SIEMENS

SIEMENS DIGITAL INDUSTRIES SOFTWARE

Introduction to Tecnomatix Plant Simulation

Analyze faster
Plan more easily
Decide more reliably
Increase your productivity!

siemens.com/software

Contents

1. Introducing Plant Simulation

Introducing Plant Simulation

Welcome to *Tecnomatix Plant Simulation*. This chapter provides a short introduction to *Plant Simulation* which is intended for the new user of *Plant Simulation*.

We will create a simple simulation model and explain the underlying concepts of the terms:

Simulation and Animation

- **Simulation Properties**
- **Animation Properties**

We also will:

- **Create Simulation Models**
- **Display Simulation Results**

You can then **Work Through the Tutorial**. There we introduce some of the most important objects.

Also consult the Plant Simulation Step-by-Step Help

Getting to Know Tecnomatix Plant Simulation

Modeling the Material Flow

Visualizing the Material Flow

Animating the Simulation Model in 2D and Viewing the Results

Importing Data for the Simulation

Setting Parameters in the Model

Also consult the Plant Simulation Reference Help

What's New

Updating an Old Model to the Current Version

Using HTML Help

The **Objects Reference Help**

The **SimTalk Reference Help**

The **Outdated SimTalk Names in 2D**

The **3D Reference Help**

The **SimTalk Access to 3D**

The **Outdated SimTalk Names in 3D**

The **Quick Reference Cards**

The **Add-Ins Reference Help**

The **Object Libraries Reference Help**

Simulation and Animation

Simulation and Animation

As a general rule **simulation** and **animation** work together and run concurrently in *Plant Simulation*.

The **simulation component** simulates the material flows. The material flow objects collect statistics values during the simulation, which we show in tables and different diagrams and from which we can draw conclusions according to the defined targets.

We explain the:

- **Simulation in Plant Simulation**
- **Simulation Properties**

The **animation component** shows the simulated material flows during the simulation in a graphically pleasing and clear way.

We explain the:

- Animation in Plant Simulation
- Animation Properties

Go to Create Simulation Models

Go to Display Simulation Results

Back to Introducing Plant Simulation

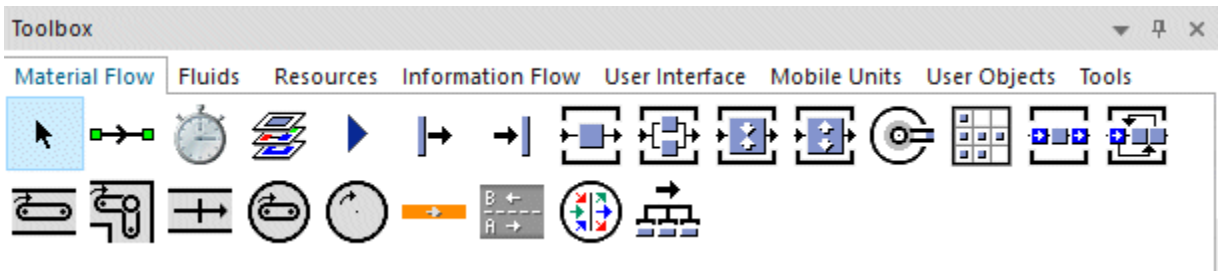
Simulation in Plant Simulation

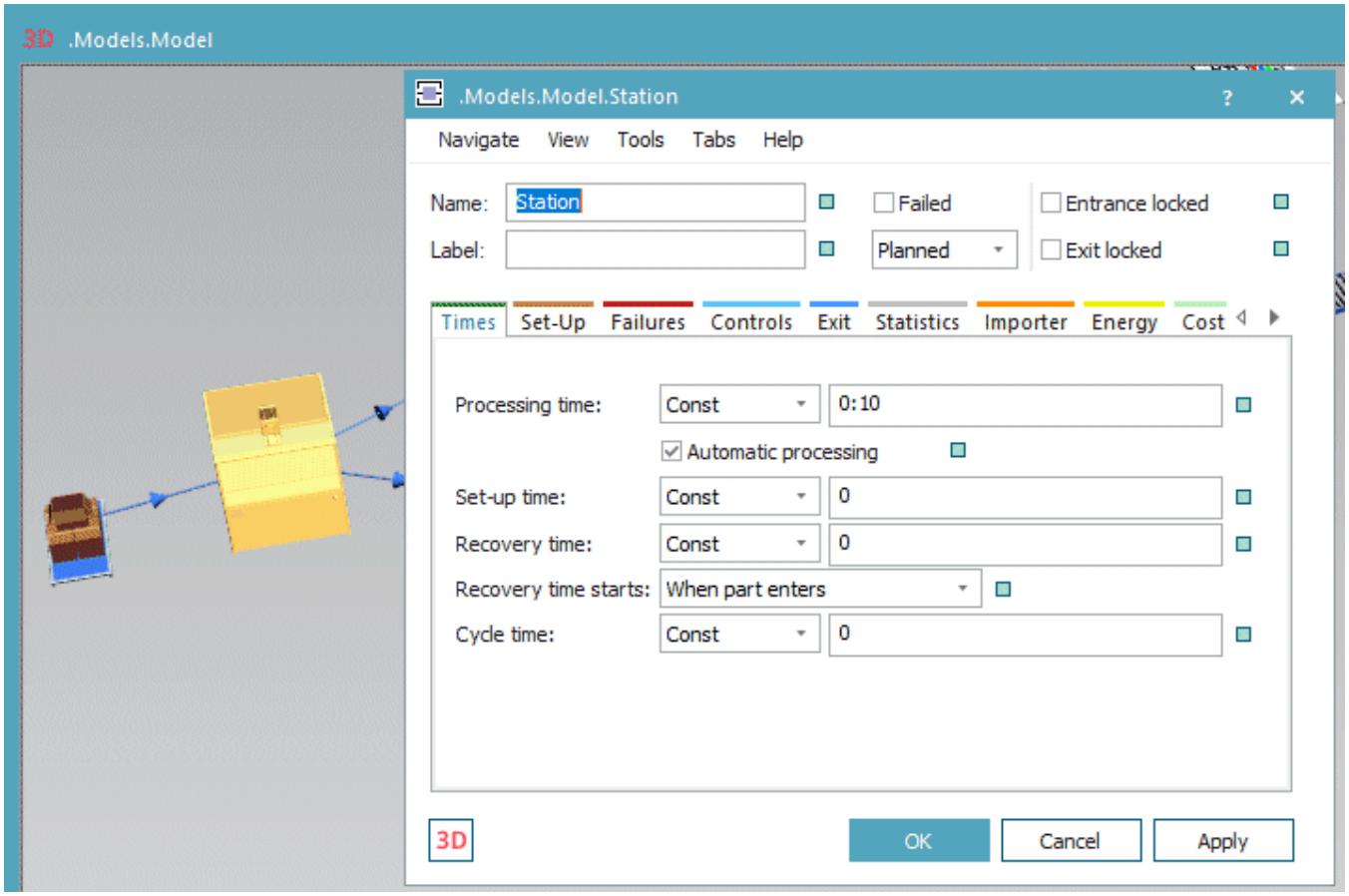
According to VDI (Verein Deutscher Ingenieure, Association of German Engineers, Directive 3633, Blatt 1, 1993) we run simulations to emulate a system, including its dynamic processes, in a model one can experiment with, to achieve results that can be transferred to a real world plant.

In our material flow simulations we want to identity the optimum of capacities, resource utilization, and buffer sizes so that the installation produces the required output.

To do so, we, for example, check the utilization of the machines, their processing, set-up, and failure times; we identify bottlenecks in the production process, we optimize the layout of the installation, to find out the optimal dimensioning of the materials-handling technology, etc.

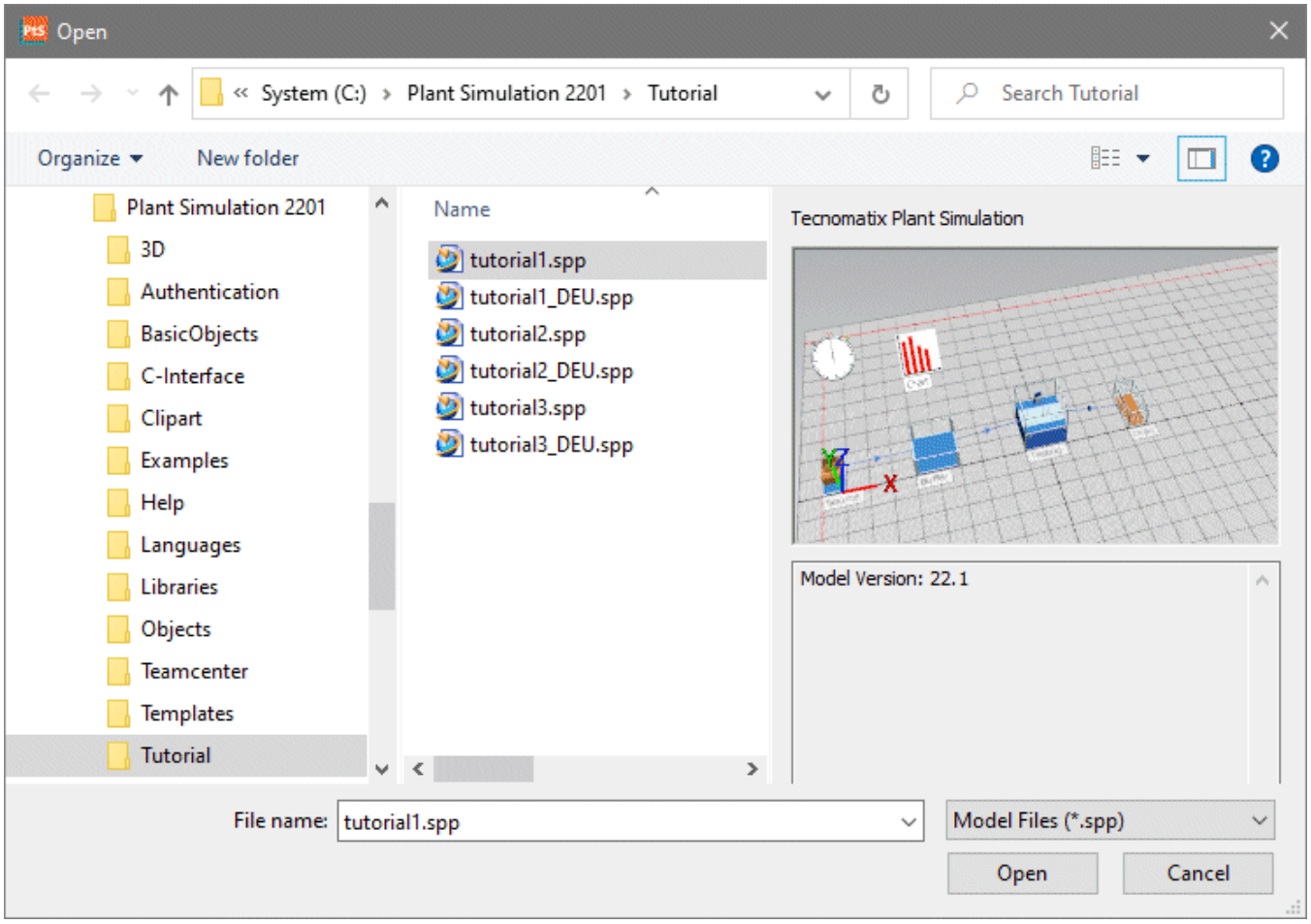
We control the **simulation** with the simulation properties on the tabs of the dialogs of the material flow objects, the resource objects, the mobile objects, and the fluid objects. We open the dialogs of the objects by double-clicking their icon.





Simulation and Modeling Concepts and the subtopics **What is Simulation?**, **Time-Oriented Simulation and Event-Controlled Simulation**, **Why Employ Simulation?**, and **Implement a Simulation Project** in the *Step-by-Step-Help* describe this in detail.

We also offer a short tutorial. The model files are located in the **Plant Simulation installation folder > Plant Simulation > Tutorial**, compare the example below.

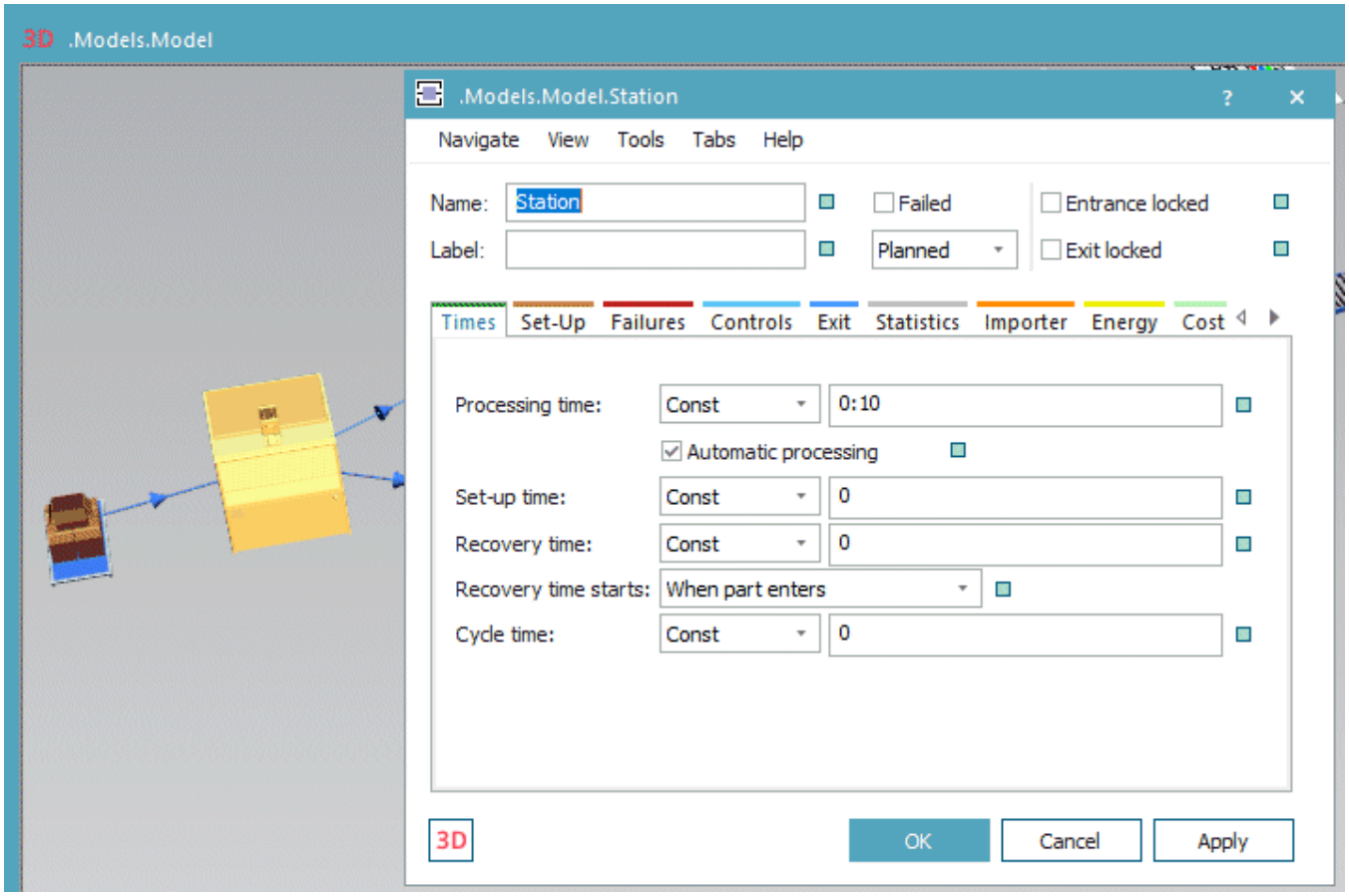


The topic **Working Through the Tutorial** guides you through the individual modeling steps.

Back to Simulation and Animation

Simulation Properties

We can set the **simulation properties** of the objects on the tabs of the dialogs of the **material flow objects**, the **resource objects**, the **mobile objects**, and the **fluid objects**. To do so, we double-click the icon of the respective object in the *Frame* named **Model**.



We can set these and additional settings for the simulation of the material flows:

- Times on the tab **Times**.
- Set-up properties on the tab **Set-Up**.
- Interruptions (failures, pauses) on the tab **Failures**.
- Controls, which react on events during the simulation, on the tab **Controls**.
- Exit behavior, which controls the material flow, on the tab **Exit**.

In principle you can do this in *Plant Simulation*

- **Change Values in the Dialog of the Objects**
- **Change Values in the Dialog Show Attributes and Methods**
- **Change Values by Assigning a Value in SimTalk**

We can change to the **animation properties** by clicking the 3D button  . This opens the dialog **Edit 3D Properties**.

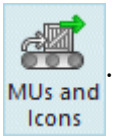
Back to Simulation and Animation

Animation in Plant Simulation

Plant Simulation animates the simulation model automatically, in 2D, compare **Animate the Simulation Model in 2D and View the Results**, as well as in 3D, as we show below.

The **animation** visualizes the material flow/parts flow through the installation and thus allows to track the journey of the parts. In addition you can replace the graphics of the material flow objects with graphics of your machines and then animate these graphics with poses to make them look more realistic.

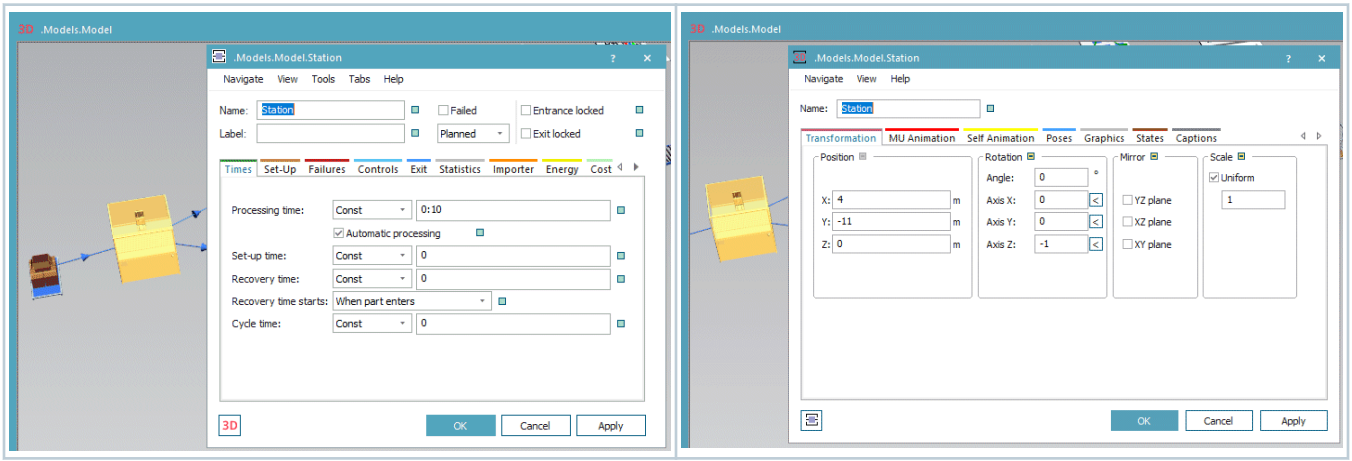
This makes it easier to understand the processes and procedures in the model for the modeler and for managers or customers who are to be convinced of the simulated solution.

If we do not need the **animation** or would like the simulation to run faster, we can deactivate the animation by clicking 

.

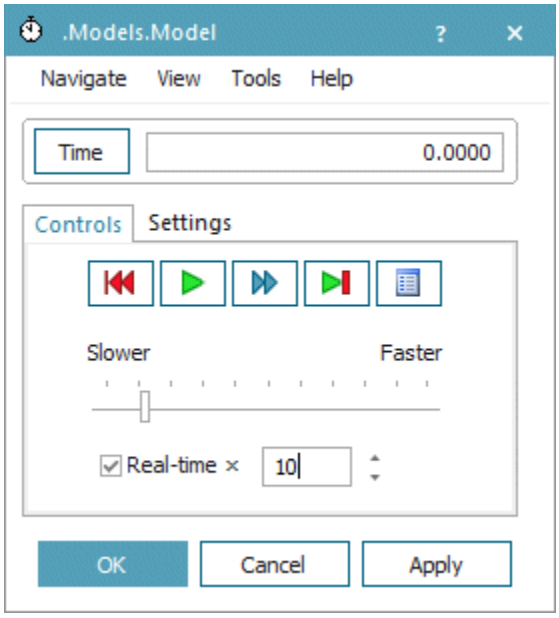
We can set the **animation properties** of the objects in 3D by clicking the respective object once in the model window and by then pressing the **spacebar**. If the dialog with the **simulation properties** is open, we can click 

to open the dialog **Edit 3D Properties**.



Note:

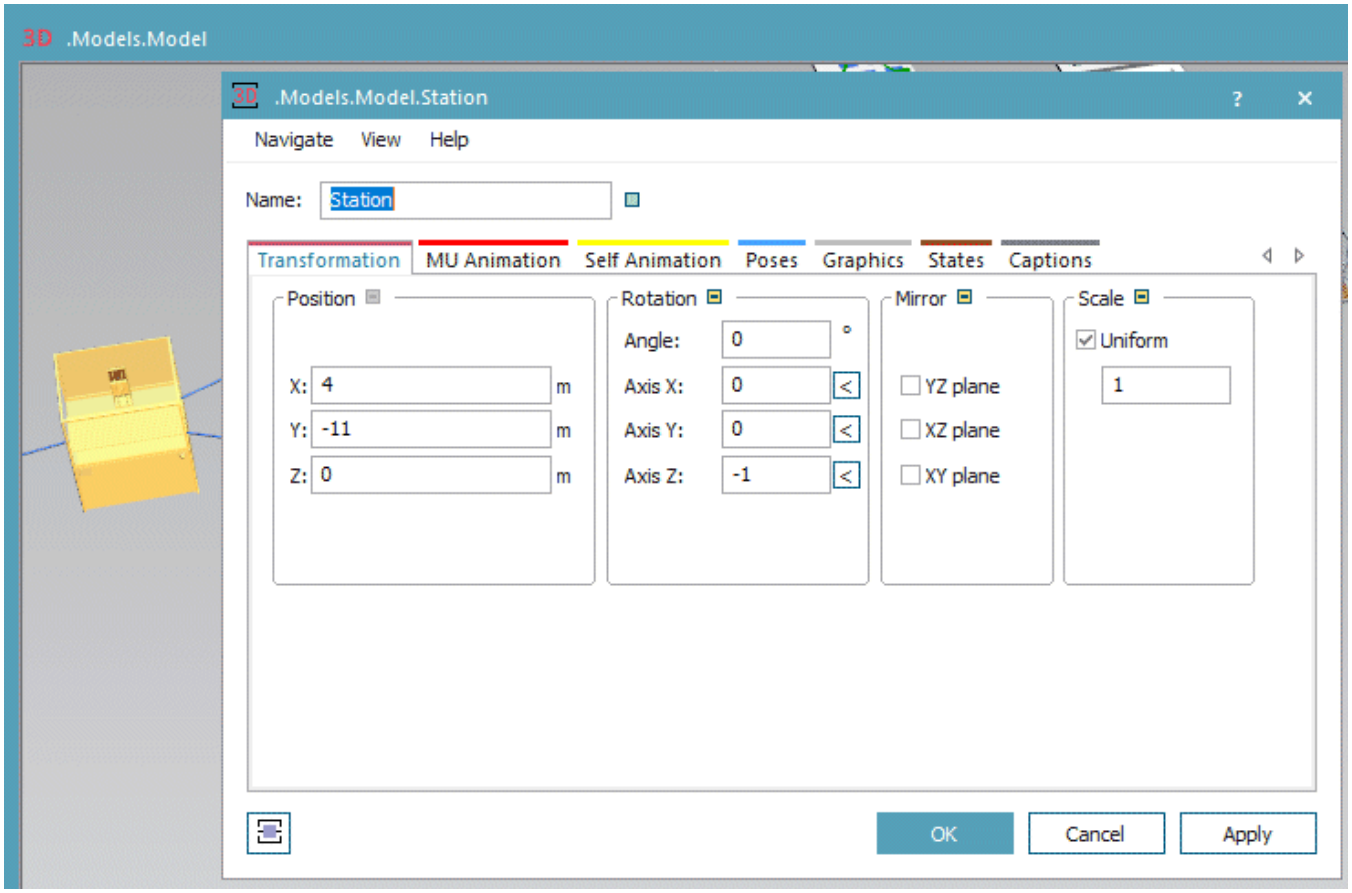
We recommend to always activate **Real time** in the *EventController* in your 3D model as the simulation runs faster in principle in a **3D Only** model as *Plant Simulation* does not have to compute the animation events for 2D.



Back to Simulation and Animation

Animation Properties

We can set the **animation properties** of the objects in 3D by clicking the object once in the model window and by pressing the **spacebar**.



We can set these and additional settings for the animation of the material flows in the dialog **Edit 3D Properties**:

- The position, rotation, and scaling of the objects on the tab **Transformation**
- The appearance of the parts on the tab **Appearance** of the MUs
- The appearance of materials-handling equipment on the tab **Appearance** of the length-oriented objects
- Color the animation object on the tab **Material**
- Define animation paths for:
  - MU Animations on the tab **MU Animation**
  - Animations of the objects on the tab **Self Animation**
  - The animation of the robot arm on the tab **Robot Arm Animation**
- Poses of the objects on the tab **Poses**

- Joints of the objects on the tab **Joint**

In principle you can do this in *Plant Simulation*

- **Change Values in the Dialog of the Objects**
- **Change Values in the Dialog Show Attributes and Methods**
- **Change Values by Assigning a Value in SimTalk**

We can click the  button to change to the simulation properties of the objects.

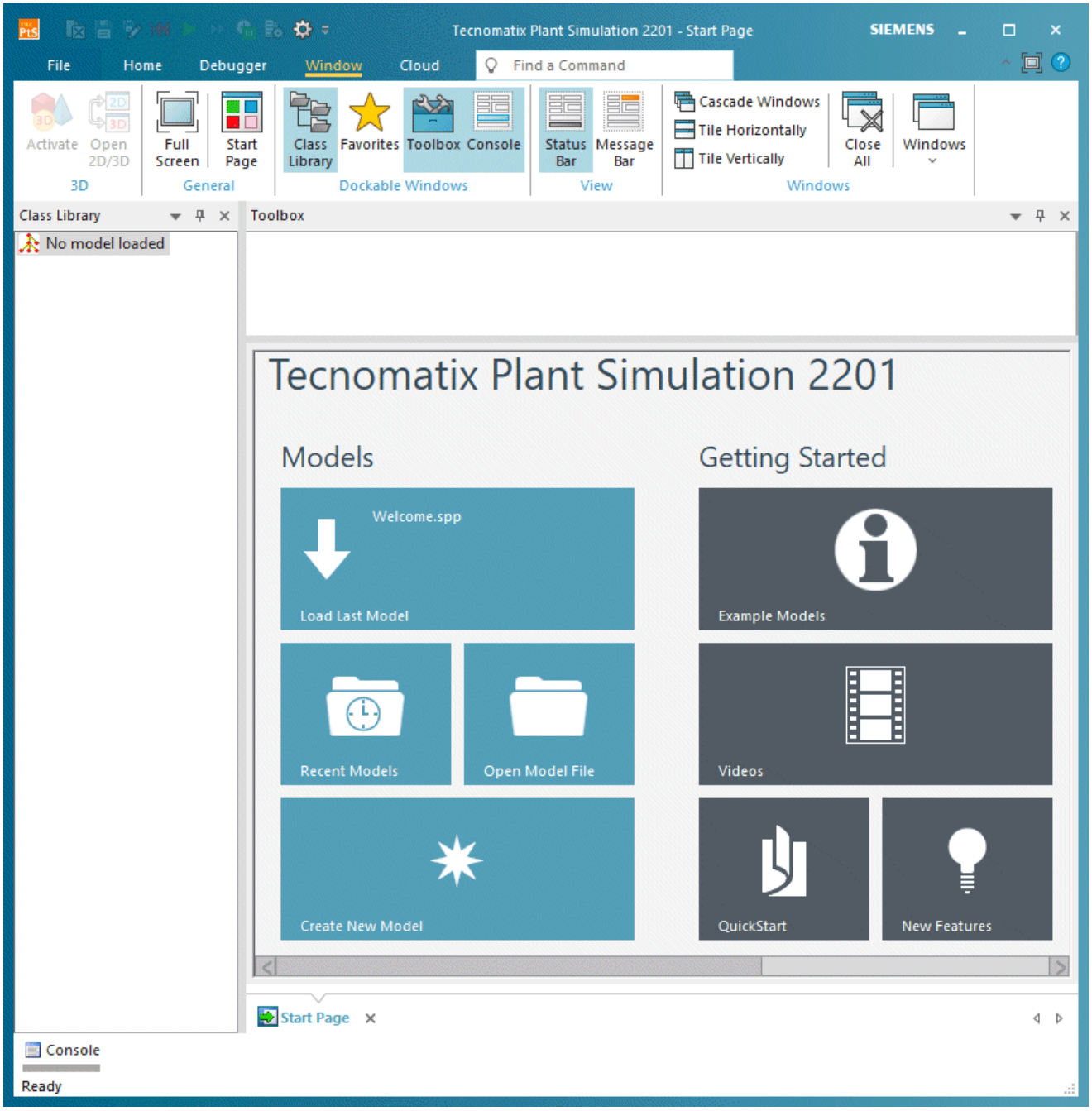
Back to Simulation and Animation

Creating Simulation Models

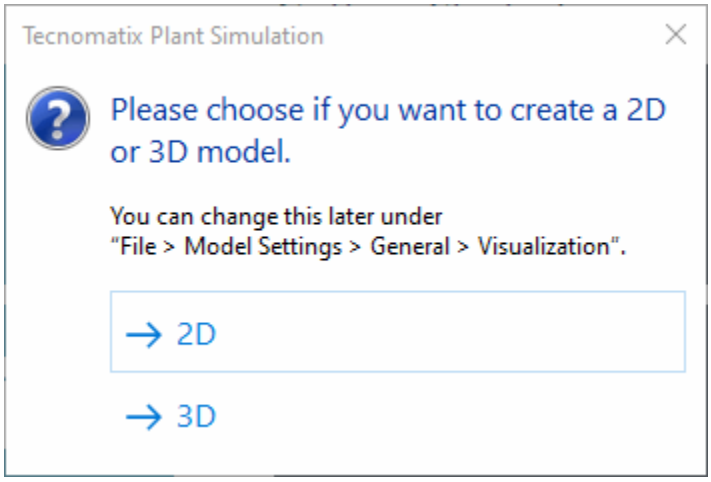
Create a Simulation Model

We proceed as follows to create our simulation model:

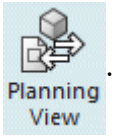
- We start *Plant Simulation*.
- We click **Create New Model** on the tab **Start**.



- Now *Plant Simulation* shows a dialog an, in which we can select if we would like to create the simulation model in 2D or in 3D.



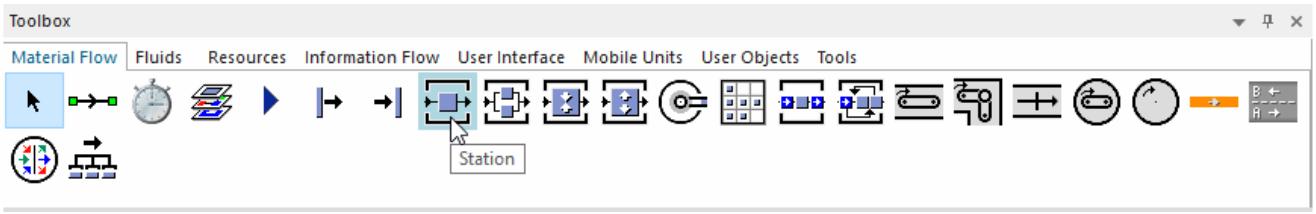
Generally we always recommend to create the models in 3D. This way you always have a model that shows a graphically pleasing and good-looking visualization of the material flow and that clearly resembles the actual look of the modeled installation.
A **2D model** is ideal if the visualization of the material flow is not that important for you and if you are mainly interested in the statistical data that the material flow objects collected.

- We create our model in 3D. By default we model in three-dimensional space.
  If you prefer to model in top view, i.e., in two dimensions, change to the **View** tab and click **Planning View** 

.

- Now we can start modeling. We insert the required material flow objects from the tab **Material Flow** in the **Toolbox**. These objects simulate the flow of the parts through our installation.

> Note:
>
> Drag the mouse over an object in the **Toolbox** to show a *Tooltip* with the object name.



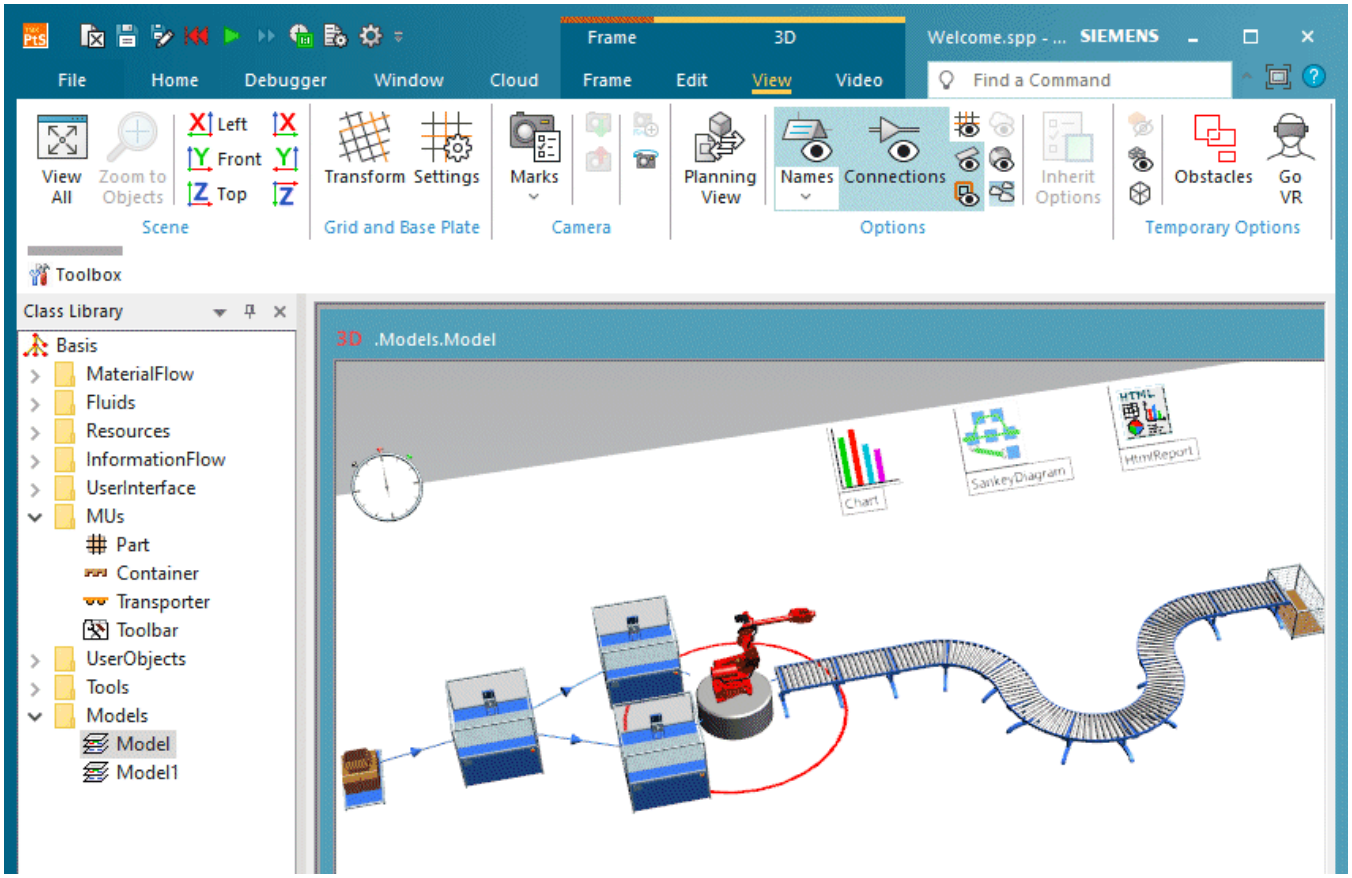
Click the object with the left mouse button. Drag the mouse to the position of your choice in the *Frame* named **Model** and click the left mouse button once.

- A *Source*  produces the part which the stations process or convey between the stations.

- A *Station*  doing the rough-processing of the parts.
- Two additional *Stations* which further process the parts.
- A *PickAndPlace robot*  which places the arriving parts to the conveyor.
- A *Conveyor*  which moves the parts to the *Drain*.
- A *Drain*  which removes the parts from the installation.

  Then we have to connect the inserted objects so that the parts can flow between the stations. To do so, we hold down the **Ctrl** key, click the *Connector*  in the **Toolbox**, drag the mouse to the *Frame* named **Model**, and click on the objects one after the other.

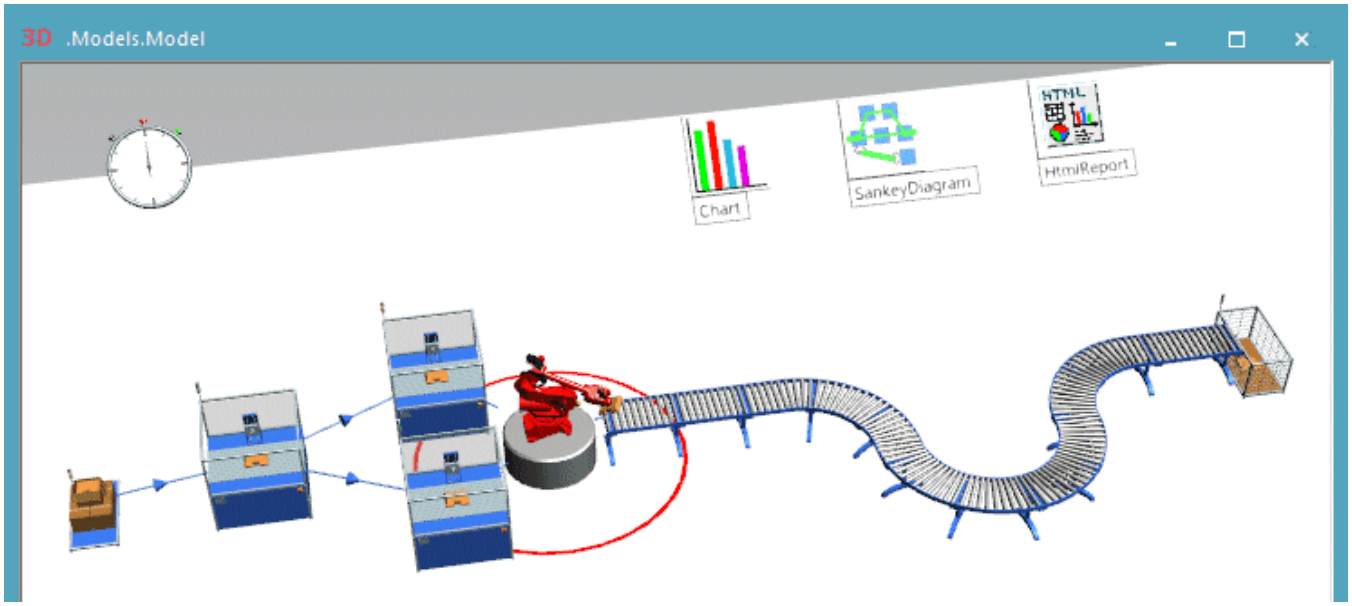
The finished model looks like this:



We can now run a **simulation** with an appealing **animation** with the **factory settings**.

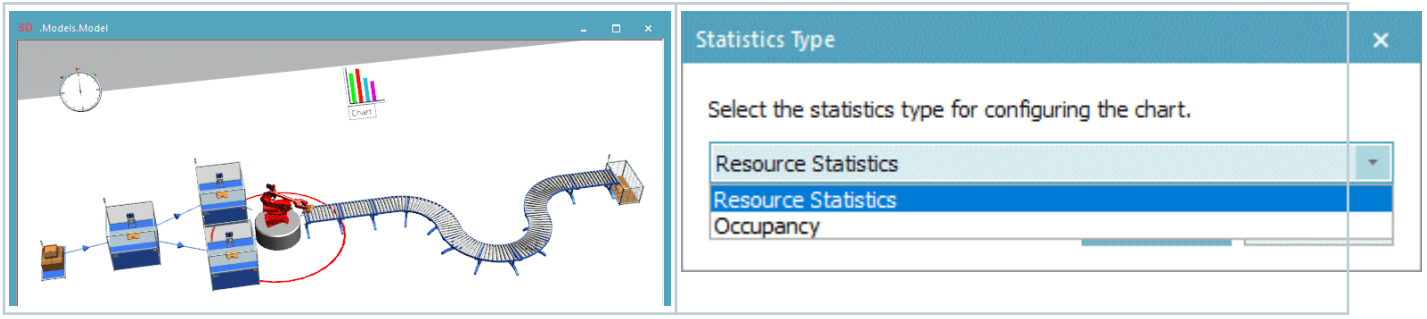
Click **Start/Stop Simulation** on the **Start** ribbon tab.

We also hide the grid on the **View** ribbon tab as it is only intended as a modeling help.

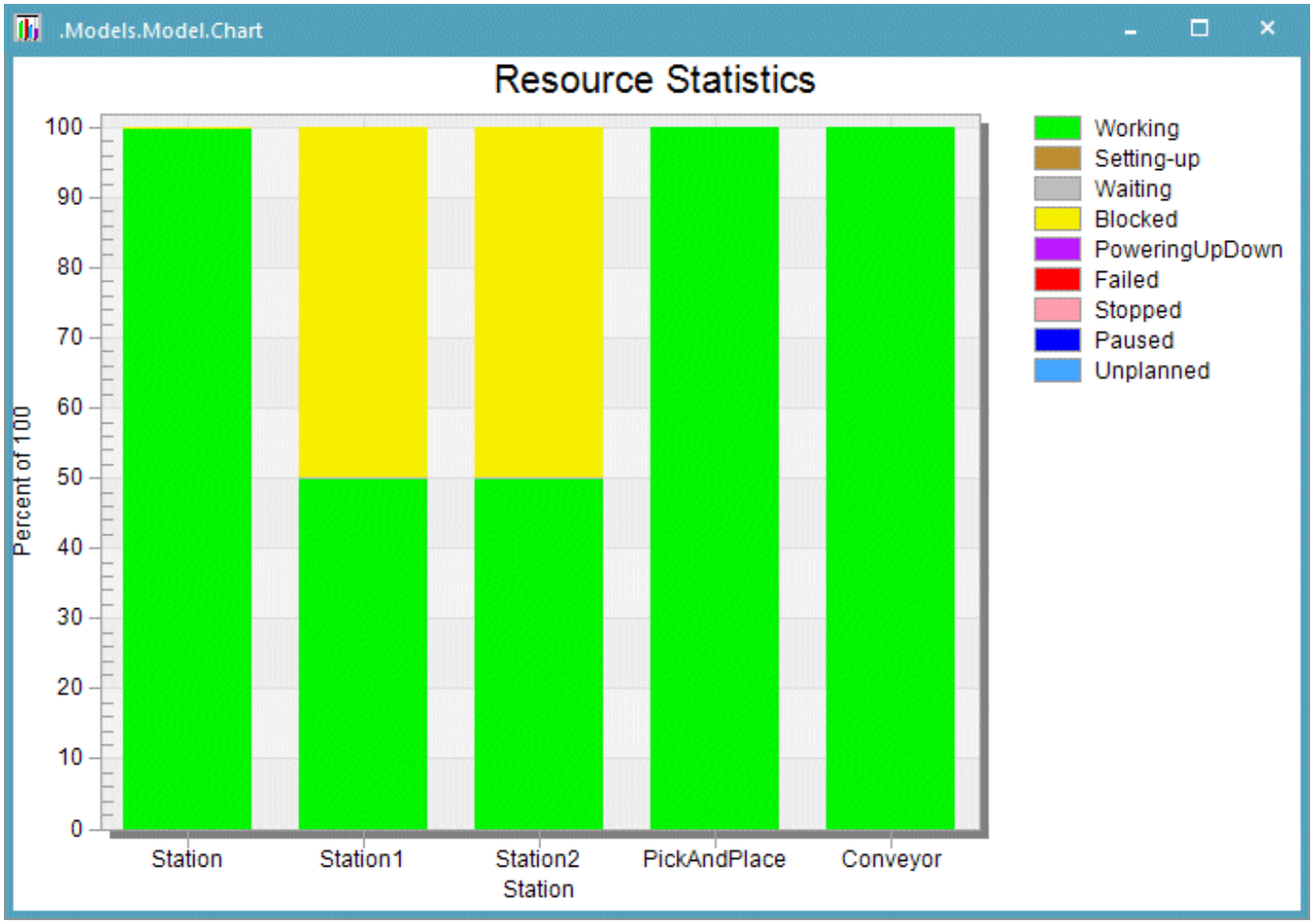


To better see the effects of **changed simulation properties**, we also insert a *Chart* which clearly shows the changed settings.

To do so, we press **Ctrl+A** to select all objects in the *Frame*. As we are only interested in the material flow objects, we then hold down **Ctrl** and click the *EventController*, the *Source*, the *Drain*, and the *Chart* to deselect them. Then we drag the selected objects onto the icon of the *Chart* and drop them there. We select **Resource Statistics** in the dialog **Statistics Type**.



After the simulation did run, we can click the *Chart* with the right mouse button and select **Show**. The standard settings of the objects provide these results:



The *Station* is working 100 % of the time, the following *Stations* are working 50 % of the time each, *Robot* and *Conveyor* are working 100 % of the time.

After having run the **simulation** with the **factory settings** of **simulation** and **animation**, we can:

- **Change Simulation Settings**
- **Change Animation Settings**

Compare the video **Creating a Simple Model** under Window > Start Page > Getting Started > Videos.

Compare Working with the Frame

Compare Modeling the Material Flow

Back to Simulation and Animation

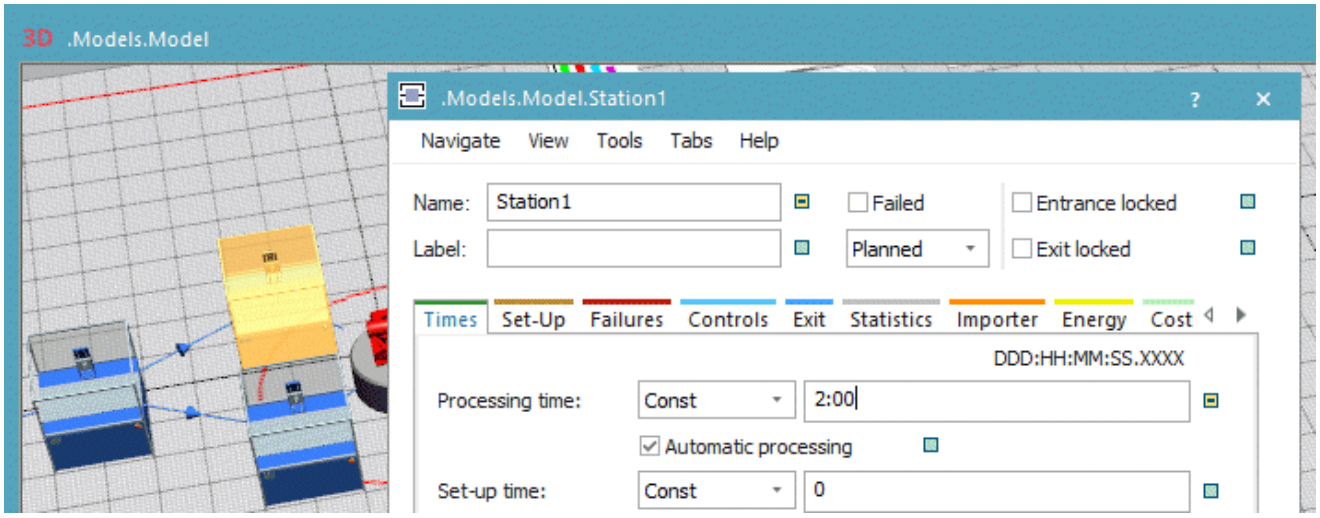
Go to Display Simulation Results

Back to Introducing Plant Simulation

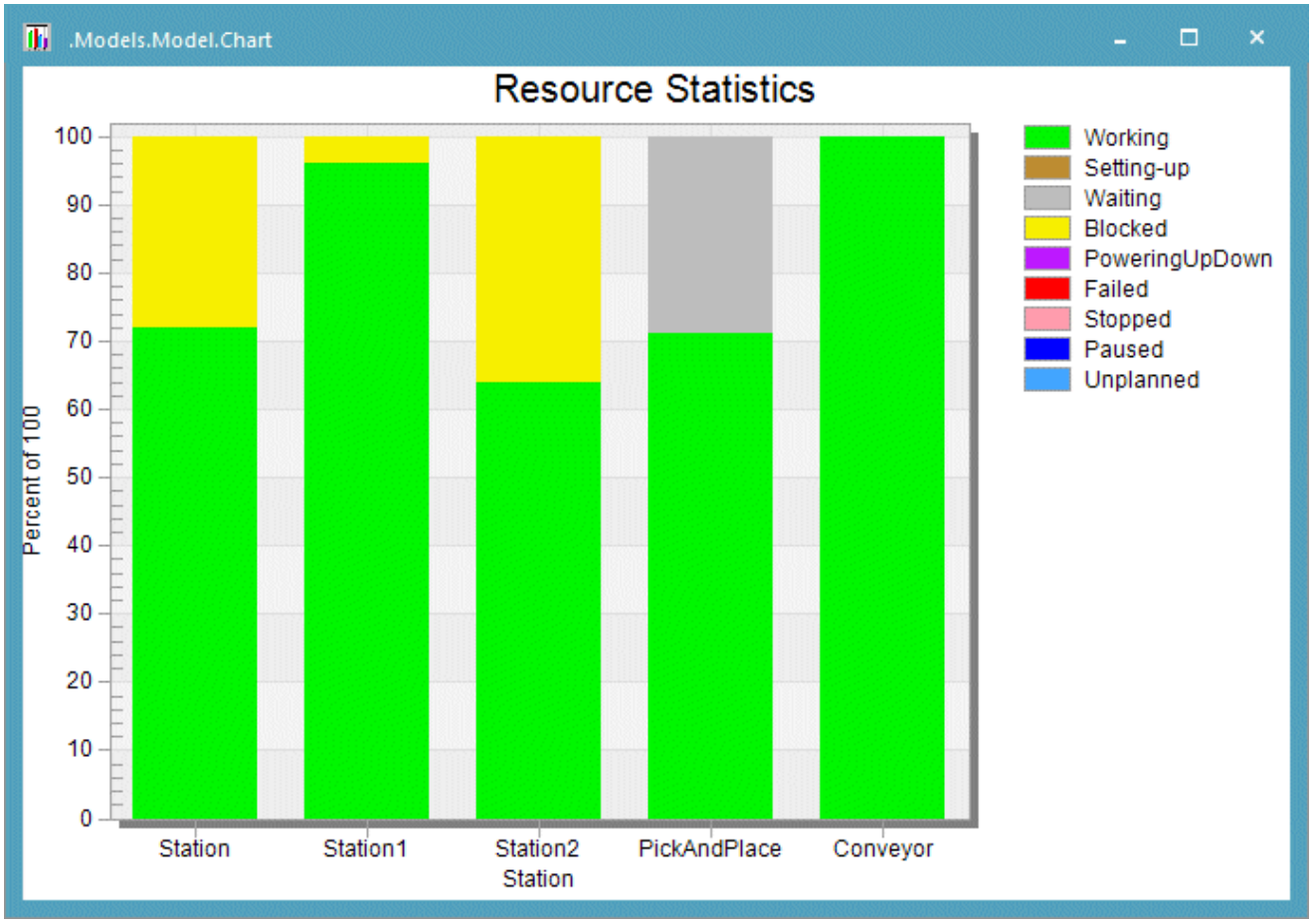
Change Simulation Settings

We can change the **simulation settings** of the objects to simulate different scenarios with changed values.

- We can, for example, increase the **processing time** of the *Station* located at the top, named *Station1*, from 10 seconds to 2 minutes.

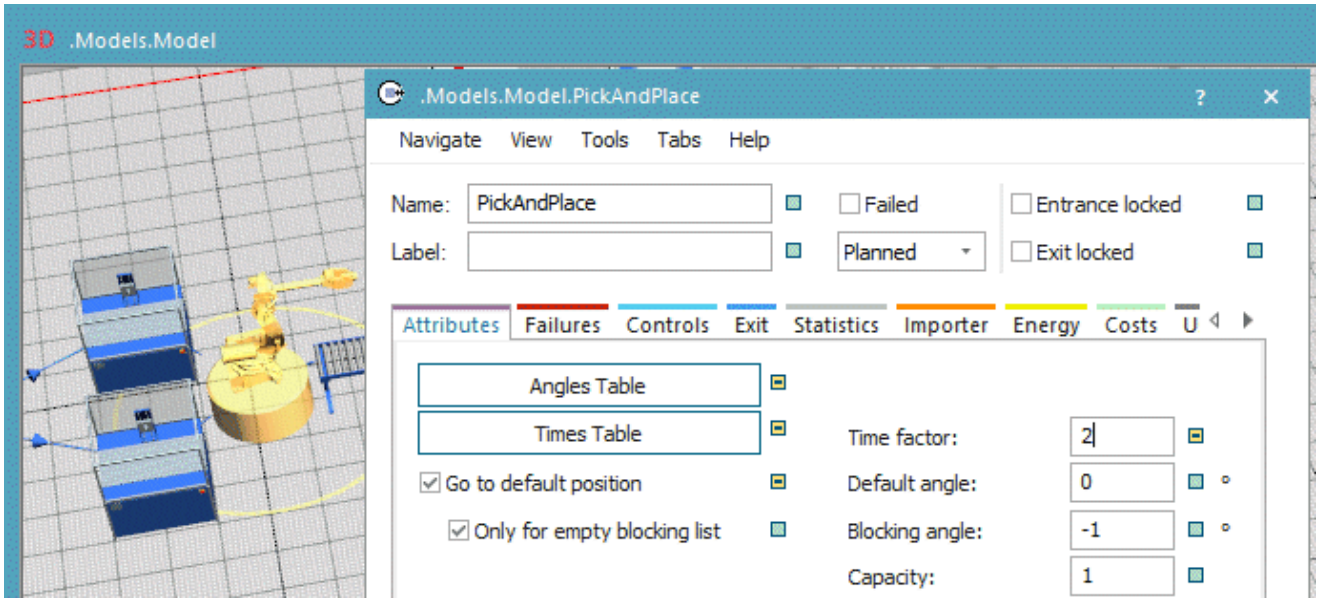


The changed **processing time** has these effects:

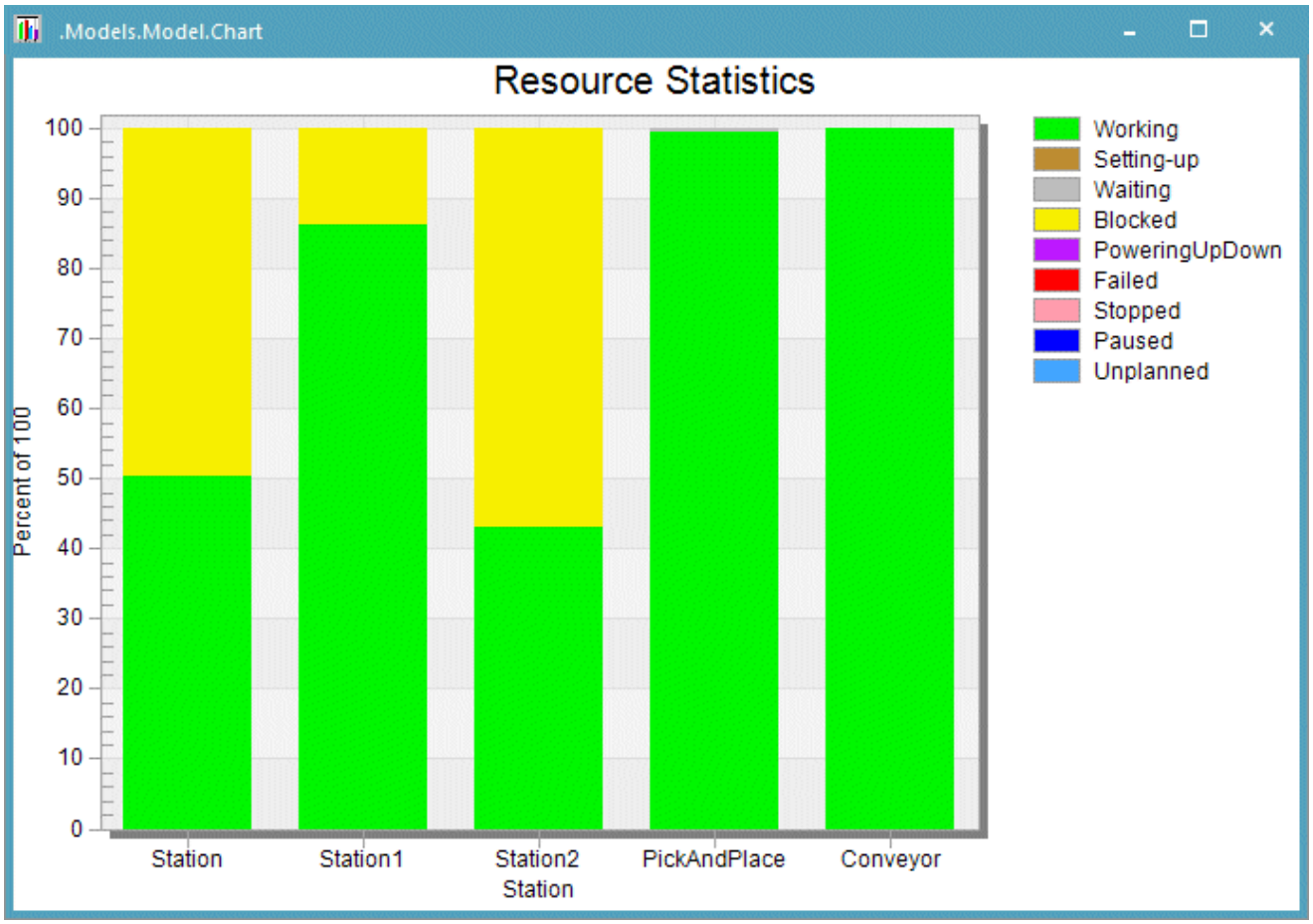


The working portion of the *Station* fell to 70 %, while it rose for the following *Stations*, the *Robot* is now waiting for parts and the *Conveyor* is now 100 % of the time again.

- We then increase the **time factor** of the *PickAndPlace robot* from 1 to 2.



The changed **time factor** has these effects:



The working portion of the *Station* and the following *Stations* fell, the *Robot* is working 100 % of the time again, the working portion of the *Conveyor* did not change.

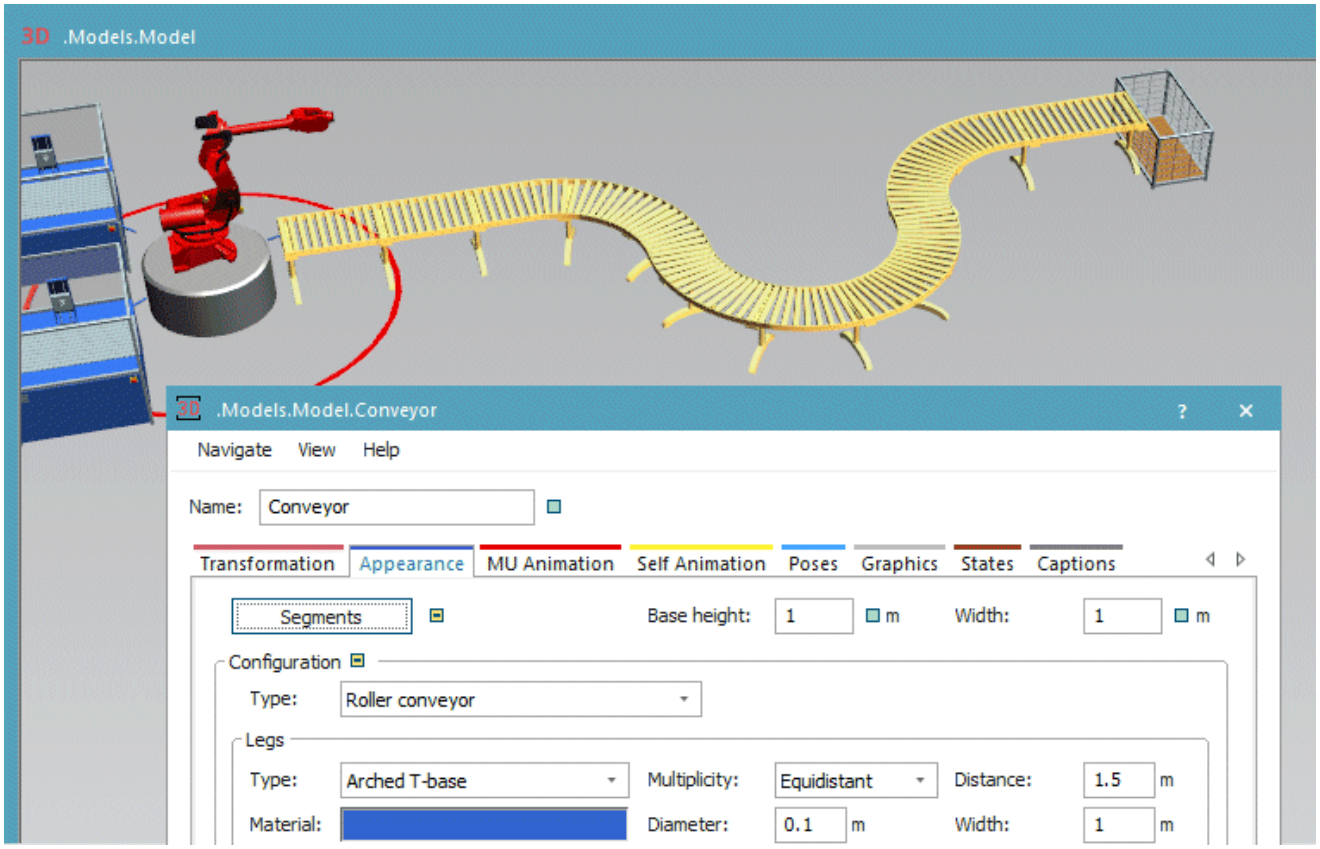
Go to Change Animation Settings

Back to Creating Simulation Models

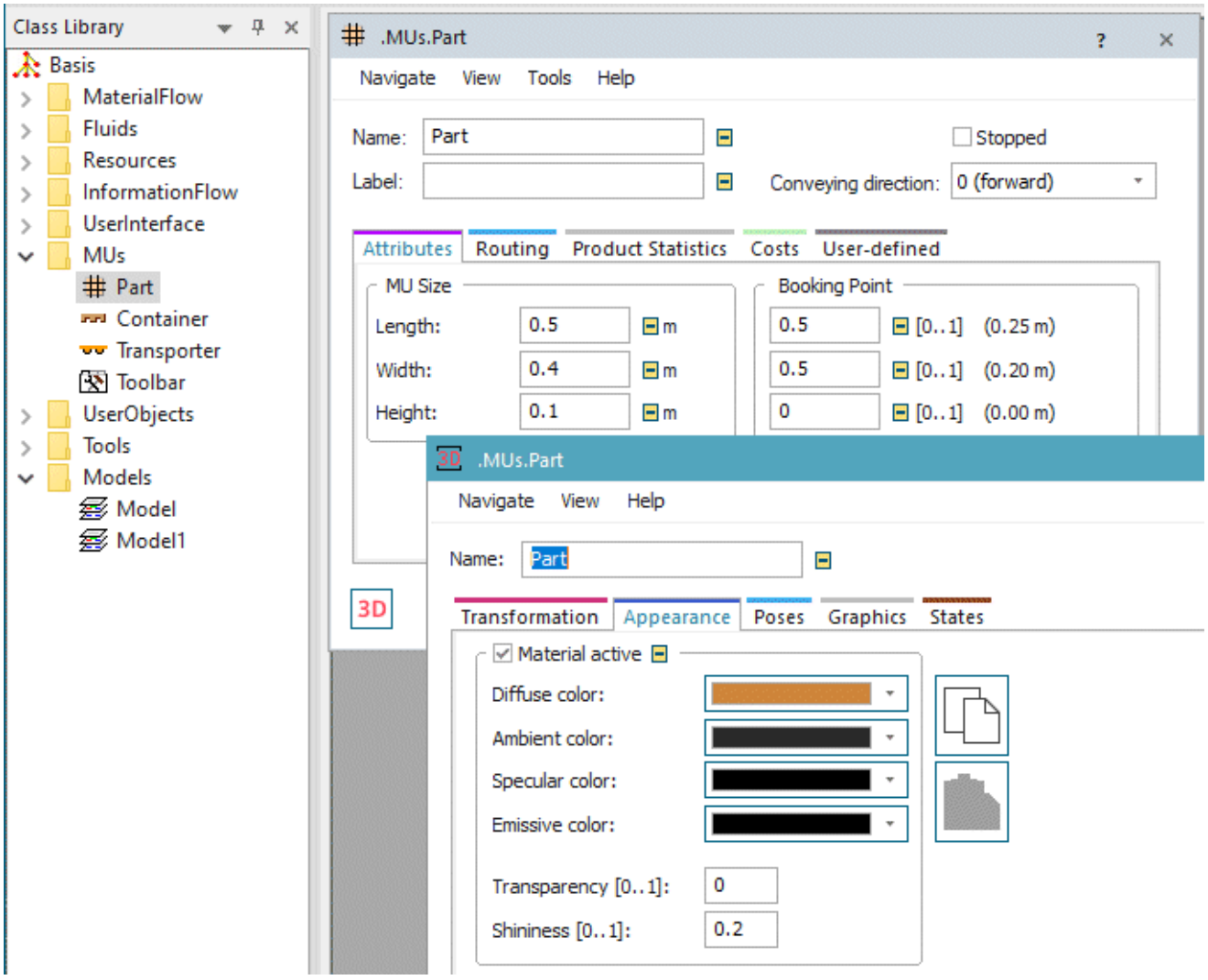
Change Animation Settings

After the simulation settings we are going to change some of the **animation settings**:

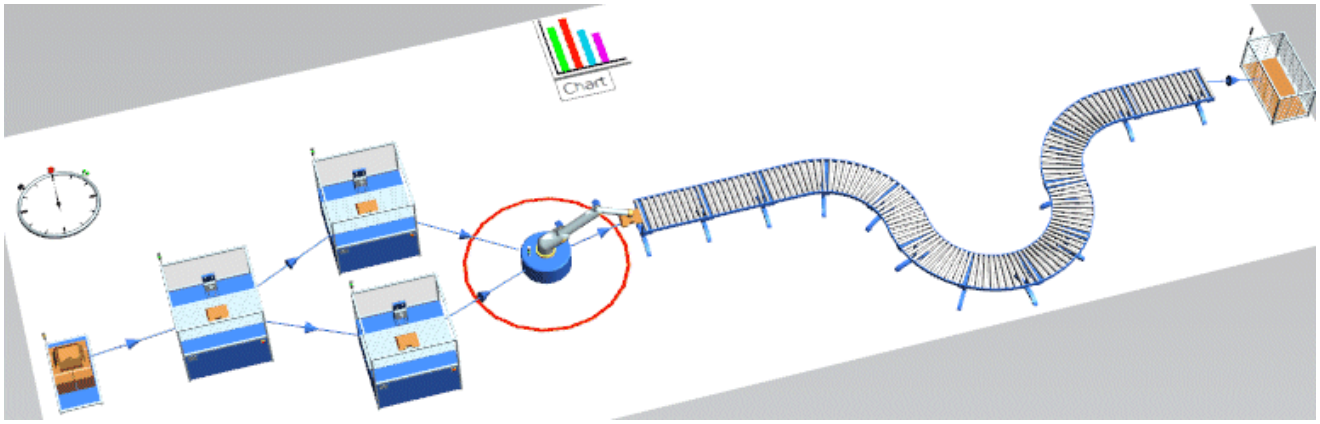
- For the *Conveyor* we select another configuration so that it resembles the conveyor in our installation. To do so, we click on the *Conveyor* once with the left mouse button and press the **spacebar**. Instead of the default **belt conveyor** we use a **roller conveyor** with **arched T-based legs spaced** `1.5` meters from each other. It then looks like this:



- As our white part is hard to see during the simulation, we change its color. As we want to do this for all produced parts, we edit the *Class* of the *Part*.
To do so, we change to the *Class Library*, open the folder *MUs*, and double-click the *Part*. This opens the dialog of the **simulation settings**. There we click  to open the dialog of the **animation settings**. There we can activate the material of the *Part* and select brown as color.

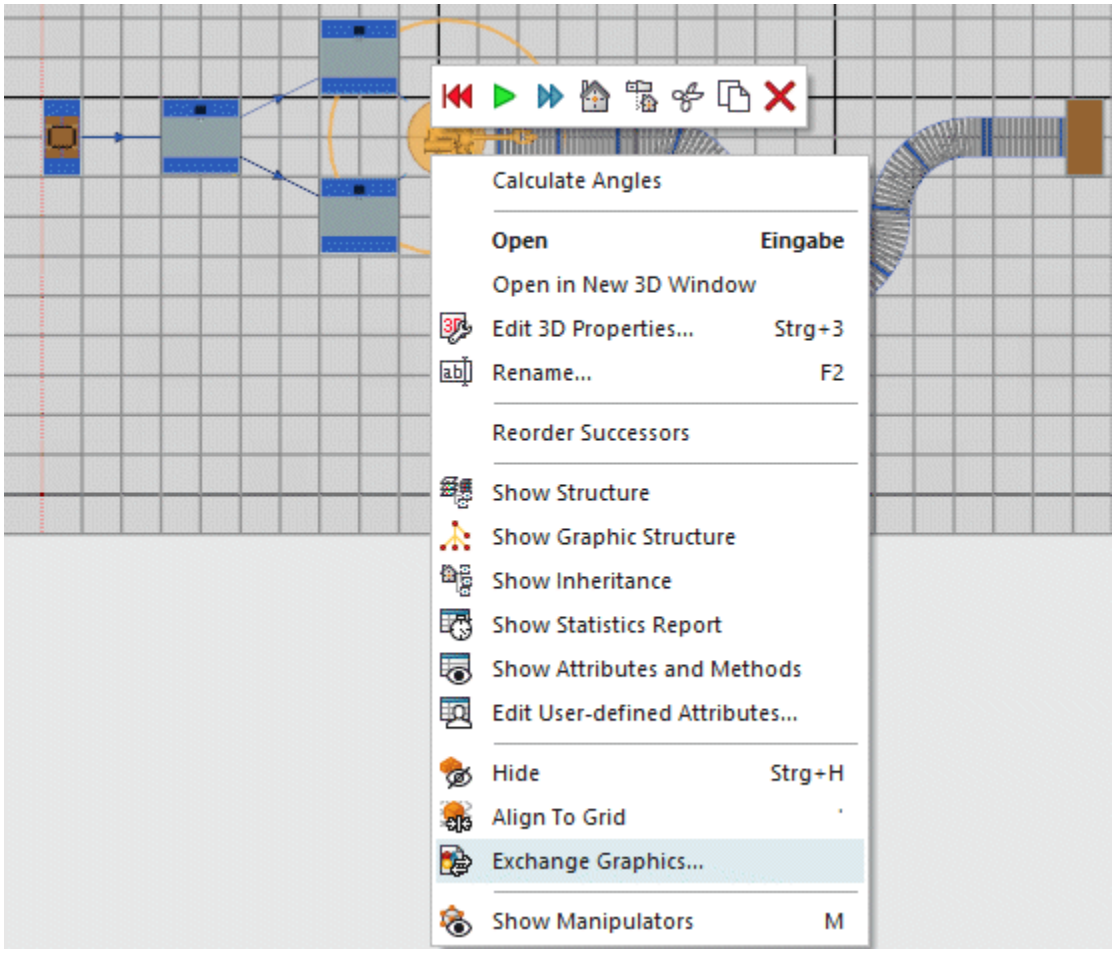


When we then run the simulation, we see that our part now has the color we selected, namely brown.

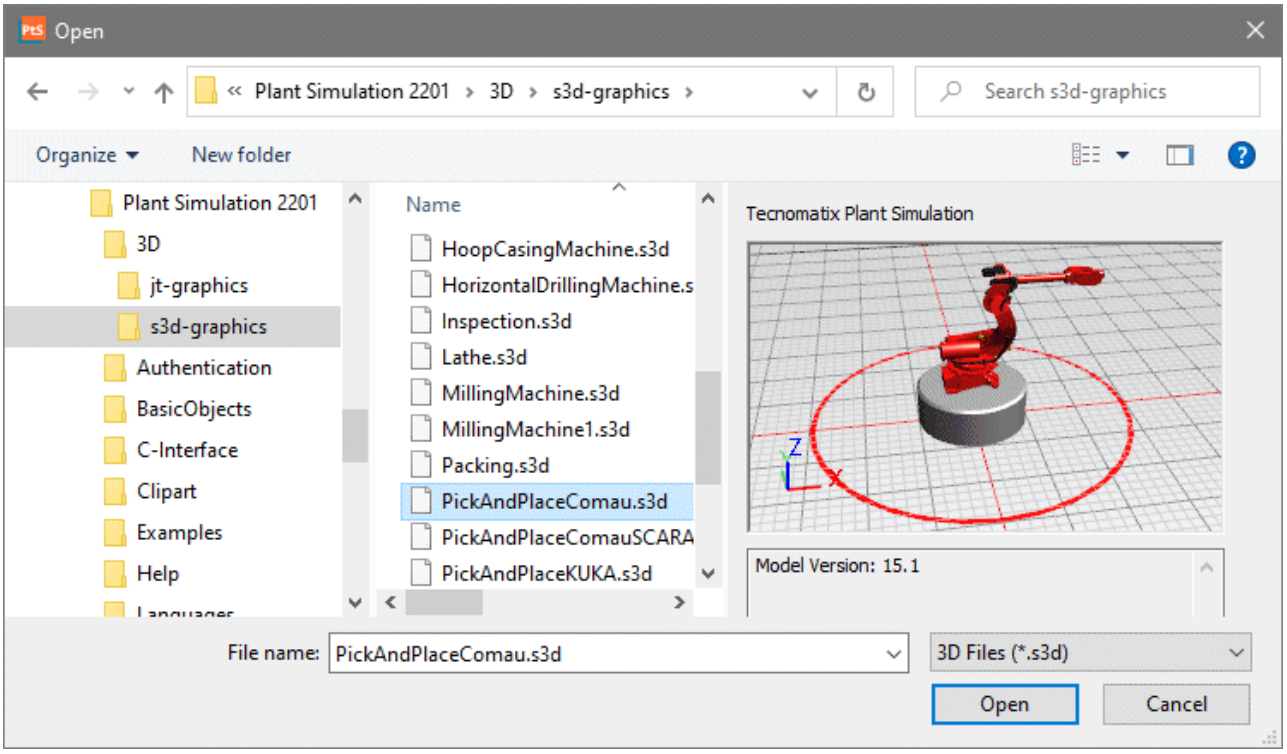


- Next, we replace the graphic of our *robot* so that it matches the *robot* in our installation:

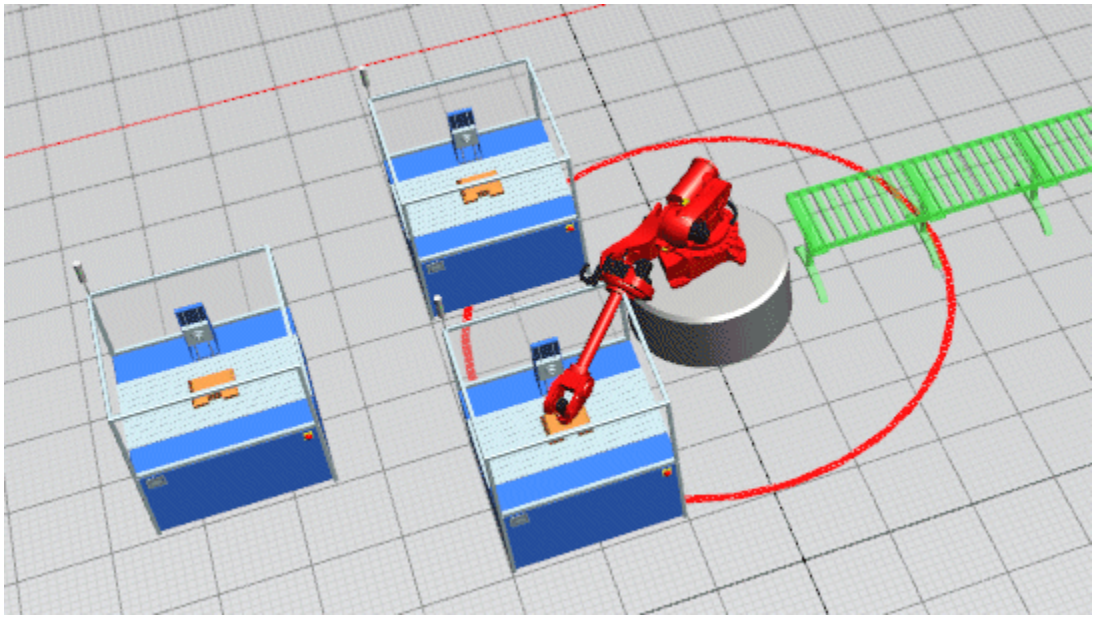
- We click the *robot* with the right mouse button and select **Exchange Graphics**.



- We select the *Comau PickAndPlace robot*.

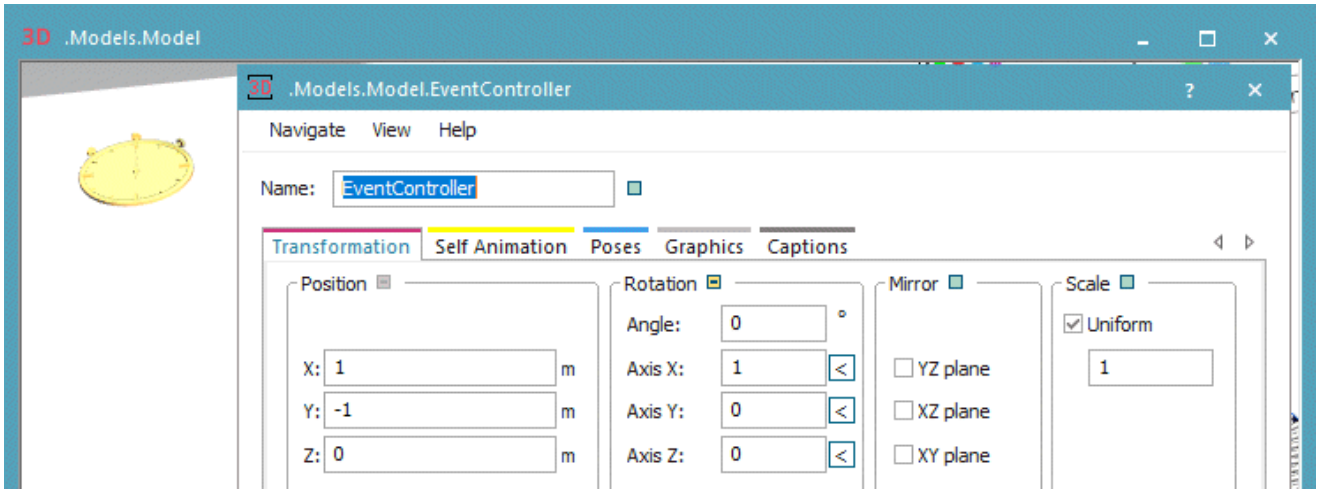


- As the *robot* is too far away from the feeding *Stations*, we adjust the positions as shown below. Drag a marquee around the *robot*, the *Conveyor*, and the *Drain* and press the **Left arrow key** until the position fits.



Animating the Robot Arm in 3D shows how to prevent that the robot arm moves through the protective cover and the parts holder and moves above both.

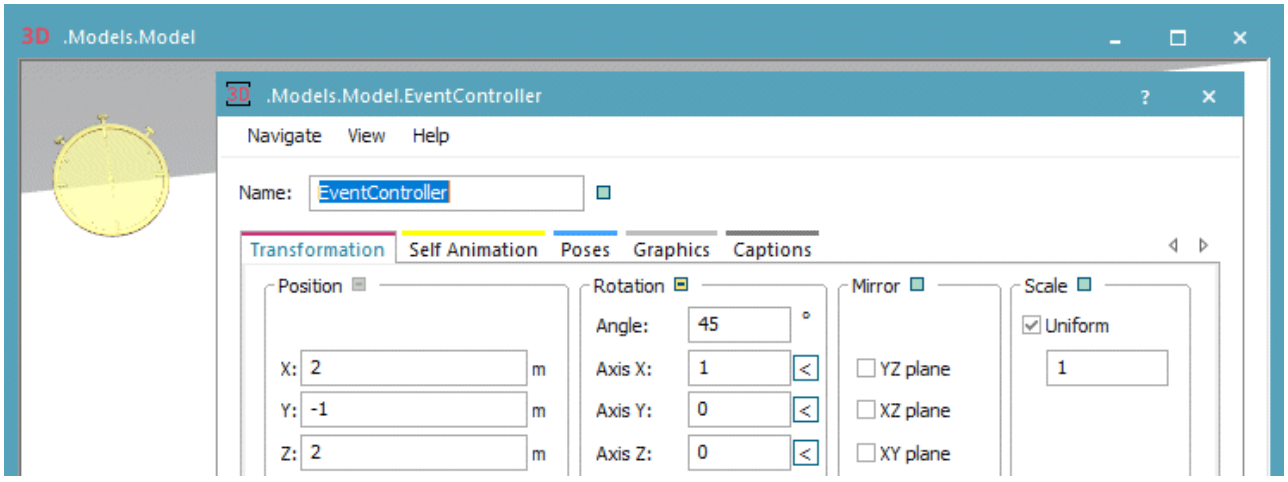
- As we do not like the position of the *EventController*, the clock lying flat on the floor, we change that as well. To do so, we click the *EventController* with the left mouse button and press the **spacebar**. The standard settings on the tab **Transformation** look like this:



We changed these settings:

- We moved the **Z position** of the *EventController* up to `5.4` meters.

- We rotated the clock by 90 degrees forward on the **X axis**. To do so, we typed in `90` as **angle** and clicked the button next to **X axis**.



The clock now hangs on the rear wall of the installation with the face facing forward.

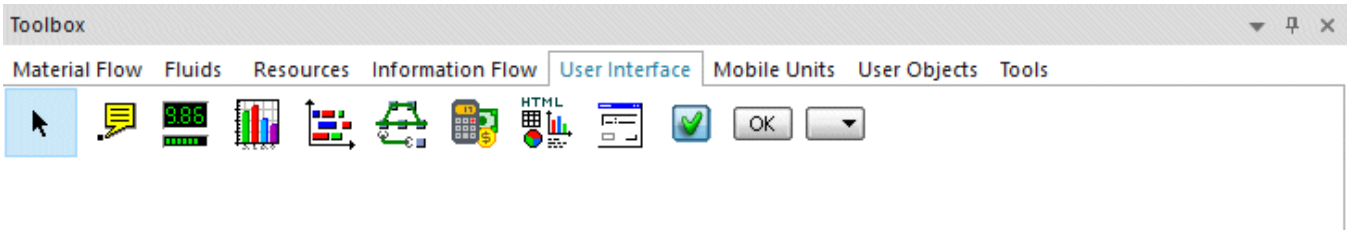
Back to Change Simulation Settings

Back to Creating Simulation Models

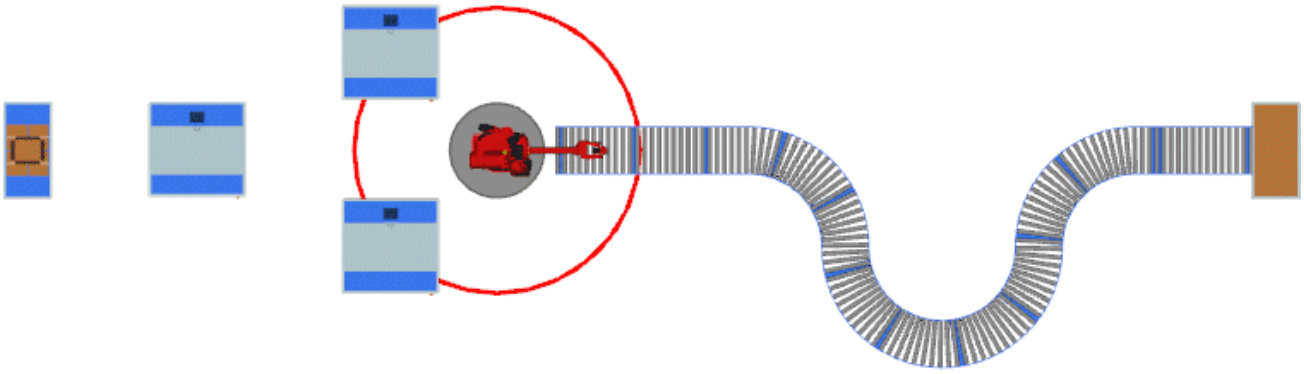
Displaying Simulation Results

Display Simulation Results

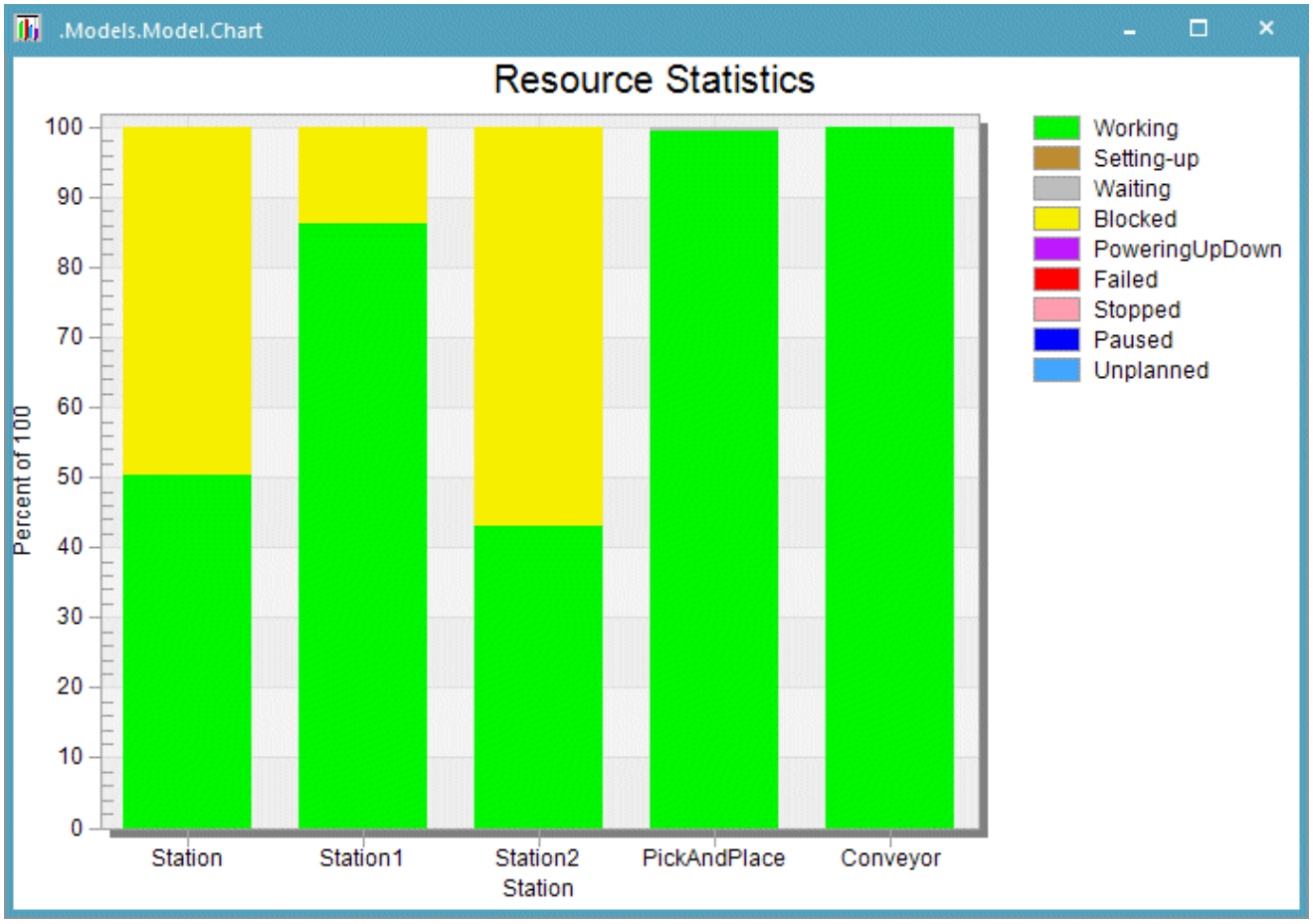
After *Plant Simulation* has executed the simulation run, we can show and analyze the simulation results. To do so, we use **Display and User Interface Objects**.



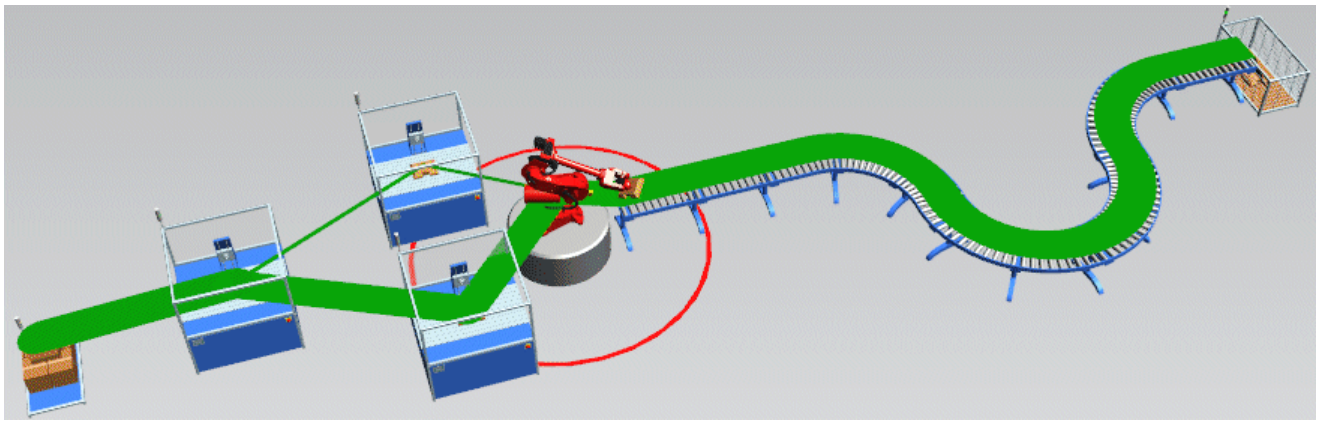
We inserted a *Chart*, a *SankeyDiagram*, and an *HtmlReport* each. We use these objects with their respective standard settings.



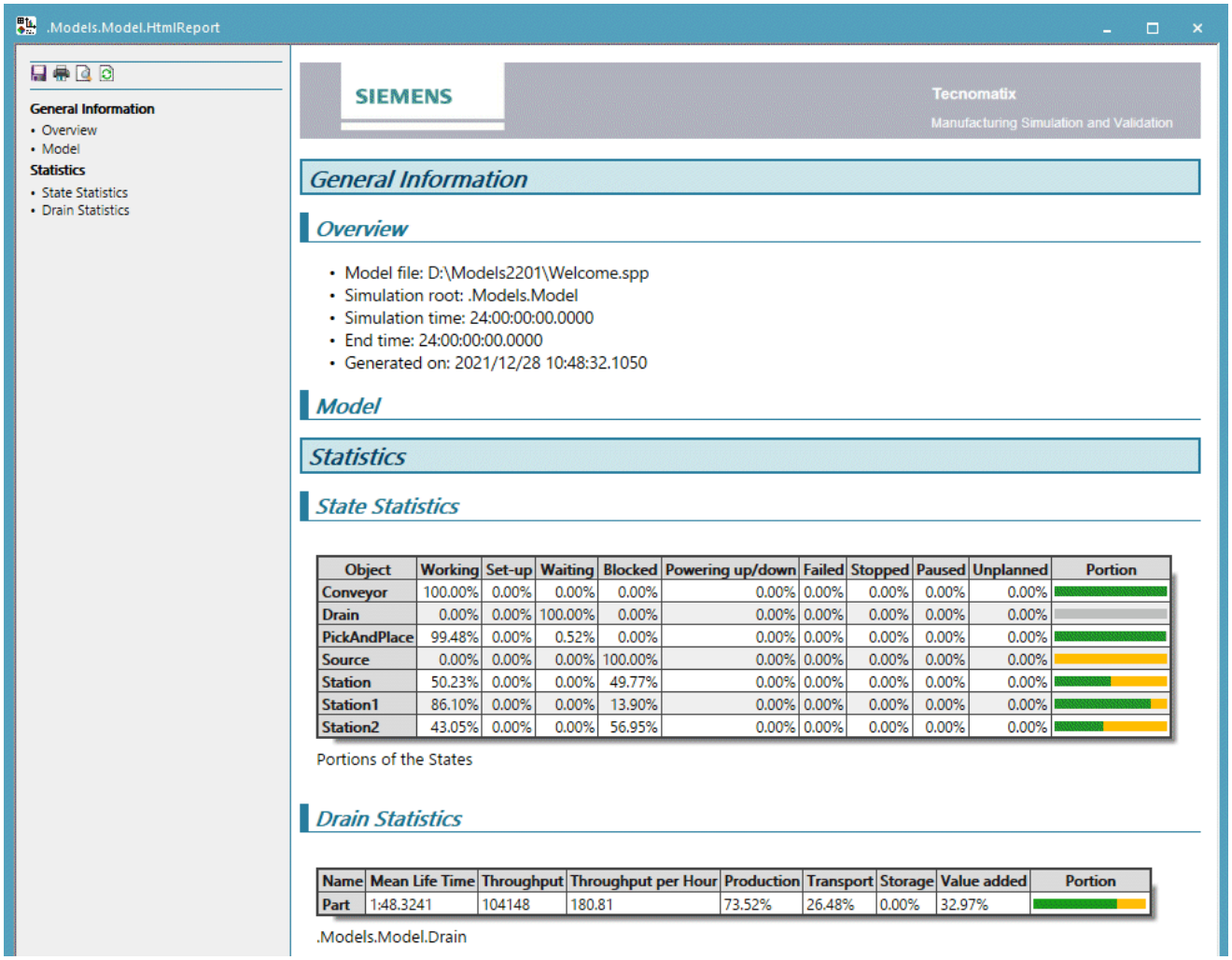
- The **Chart** shows resource statistics of the material flow objects which we selected.
  After we executed the simulation, we click the *Chart* with the right mouse button and select **Show**.
  The standard settings provide these results:



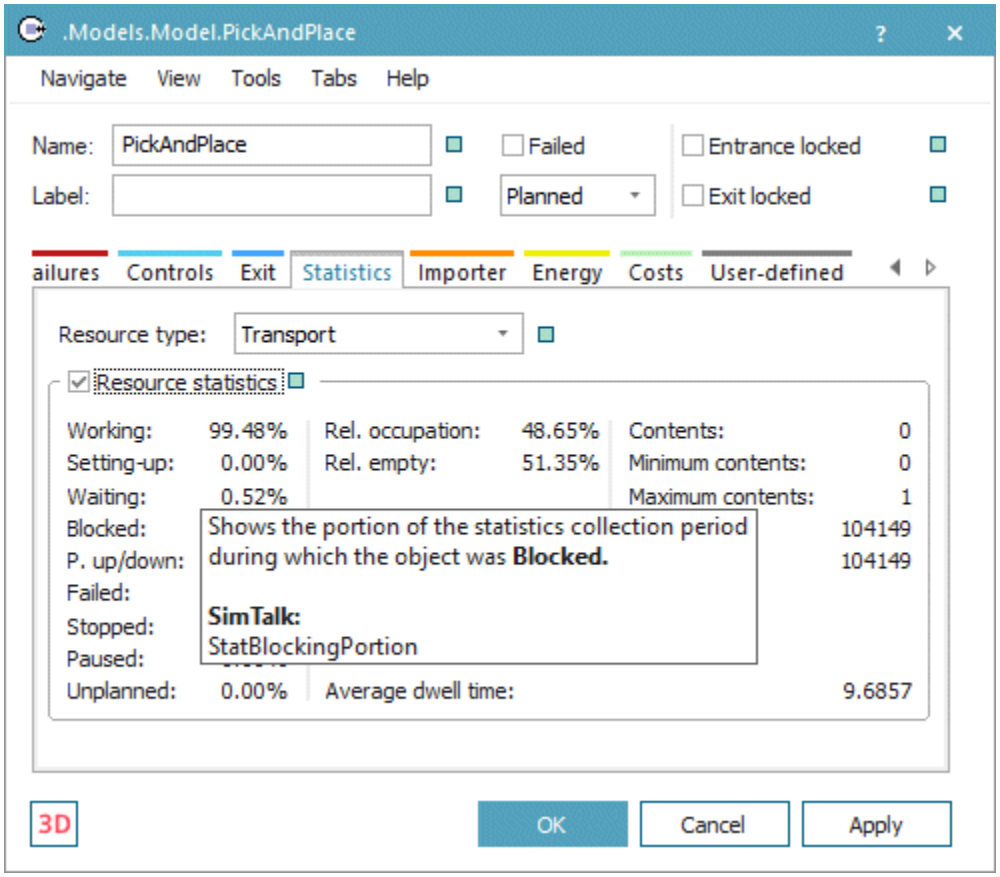
- The **SankeyDiagram** shows the flows of parts through the installation with arrows in different widths. We see that more parts take the route across *Station2* than *Station1*.



- The **HtmlReport** shows general information about the simulation model and **state statistics** and **Drain statistics** values.

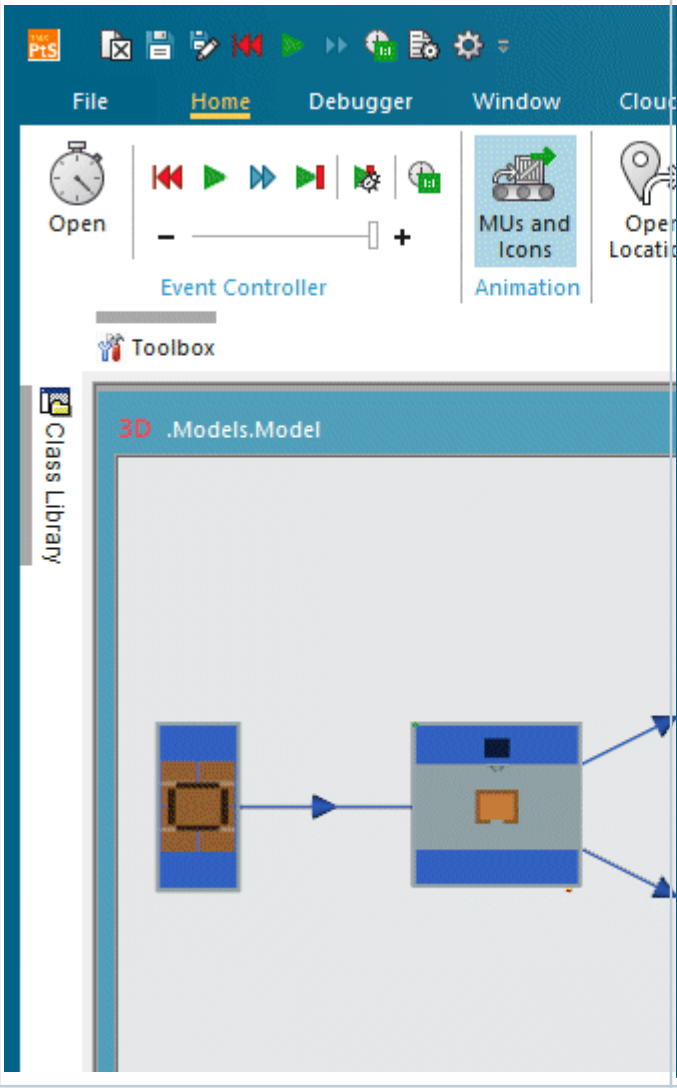
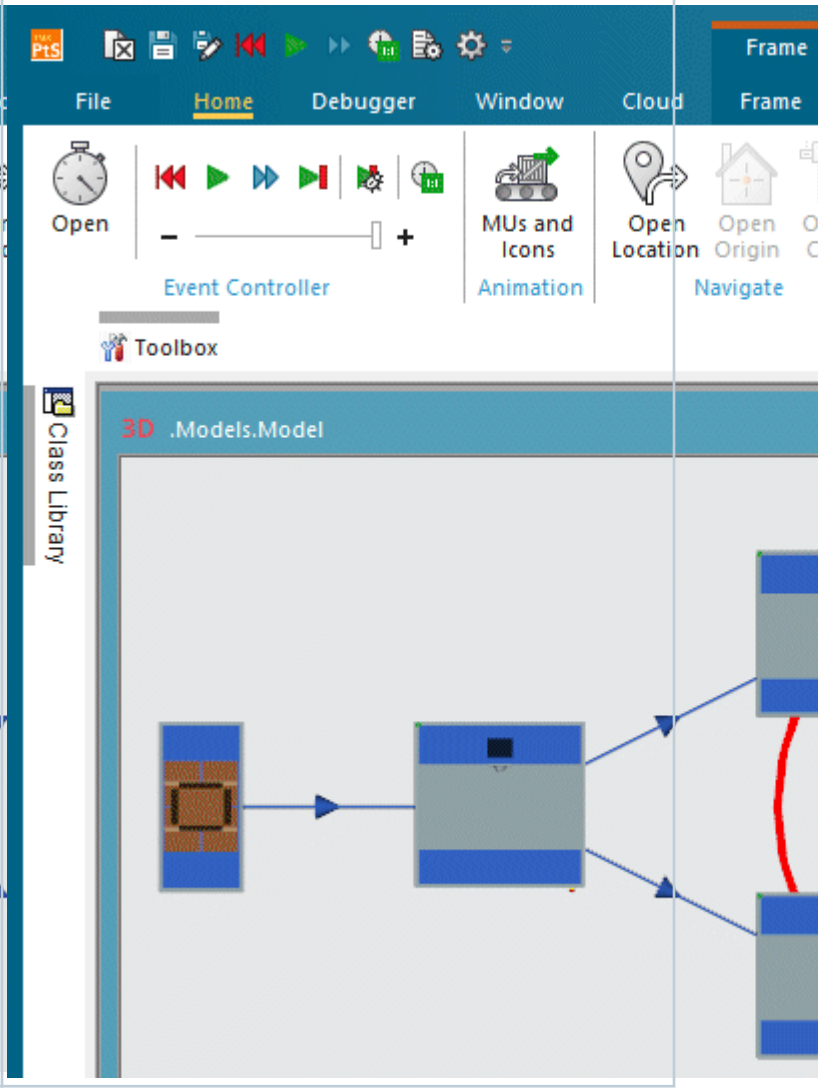


- In addition each object shows the most important values on its tab **Statistics**.
  In the dialogs of the objects you can display *What's This Help* for the individual dialog items. To do so, click the question mark on the title bar of the dialog window and then on the dialog item for which you need help. *What's This Help* shows a description of the dialog item and the name of the programming command with which you can set or query it.

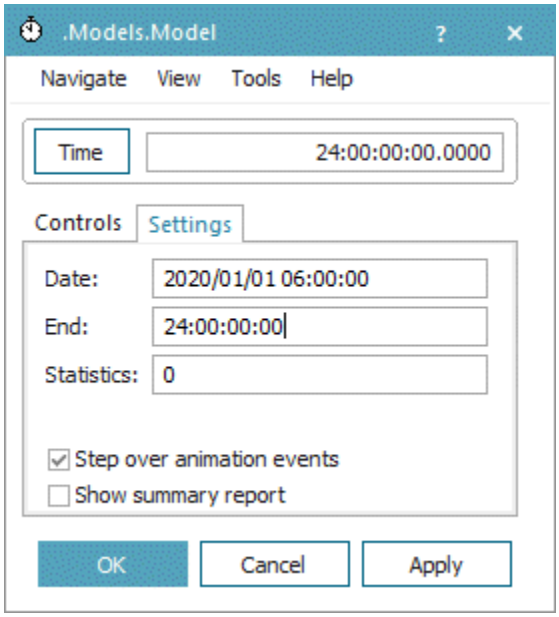


Finally we execute a simulation run with **deactivated animation**. Then *Plant Simulation* neither shows the parts nor the movement of the *Robot* during the simulation.

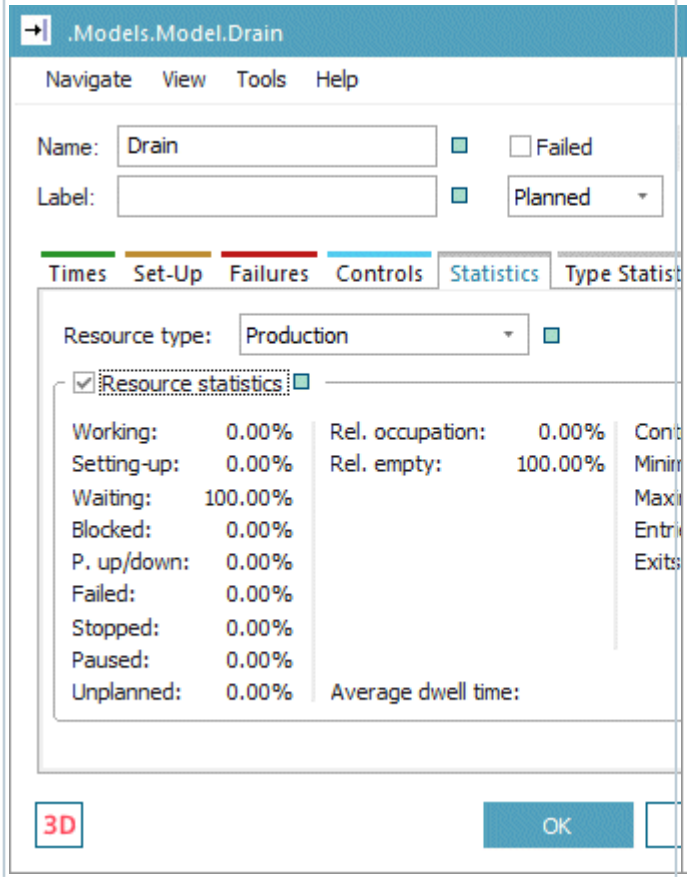
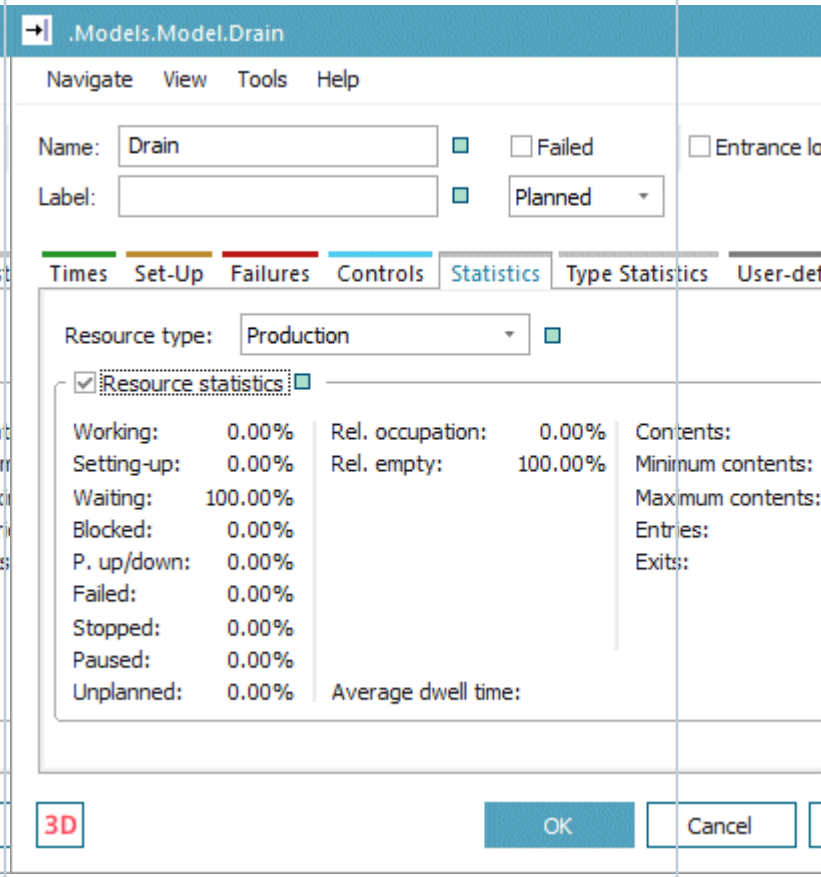
To do so, we can click **Start Fast Forward Simulation**  and watch how much faster the simulation runs without animation.

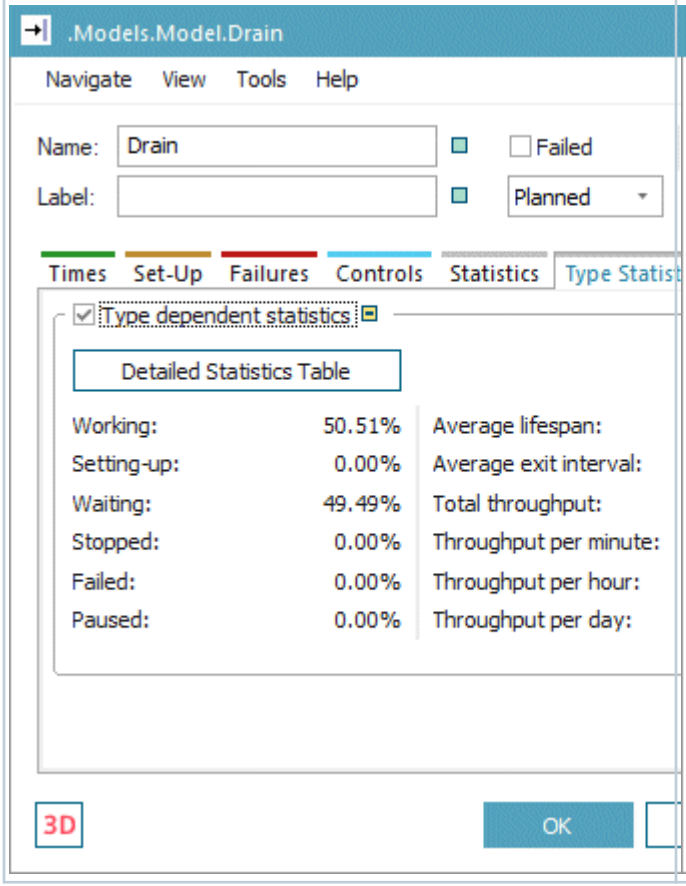
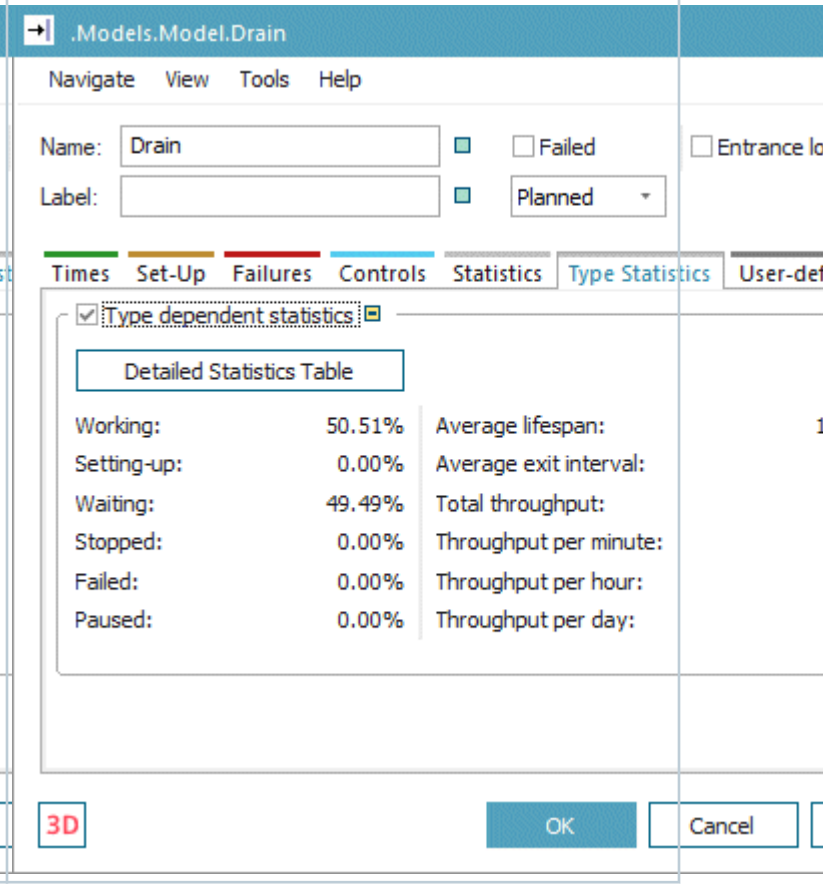
Simulation with animation	Simulation without animation
	

To better see that we only simulate for 24 hours. To do so, we type in an **end time** of 24 hours on the tab **Settings** of the *EventController*.



The results of the simulation run without animation are the same as those of a simulation run with animation. The statistics values, which the *Drain* collected, show this:

Simulation with animation	Simulation without animation
	

Simulation with animation	Simulation without animation
	

Compare these topics in the *Step-by-Step Help*:

Animate the Simulation Model in 2D and View the Results

- **Viewing and Visualizing Statistics**
  - **Viewing Statistics in the Dialogs of the Objects**
  - **Showing Statistics in a Chart**
  - **Viewing the Statistics Report**
  - **Showing Statistics and Other Values in a Report**
  - **Show Values with the Display**
  - **Showing Part Flows in a SankeyDiagram**
  - **Showing Parts on Resources in a GanttChart**

Back to Simulation and Animation

Back to Creating Simulation Models

Back to Plant Simulation for Beginners

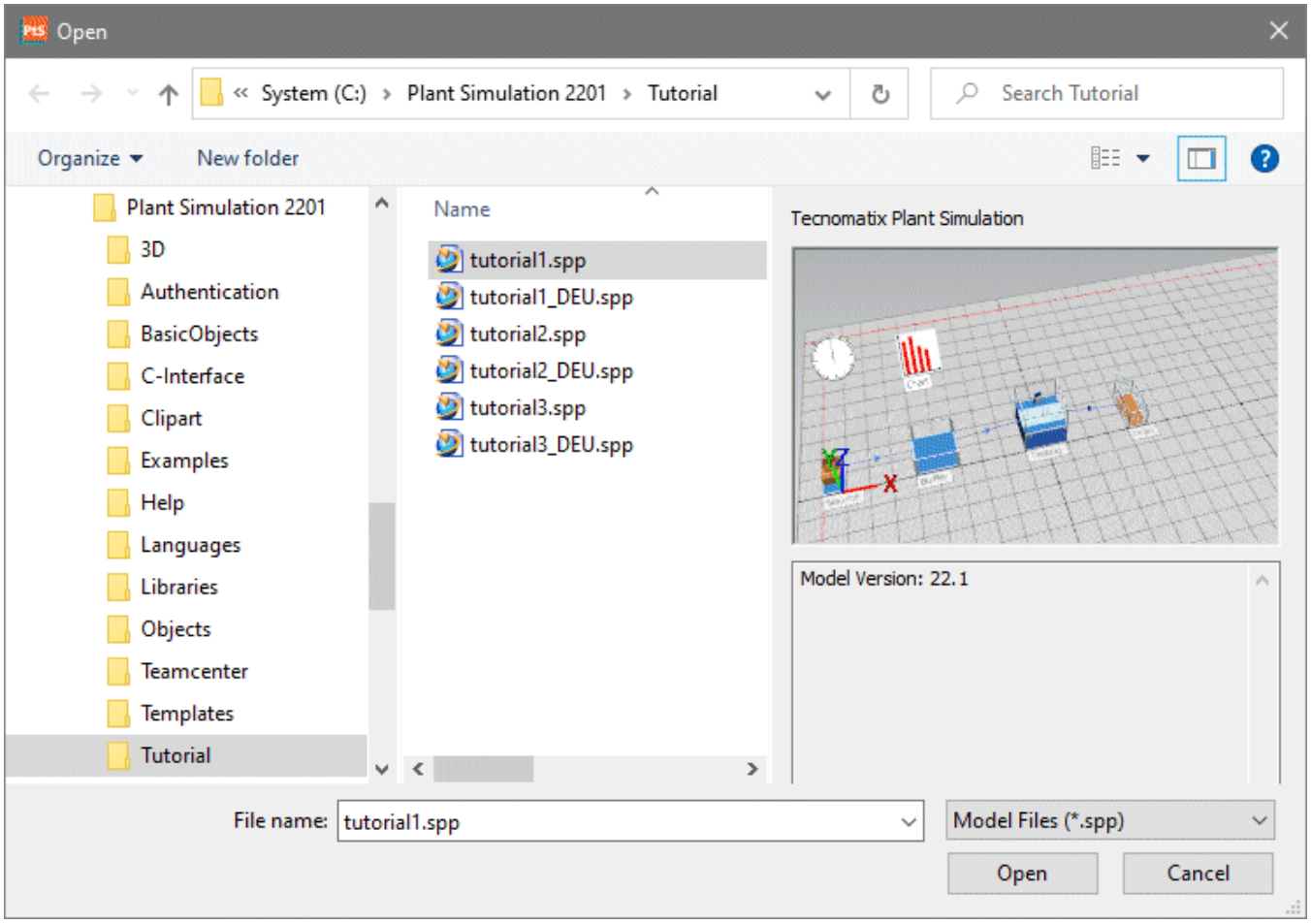
Working Through the Tutorial

Work Through the Tutorial

The built-in tutorial introduces you to modeling in *Plant Simulation*. It is short and yet comprehensive enough to get you started with creating and executing simulation models in *Plant Simulation*. If you have not already done so, we recommend that you familiarize yourself with the *Plant Simulation* user interface, with the **Ribbon Bar**, and with the objects in the **Class Library** and the **Toolbox**.

In our tutorial model we create a testing line for monitors and for game consoles. We will first create a testing station before adding two stations to the main line. Monitors and game consoles will enter the processing line, will be put into containers, moved across a line to a pre-testing station, then to the main testing station, before being packed and shipped.

Creating the entire model is quick and easy. You can, however, save your models and return to them at a later point in time. The respective model files are located in the **Plant Simulation installation folder** > **Plant Simulation** > **Tutorial**, compare the example below.



Go to Tutorial Part 1

Go to Tutorial Part 2

Go to Tutorial Part 3

Back to Introducing Plant Simulation

Tutorial Part 1

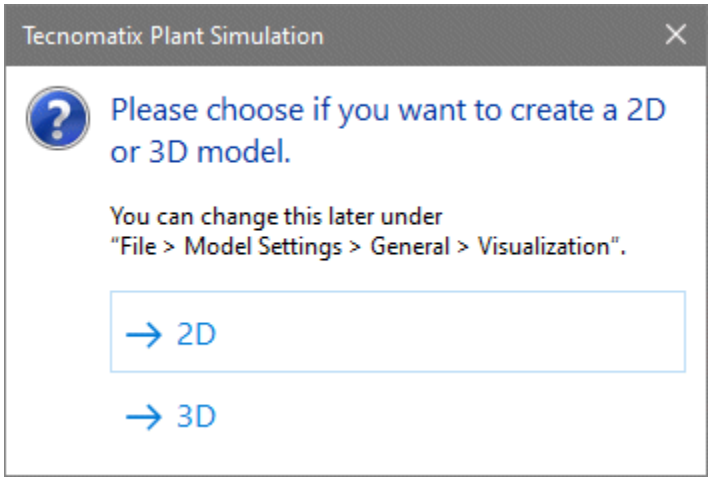
Tutorial Part 1

In part 1 of our tutorial we will create a folder for our simulation model, name it *TestingLine*, and build a basic test station for the production line.

Proceed as follows to create a new *Folder* and a new *Frame*.

- Click **Create New Model** on the **Start Page** to create a new model.

- Click **3D** in the dialog, which *Plant Simulation* shows, to create the simulation model in 3D.



- Click the object **Basis** at the very top in the *Class Library* with the right mouse button and select **New** > **Folder**.

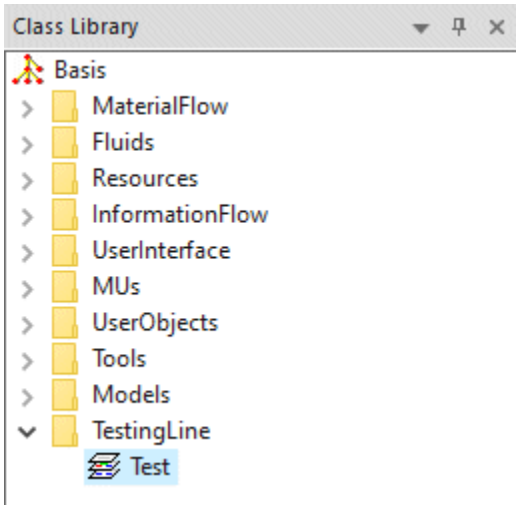
- Click the new folder with the right mouse button, select **Rename**, and rename it to `TestingLine`.
  We now created the folder in which we store our simulation models.

Next, we will create a new *Frame*. The **Frame** is the container in which we build our simulation models.

- Click the folder *TestingLine* in the *Class Library* with the right mouse button and select **New** > **Model Frame**.
  This creates a *Frame* that does not show its contents towards the outside and that contains an *EventController* for running simulations.

- Click the *Frame* with the right mouse button, select **Rename**, and rename it to `Test`.

- Double-click the *Frame* named *Test* to open it.
  Now we have created our first *Frame*, named *Test*, for the testing line for the monitors and the game consoles. We can insert the stations that we need.

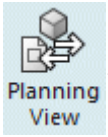


Go to Tutorial Part 2

Go to Tutorial Part 3

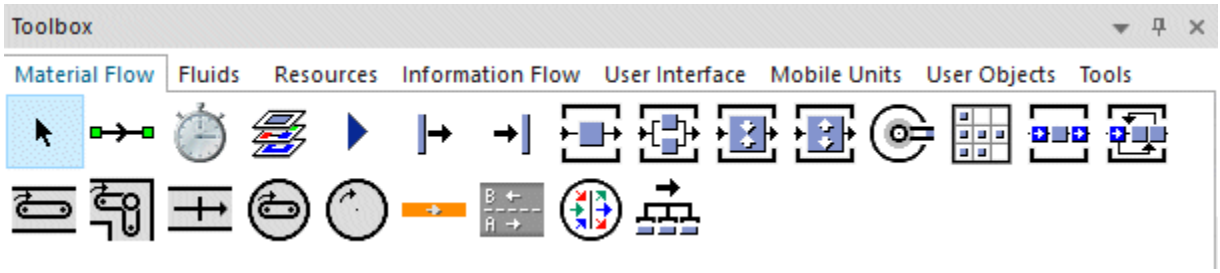
Model the Receiving Department with the Source

The first object that we'll insert into our simulation model is the **Source**. It produces the parts, in our case the monitors and game consoles, which will be moving through the production system. The *Source* might, for example, represent the machines that produce the parts in the plant or the receiving department of the plant.

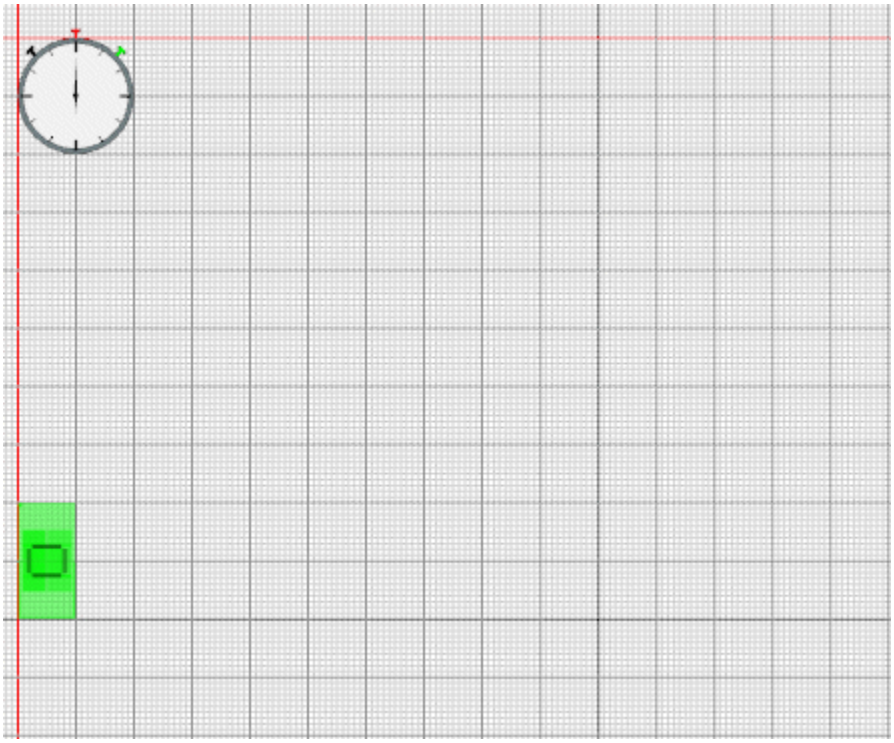
- Double-click the *Frame* named *Test* to open it.
  As it is easier to insert the objects in top view, i.e., in two dimensions instead of in three, change to the tab **View** and click **Planning View** 

.

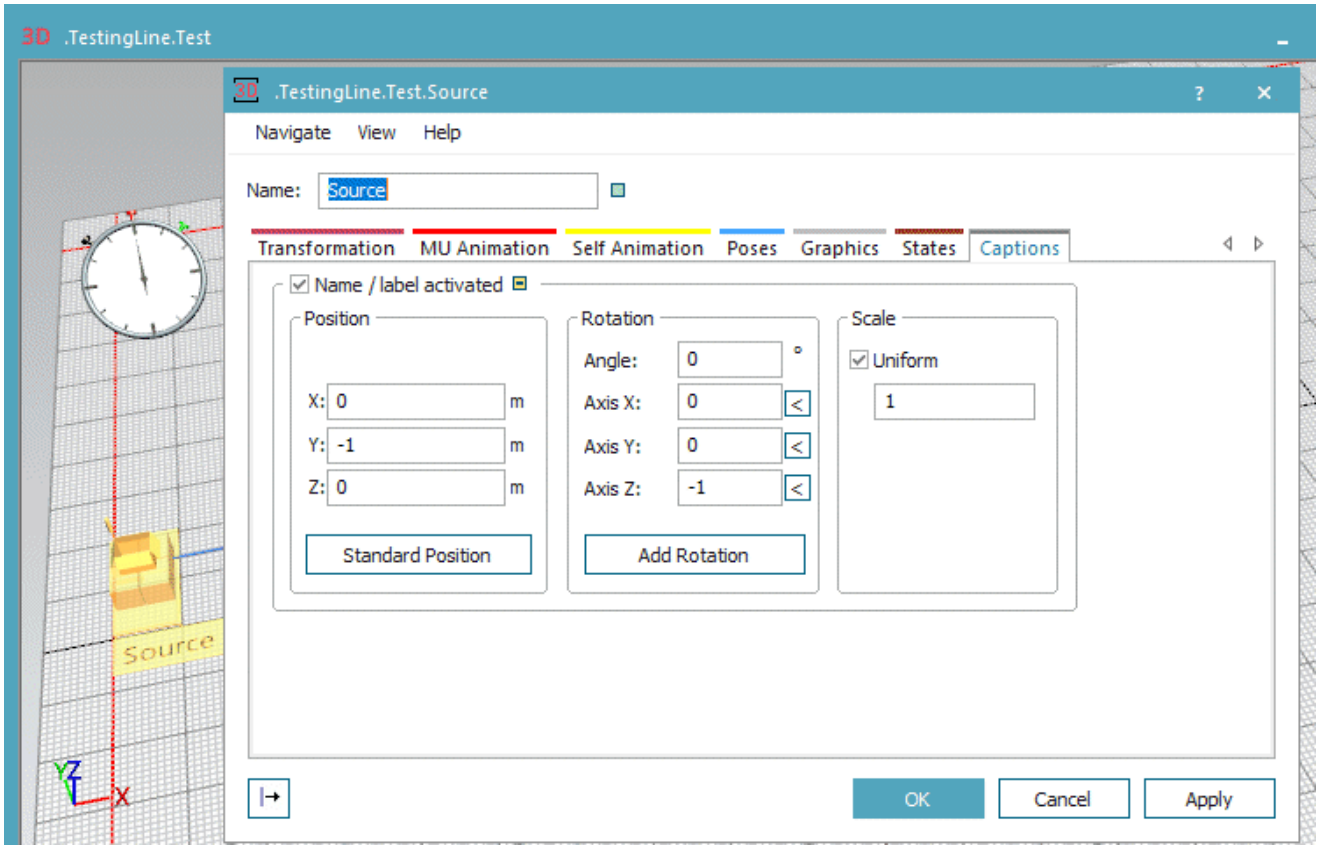
- Click the *Source*  on the tab **Material Flow** in the *Toolbox*.



- Move the mouse over the *Frame* and click the left mouse button on the left side of the *Frame* to insert it. You can zoom the contents of the *Frame* by rolling the mouse wheel.



By default *Plant Simulation* does not show the names of the objects. Sometimes this is helpful while modeling though. Click the object with the left mouse button and press the **spacebar**. Click the tab **Captions** and activate **Name/Label enabled**.



You have to repeat this for each object whose name you would like to show.

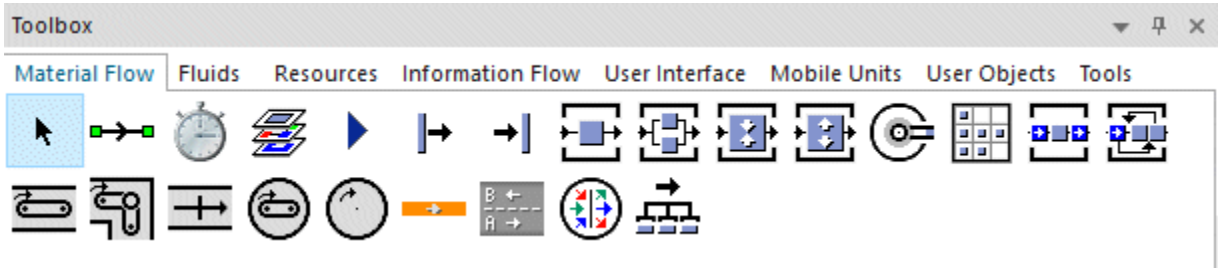
To hide displayed object names in the 3D window again, click **Show Object Names** 

on the **View** ribbon tab.

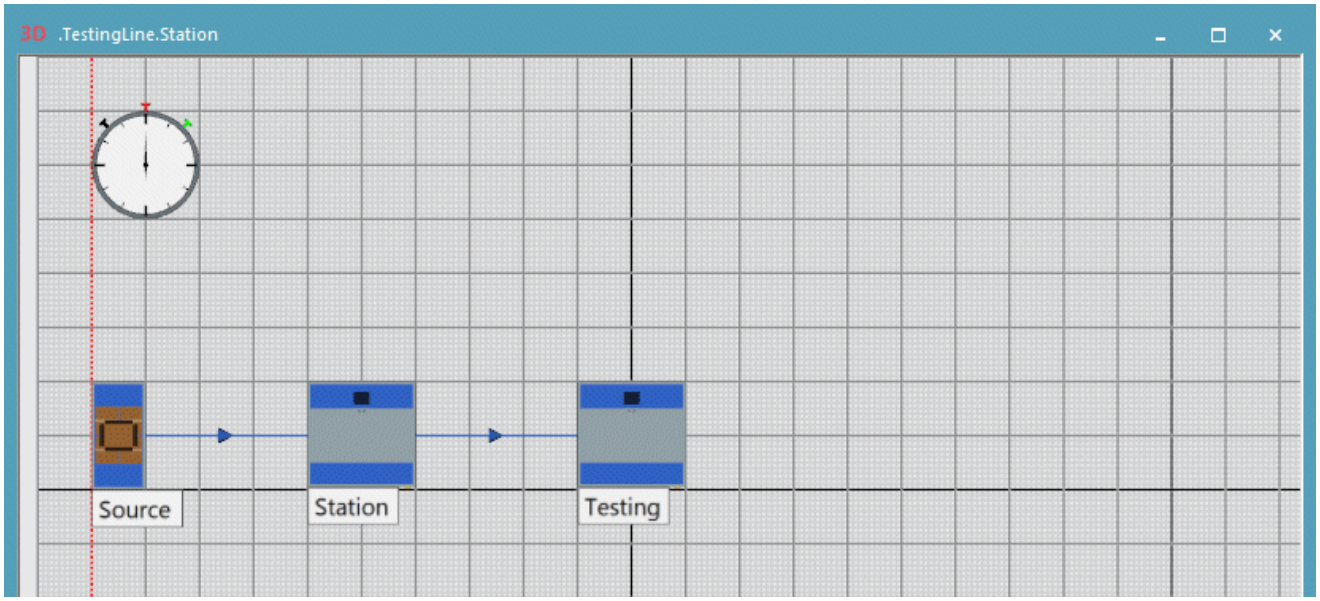
Model the Processing Stations with the Station

Next, we will insert two objects of type **Station**. The *Station* is a generic object which represents any station or machine on which parts spend a certain amount of time to be processed.

- Click the *Station*  on the tab **Material Flow** in the *Toolbox*.



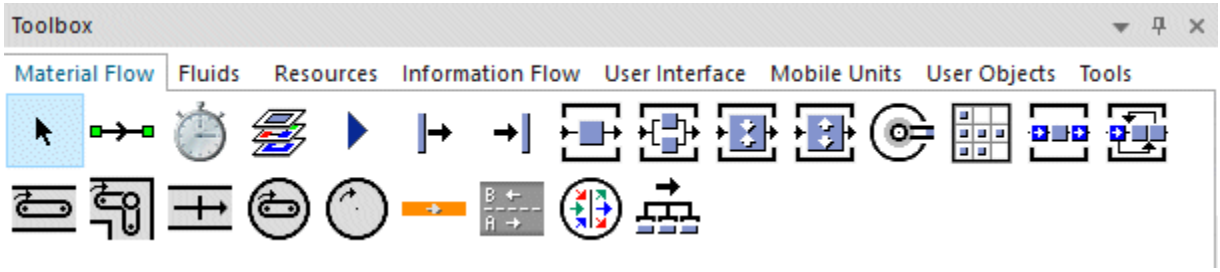
- Move the mouse over the *Frame* named *Test*.
- Hold down **Ctrl** and insert one *Station* to the right of the *Source* and a second one to the right of the first *Station*.
- Click the second *Station* with the right mouse button and rename it to `Testing`.



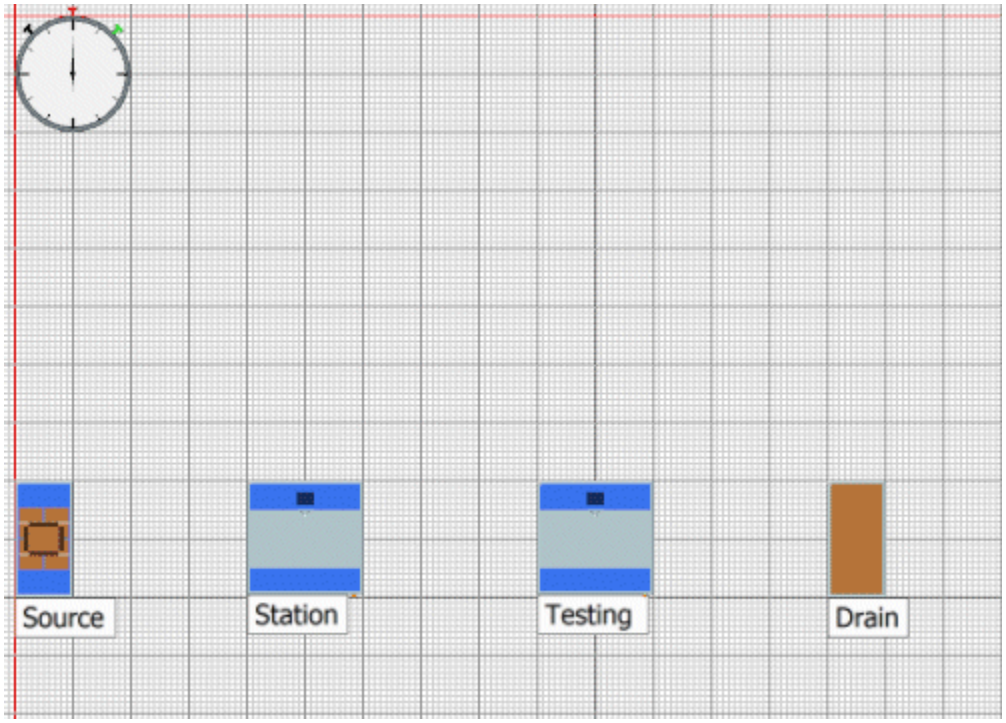
Model the Shipping Department with the Drain

The last object we need is an object of type **Drain**. The *Drain* removes the parts from our plant. It might, for example, represent the shipping department of our plant.

- Click the *Drain*  on the tab **Material Flow** in the *Toolbox*.



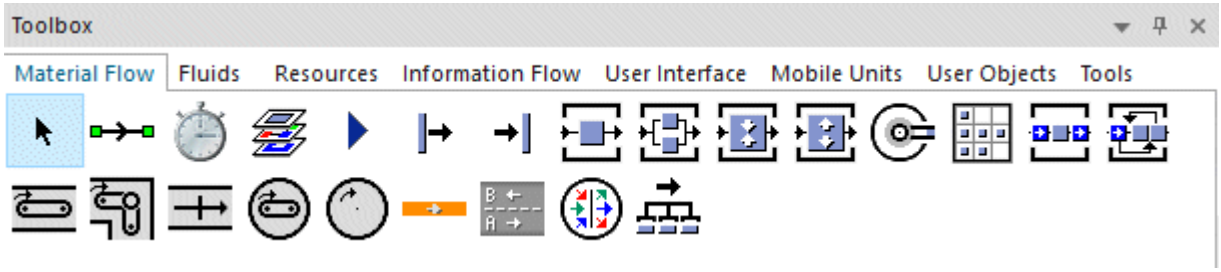
- Insert it to the right of the *Station* named *Testing*.



Connect the Material Flow Objects with Connectors

Now that we have inserted the objects we need for our first project, we have to connect them with the **Connector**. The *Connectors* determine how the parts move through our plant. The parts move through the plant in the sequence in which you connect the objects.

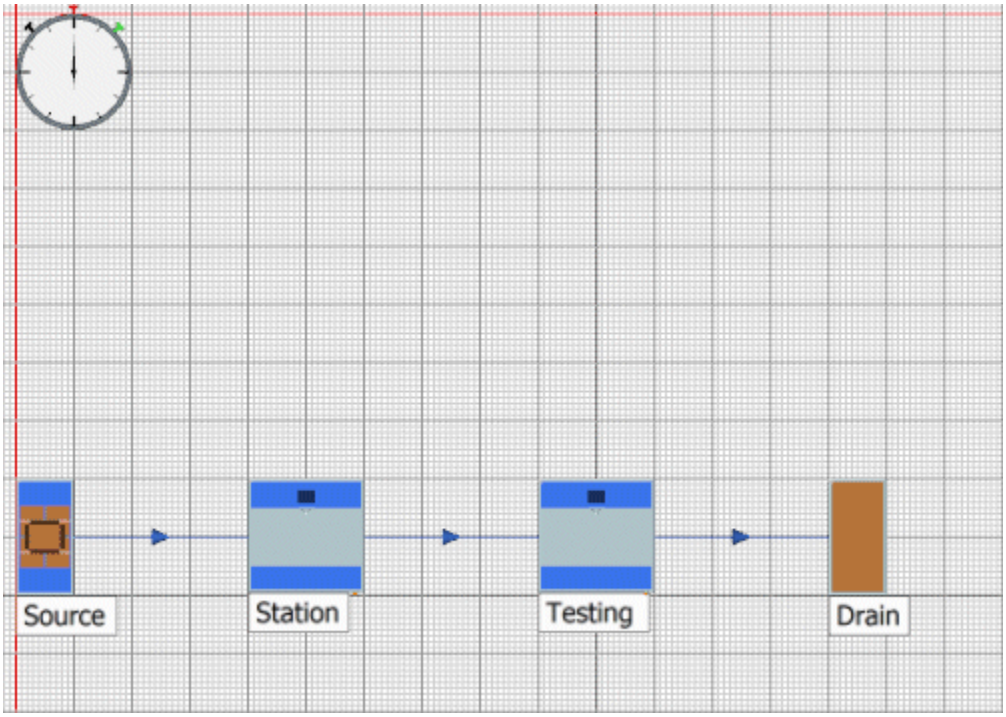
- Select the *Connector*  on the tab **Material Flow** in the *Toolbox* to activate connect mode.



- Click the *Source* with the left mouse button. It is the starting point of the connection.
- Next, move the mouse over the icon of the first *Station*, the first target object, and left click to connect the two objects.
- Repeat this for all objects within the *Frame* named *Test*.

Note:

To connect several objects one after the other, hold down **Ctrl** before you click on the *Connector* in the *Toolbox*.



We can now test the model by running a simulation with the *EventController*.

Run the Simulation with the Event Controller

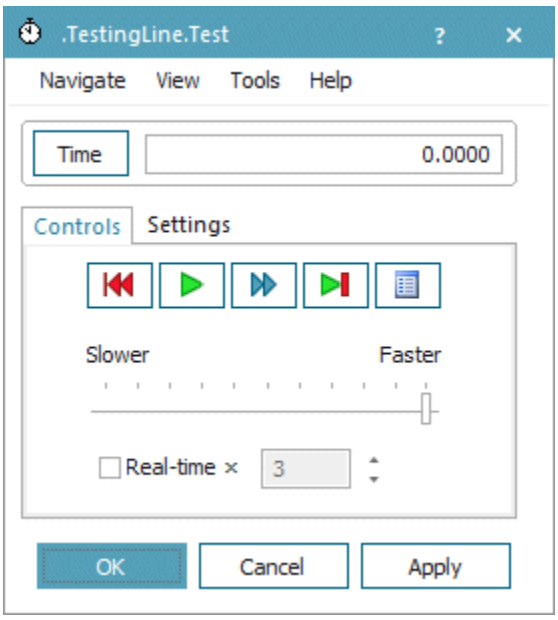
You can start, stop and reset the simulation with the **EventController**. You can also control the speed of the simulation.

Double-click the icon of the *EventController*  to open its dialog window.

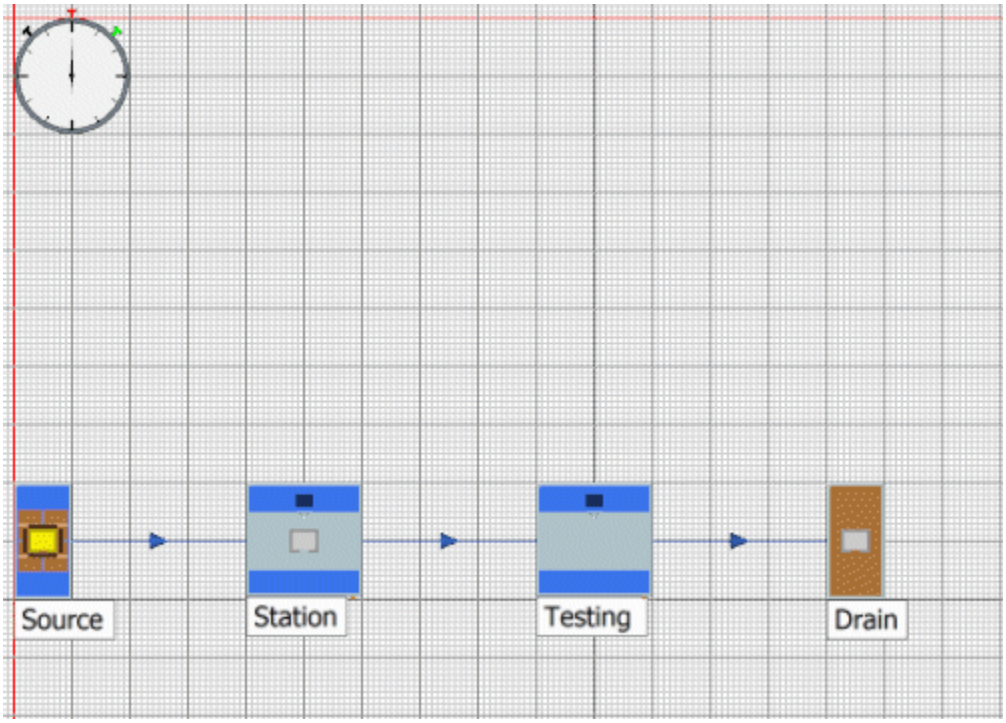
- Click **Start/Stop Simulation**  to run the simulation.
  You will notice that the *Source* produces the parts, that they are then moved on to the *Stations*, are tested in the *Station* named *Testing*, and exit the plant via the *Drain*. If you reduce the **simulation speed** a bit, by dragging the **Faster/Slower** slider to the left, you can see this better.

Note:

We recommend to always activate **Real time** in the *EventController* in your 3D model as the simulation runs faster in principle in a**3D Only** model as *Plant Simulation* does not have to compute the animation events for 2D.

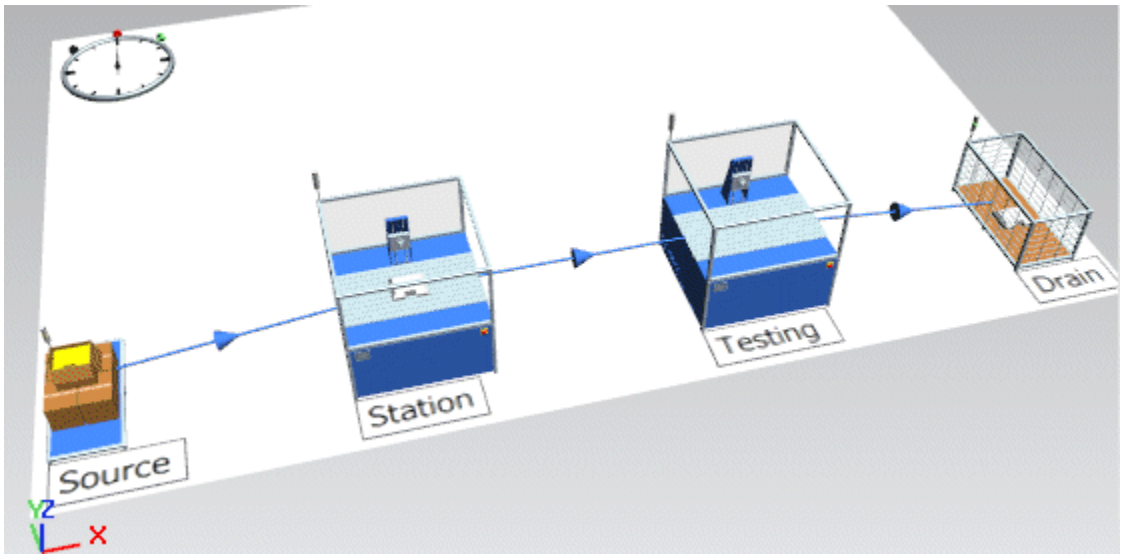


- Click the buttons **Start Simulation** and **Reset Simulation** to stop the simulation and to reset your simulation model.



As we have finished modeling the first part of the tutorial, we can deactivate **Planning View** and the **Grid** on the **View** tab of the ribbon bar and thus display the model in three-dimensional space.

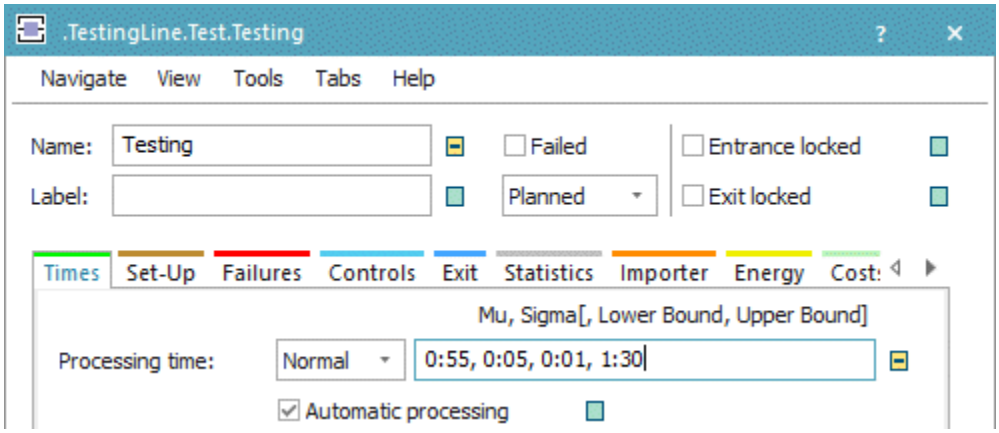
You can **move the scene with the mouse** and zoom it with the mouse wheel.



Select Distributions for Processing and Production Times

We will now change the **processing time** of the *Station Testing* from the default time of **1** minute to a **probability distribution**, let's say the **Normal distribution**. This way the processing time for each part will be based on a random number according to the **Normal distribution**.

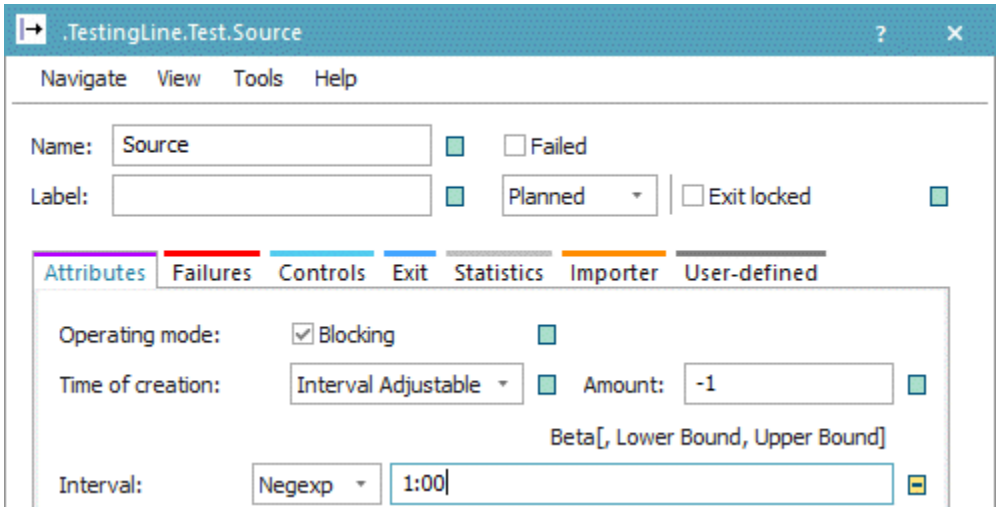
- Open the dialog window of the *Station Testing* and click the tab **Times**.
- Select the **Normal distribution** from the drop-down list **Processing time**.
- Type in `0:55`, `0:05`, `0:01`, `1:30` as the **Processing time**.



Plant Simulation shows the **parameters**, which this distribution requires, above the text box.
In *Plant Simulation* we separate seconds from minutes with a colon (:). So `1:30` stands for 1 minute and 30 seconds, compare **Enter Times**.
The **processing time** for the station named *Testing* now follows the **Normal distribution** with a **mean value** of `55` seconds and a **standard deviation** of `5` seconds.

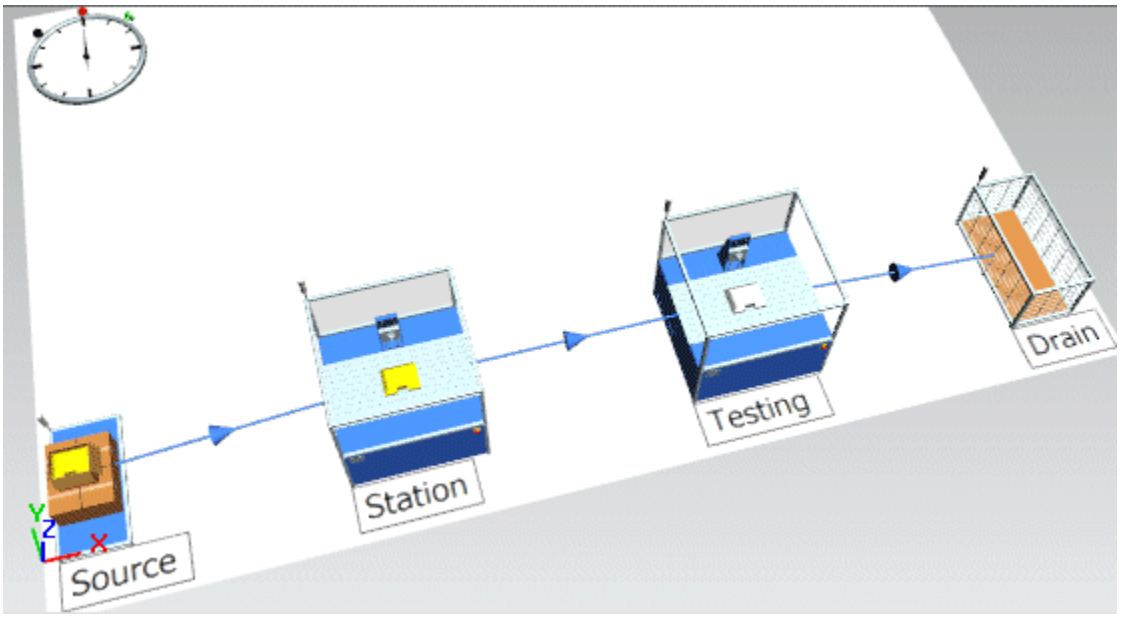
Next, we'll select a distribution in the *Source* according to which it produces the parts.

- Open the dialog window of the *Source*.
- Change the **Interval** to the **Negexp distribution** on the tab **Attributes**.
- Type in a distribution time of `1:00` minute.



To allow us to see if the parts and stations are blocked during the simulation, we select **File > Model Settings > 3D** and activate **Show states as colors if no state graphics are present**.

Run the simulation again. You will notice that the parts now sometimes are yellow. This means that the parts are **blocked**, i.e., they cannot move on to the following target station because it is still occupied by the preceding part.



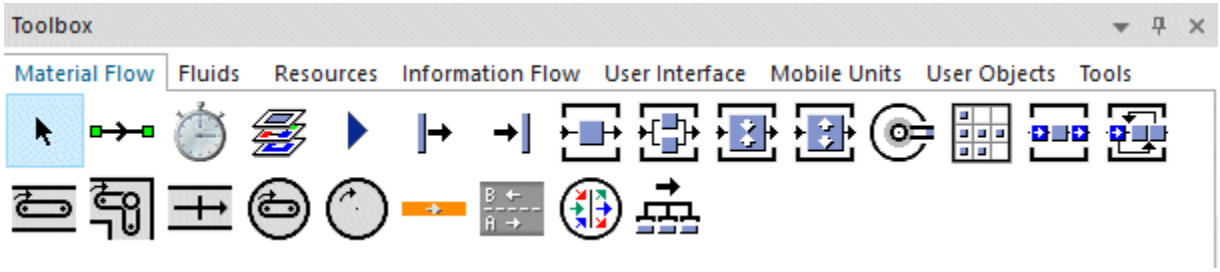
This is an issue we need to solve.

Buffering Parts to Prevent the Material Flow Slowing Down

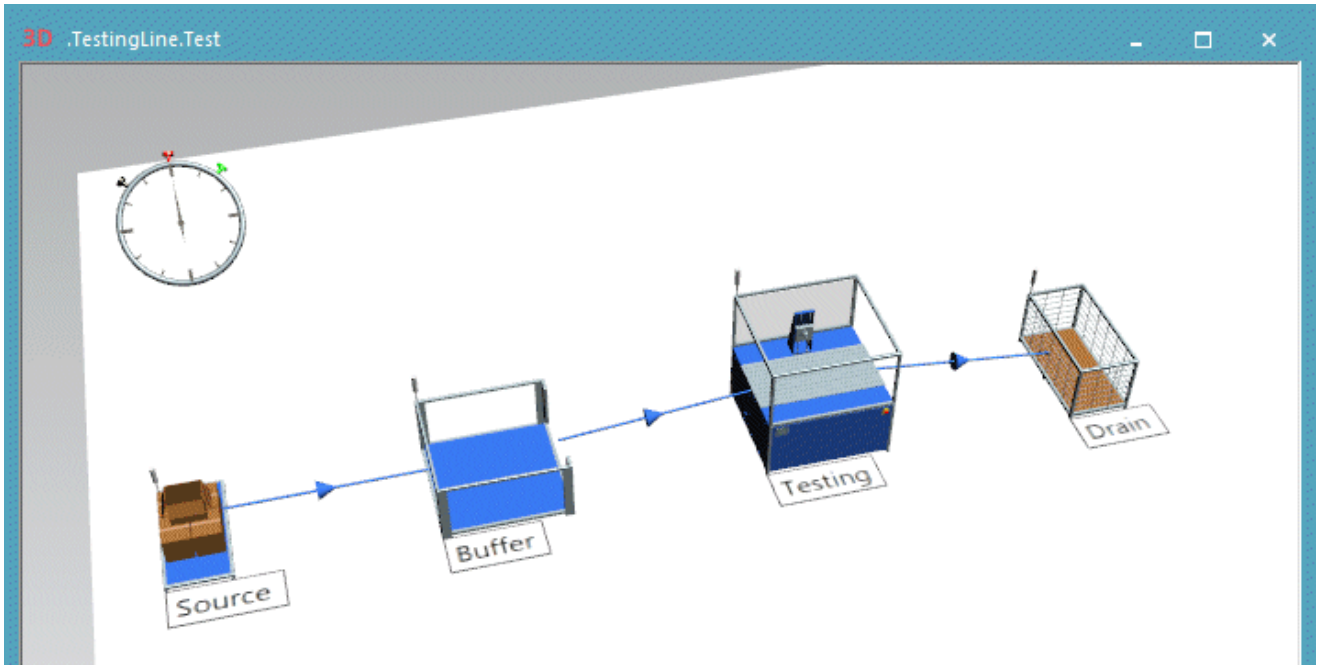
As we have created a potential bottleneck within the model, we will insert a **Buffer** between the *Source* and the station named *Testing* to prevent the material flow from grinding to a halt. The Buffer stores parts if the following components or machines fail.

- Delete the first *Station*  .

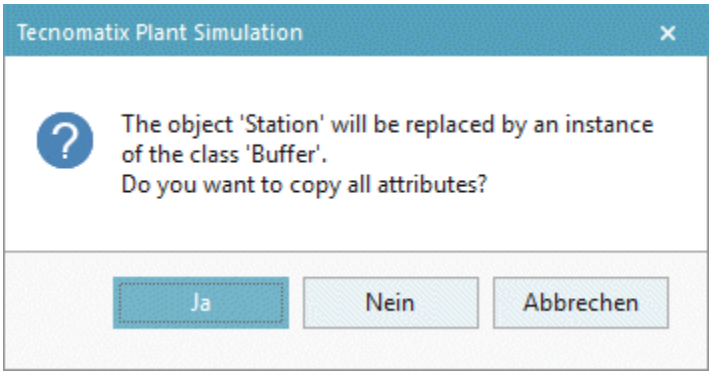
- Select the object *Buffer*  on the tab **Material Flow** in the *Toolbox* and replace the *Station* with the *Buffer*.



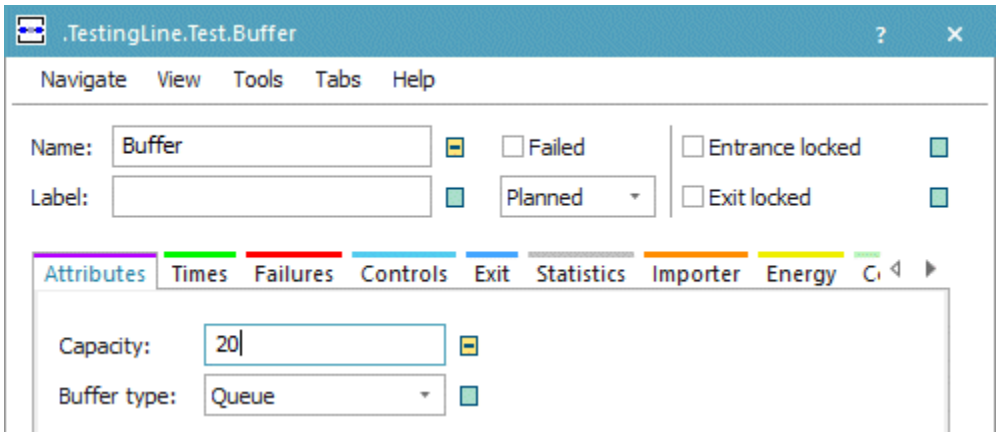
- Connect the *Source* with the *Buffer* and the *Buffer* with the station named *Testing*. The new sequence of stations now is *Source* - *Buffer* - *Testing*.



Instead, you an also hold down the **Alt** key, select the *Buffer* drag it over the *Station* in the *Frame* and drop it there. When you proceed like this, the *Connectors* are retained, meaning you do not have to reconnect the objects. Click **No** in the dialog that will be opened.

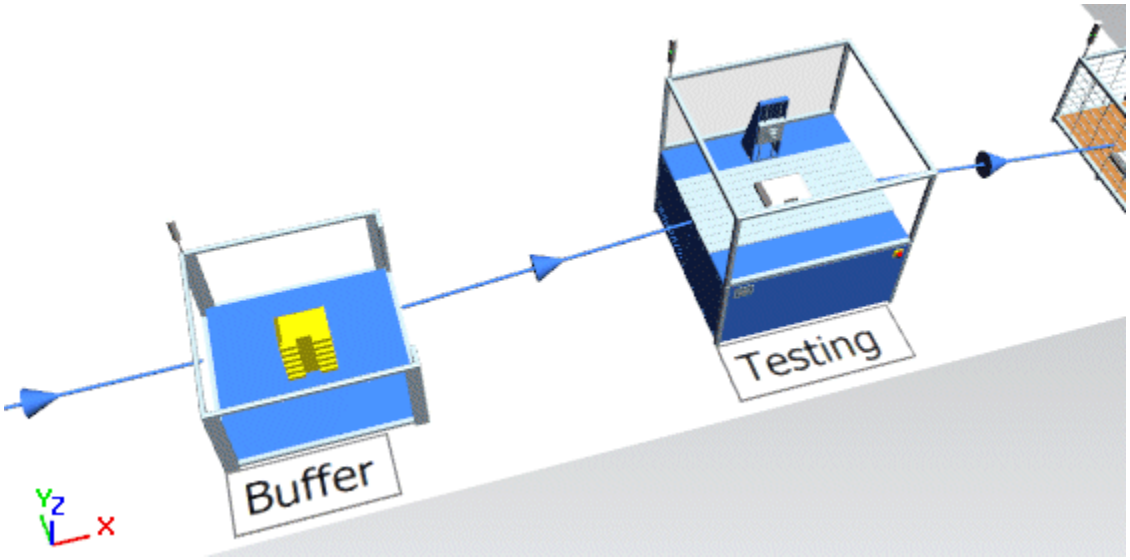


- Open the dialog window of the *Buffer* and change to the tab **Attributes**. Change the **Capacity** from **8** to `20`.



- **Apply** the changes and close the dialog window.

When you now run the simulation, you will notice that the *Buffer* holds more than one part. Rather than being blocked immediately, it accumulates parts to a maximum of 20 parts. Once it reaches the capacity of **20**, it will not allow any more parts to enter until a part has moved on to the station named *Testing*.

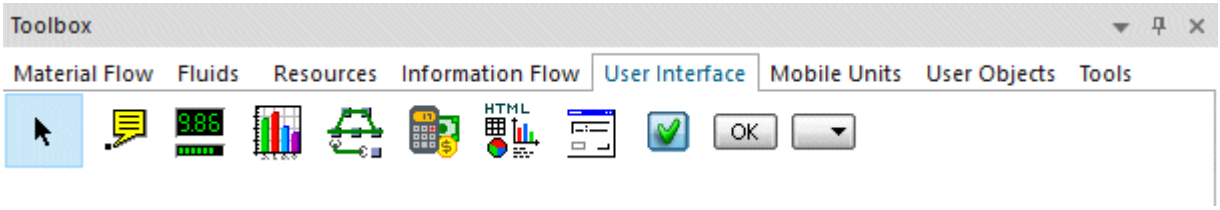


Buffering parts within the production line shows how you can use the *Buffer*.

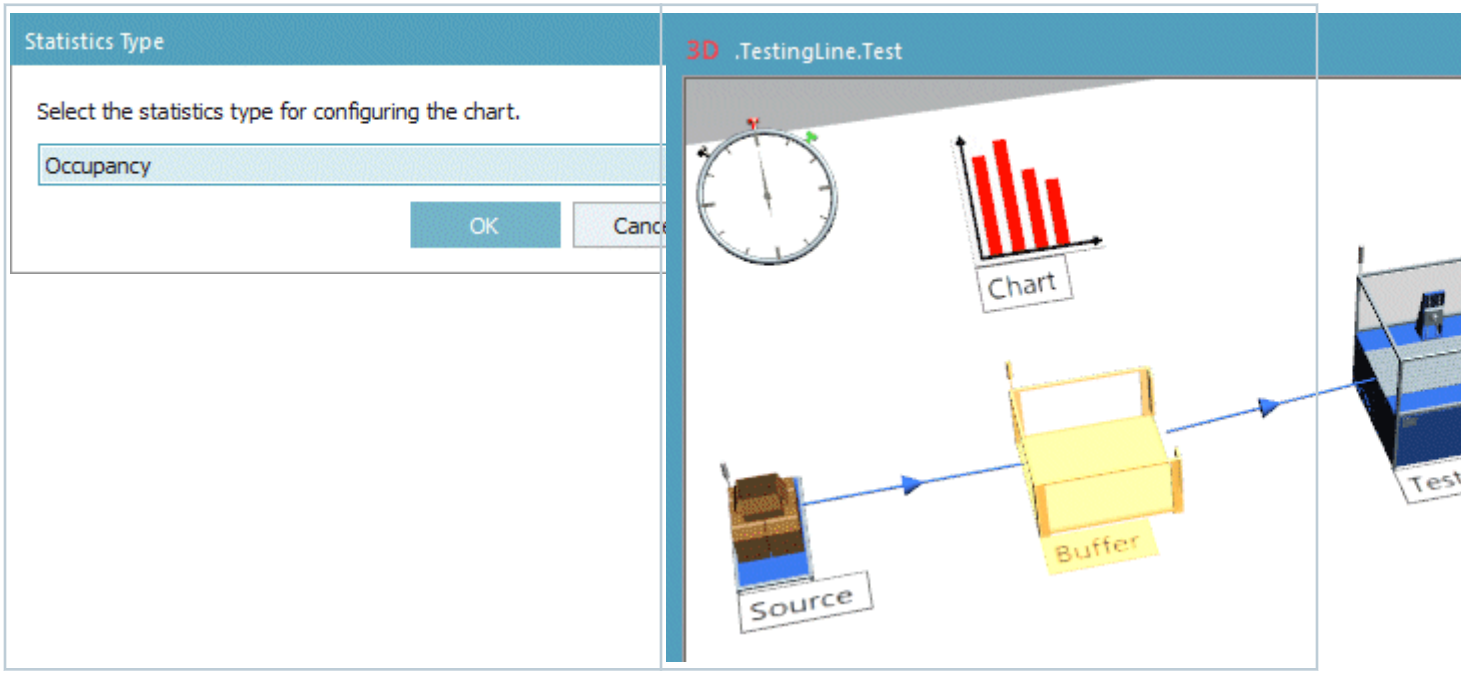
Show the Number of Parts in the Buffer with the Chart

We will now insert a **Chart** into the model to view the number of parts that are located in the *Buffer* during the simulation run.

- Click the object *Chart*  on the tab **User Interface** in the *Toolbox*.

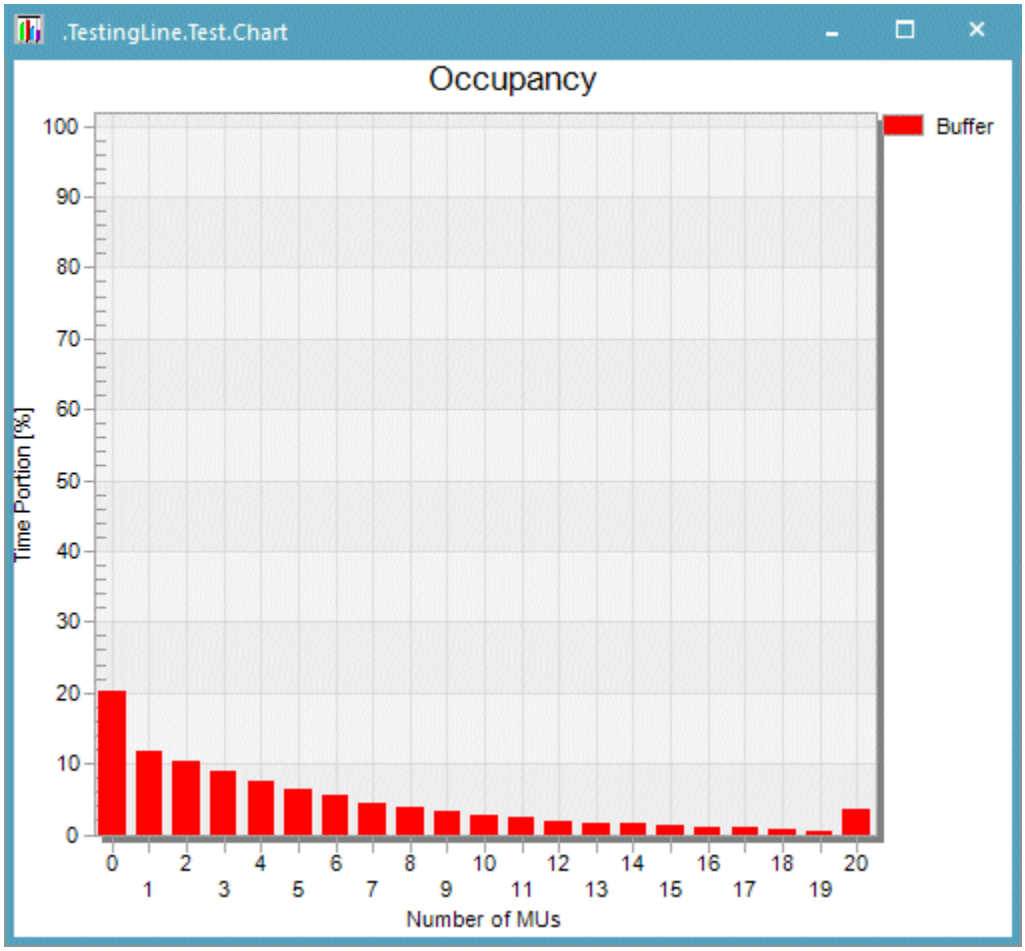


- Insert the *Chart* above the *Buffer*.
- Drag the *Buffer* onto the *Chart* and drop it. Make sure that **Occupancy** is selected in the dialog **Statistics Type**. Click **OK**.



- The *Chart* window opens as a **histogram**.
- Click **Reset Simulation** and **Start/Stop Simulation** in the *EventController* to reset the simulation model and to start the simulation.
- Save your simulation model.

The **histogram** shows how many parts were located in the *Buffer* during which percentage of the time.



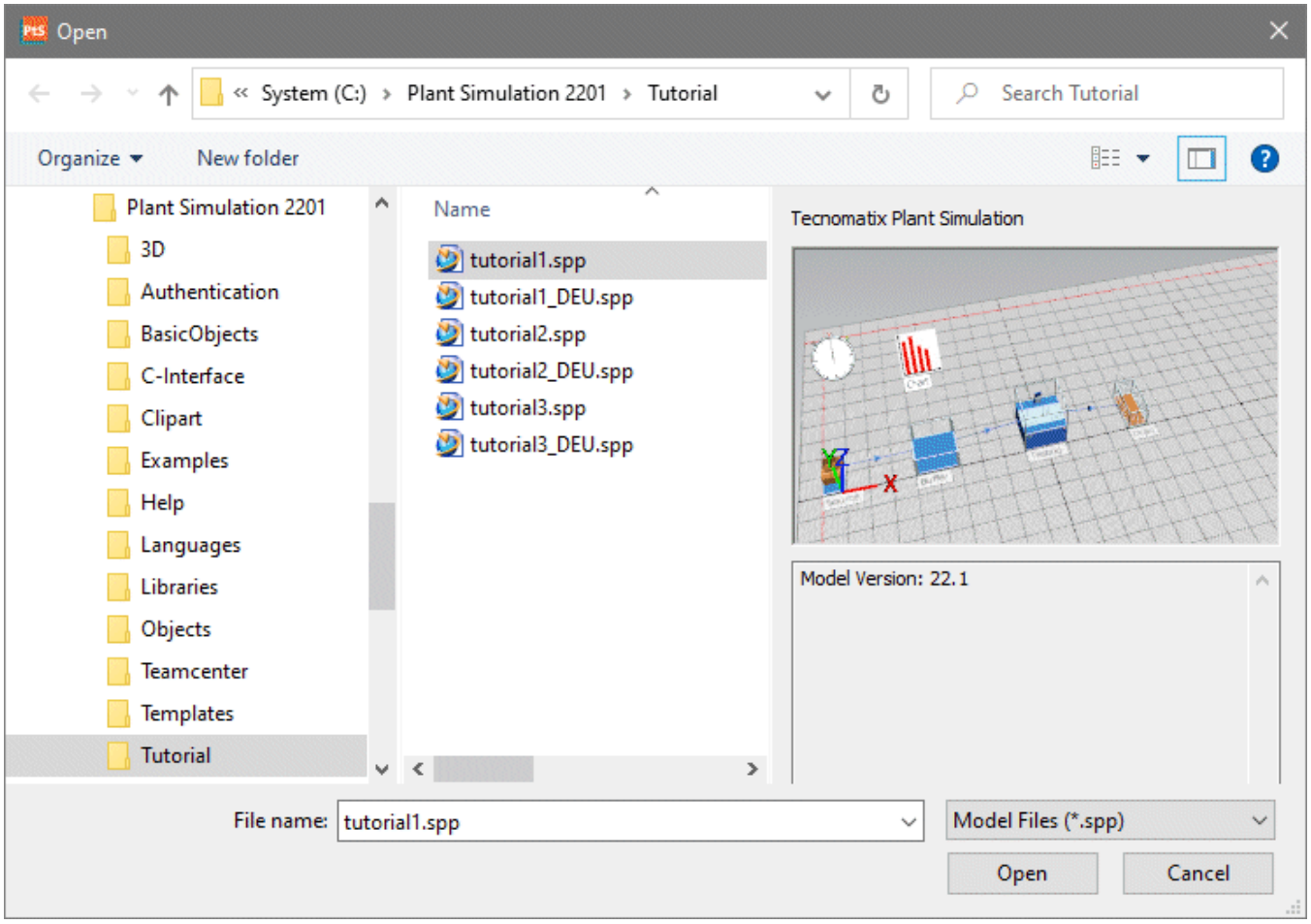
If you closed the display window of the *Chart*, click it with the right mouse button, and select **Show** on the context menu.

Showing statistics in a chart shows how you can use the *Chart*.

Tutorial Part 2

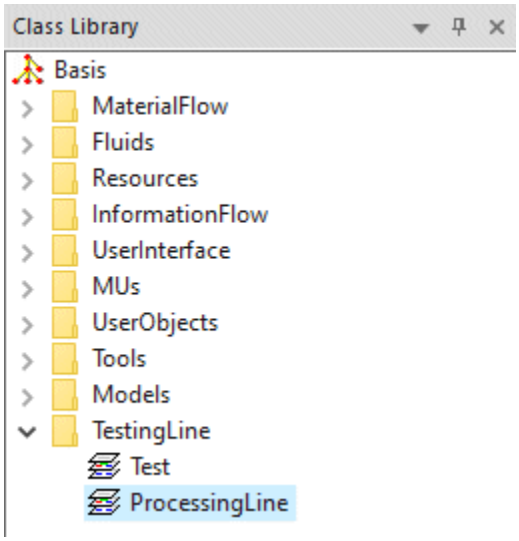
Tutorial Part 2

If you have not completed **Part 1** of the tutorial, you can open the respective tutorial model from the **Plant Simulation installation folder** > **Plant Simulation** > **Tutorial**, compare the example below.

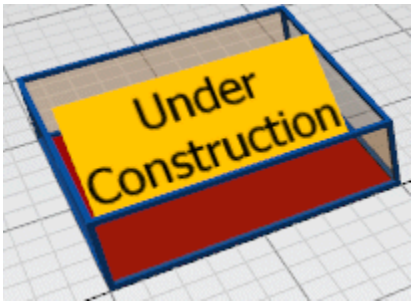


We will start this part of the tutorial by creating another *Frame* within our folder *TestingLine*. Here we also insert a *Source*, a *Drain* and several *Stations*. We will also be using the *Frame* named *Test*, which we created in **Part 1** of the tutorial.

- Create a new *Frame* is described in **Part 1**.
- Click the folder *TestingLine* in the *Class Library* with the right mouse button and select **New** > **Glass Box Frame**. This creates a *Frame* that shows its **contents** towards the outside, but not its **default graphic** and its **caption**.
- Rename the new *Frame* to `ProcessingLine`.

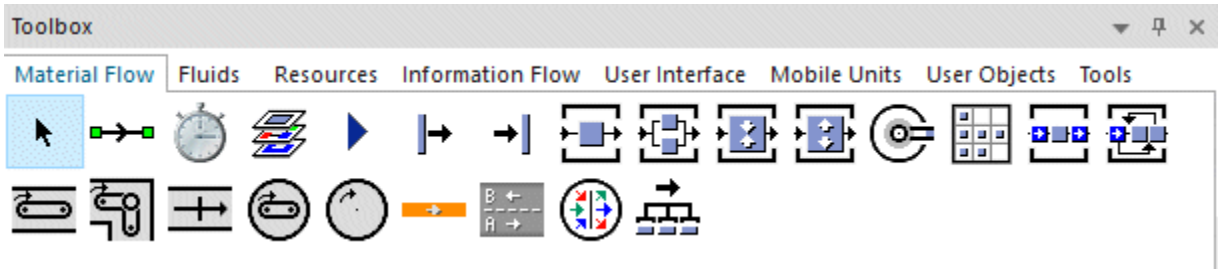


- Double-click the icon of the *Frame* named *ProcessingLine*. As we do not need the graphic **Under Construction** of the *Frame*, we delete it.



We will now insert the objects which we need into the *Frame* named *ProcessingLine*.

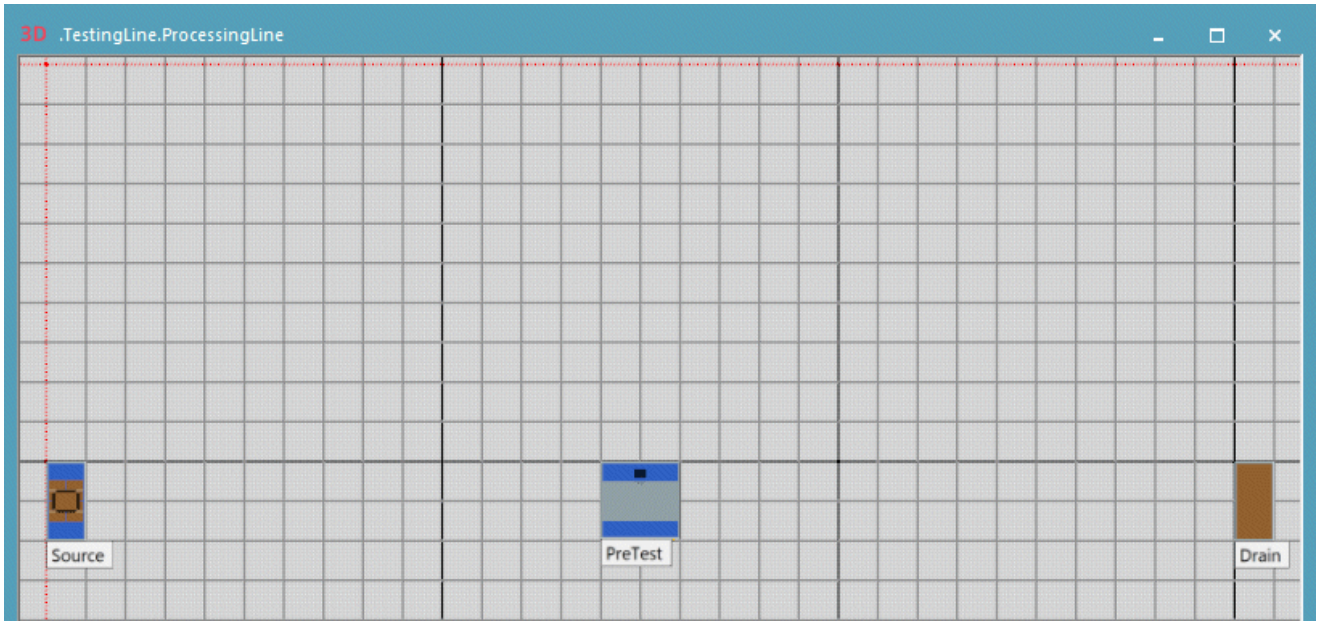
- Insert a *Source* .



- Insert a *Station* and rename it to `PreTest`.

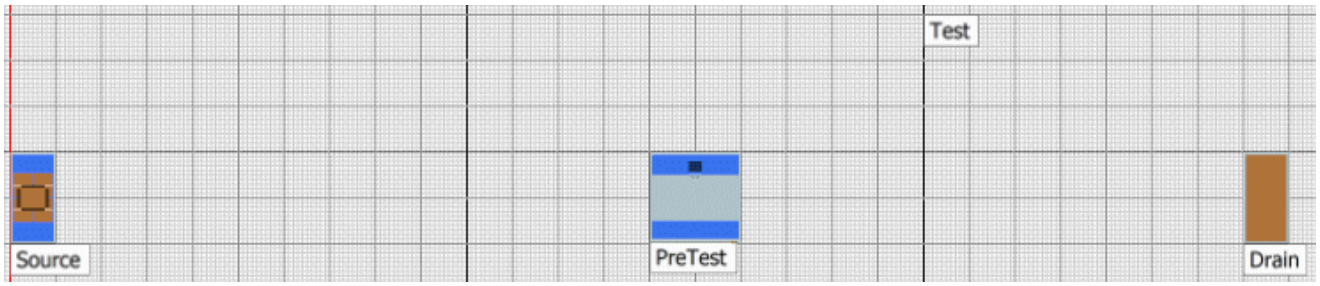
- Open the dialog window of the *Station* named *PreTest*.

- On the tab **Times** select **NegExp** as the **Processing time**.
- Type in `1:00` as the **Processing time**.
- Insert a *Drain*  .



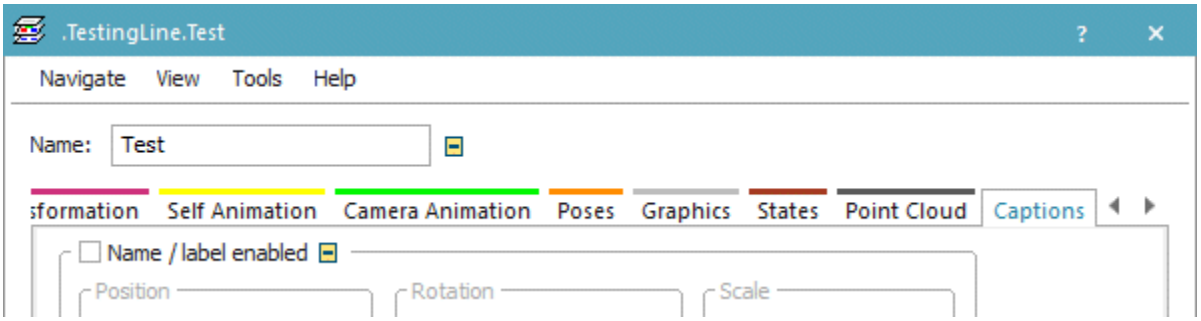
Next, we will insert the two *Frames* named *Test*, which we created in **Part 1**, between the station named *PreTest* and the *Drain*.

- When we insert our *Test Frame*, we see that it shows its **caption**. It does not show its **content** during the simulation though.

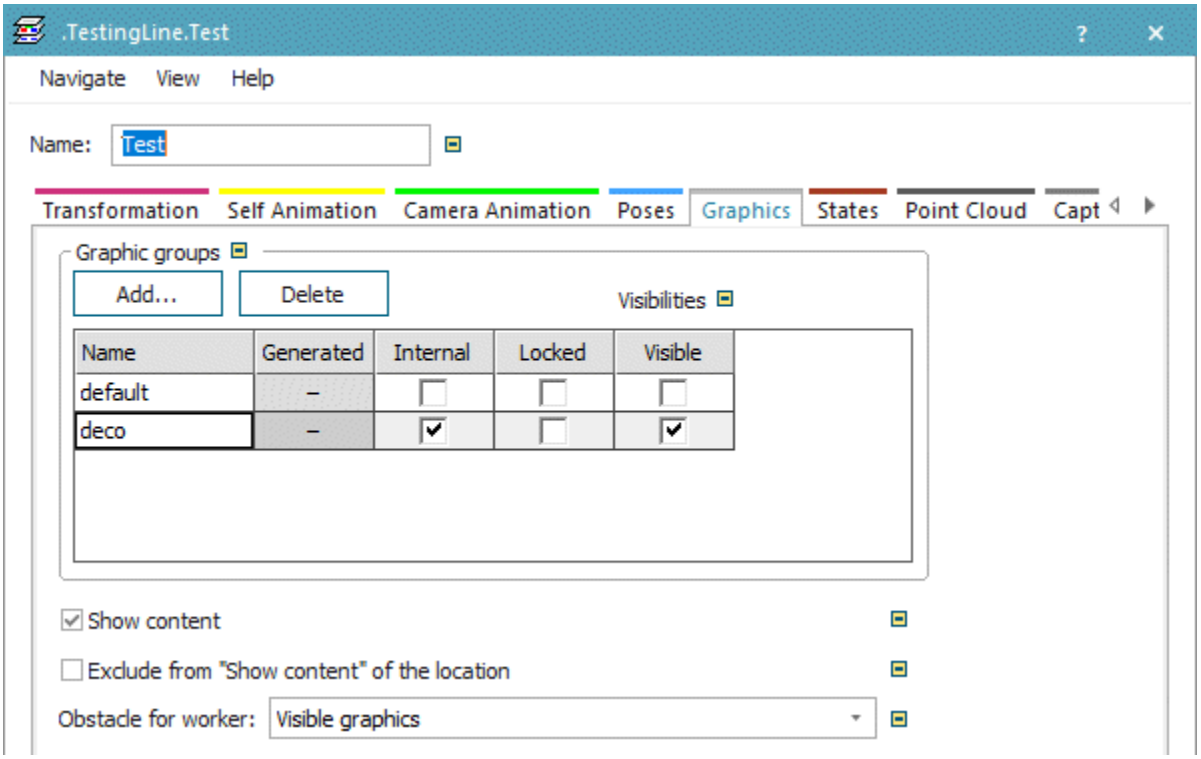


For this reason we change the type of the *Test Frame* from **Model Frame** to **Glass Box Frame**.

- Click the *Frame* named *Test* in the *Class Library* with the right mouse button and select **Edit 3D Properties**.
- Change to the tab **Captions** and clear **Name/Label enabled**.



- Change to the tab **Graphics**, select **Show content** and clear **Visible** for the graphic group named **default**.



- Click the *Frame* named *Test* in the folder *TestingLine*.
- Drag it between the station *PreTest* and the *Drain*, and drop it there.
- Rename this *Frame* to `Test1`. As **Test1 shows** its **content**, we see all of the stations contained within, namely the *Buffer*, the station named *Testing*, and the *Chart*.
- To create a second *Test Frame*, hold down the **Ctrl** key, move the mouse over the *Frame* named *Test1*, and click the left mouse button.
- Drag *Test1* downwards and drop it. If you cannot see the derived *Frame*, scroll down in the *Frame ProcessingLine*.

- Rename this *Frame* to `Test2`.

Back to Tutorial Part 1

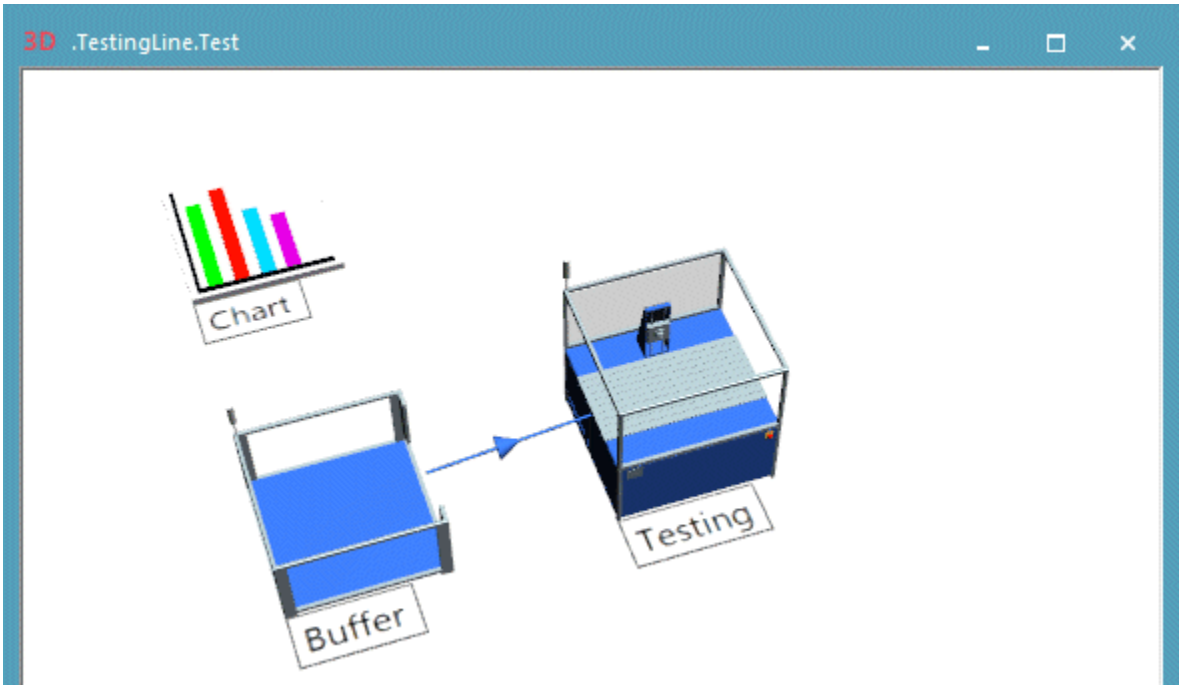
Go to Tutorial Part 3

Working with Inheritance of Object Classes

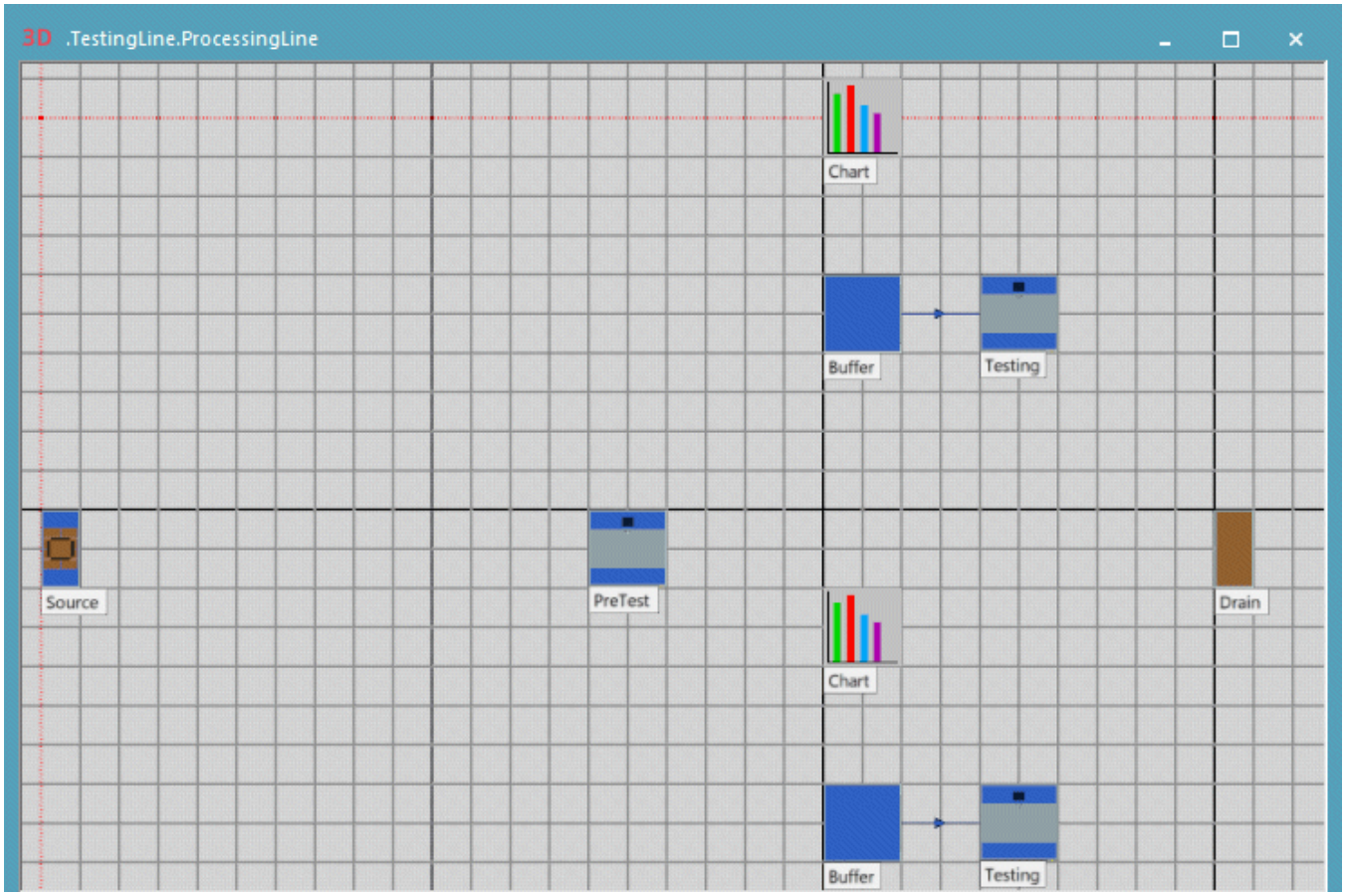
Before we can connect and run this model, we have to edit the *Test* objects. To do this, we will edit the object *Test* in the *Class Library*. Editing the class object automatically propagates our changes to all of its instances in our simulation model, *Test1* and *Test2* in our example.

- Open the *Frame* named *Test* in the *Class Library*.

- Delete the *Source*, the *Drain*, and the *EventController* from the *Frame* named *Test*.



You will notice that this also deleted the *Source*, the *Drain*, and the *EventController* from the *Frames* named *Test1* and *Test2*.



Related Topics

Inheritance

Using Inheritance

Modeling Hierarchically

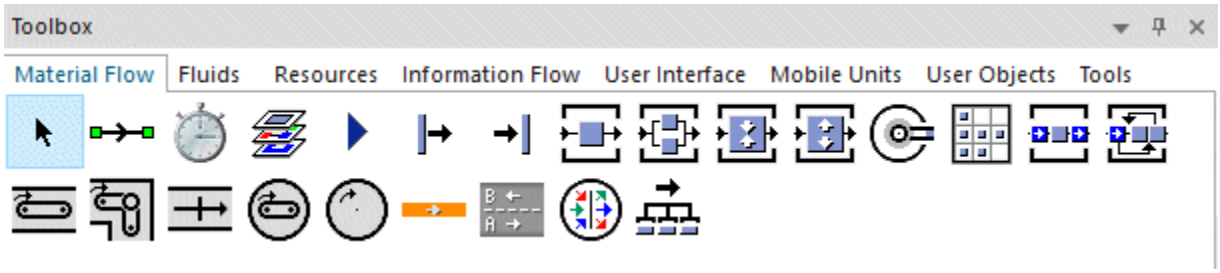
Introducing Classes

Working with Classes in the Class Library

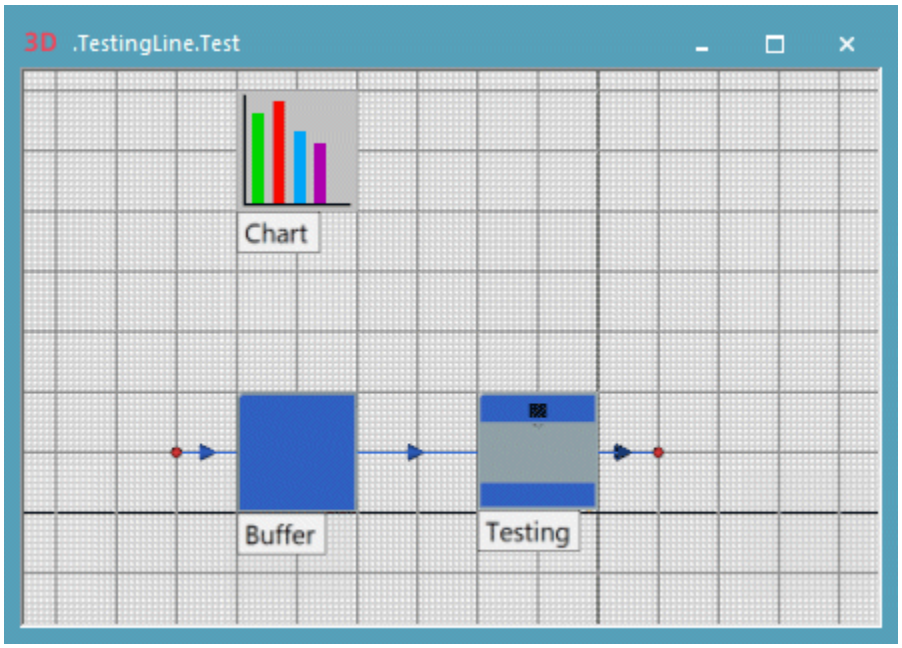
Model Transitions between Frames

We will now insert two **Interface** objects in place of the *Source* and the *Drain* into the *Frame* named *Test*. *Interface* objects determine where the flow of materials enters and exits a *Frame*.

- Click the *Interface* on the tab **Material Flow** in the *Toolbox*.



- Insert the first *Interface* in place of the deleted *Source*.
- Insert the second *Interface* in place of the deleted *Drain*.
- Click the *Connector* in the *Toolbox*.
- Connect the first *Interface* with the *Buffer*.
- Connect the station *Testing* with the second *Interface*.



- Close the *Frame*.

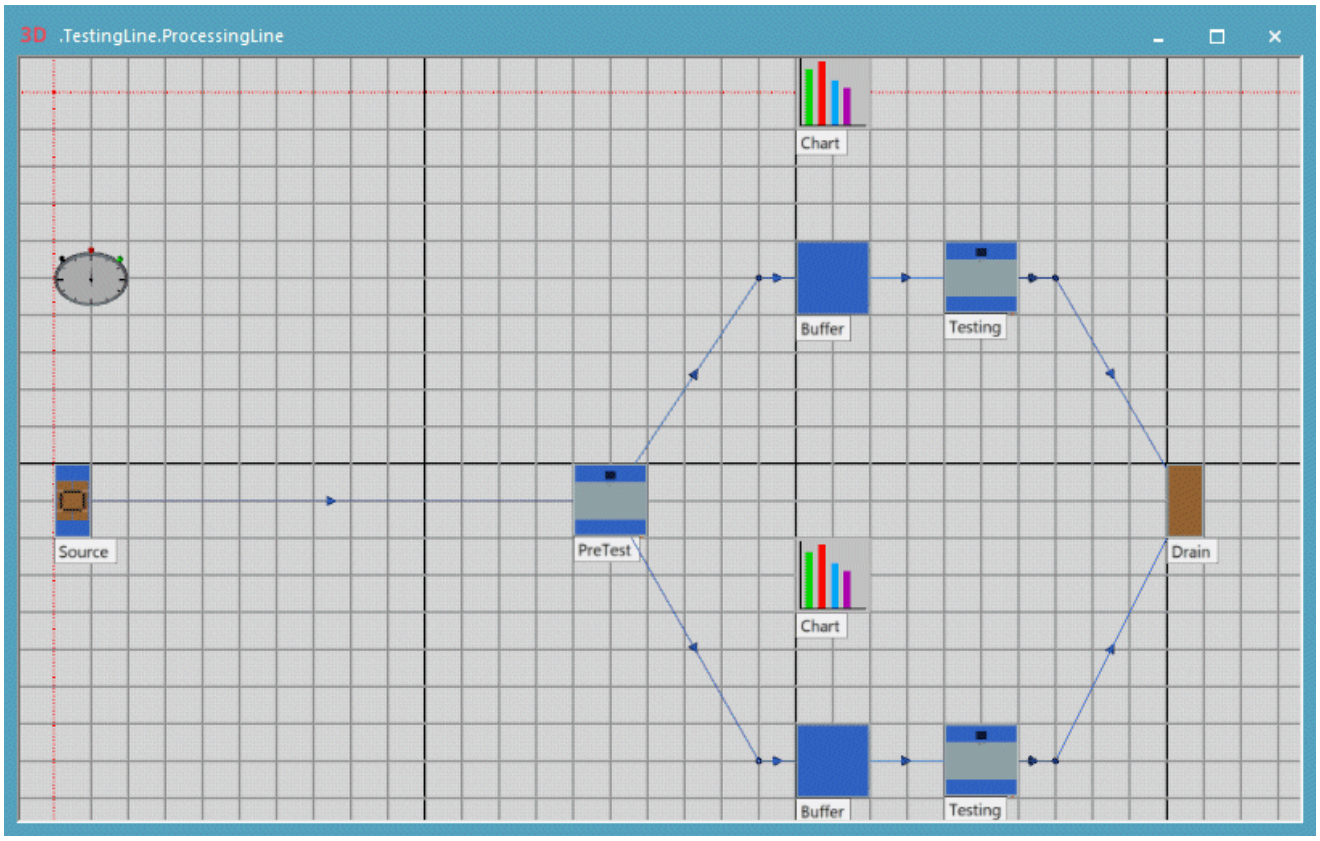
When you open the *Test Frames* inside of the model *ProcessingLine*, you will detect that the *Source* and the *Drain* have been replaced with *Interface* objects in both objects. This is known as **Inheritance**. It is a crucial feature when creating simulation models in *Plant Simulation*.

In the next step we connect all objects within the *Frame* named *ProcessingLine* using the object *Connector*.

- Click the icon of the *Connector*  in the *Toolbox*.

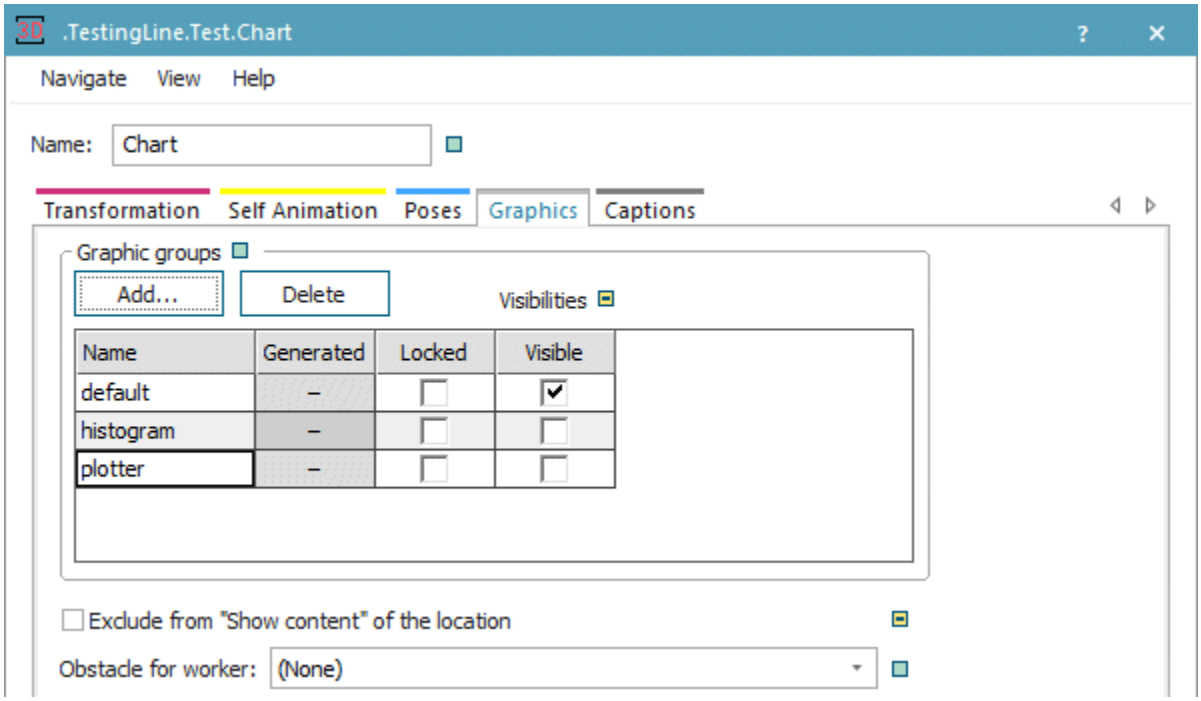
- Connect all the objects so that your model matches the screenshot below.
  - First connect *PreTest* with the *Interface* of the *Frame Test1* that is located on top.
  - Then connect *PreTest* with the Interface of the *Frame Test2* that is located on top.
  - Finally connect *Test1* with the *Drain* and then with *Test2*.

- Insert an *EventController*.



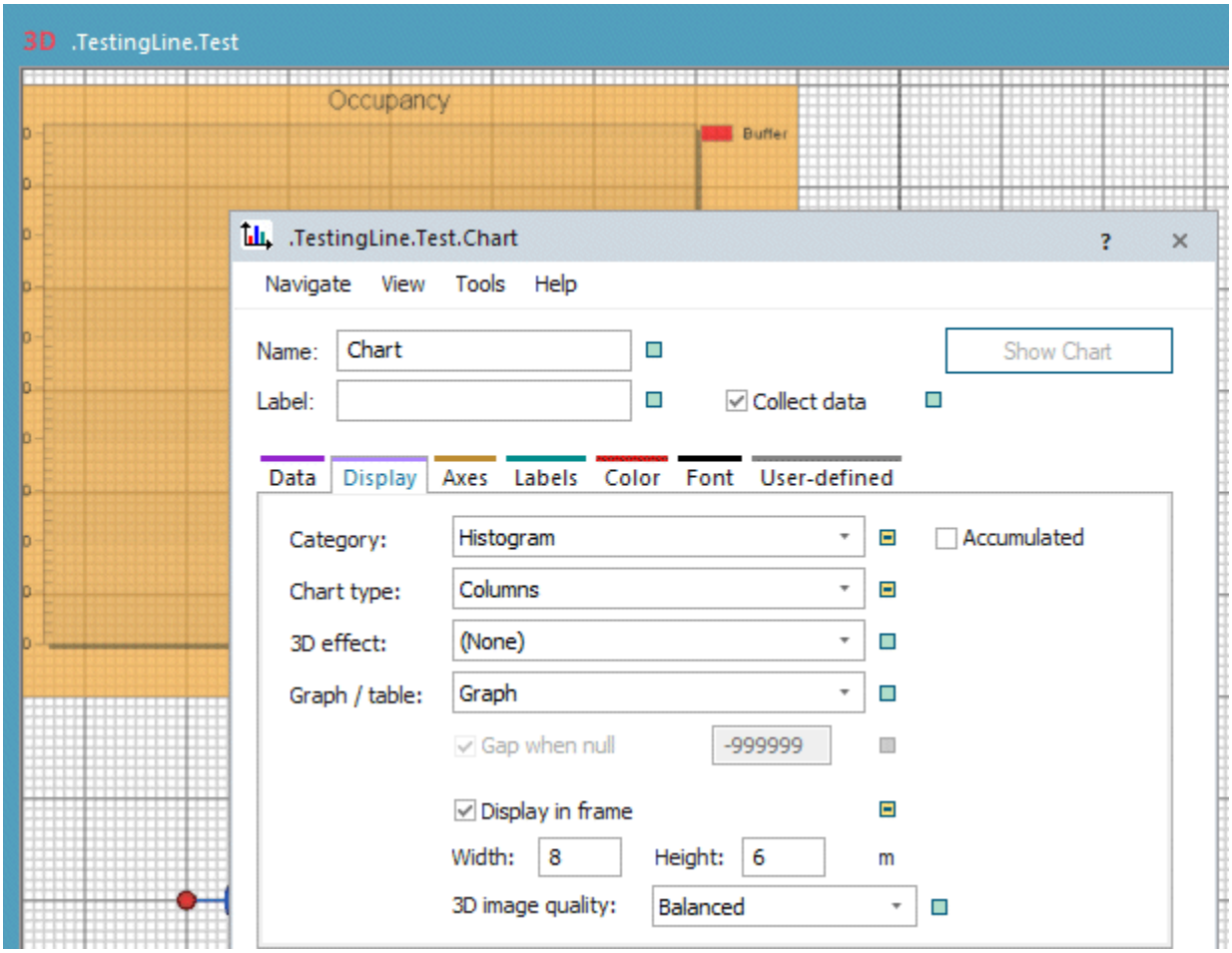
We can now run the simulation with the *EventController*. You will notice that the *Test Frames* behave like any other object within the model. When you open the *Test Frames* however, you can view the activities of the parts within the *Frames*.

By default we do not show *Information Flow Objects* and *User Interface Objects* in the simulation model as we are mainly interested in the material flows. For this reason we do not see the *Chart* when we insert our *Frame* named *Test* into the processing line. To show the *Chart*, clear the check box **Exclude from "Show content" of the location**. If you do not want to show the *Chart* any longer, select the check box again.



Sometimes it is helpful to show the *Chart* at a small scale in the *Frame* instead of its icon, for example to grasp the occupancy of the *Buffers* at a glance. To do so, double-click the *Chart* in the *Frame* named *Test*. Change to the tab **Display** and activate **Display in frame**.

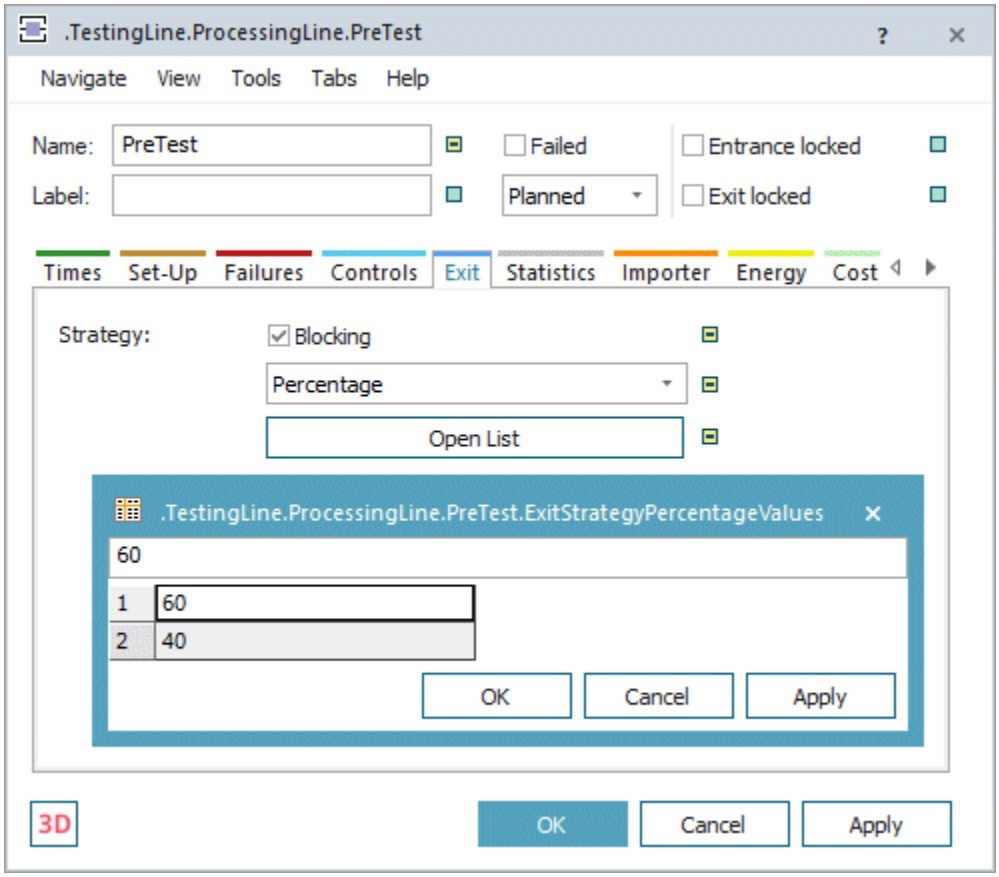
If you do not need this view any longer, clear the check box again.



Distribute the Flow of Materials with an Exit Strategy

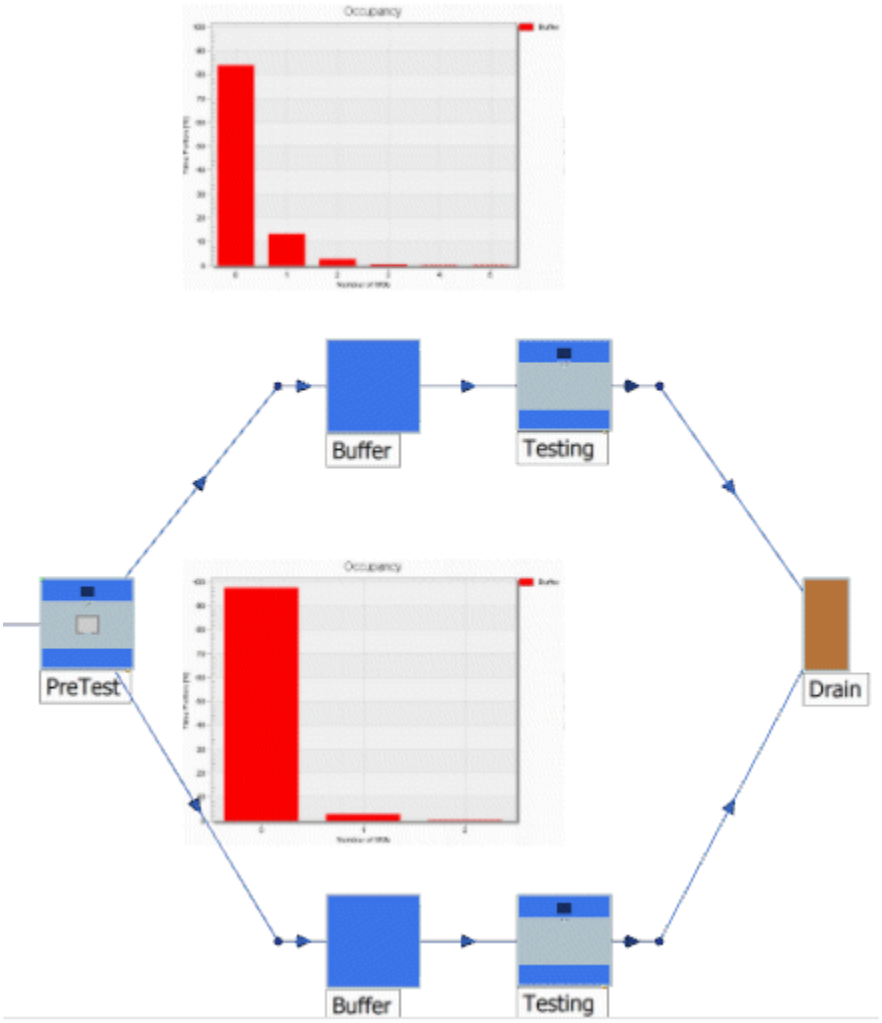
In this step we will use an **exit strategy** to distribute the flow of materials. We are going to distribute the flow of materials so that 60 % of the parts move to the station *Test1* while the remaining 40 % move to the station *Test2*.

- Open the dialog of the station *PreTest* and change to the tab **Exit Strategy**.
- Select **Percentage** from the drop-down list as the **Strategy** and select the check box **Blocking**. Then click **Apply**.
- Click the button **Open List** below the drop-down list box **Percentage**.
- Type `60` into the first row, press the **Enter** key, then type in `40` into the second row. This means that 60 % of the parts move to the successor with the number 1 and 40 % to the successor with the number 2.



- Click **OK** to apply your changes and to close the station named *PreTest*.

When you now run the simulation and analyze the *Charts* in the two *Test* stations, you will notice that more parts are processed in the station *Test1* than in the station *Test2*. This is caused by the distribution we entered into the **Percentage table** of the station *PreTest*.



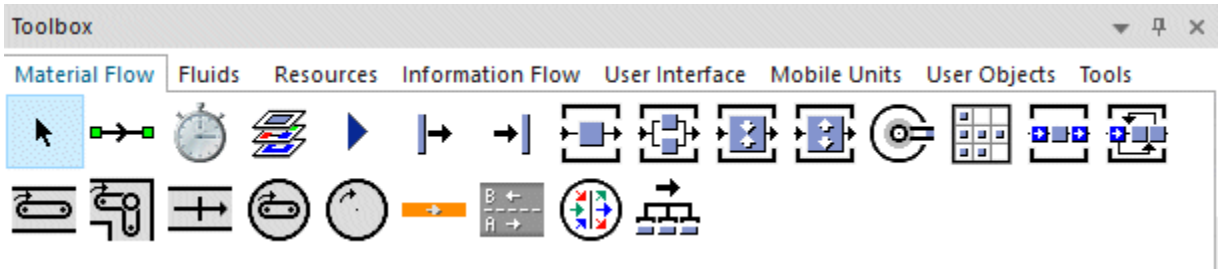
Note:

If it is the other way round, namely more parts are processed on the station *Test2* than on the station *Test1*, delete the *Connectors* between *PreTest* and the *Test* stations. Then first connect *PreTest* with *Test1* and then *PreTest* with *Test2*. The test station which you connected first to the *PreTest* station is successor number 1, the station which you connected after that with the *PreTest* station is successor number 2. Successor number 1 is always served before successor number 2.

Model Conveyors

Now we are going to insert an object of type **Conveyor** into our simulation model. It represents a conveyor feeding parts to the testing stations. First, delete the *Connector* between the *Source* and the *Station PreTest*. To fit the *Conveyor* between the stations, you might have to move the rest of your objects to the right. Drag a marquee across all objects to select them. Then, move them to the right with the right arrow key. To move them by an entire grid unit at a time, hold down **Shift** and press the right arrow key.

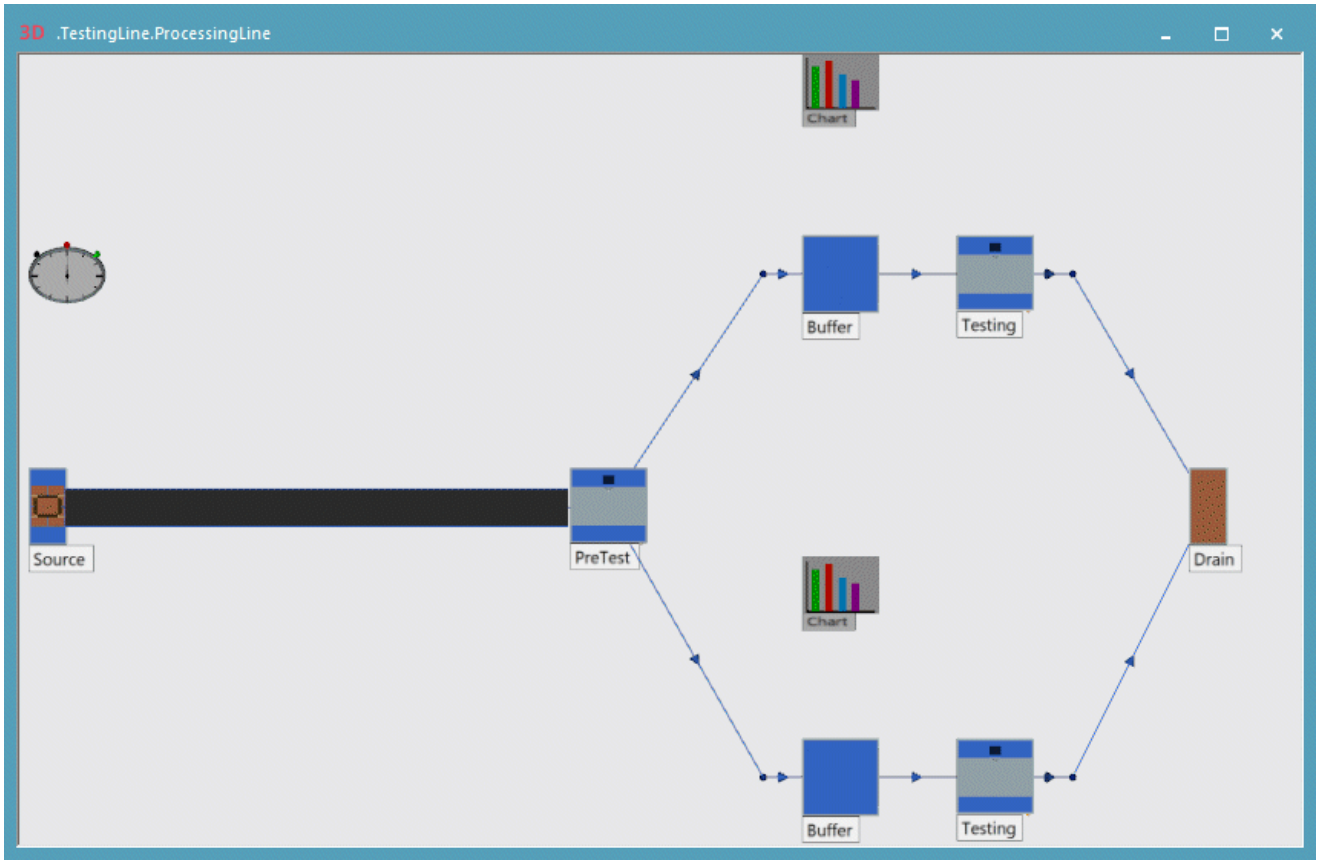
- Select the *Conveyor* on the tab **Material Flow** in the *Toolbox*.



- Insert the *Conveyor* between the *Source* and the station *PreTest*.

- The first mouse click determines the starting point, the second click sets the end point of the *Conveyor*.

- Connect the *Conveyor* with the *Source* and the station *PreTest*.
  If you have trouble connecting the *Conveyor*, move it down with the down arrow key, connect it with the *Source* and with the station *PreTest*, and then move it up again with the up arrow key.

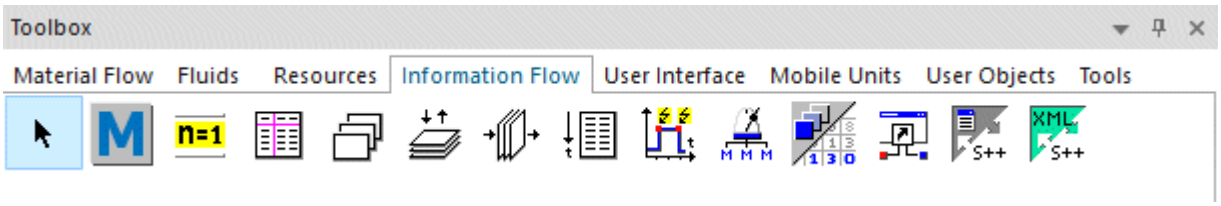


Count Parts on the Conveyor with Variable and Method

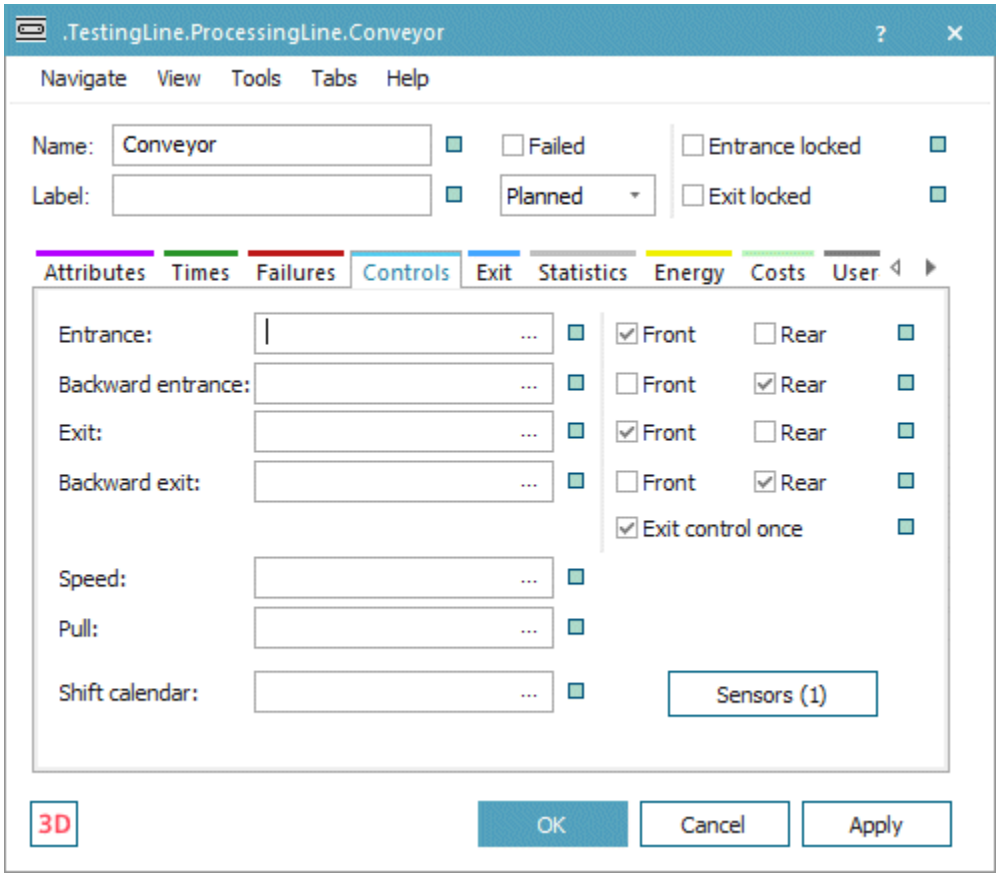
When you run the simulation, you will see the parts moving along the *Conveyor* to the station *PreTest*. To count the parts entering the *Conveyor*, we will insert a **sensor** at the beginning of the *Conveyor*. We will then use a **Method** to make *Plant Simulation* increase a counter in a **Variable** whenever a part passes the sensor.

You can write source code in a *Method* to define special behavior which cannot be set by selecting or entering settings into the dialogs of the objects. *Plant Simulation* provides the proprietary programming language **SimTalk** for this purpose.

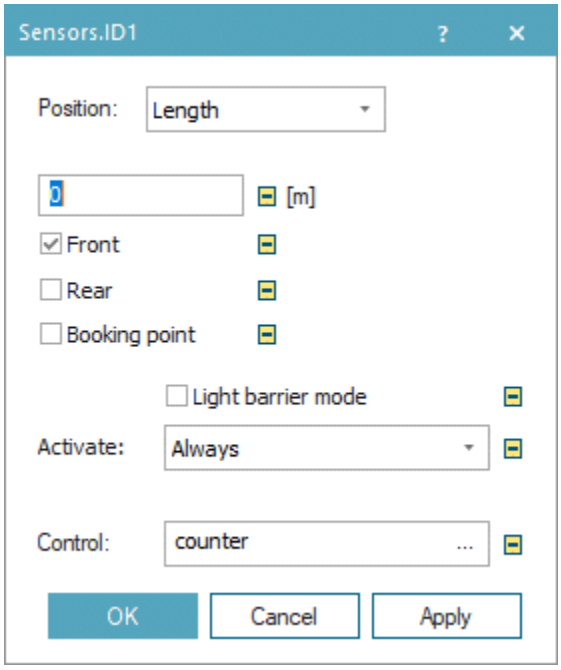
Insert a *Method*  from the tab **Information Flow** in the *Toolbox* below the object *Conveyor*.



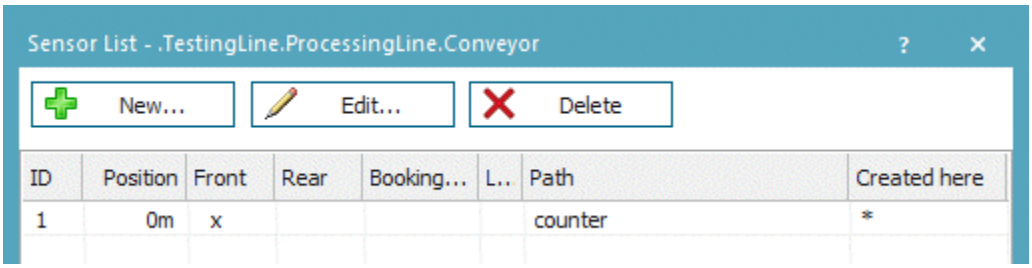
- Click the *Method* with the right mouse button and rename it to `counter`.
- Open the dialog window of the *Conveyor*.
- Click the tab **Controls**.
- Click **Sensors**.



- Click **New** and enter `0` as the **Position** of the sensor. This places it at the start of the *Conveyor*.
- Click the button in the text box **Control**, select *counter* and then click **OK**.



- Close the dialog **Sensor List**.



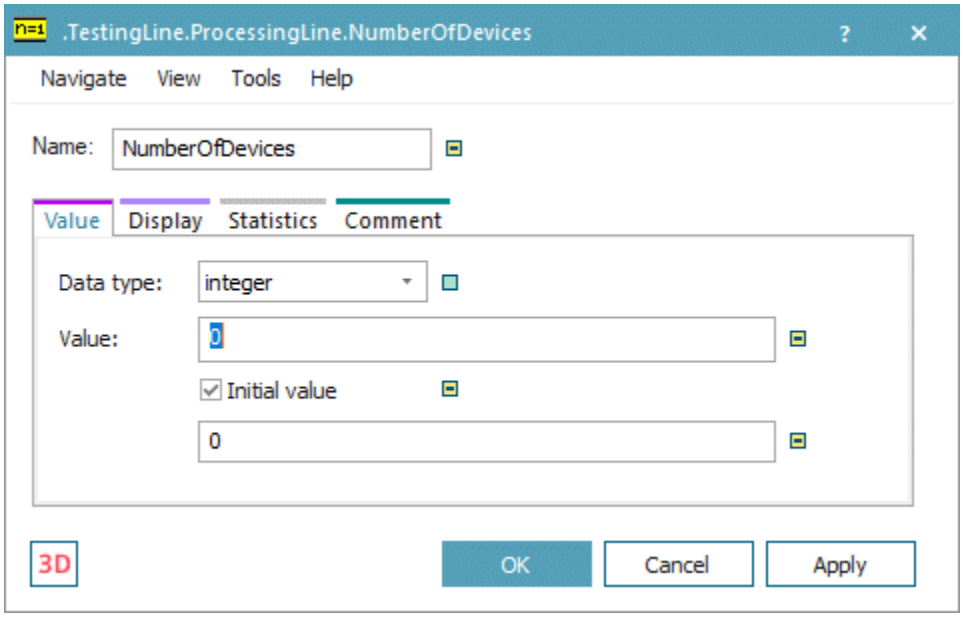
- Click **OK** again to apply your changes and to close the dialog window of the *Conveyor*.
- Double-click the method *counter*.
- Copy the following source code and paste it into your method. To do so, select the text, then click it with the right mouse button and select **Copy** on the context menu, or press **Ctrl+A**, **Ctrl+C**, and then **Ctrl+V**.

```
NumberOfDevices := NumberOfDevices + 1
```

- **Apply** the source code by clicking the button  on the **Edit** ribbon tab and then close the method window.

Insert a **Variable**  into your simulation model from the tab **Information Flow** in the *Toolbox* above the *Conveyor*.

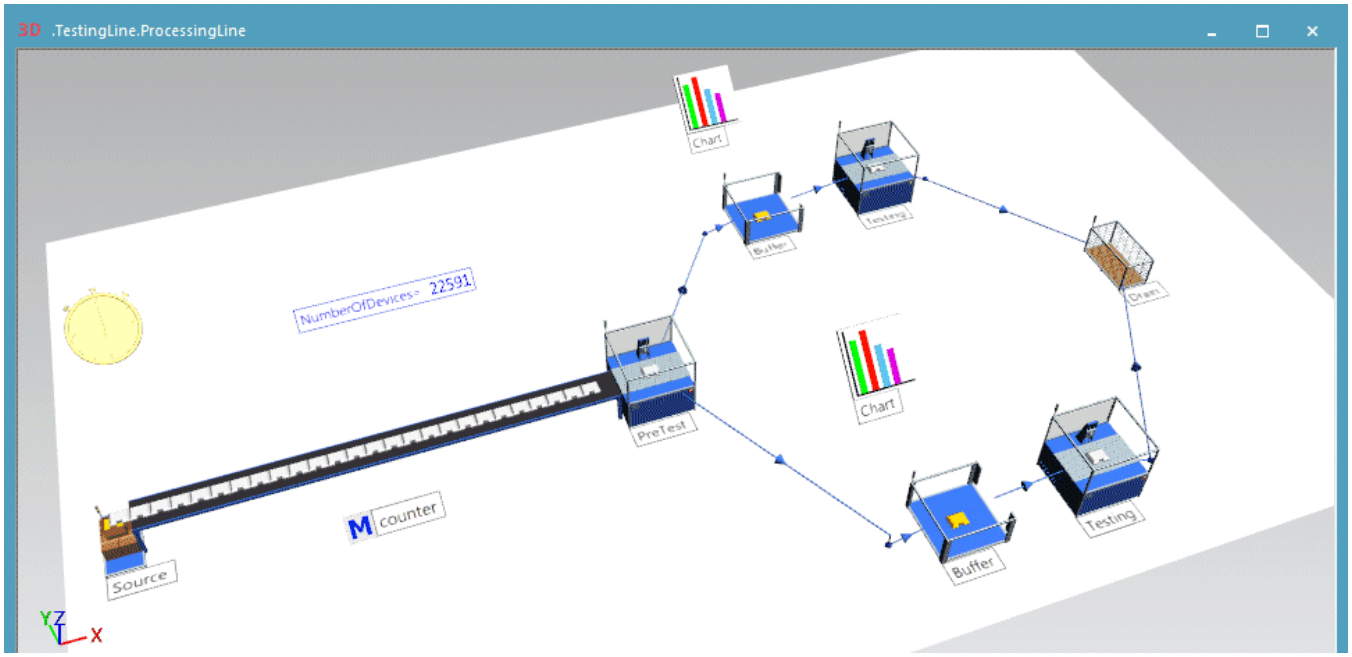
- Double-click the *Variable* and name it `NumberOfDevices`. Select the check box **Initial value** and enter the value `0`. This way the value of the *Variable* is automatically set to 0 when the simulation starts.



- On the tab **Display** select the **Font size** > **Large**. If you want to, you can also select a different color. We selected blue.

- Save your simulation model.

Run the simulation to watch the parts moving along the *Conveyor* triggering the sensor and increasing the counter. To better follow the simulation, decrease the **simulation speed** in the *EventController*.

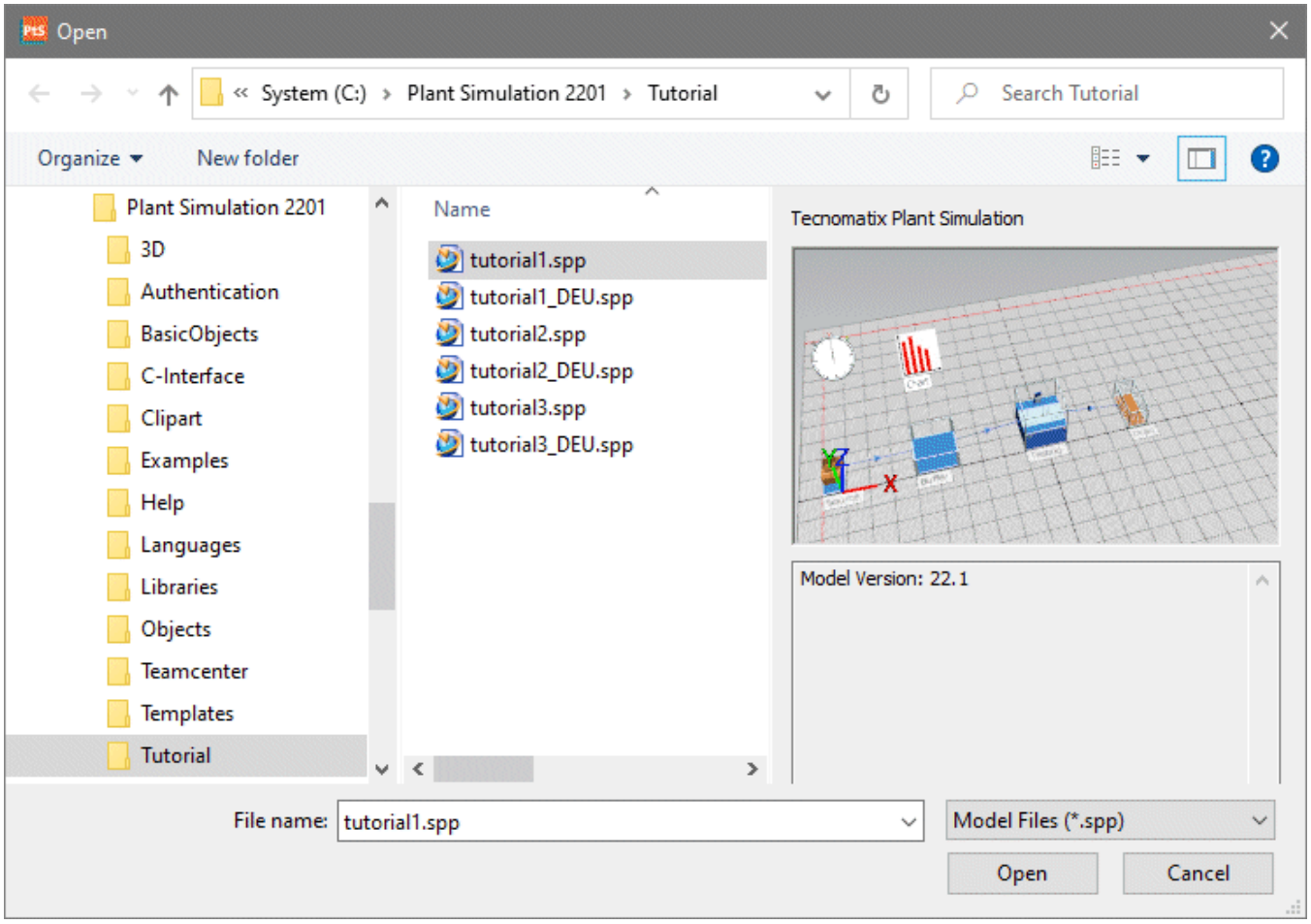


Save your simulation model.

Tutorial Part 3

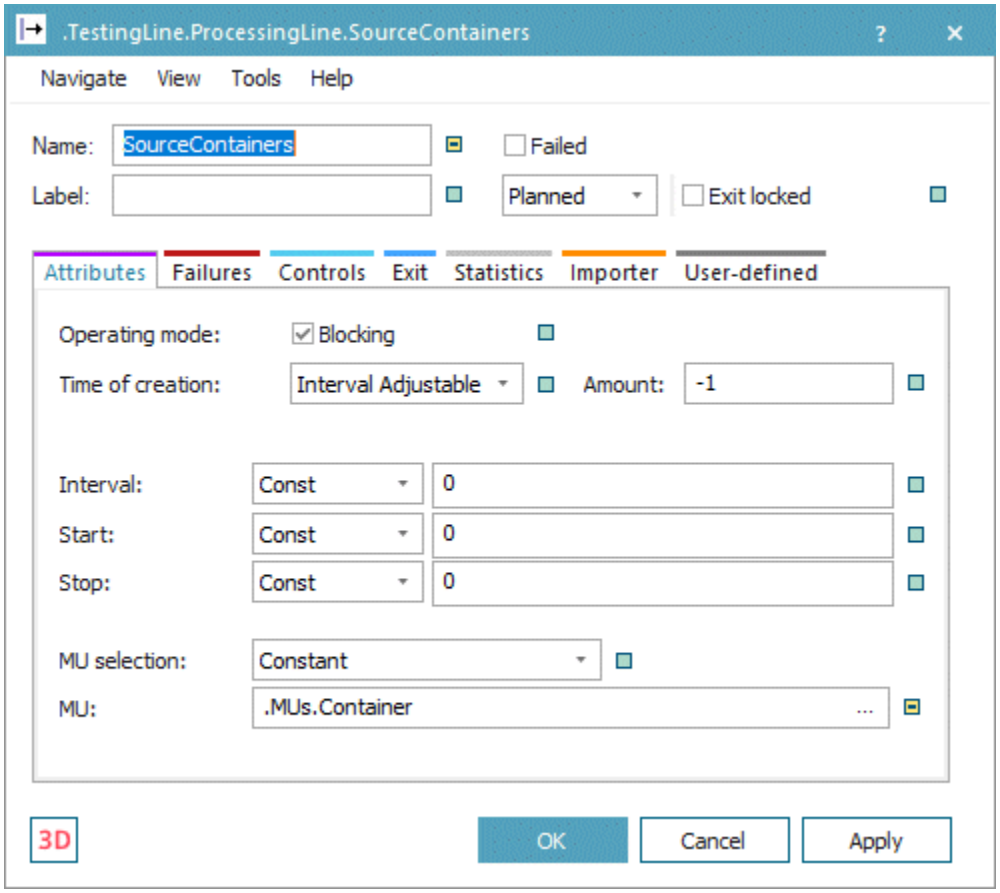
Tutorial Part 3

If you have not completed Part 2, you can open the respective tutorial model from the **Plant Simulation installation folder** > **Plant Simulation** > **Tutorial**, compare the example below.



In this part we will insert a second *Source* to produce *Containers*. We will also insert the object **AssemblyStation** to load parts onto the *Containers* before the parts are processed. In doing so, you might have to move the objects in the *Frame* a bit to the right.

- Insert another *Source* below the existing *Source* in the *Frame* named *ProcessingLine*.
- Click the new *Source* with the right mouse button and rename to `SourceContainers`.
- Click the ellipsis button in the text box **MU** on the tab **Attributes** and select the object **Container** in the folder **MUs** in the *Class Library*. This way we tell the *Source* to produce *containers*.



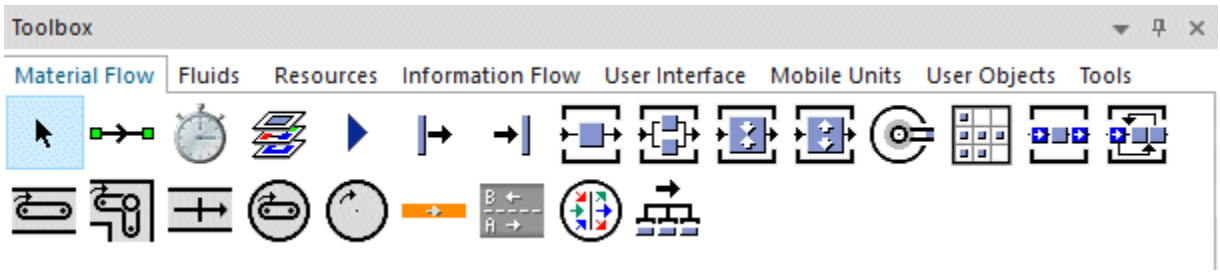
Back to Tutorial Part 1

Back to Tutorial Part 2

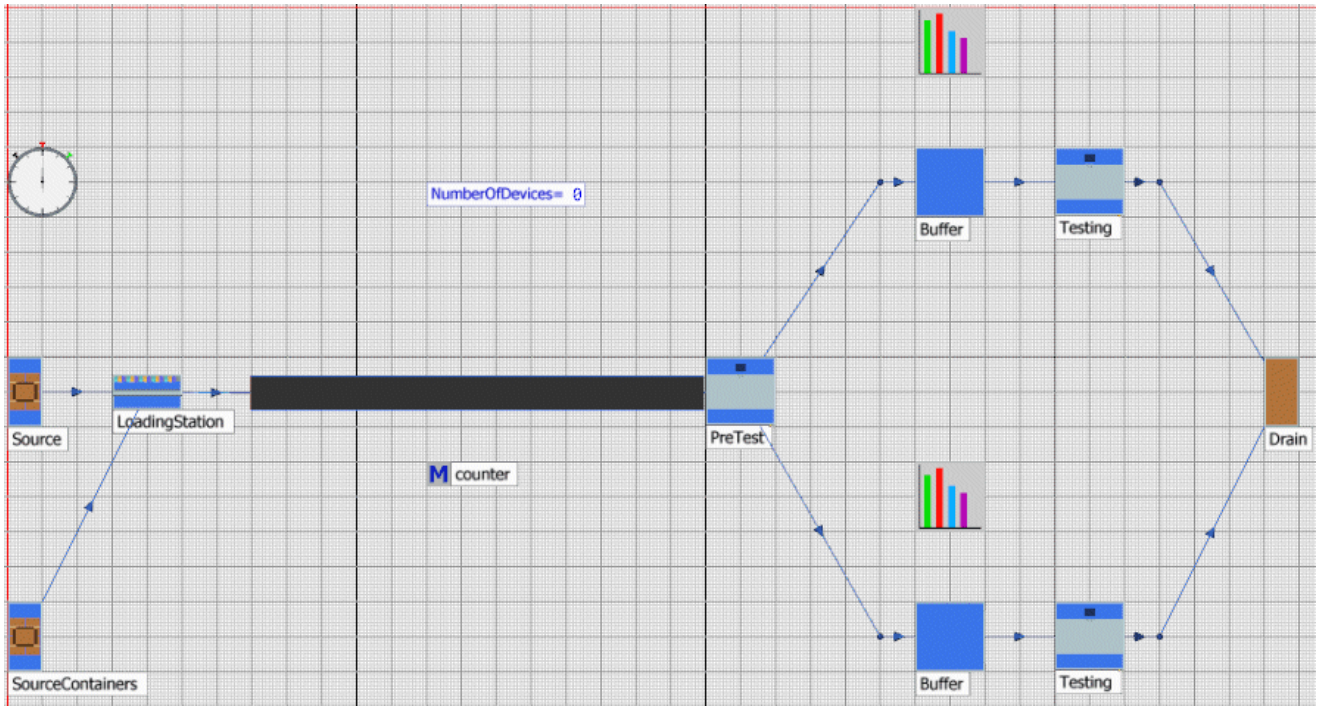
Load Containers

To load parts on the objects of type **Container** :

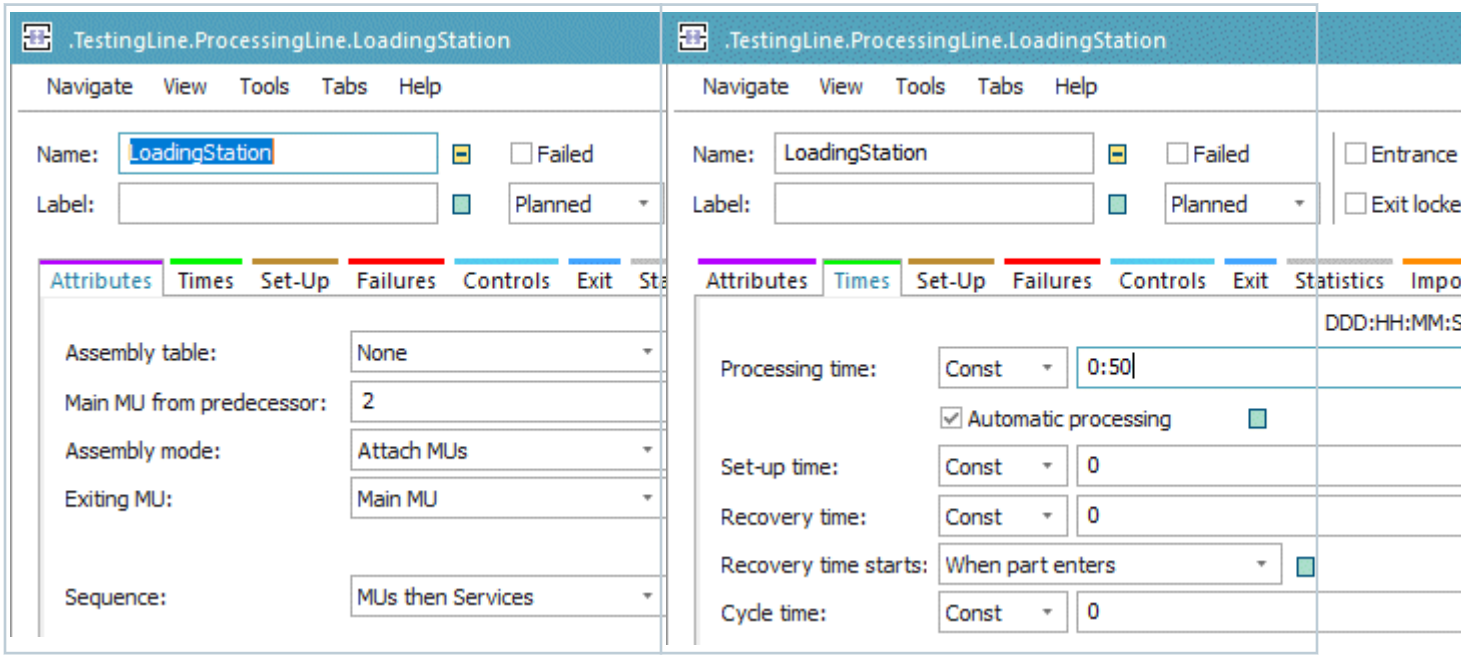
- Drag the object **AssemblyStation** from the tab **Material Flow** in the *Toolbox* on the *Connector* between the *Source* and the *Conveyor* and drop it there. This way you don't have to delete the *Connector* between the *Source* and the *Conveyor* and insert it anew.



- Rename the station to `LoadingStation`. Connect the *SourceContainers* with the *LoadingStation*.

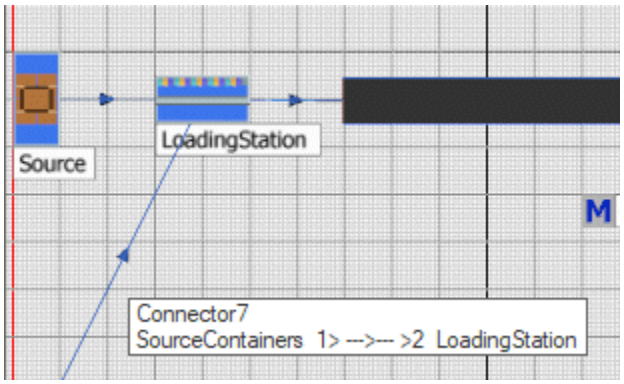


- Double-click the *LoadingStation* and select the **Assembly mode** > **Attach MUs** on the tab **Attributes**. Change to the tab **Times** and type in a **Processing time** of 50 seconds, i.e., `0:50`.



As the *AssemblyStation* is connected to two stations, the order in which you connect it with the predecessors is important. If the assembly process does not work as expected, check the numbering of the predecessors by dragging the mouse over the *Connector* and viewing the *Tooltip*.

In our case we entered `2` into the text box **Main MU from predecessor** as only the transporting part from the predecessor with the number 2 can take on parts.

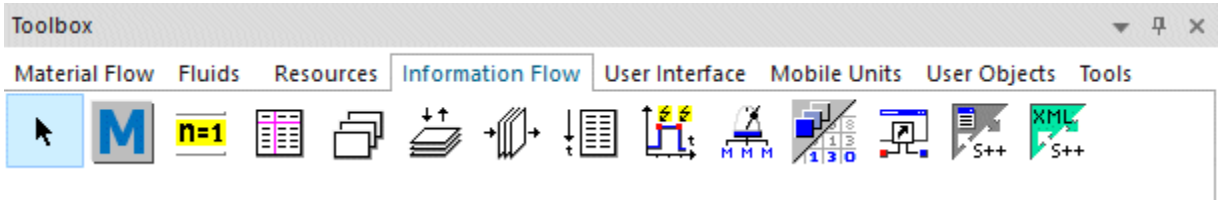


Specify the Parts to be Produced in a DataTable

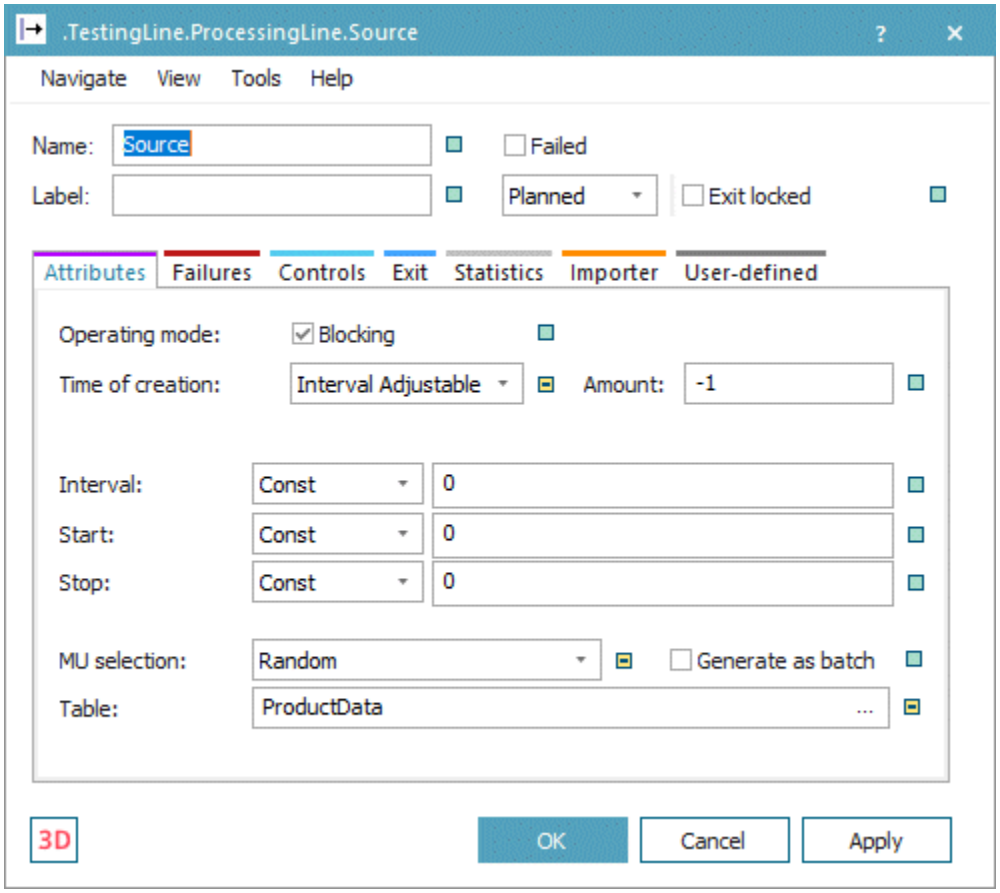
Specify the Parts to be Produced in a DataTable

Next, we will introduce a second type of *MU*, rename the types to `Monitor` and `VideoGameConsole`, and use a *DataTable* to set the percentage of each part that will be tested in the model.

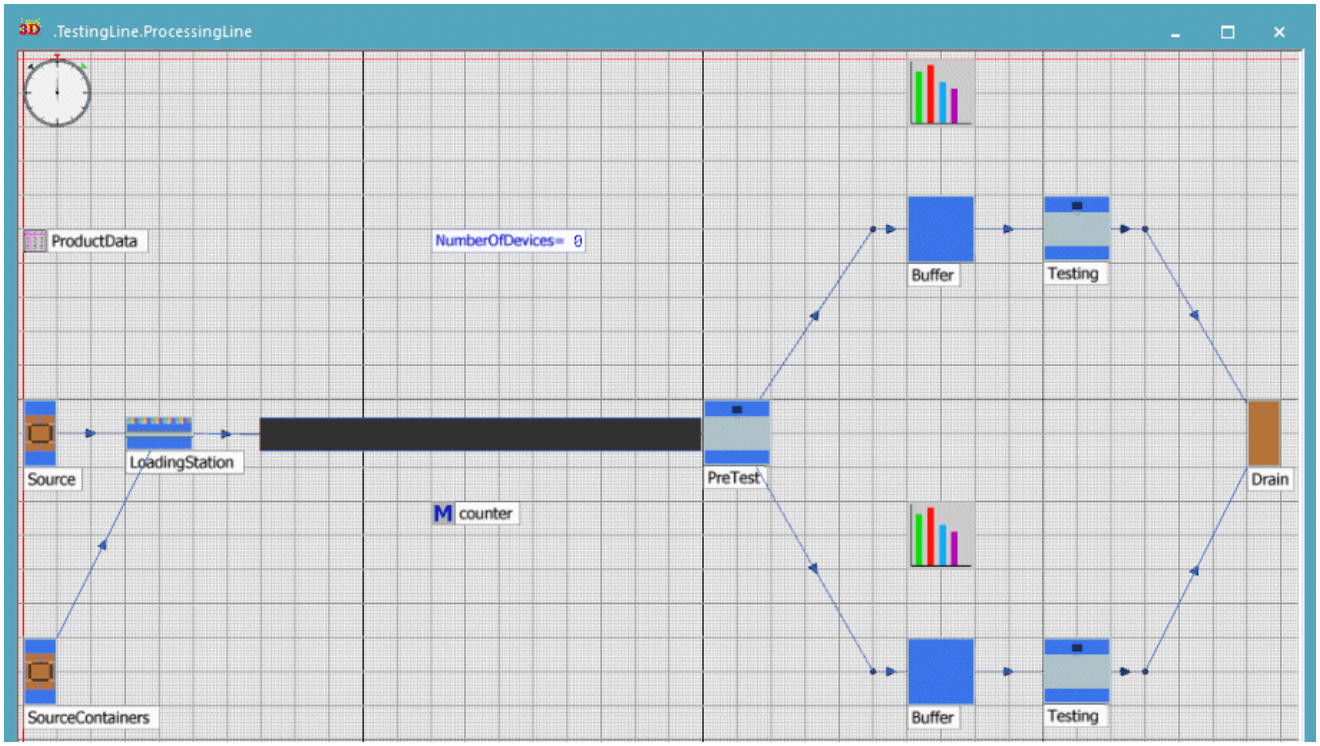
- Insert a **DataTable** from the tab **Information Flow** in the *Toolbox* above the *Source*.



- Click the *DataTable* with the right mouse button and rename it to `ProductData`.
- Open the dialog window of the *Source*.
- Select **Random** as the **MU selection** on the tab **Attributes**.
- Click ... and select the table *ProductData* in the text box **Table**.



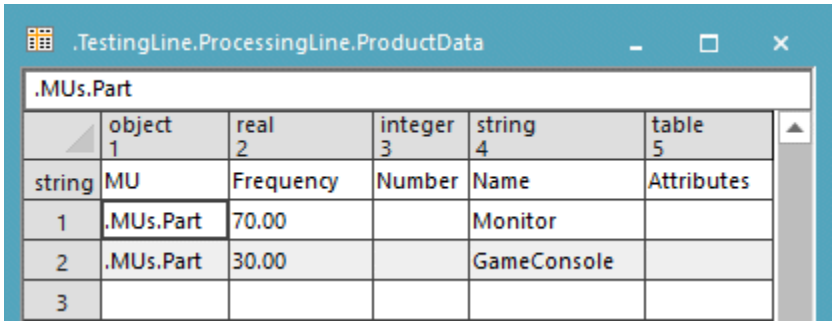
- Click **OK** to apply your changes and to close the window.



Edit the Product Data

Plant Simulation automatically formatted the *DataTable* named *ProductData* to serve as the **distribution table** for the *Source*. We will now type in `Monitor` and `GameConsole` as the products that we are going to process.

- Open the *DataTable* named *ProductData*.
- Select the object **Part** in the folder **MUs** in the *Class Library*. Drag this object to row 1 of the column **MU** of the table *ProductData* and drop it there.
- Enter `70.00` into row 1 of the column **Frequency**.
- Enter `Monitor` into row 1 of the column **Name**.
- Drag the object *Part* from the *Class Library* to row 2 of the column **MU** and drop it there.
- Enter `30.00` into row 2 of the column **Frequency**.
- Enter `GameConsole` into row 2 of the column **Name**.



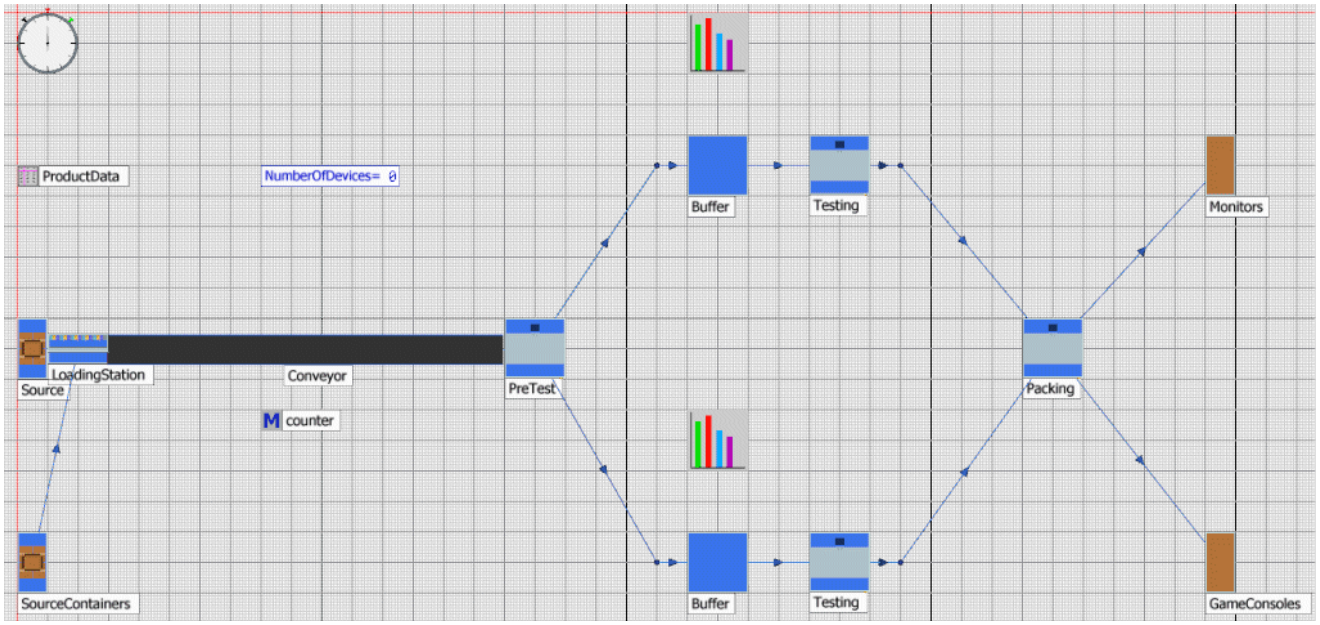
	object 1	real 2	integer 3	string 4	table 5
string	MU	Frequency	Number	Name	Attributes
1	.MUs.Part	70.00		Monitor	
2	.MUs.Part	30.00		GameConsole	
3					

- Click outside the table cell which you just edited and close the table.
- Once you run the simulation, you will see that the *Source* produces 70 % monitors and 30 % game consoles for testing.

The next step will be to separate these two devices after they have been tested in the *Testing stations* and to record the amount of each that have been tested within a *DataTable*.

To do so, we will program another control to separate the monitors and game consoles after they have been tested, and record the amount of each of these devices in a table.

- Click the *Drain* with the right mouse button and rename it to `Monitors`.
- Delete the *Connectors* between the stations *Test1* and *Test2* and the *Drain*.
- Insert a second *Drain* below *Monitors* and rename it to `GameConsoles`.
- Insert a *Station* between the *Testing stations* and the two *Drains*.
- Click the *Station* with the right mouse button and rename it to `Packing`.
- Connect all objects and move the *LoadingStation* and the *Conveyor* to the left.

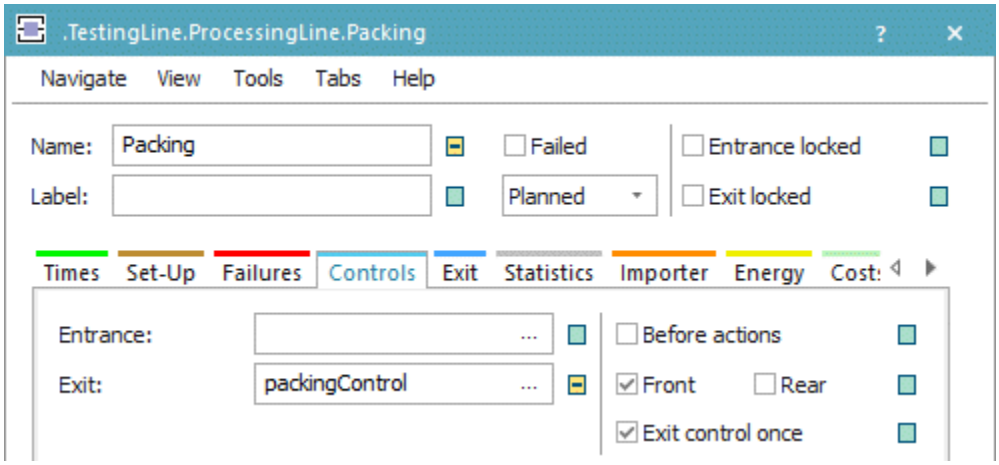


When you run the simulation now, you will detect the default behavior of the *Station*, namely that the parts, on leaving the station *Packing*, alternate between the two *Drains*. We need to separate the monitors from the game consoles and send them to their respective *Drain* though. We accomplish this by using a *Method* as an **exit control** in the station *Packing*.

- Insert a *Method* below the *Station* named *Packing*.
- Rename this *Method* to `packingControl`.
- We entered the following source code:

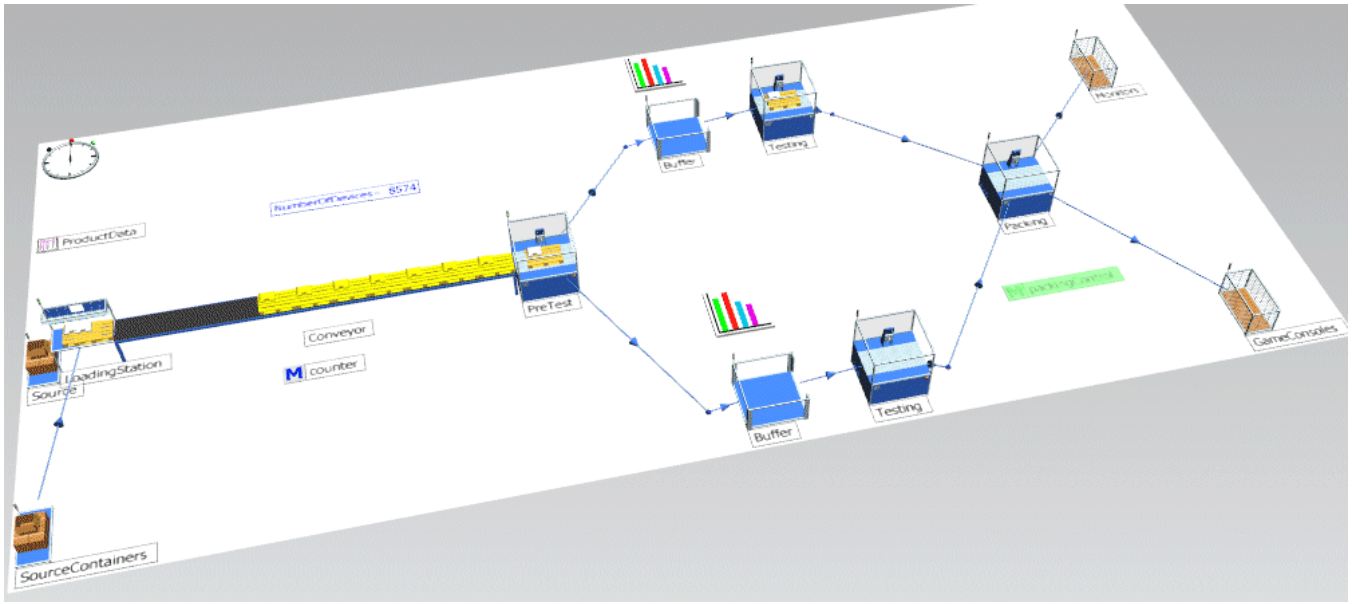
```
if @.cont.name = "Monitor" // move monitors to Drain named Monitors
   @.move(Monitors)
else
   @.move(GameConsoles)    // move game consoles to Drain named
GameConsoles
end
```

- Open the *Station* named *Packing* and click the tab **Controls**.
- Click the button in the text box **Exit** and select the *Method* named *packingControl*.



- Click **OK** to apply your changes and to close the window.

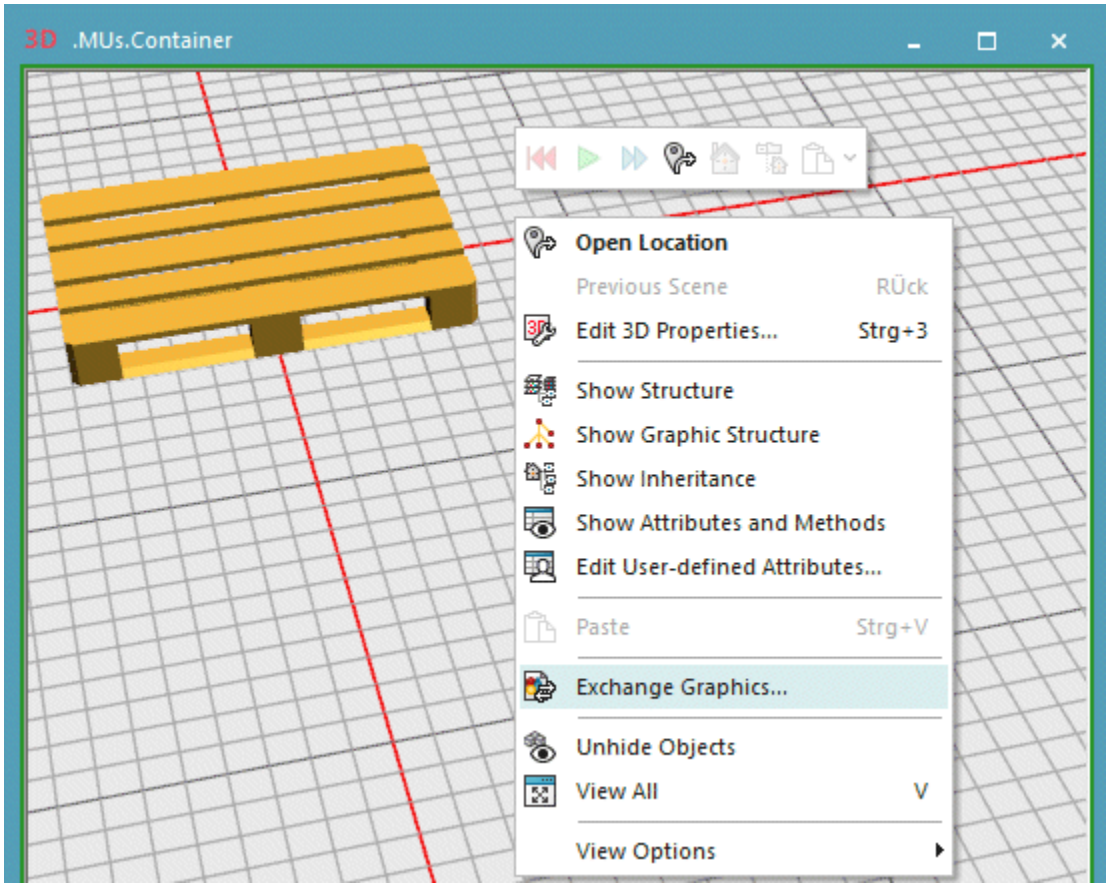
After the parts have been processed on the *Station* named *Packing*, they are sorted by the *Method* named *packingControl* and are sent on to their respective *Drains*.



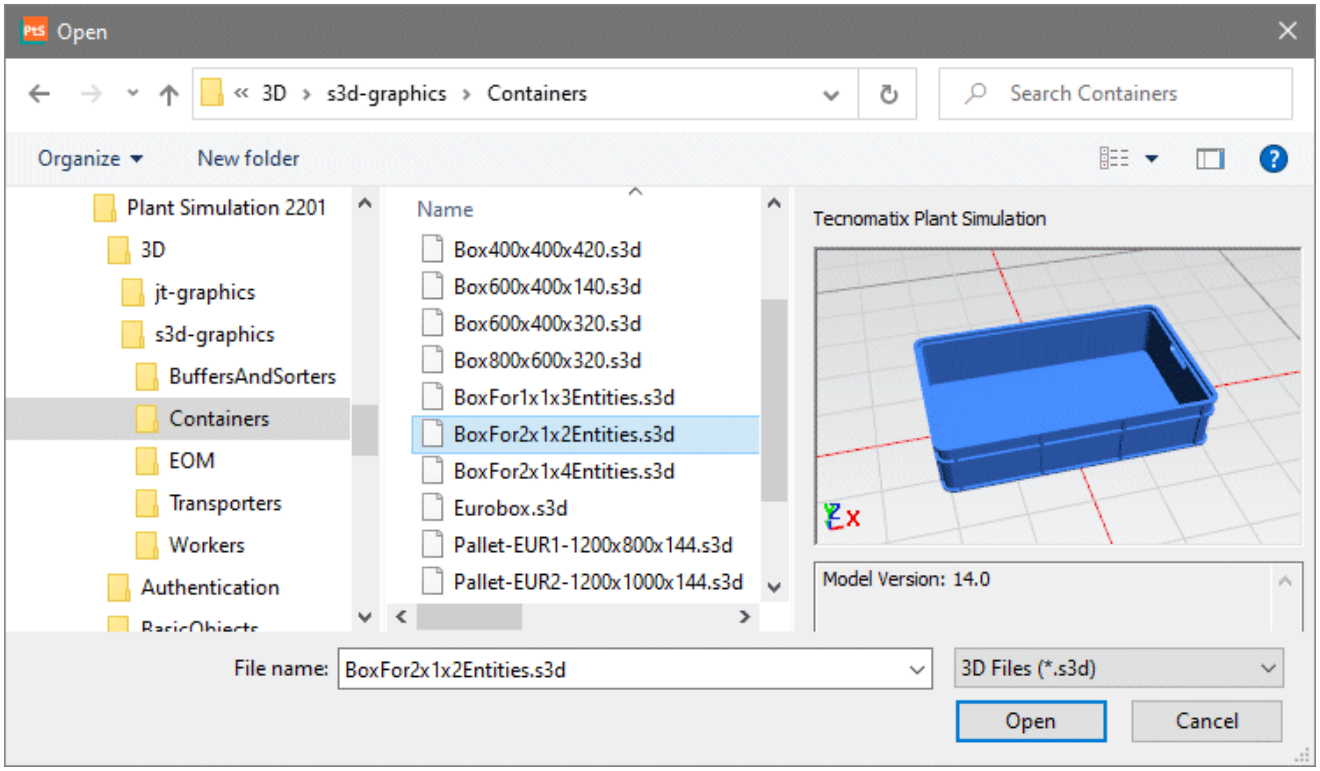
Replace the Pallet with a Transport Box

As the pallets on the conveyor and on the stations do not look realistic for our purpose, we change the graphic of the *Container*. As we want to do this for all *Containers*, we do it in the object class.

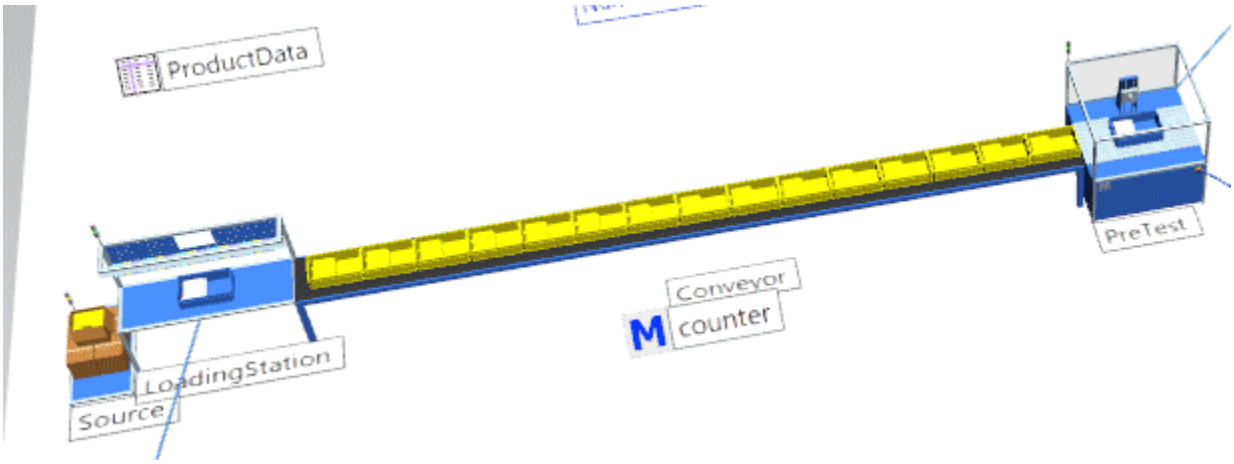
- Open the folder named **MUs** in the *Class Library*.
- Click the *Container* with the right mouse button and select **Open in 3D**.
- Click into the background of the window and select **Exchange Graphics**.



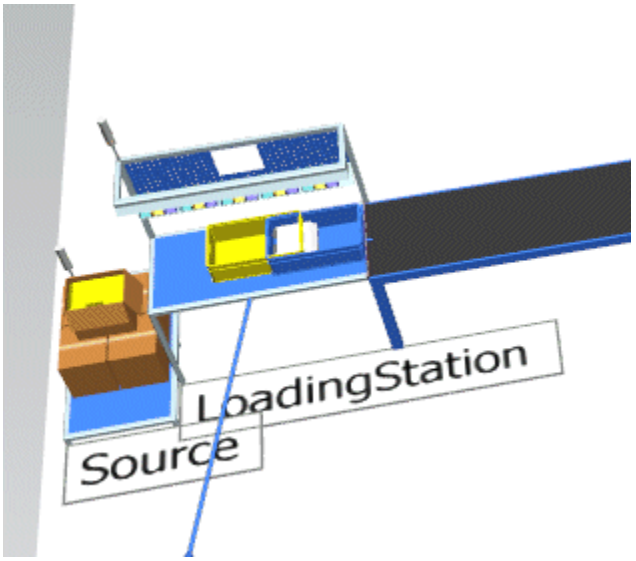
- We selected the transport box named **BoxFor2x1x2Entities.s3d** and clicked **Yes** in the dialog that was opened afterwards.



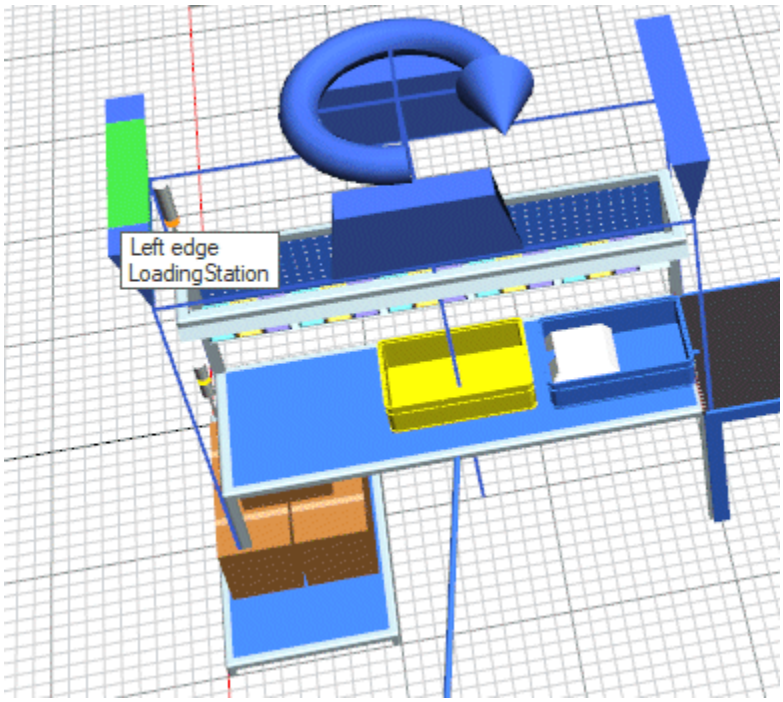
This then looks like this:



- When we run the simulation, we see that an empty transport box that moves onto the *LoadingStation*, overlaps the loaded transport box that is already located there.



- To fix this problem, click the *LoadingStation* and press the **M** key, **Show Manipulators**. Click the left border of the *LoadingStation* and press the Left arrow key until the transport boxes do not overlap any longer.

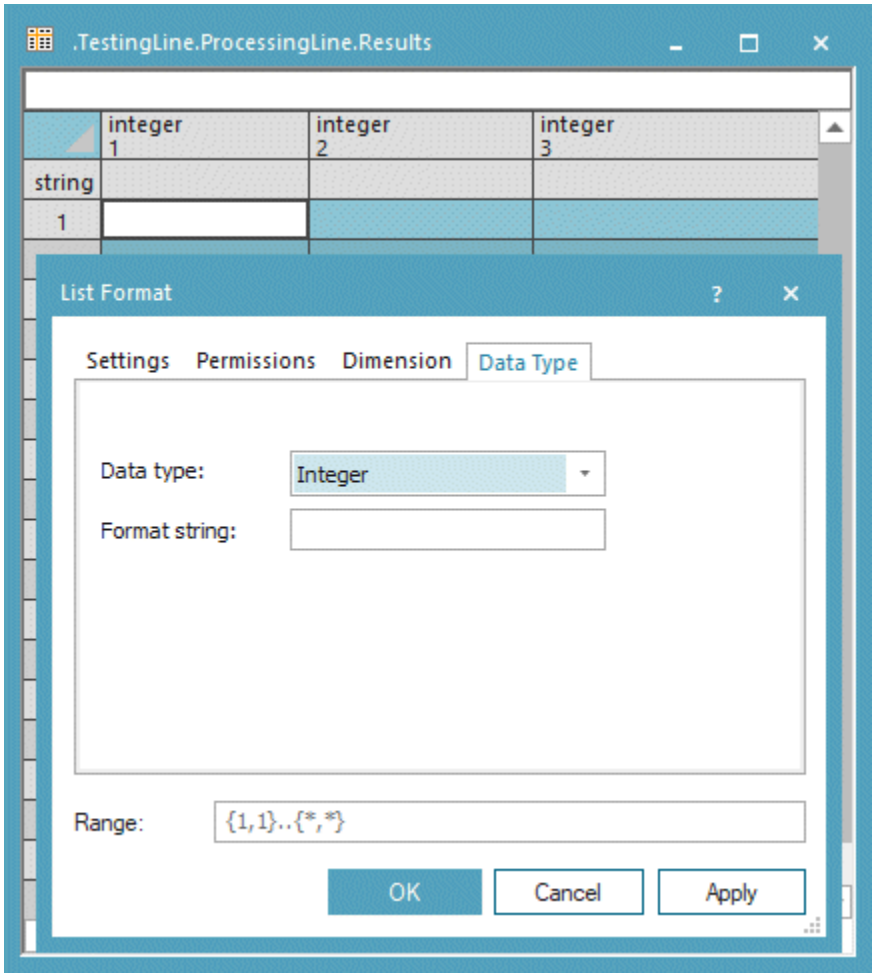


Then you have to move the *Source* to the left to make the positions fit again, as we changed the width of the *LoadingStation*. Now everything looks as it should.

Record Simulation Results in a DataTable

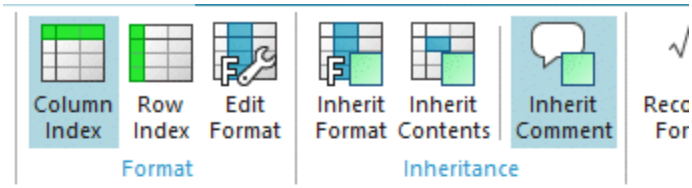
To finish our simulation model, we will insert a *DataTable* to record the ratio of the monitors to DVD players that have been tested.

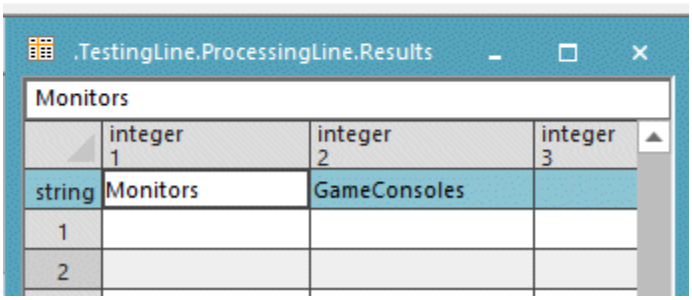
- Insert another *DataTable* on the top right side of our *ProcessingLine*.
- Rename the *DataTable* to `Results`.
- Select the entire table by clicking the button in the top left corner of the cell grid.
- Then, click the right mouse button on the **Select All** button, select **Format**, and change the data type of the cells to **Integer**.
- Click **OK** to apply these changes.



- Now click **Activate Column Index** in the ribbon tab **List**.

- We have now activated the column index, i.e., the column header into which we can enter our product names.
- Enter `Monitors` into row 0, to the right of string, of column 1.
- Enter `GameConsoles` into row 0 of column 2.





- Click in an empty cell and close the table.

The *Results* table can now record the amount of monitors and game consoles that have been tested by the *TestingLine*. The next step will be to modify the **exit control** named *packingControl* of the *Packing station* to record the results.

- Open the *Method* named *packingControl*.
- Edit the source code as follows:

```
if @.cont.name = "Monitor"
   @.move(Monitors)
   Results["Monitors",1] += 1
else
   @.move(GameConsoles)
   Results["GameConsoles",1] += 1
end
```

> Note:
>
> You can also insert the column numbers in place of the index headings **Monitors** and **GameConsoles**.

- Click **Apply Changes** on the **Edit** ribbon tab.
  When you run the simulation, the amount of monitors and game consoles, which have been tested, will be recorded in the *Results* table.

At the moment the numbers of the parts in the *Results* table increase with each and every simulation run. We would like to delete the contents of the table though when we reset the simulation with the *EventController*. To do so, we insert a **reset** method.

- Insert another *Method* object.
- Rename the *Method* to `reset` (notice how the default icon changes).
- Type in the following source code into the **reset** method:

```
Results.delete
```

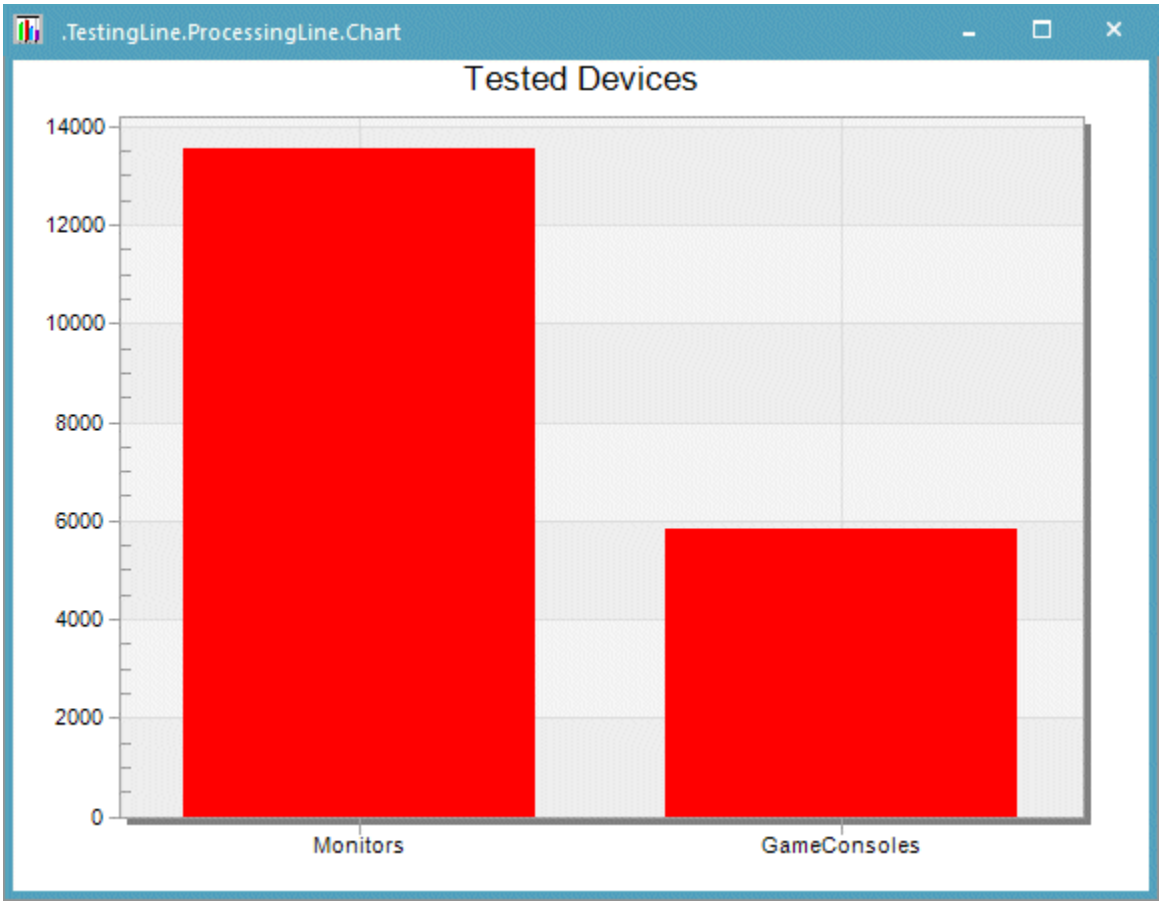
- Click **Apply** in the **Edit** ribbon tab of the *Method* window and close the *Method*.

Run the simulation and compare the results in the table *Results* with the total number of parts that the *Variable* recorded.

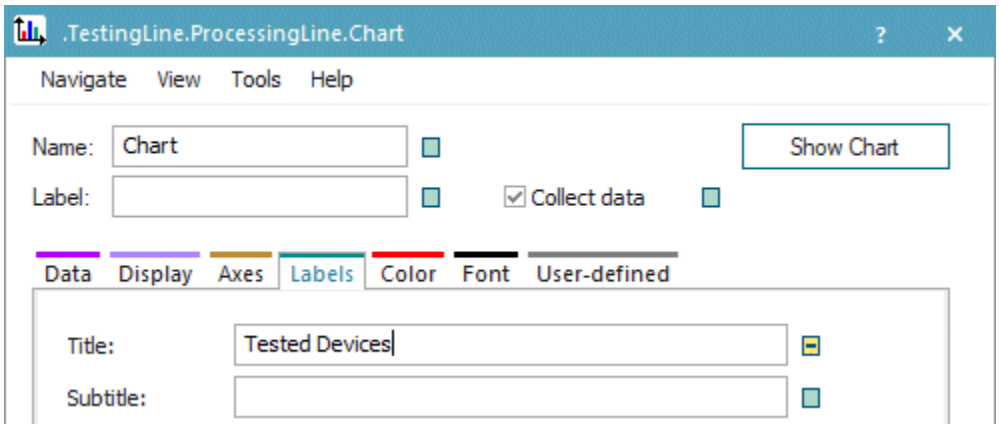
Show Simulation Results in a Chart

We will now insert a **Chart** to view the number of parts that have been tested by our *ProcessingLine*.

- Insert a *Chart* next to the *DataTable* named *Results*.
- Click the *DataTable* named *Results* and hold down the left mouse button.
- Drag the *DataTable* onto the icon of the *Chart* and drop it there.
- This opens a *Chart* of the *DataTable* named *Results*.



We entered the title `Tested Devices` on the **tab Labels** of the *Chart*.



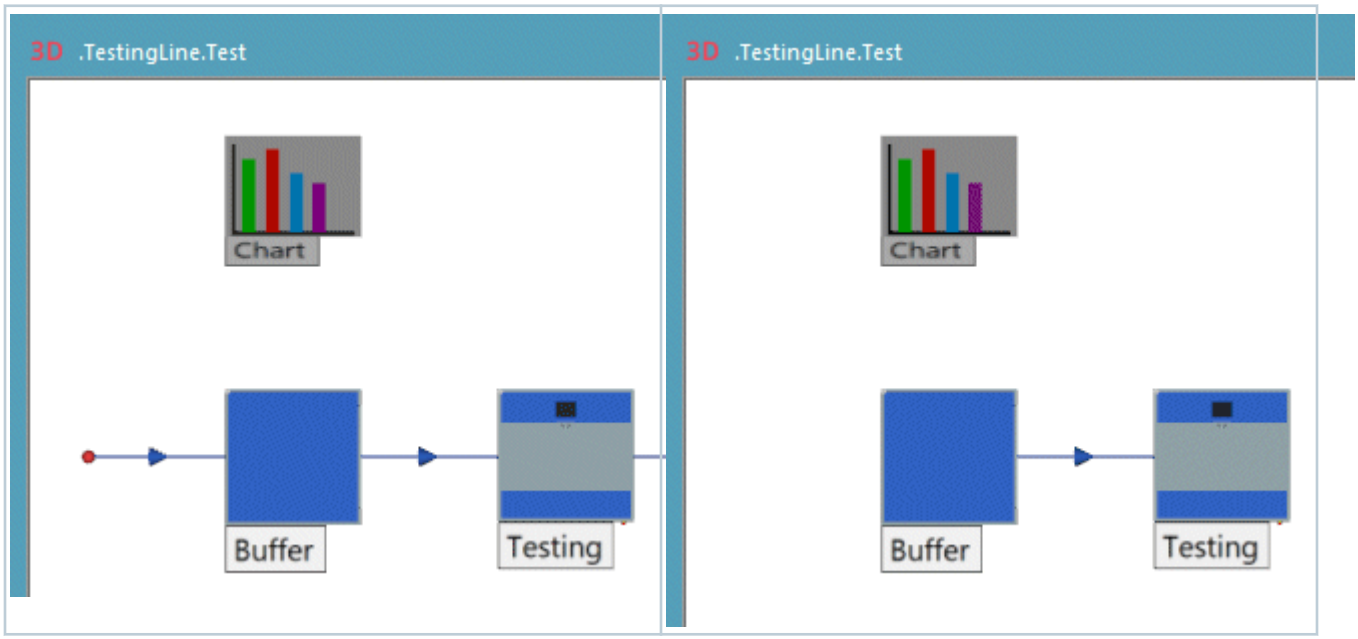
Click the *Chart* with the right mouse button and select **Show** to reopen the display window of the *Chart*.

- Save your simulation model.

Delete the No Longer Needed Interfaces

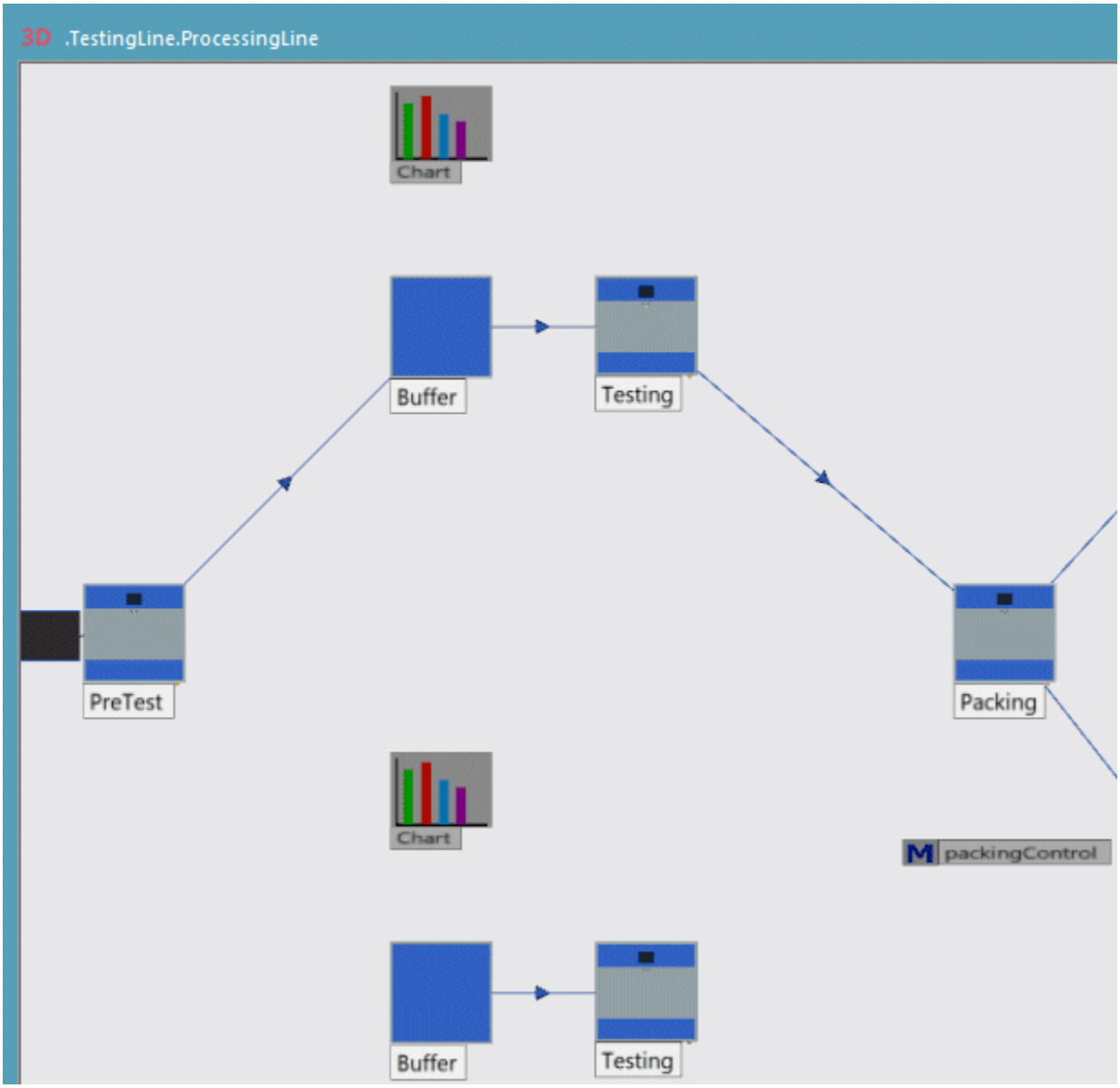
In the current version *sub-Frames* that only contain a single material flow object, you do not have to insert *Interfaces*, but can connect the *sub-Frame* directly with its predecessor and its successor in the surrounding *Frames*. Connections without *Interfaces* only work across a single lower hierarchy level, not across several nested hierarchy levels.

- Open the *Frame* named *Test* in the *Class Library*. Delete the *Interfaces* named *Entry* and *Interface1*.

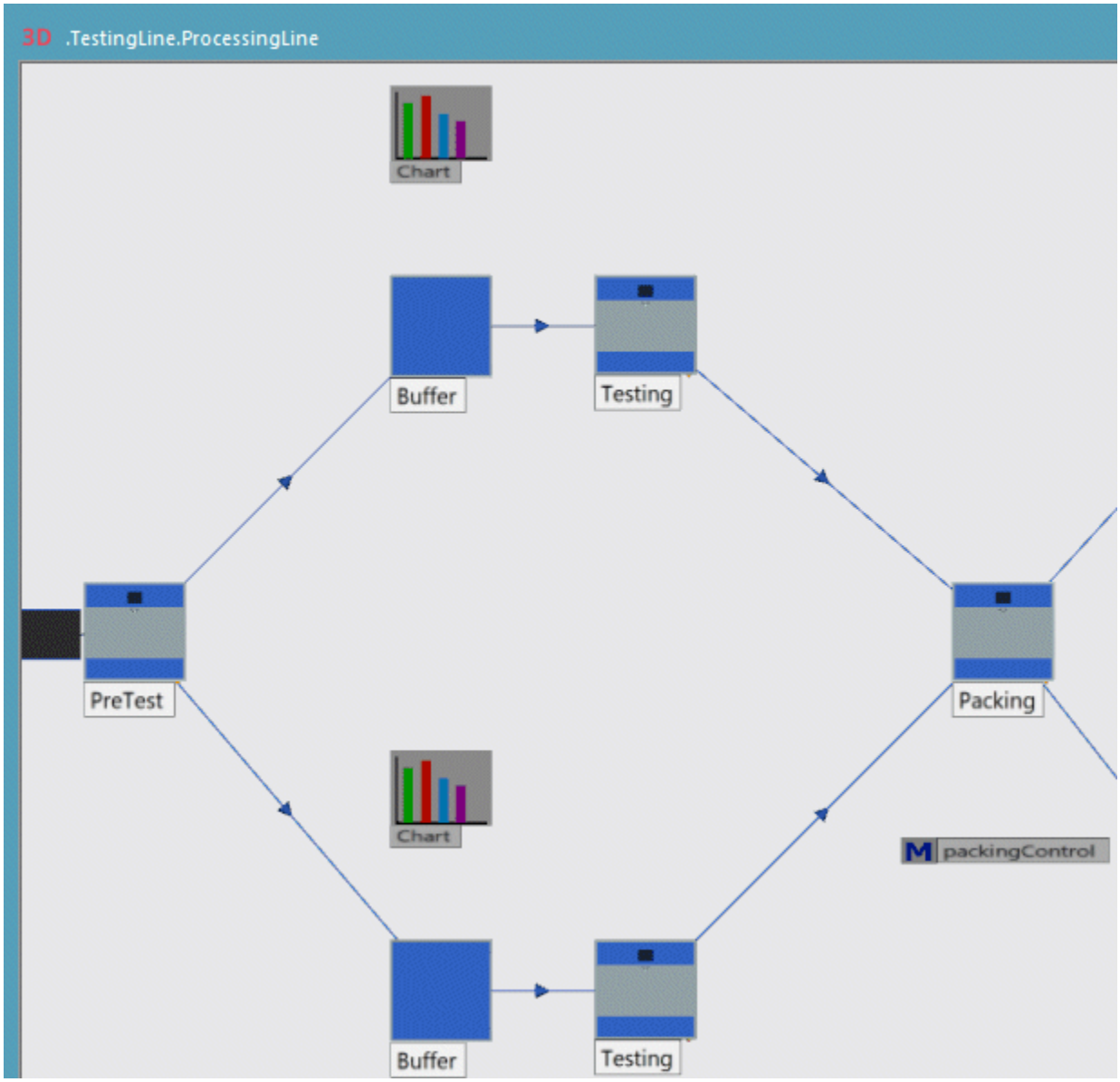


The model now looks like this:

- Connect the station *PreTest* with the *Buffer* in the *Frame Test1* and the station *Testing* with the station *Packing* with a *Connector* each.



- Repeat this for the *Frame Test2*.



- Save your simulation model.

This completes our tutorial as we have solved all of our modeling tasks.

Back to Tutorial Part 1

Back to Tutorial Part 2

Back to Tutorial Part 3

Back to Working Through the Tutorial

Index

Siemens Digital Industries Software

Americas: 1 800 498 5351

EMEA: 00 800 70002222

Asia-Pacific: 001 800 03061910

For additional numbers, click here.

About Siemens Digital Industries Software

Siemens Digital Industries Software is driving transformation to enable a digital enterprise where engineering, manufacturing and electronics design meet tomorrow. Xcelerator, the comprehensive and integrated portfolio of software and services from Siemens Digital Industries Software, helps companies of all sizes create and leverage a comprehensive digital twin that provides organizations with new insights, opportunities and levels of automation to drive innovation. For more information on Siemens Digital Industries Software products and services, visit siemens.com/software or follow us on LinkedIn, Twitter, Facebook and Instagram. Siemens Digital Industries Software – Where today meets tomorrow.

siemens.com/software