up at the bottom of the Model Window, as shown in Figure 4.39.

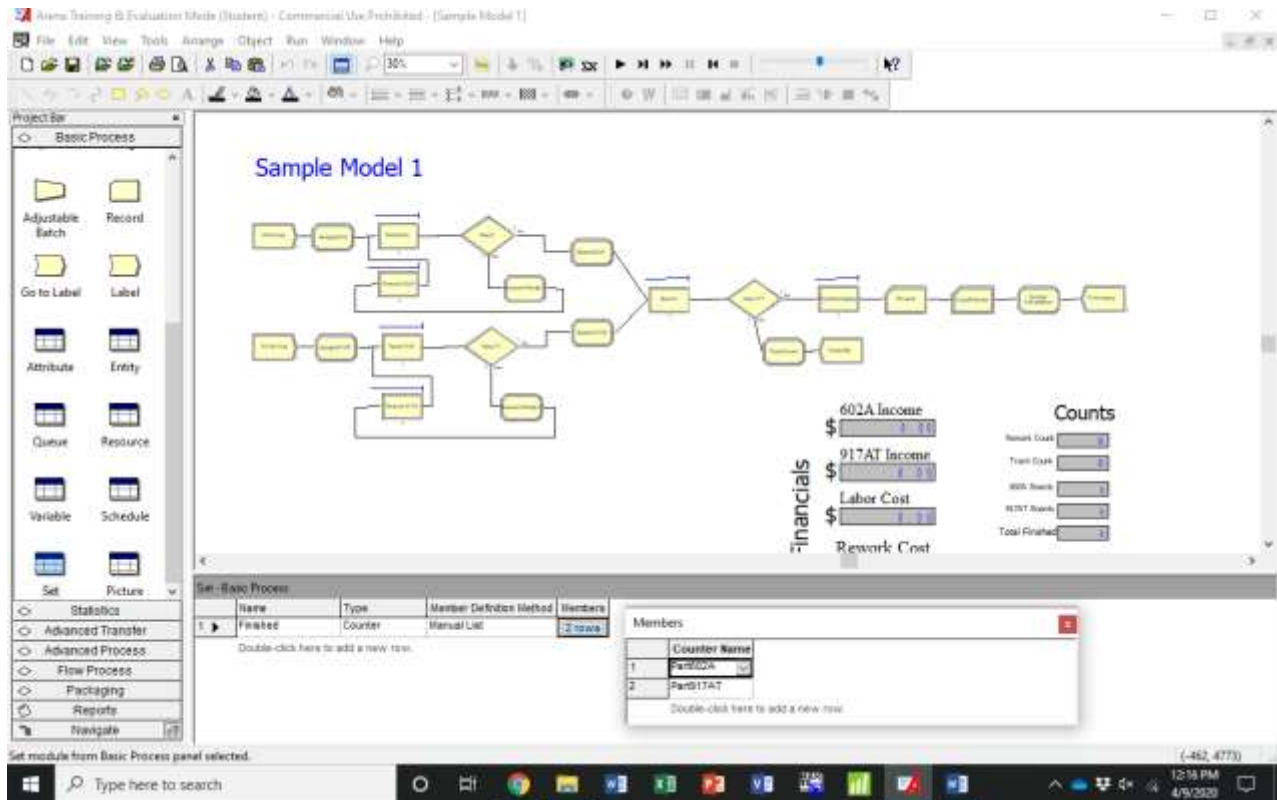


Figure 4.39. The Set data module.

Recall that information in the Set data module was initiated in the Record module by checkmarking the box labeled Record into Set. In the Name column, the name Finished was entered in the Record module and is then transferred directly to the Set data module. In the Type column, the options given are Resource, Counter, Tally, Entity Type, and Entity Picture. The selected Type originated in the Record module. In the Member Definition Method column, there are two options: Manual List and Data File. The Default value is Manual List. If Counter is selected in the Type column, then double-click in the Members column to manually add each Counter Name. This is an important, but easy to overlook, step. This enables Arena to record statistics in the Set named Finished by Board Types Part 602A and Part 917AT that were defined in our Create modules. Otherwise, by forgetting to add the appropriate Counter Names in the Members column, Arena would not know for which Members (or Board Types) to record statistics. It could only obtain overall statistics rather than statistics broken down by Member (or Board Type). Another way to count the number of units given that they have been counted into a Set is to add a variable display with the expression. For example, if we use the Set feature to count the

number of different colors of marbles, such as blue marbles, red marbles, green marbles, and purple marbles, we could use the variable command, or expression, NC(blue marbles) to obtain the current number count of blue marbles.

4.3 Defining the Run Length

We will use Sample Model 2 in Figure 4.40 to define the run length of a simulation model.

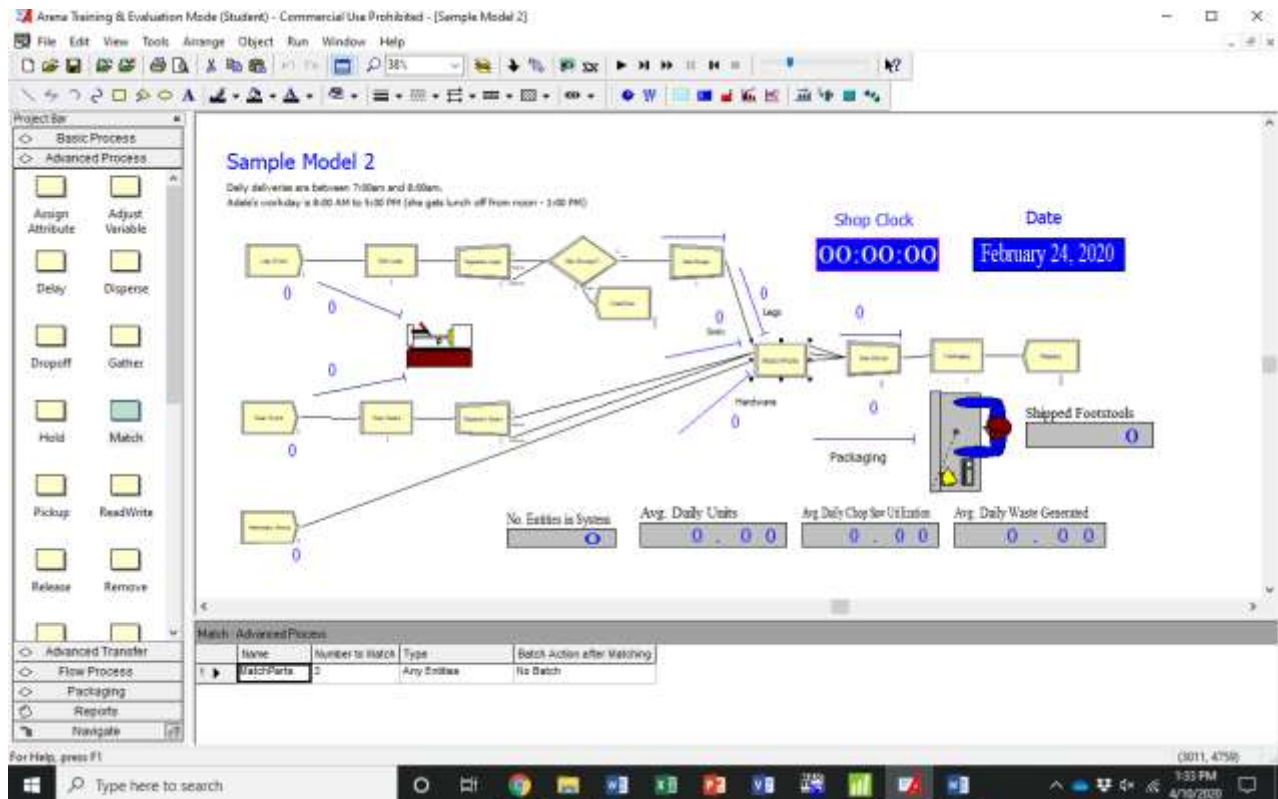


Figure 4.40. Sample Model 2.

Click on the Run tab in the NavBar, then click on Setup to define the model run length, as shown in Figure 4.41.

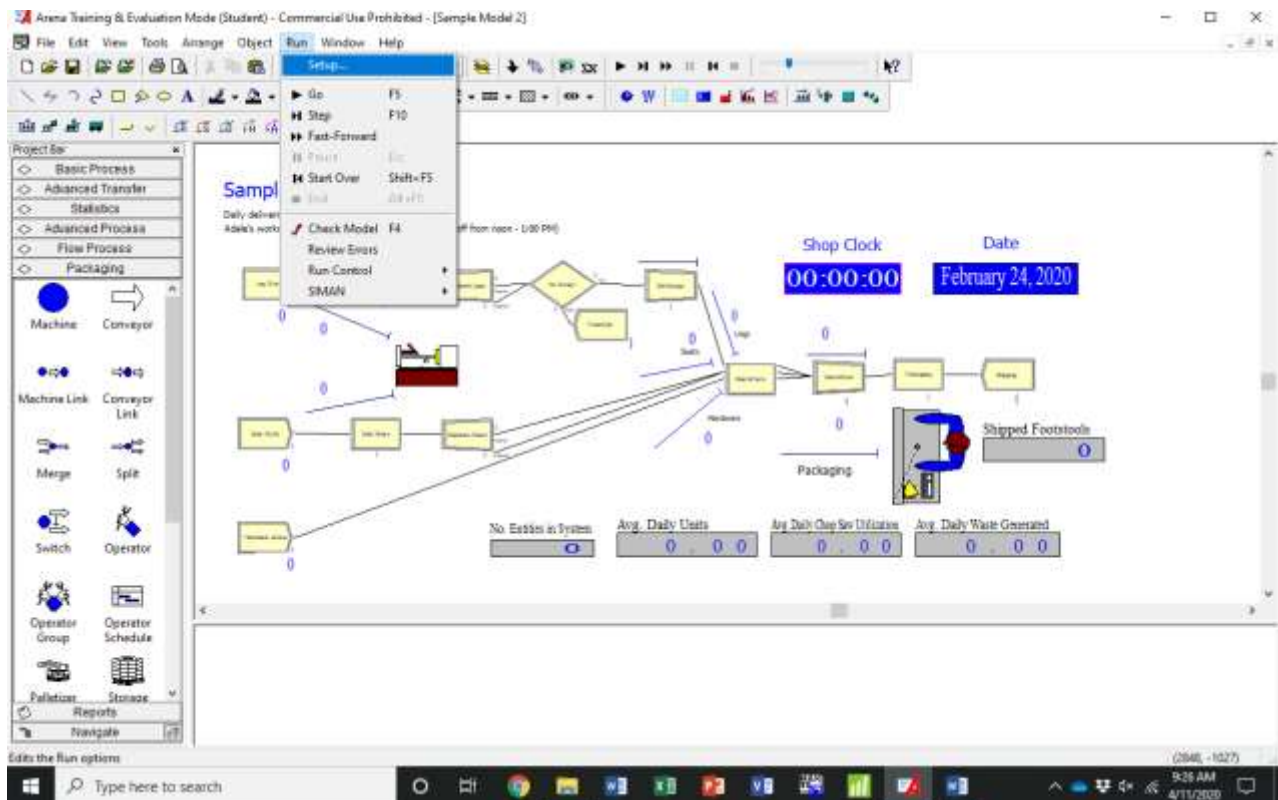


Figure 4.41. Run > Setup in Sample Model 2.

Click on Setup to open the Replication Parameters dialog box (see Figure 4.42).

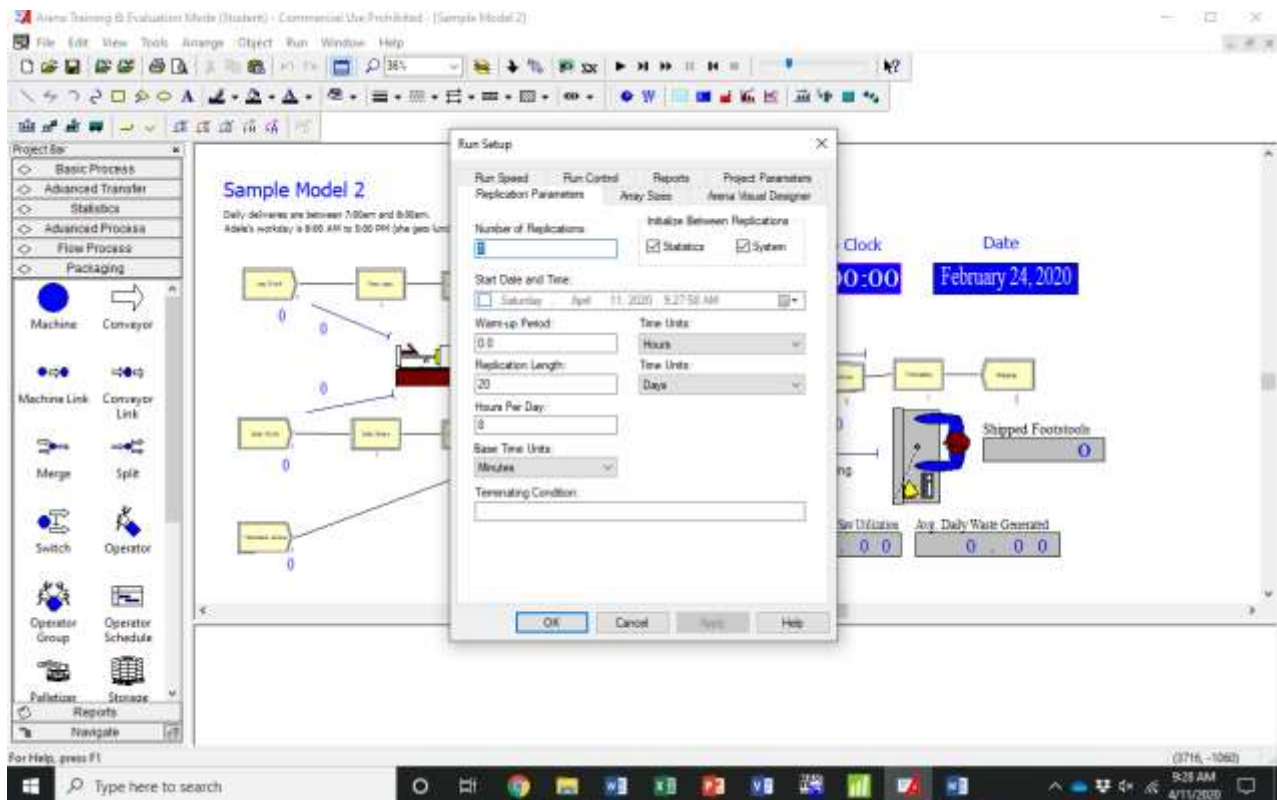


Figure 4.42. Replication Parameters tab for Run > Setup in Sample Model 2.

You will notice seven tabs of which we will use only three: Replication Parameters, Reports, and Project Parameters. From Figure 8.3, we see the dialog box for the Replication Parameters tab. In the Number of Replications field, manually enter the number of replications to wish to run. The Start Date and Time field automatically displays the current date and time. In the Warm-up Period field, you can leave the Default value of 0.0 or you can change this to a numerical value that is coupled with the Time Units field, which offers options such as Seconds, Minutes, Hours, and Days, thereby creating a warm-up period before the model gets to a normal operating condition status. There are two ways to define a terminating condition, or the run length, of your model: 1) enter values in the Replication Length and Time Units fields. For example, the run length in Sample Model 2 from Figure 8.3 is 20 Days; or 2) enter an expression in the Terminating Condition field. Enter a value in the Hours Per Day field. In the Base Time Units field, select from the options in the drop-down menu: Seconds, Minutes, Hours, or Days. Your selection here converts all time measurements in your model to your chosen selection in the output report.

In the Reports tab shown in Figure 4.43, select from the choices in the drop-down menu.

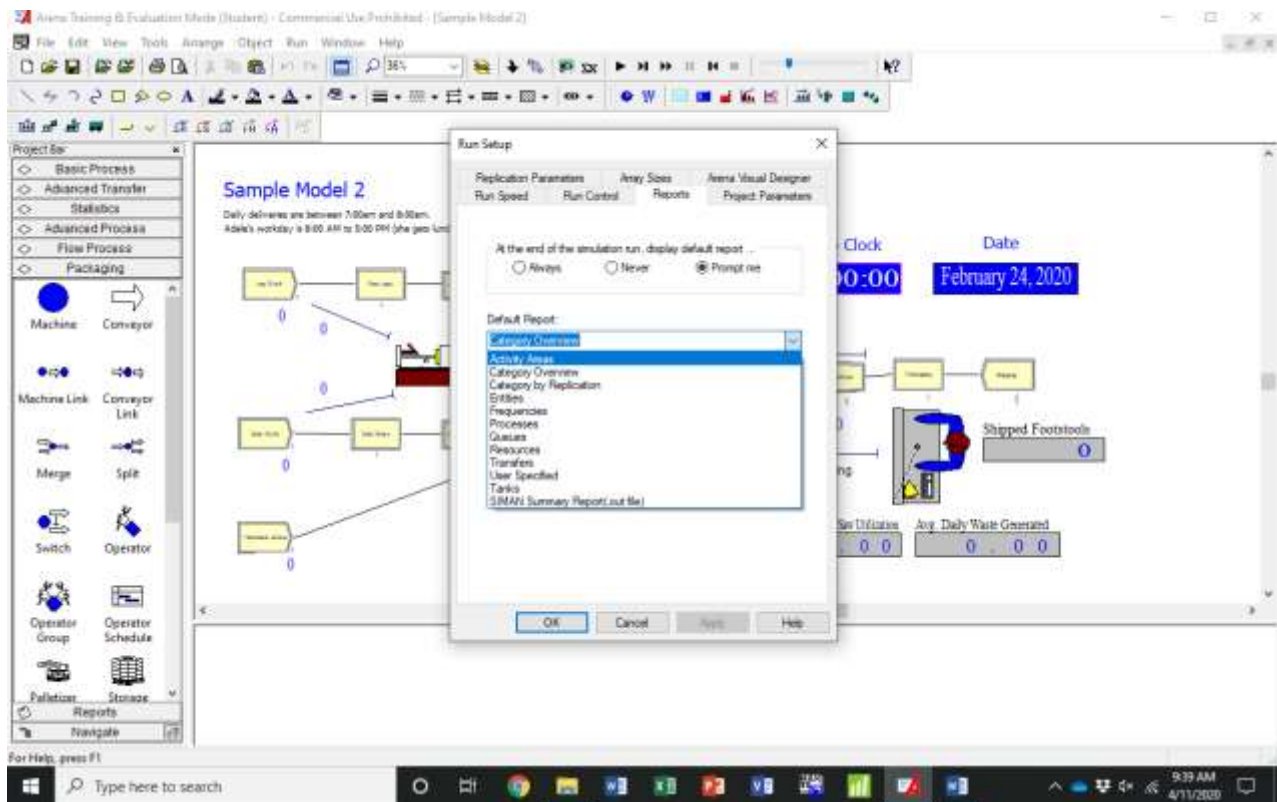


Figure 4.43. The Reports tab for Run > Setup in Sample Model 2.

As you can see, there are quite a number of different output reports that Arena generates when the model runs to completion. If the model crashes because it has one or more bugs, or errors, in the model, an output report will not be generated. Two of the most common output reports are the Category Overview report and the SIMAN Summary Report. Both reports contain the same output information, albeit in different formats.

The analyst can click on a radio dial to let Arena know whether to always display the selected output report when the model runs to completion, or to never show the output report, or to prompt the analyst for the selected output report. The analyst would then have the option to accept or decline viewing the output report.

In the Project Parameters tab shown in Figure 4.44, the analyst can enter a Project Title, the Analyst Name(s), and a brief description of what the simulation model represent in the Project Description field.

In the Statistics Collection section, the analyst can check the boxes for which he/she wants Arena to capture statistics during the simulation run. These results would be incorporated in the output report.

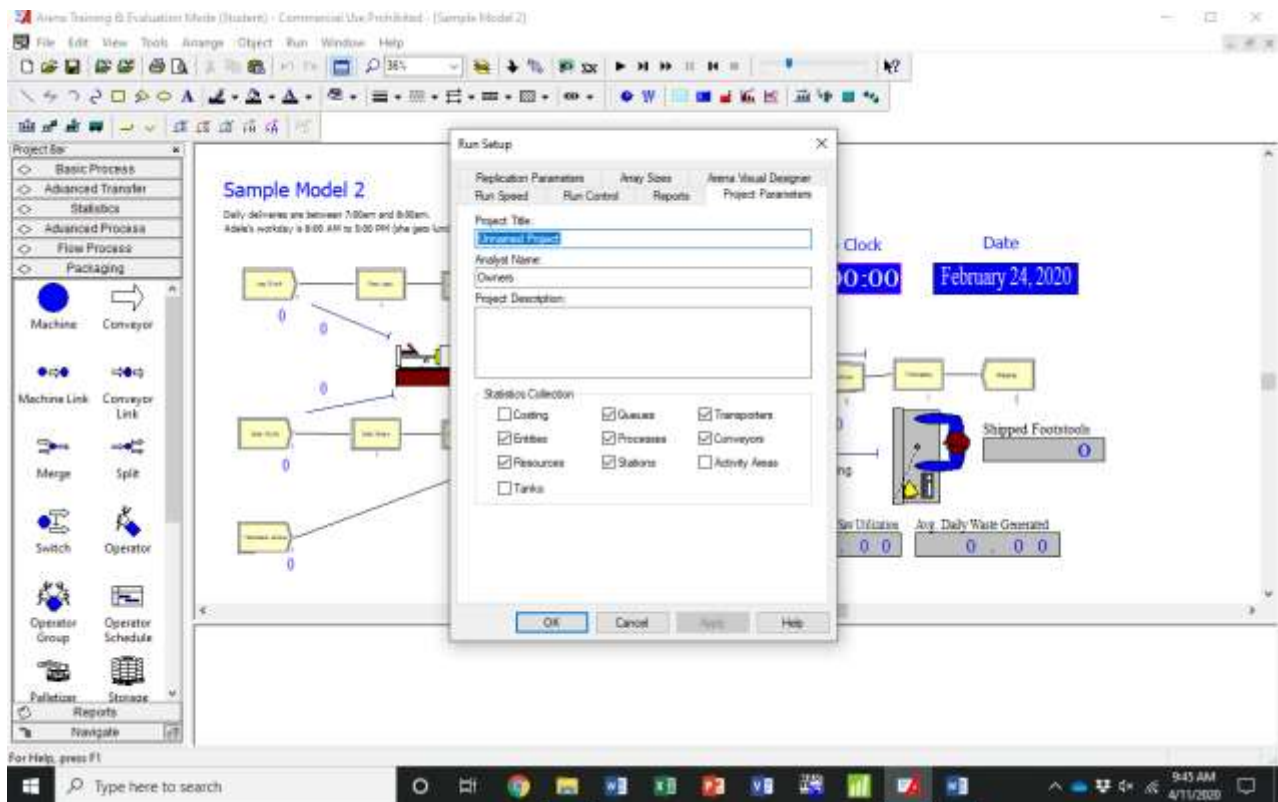


Figure 4.44. The Project Parameters tab in Run > Setup for Sample Model 2.