



ŠKODA AUTO University

Computer Simulation of Logistics Processes

Standard Objects of Plant Simulation

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Standard Objects of Plant Simulation

Aim of the lecture

- To introduce objects usage and functionalities of the following groups:
 - Information Flow,
 - UserInterface,
 - MUs,
 - Tools.




Standard Objects of Plant Simulation

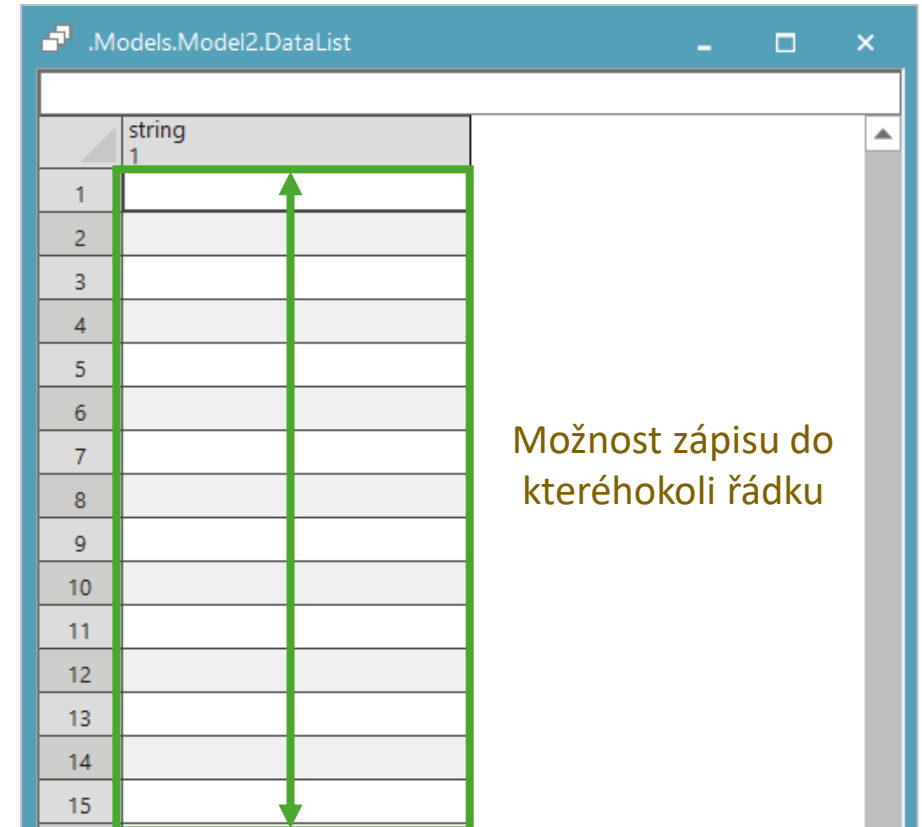
Structure of the lecture

- Standard objects of group “**Information Flow**”:
 - DataList, DataStack, DataQueue.
 - TimeSequence.
 - Trigger, Generator.
 - AttributeExplorer, XMLinterface, FileInterface, FileLink.
- Standard objects of group “**UserInterface**”:
 - Comment, Display, Chart, HtmlReport, Dialog, Checkbox, DropDownList, SankeyDiagramm.
- Standard objects of group “**MUs**”:
 - Part, Container, Transporter.
- Standard objects of group “**Tools**”:
 - BottleneckAnalyzer, ExperimentManager, GAWizard, TransferStation.

Standard Objects of Plant Simulation


DataList

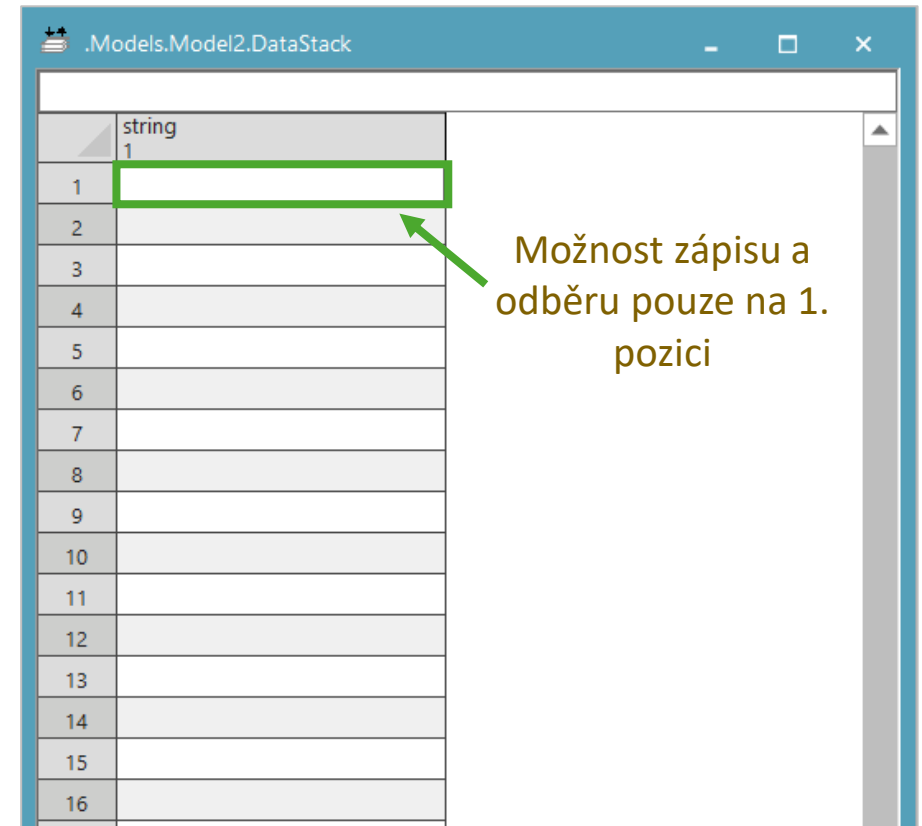
- Icon 
- Object of the group “Information Flow”.
- It is used as a data queue.
- “DataList” is a list with one column, which is characteristic with the possibility of random access to each of positions inside. Each cell is addressed by a row number. An incoming Part causes the movement all other entities behind, they are moved one position lower.
- We can think of it as a “card file catalogue”, similar to those used in libraries.



Standard Objects of Plant Simulation


DataStack

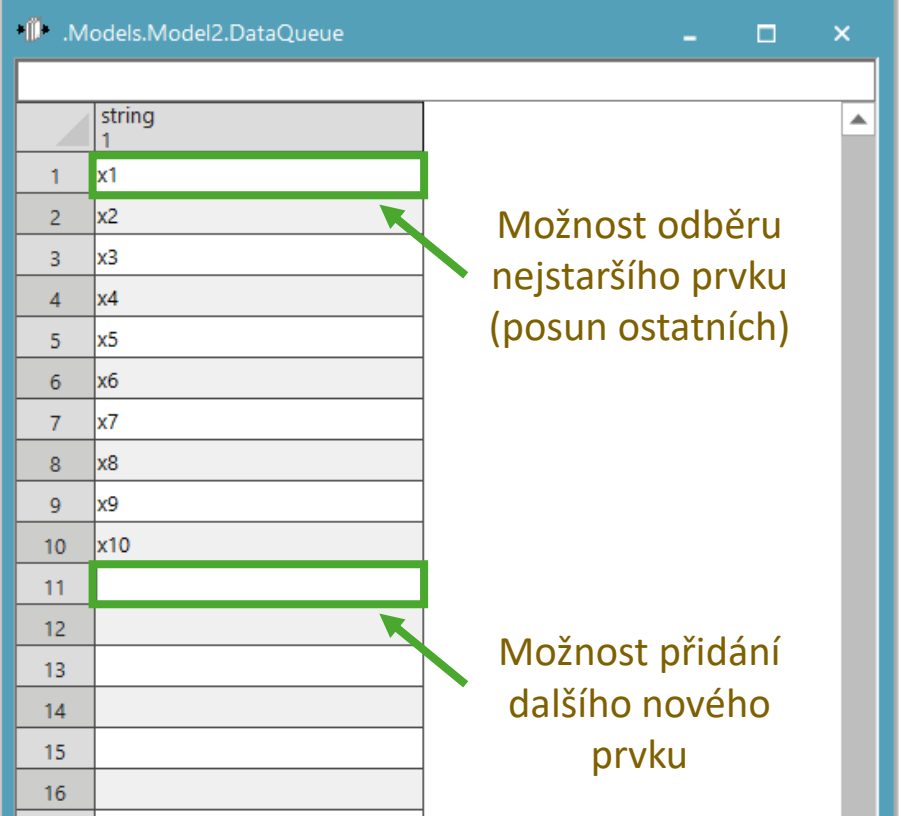
- Icon 
- It is used as a **queue of data** type buffer (stack).
- “DataStack” is a list with **one column**, which is characteristic with the possibility to access to data in strategy **LIFO** (Last In First Out).
- Plant Simulation always accesses to data in objects in the upper row. It always uses the first row for inserting object or its taking-out.
- The example is washing dishes. One person washes the plates and stacks them, another person wipes them, i.e. takes plates from the top of stack. Another example is the system of using shopping carts at shopping centers or stacking pallets.



Standard Objects of Plant Simulation

DataQueue


- Icon 
- It is used as **data queue**.
- “DataQueue” is **a list with one column**, which is characteristic with the possibility to access to data in strategy **FIFO** (First In First Out). Each cell is addressed by a row number.
- The object which enters is written on the new last row of the list. The taken-out object is always the oldest one i.e. on the first row. This leads to one-position-up movement of all objects in the list.
- Typical example of this system is “traffic jam”.

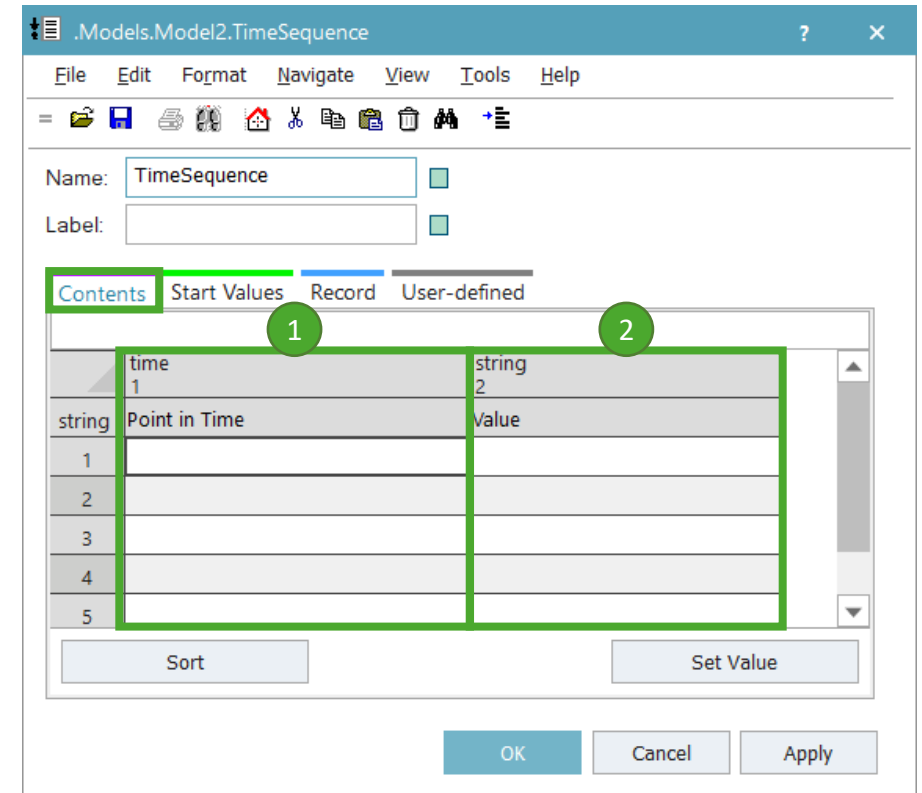


	string
1	x1
2	x2
3	x3
4	x4
5	x5
6	x6
7	x7
8	x8
9	x9
10	x10
11	
12	
13	
14	
15	
16	

Standard Objects of Plant Simulation


TimeSequence

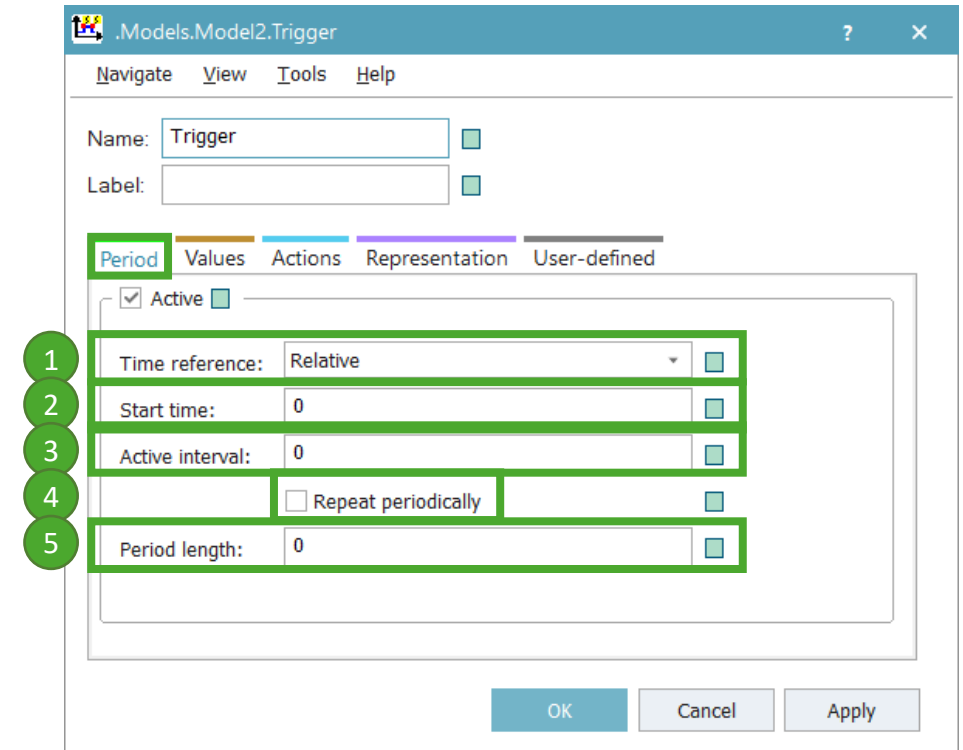
- Icon 
- It is used as a **schedule of time activities**.
- The first column is used for entering of **time values** (1) and the second one for **the values associated** to this time (2).
- It can be used to record, manage time-related values such as shift schedules and equipment maintenance schedules.
- The object behaves as a **list with one column**, where cannot be a blank cell or pairs of blank cells.



Standard Objects of Plant Simulation

Trigger

- Icon 
- It is used as a **trigger of events**.
- “Trigger” is able to **activate methods** and events programmed by them, in the exact time intervals.
- “**Time reference**” allows to set “absolute” or “relative” time (1).
- “**Start time**” represents a time moment, from which “Trigger” starts to work (2).
- “**Active interval**” (3) defines time interval in which the “Trigger” will be active.
- “**Repeat periodically**” allows to repeat cyclically defined interval (4).
- “**Period length**” (5) specifies the duration of one-time cycle during simulation tests. If the box (4) is activated, the cycle will be repeated after the end of period.




The screenshot shows the configuration window for a Trigger object. The 'Period' tab is selected, and the following settings are visible:

- Name: Trigger
- Label: (empty)
- Active:
- Time reference: Relative (1)
- Start time: 0 (2)
- Active interval: 0 (3)
- Repeat periodically: (4)
- Period length: 0 (5)

Buttons at the bottom: OK, Cancel, Apply.

Standard Objects of Plant Simulation


Generator

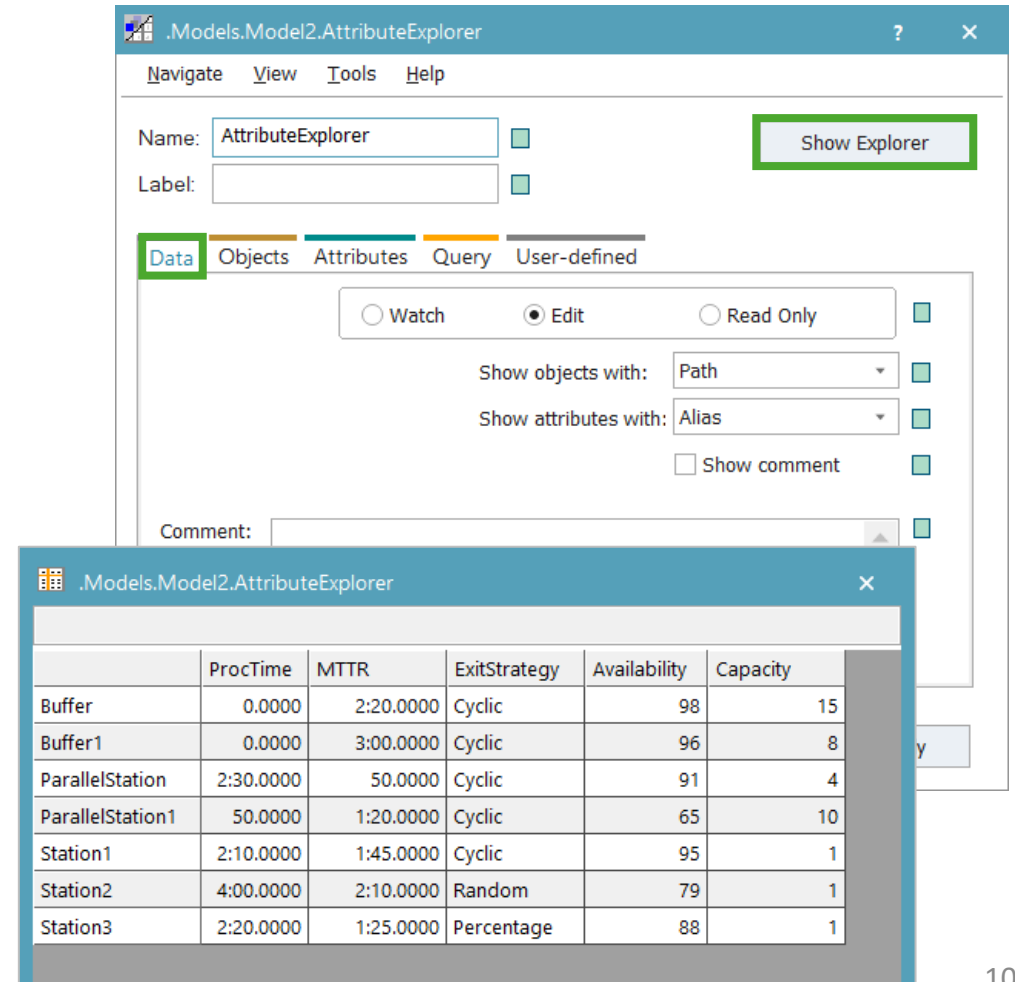
- Icon 
- It is used as a tool to activate methods in specific interval or period.
- Options “Start” and “Stop” activate the first and the last method run (1) and (2).
- “Interval” defines the time between two activations of the interval (2).
- Option (3) assigns a method to that interval.
- “Duration” determines time range between “Interval Control” (3) and “Duration Control” (4). “Duration Control” can occur always after the “Interval Control”.

The image displays two screenshots of the .Models.Model2.Generator configuration window. The top screenshot shows the 'Times' tab with the following fields: Name: Generator, Label: (empty), Active: , Start: Const 0, Stop: Const 0, Interval: Const 0, and Duration: Const 0. The bottom screenshot shows the 'Controls' tab with the following fields: Name: Generator, Label: (empty), Interval: ..., and Duration:

Standard Objects of Plant Simulation

AttributeExplorer

- Icon 
- It is used as a tool for reading, monitoring and modifying attributes of individual objects in one table.
- Different values can be entered, e.g.:
 - Capacities.
 - Processing times.
 - Mean time to repair.
 - Selected strategies.
- Attributes setting can be exported, table modification can be done afterwards out PS (e.g. in MS Excel) and then imported back again. We can test several variants.




The screenshot shows the Attribute Explorer tool interface. The top window is titled ".Models.Model2.AttributeExplorer" and has a menu bar with "Navigate", "View", "Tools", and "Help". Below the menu bar, there are input fields for "Name:" (containing "AttributeExplorer") and "Label:". To the right of the "Name:" field is a "Show Explorer" button. Below these fields are tabs for "Data", "Objects", "Attributes", "Query", and "User-defined". The "Data" tab is selected. Under the tabs, there are radio buttons for "Watch", "Edit" (selected), and "Read Only". There are also dropdown menus for "Show objects with:" (set to "Path") and "Show attributes with:" (set to "Alias"). A "Show comment" checkbox is also present. At the bottom of this window is a "Comment:" text area.

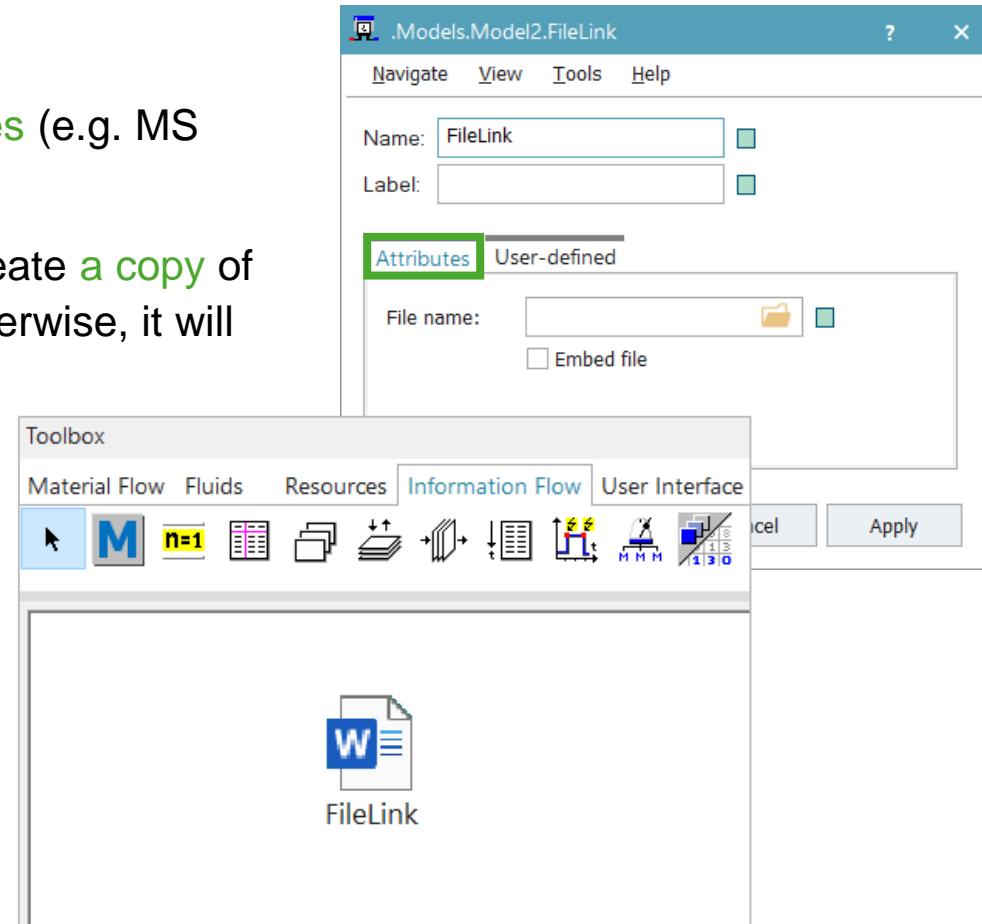
The bottom window, also titled ".Models.Model2.AttributeExplorer", displays a table with the following data:

	ProcTime	MTTR	ExitStrategy	Availability	Capacity
Buffer	0.0000	2:20.0000	Cyclic	98	15
Buffer1	0.0000	3:00.0000	Cyclic	96	8
ParallelStation	2:30.0000	50.0000	Cyclic	91	4
ParallelStation1	50.0000	1:20.0000	Cyclic	65	10
Station1	2:10.0000	1:45.0000	Cyclic	95	1
Station2	4:00.0000	2:10.0000	Random	79	1
Station3	2:20.0000	1:25.0000	Percentage	88	1

Standard Objects of Plant Simulation


FileLink

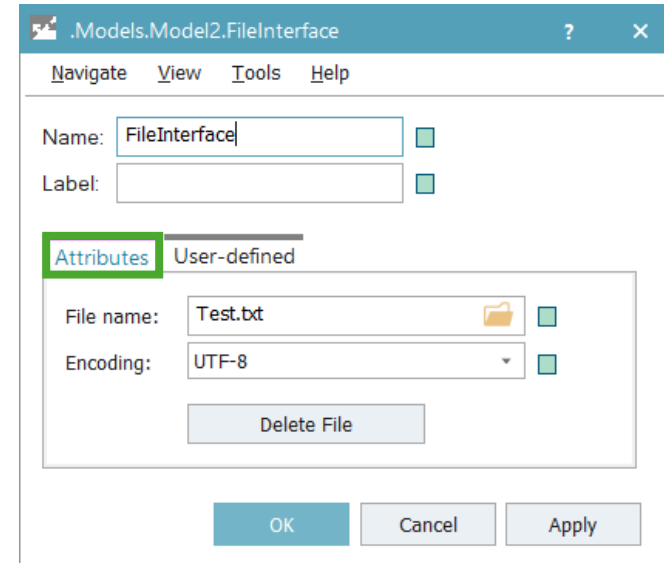
- Icon 
- It is used for inserting of files from different data sources (e.g. MS Office), straight into the “Frame” (1).
- While inserting a file we are asked (2), if we want to create a copy of file in the “Frame”? Selecting “Yes” will ensure this, otherwise, it will be only a link on the file.



Standard Objects of Plant Simulation


FileInterface

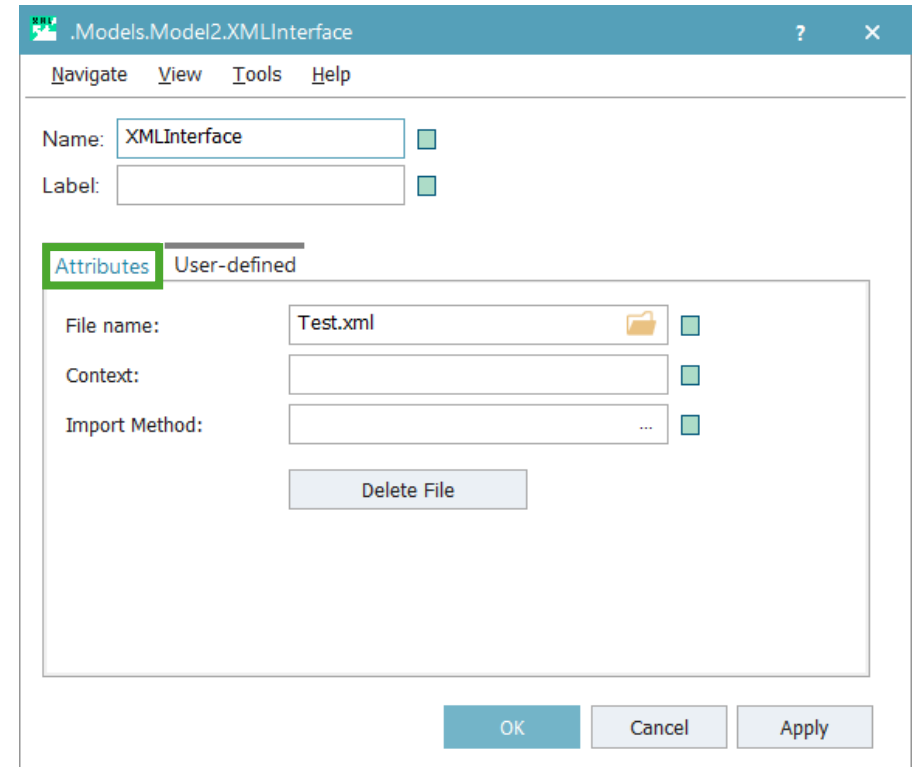
- Icon 
- With this object we can **access to data created in other applications**. So, we can create “*.txt” files and import them into the PS environment during simulation run.
- “FileInterface” supports **only characters** of following **type**:
 - Letters.
 - Numbers.
 - Special characters.



Standard Objects of Plant Simulation


XMLinterface

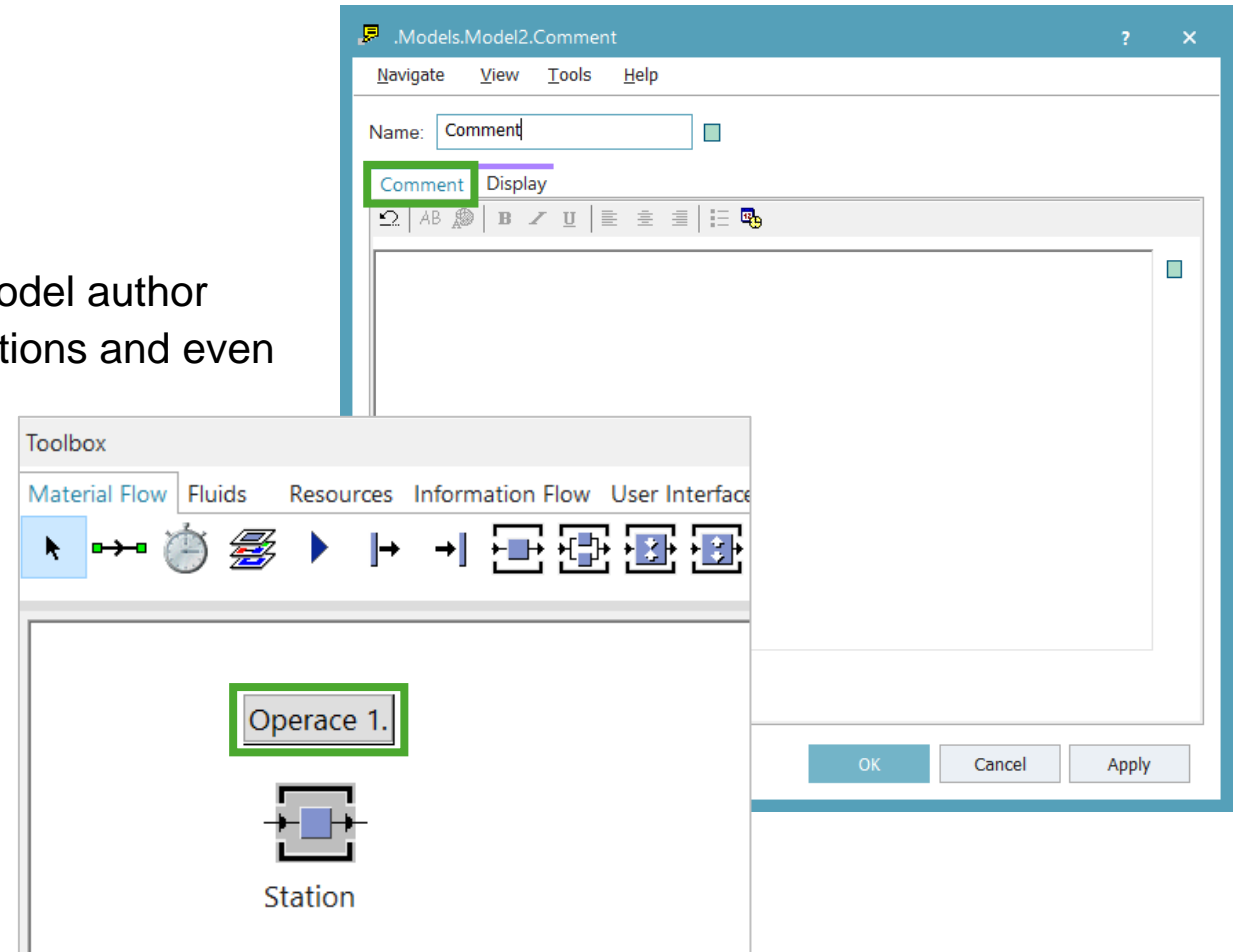
- Icon 
- It is used as a tool for **reading and retrieving data from XML files**.
- XML documents have defined structure in **ASCII format**.
- In this way, data can be loaded in PS e.g. data exported from Process Designer or XML databases.



Standard Objects of Plant Simulation


Comment

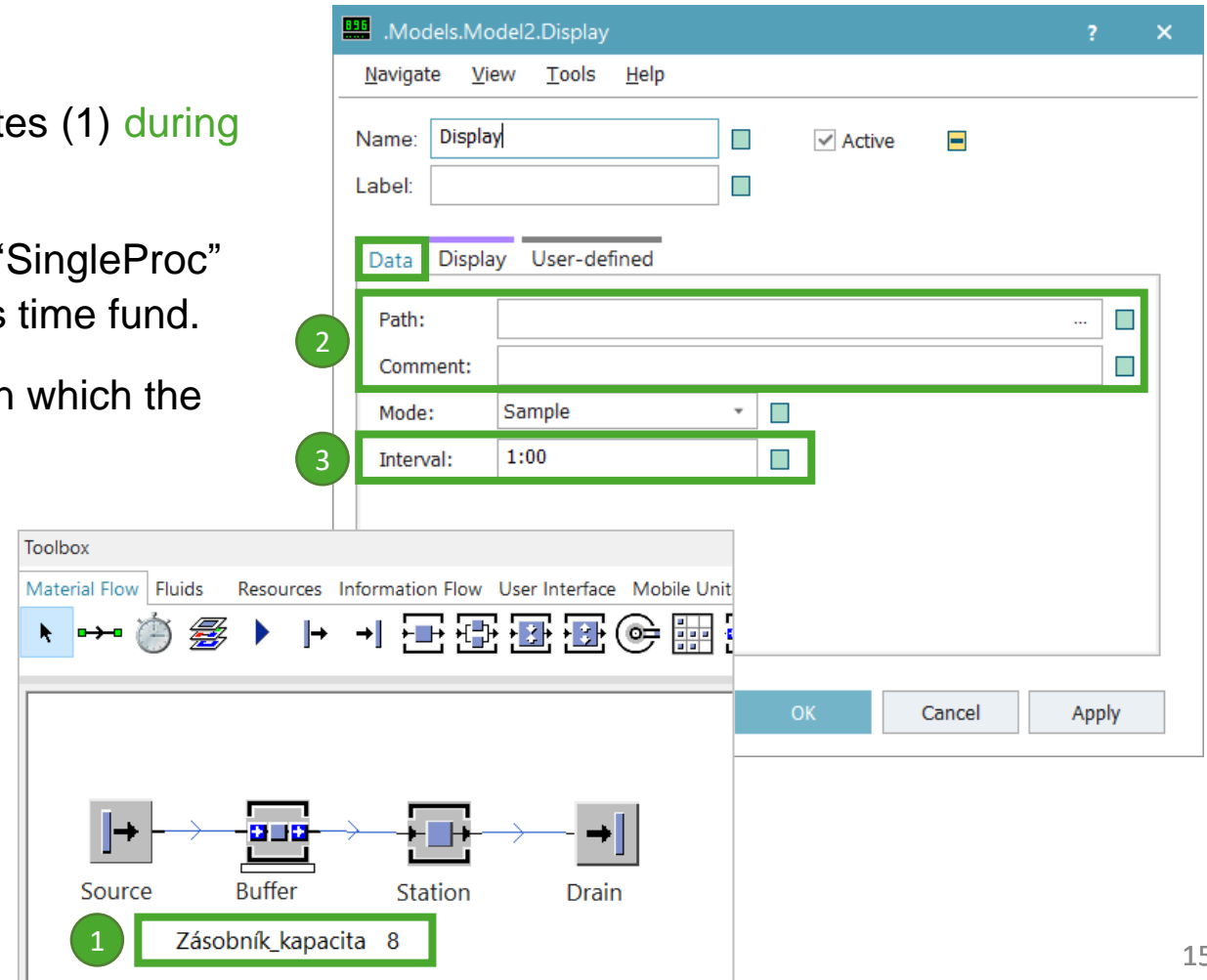
- Icon 
- Object of the group “User Interface”.
- It is used to describe model in words.
- It is useful mainly for teams of coworkers, where the model author can describe and explain useful details, particular situations and even more difficult and complex logic of the model etc.
- It contains simple editor, so it is possible to work with different letter fonts and colors.



Standard Objects of Plant Simulation

Display


- Icon 
- Object, which is able to show values of different attributes (1) during the simulation run.
- In displayed figure, it monitors failures value of station “SingleProc” i.e. what is the percentage of failures (2) in the device’s time fund.
- The option “Interval” (3) allows to define time interval, in which the values of the object “Display” will be updated.

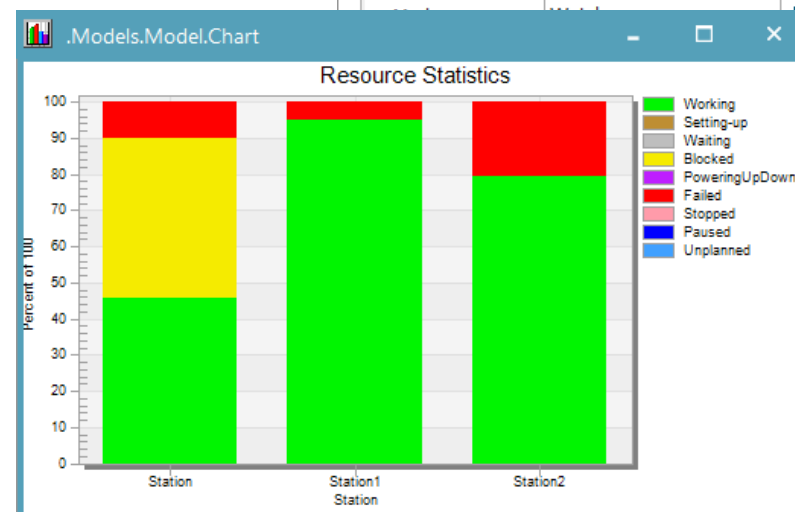
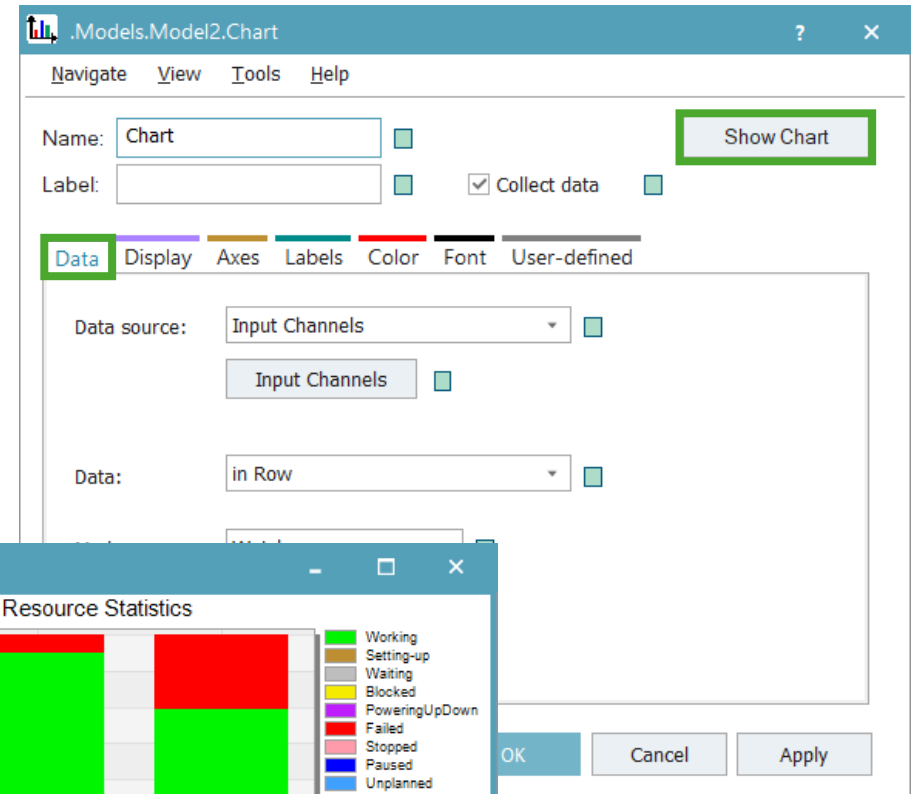


The screenshot shows the configuration window for a Display object in Plant Simulation. The window title is ".Models.Model2.Display". It has a menu bar with "Navigate", "View", "Tools", and "Help". The "Name" field is set to "Display" and the "Active" checkbox is checked. The "Label" field is empty. The "Data" tab is selected, showing the "Display" sub-tab. The "Path" field is empty, and the "Comment" field is empty. The "Mode" is set to "Sample". The "Interval" is set to "1:00". The "Toolbox" is visible at the bottom, showing the "Material Flow" tab with various icons. A diagram below the toolbox shows a process flow: Source -> Buffer -> Station -> Drain. The "Zásobník_kapacita 8" attribute is highlighted with a green box and labeled with a circled "1".

Standard Objects of Plant Simulation


Chart

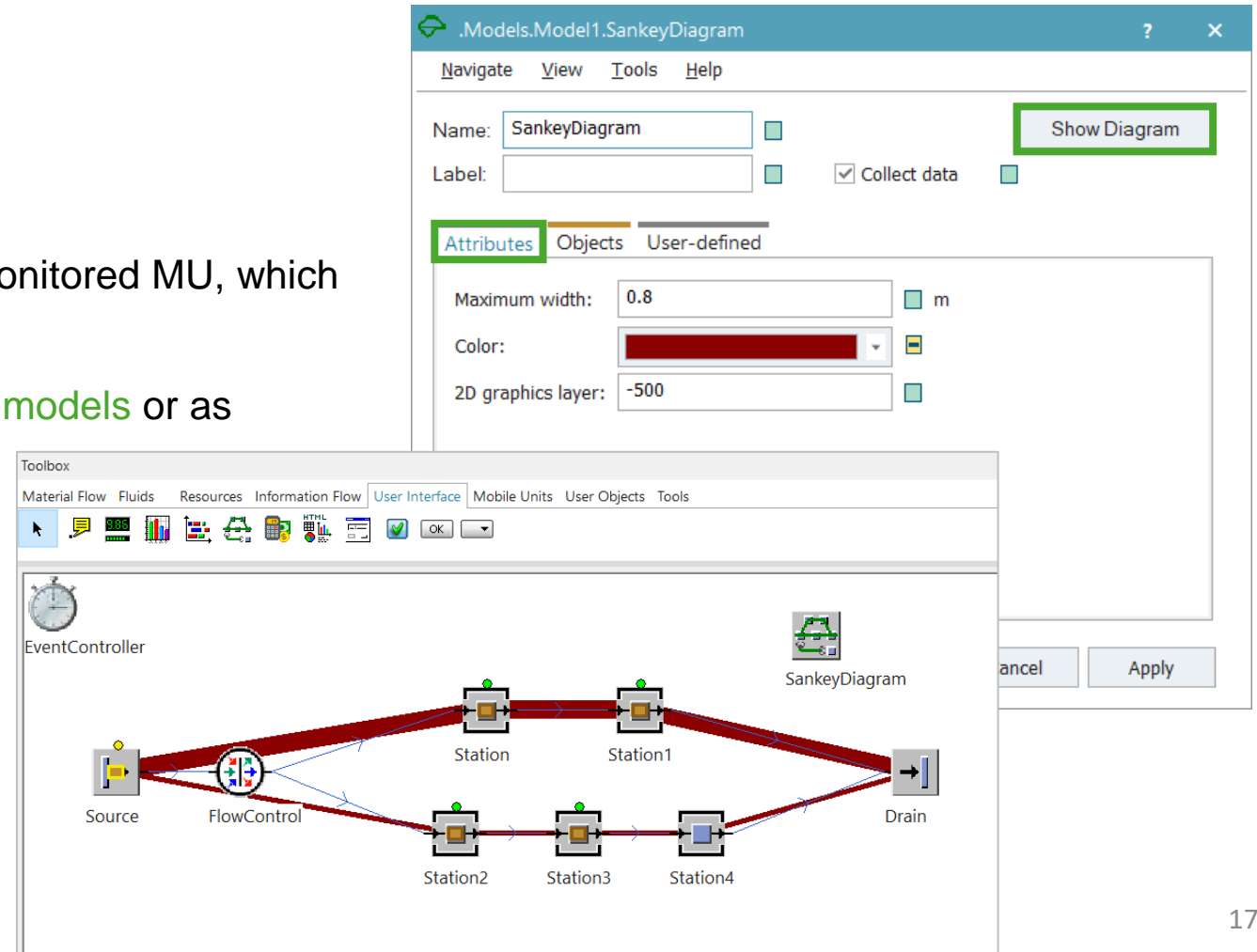
- Icon 
- The object allows to **graphically display the process of monitored variables** in simulation time.
- Graphs are very useful not only for the **presentation** of simulation experiments outputs, but also in the phase of model **validation**.
- We can select from several **graph types** (e.g. line, bar, histogram etc.).
- Graphs can be **displayed** by clicking on the icon, or by animating of this icon as graph itself. Then it is possible to monitor the graph activity directly in the "Frame" during the simulation experiment.
- Interval of the graph update** can be set (it is related to the speed of the simulation experiment).



Standard Objects of Plant Simulation

SankeyDiagramm

- Icon 
- Object of the group “Tools”.
- SankeyDiagramm shows **material flow intensity**.
- It is possible to see individual graph for each of monitored MU, which represents **individual intensity in production mix**.
- This functionality is **useful for debugging complex models** or as a supporting material for **presenting** the results of simulation experiments.



The image shows two screenshots from a simulation software interface. The top screenshot is a configuration window for a SankeyDiagramm object. The window title is ".Models.Model1.SankeyDiagramm". It has a menu bar with "Navigate", "View", "Tools", and "Help". The "Name" field is set to "SankeyDiagramm". The "Label" field is empty. There is a "Show Diagram" button highlighted with a green box. A "Collect data" checkbox is checked. Below the configuration fields are tabs for "Attributes", "Objects", and "User-defined". The "Attributes" tab is active, showing "Maximum width" set to 0.8 m, "Color" set to a dark red color, and "2D graphics layer" set to -500. The bottom screenshot shows a simulation model diagram with a "Toolbox" at the top. The toolbox has tabs for "Material Flow", "Fluids", "Resources", "Information Flow", "User Interface", "Mobile Units", "User Objects", and "Tools". The "Tools" tab is active, showing various icons. The main diagram area shows a flow network with a "Source" on the left, a "FlowControl" object, and a "Drain" on the right. The flow network consists of "Station" and "Station1" in the top row, and "Station2", "Station3", and "Station4" in the bottom row. Red arrows represent the material flow between these stations. A "SankeyDiagramm" icon is visible in the top right corner of the diagram area.

Standard Objects of Plant Simulation

HtmlReport

- Icon
- An object used to display the results of simulation tests into overview images, tables and diagrams via HTML page.

Generated on: 2023/02/20 22:29:29.6170

Model

Statistics

State Statistics

Object	Working	Set-up	Waiting	Blocked	Powering up/down	Failed	Stopped	Paused	Unplanned	Portion
Drain	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	
Source	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	
Station	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	
Station1	100.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	
Station2	29.93%	0.00%	0.00%	0.00%	0.00%	70.07%	0.00%	0.00%	0.00%	
Station3	29.93%	0.00%	70.07%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	
Station4	29.93%	0.00%	70.07%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	

Portions of the States

Drain Statistics

.Models.Model1.HtmlReport

Navigate View Tools Help

Name:

Label:


Content User-defined

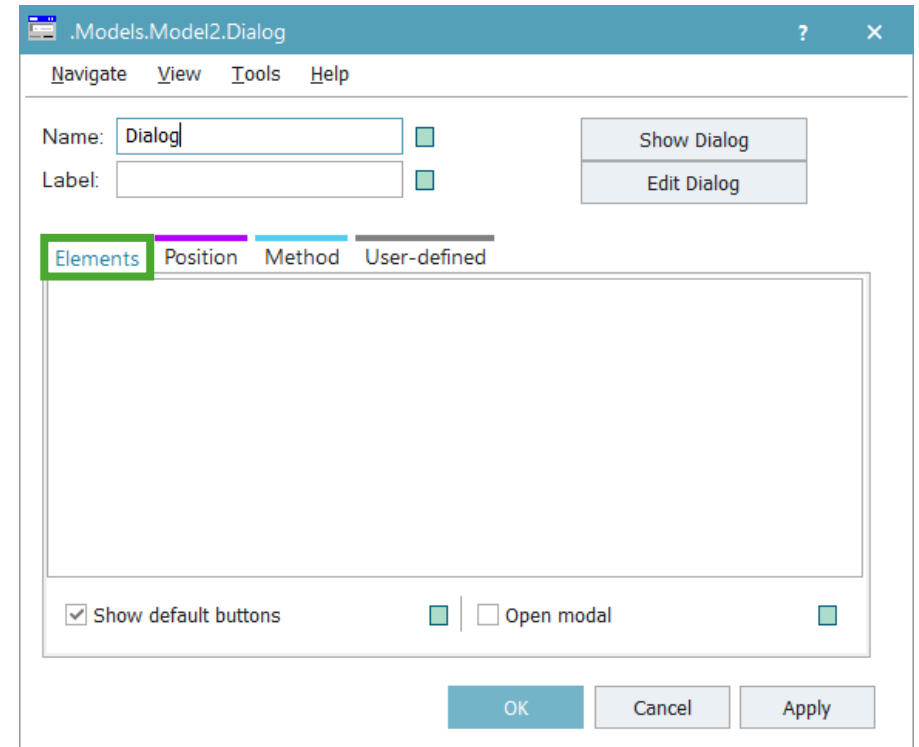
```
[!self, Header, *]
# General Information
## Overview
* Model file: [=modelFile]
* Simulation root: [EventController.Location]
* Simulation time: [EventController.SimTime]
* End time: [EventController.End]
* Generated on: [=sysdate]

## Model
><[current, *]
# Statistics
## State Statistics
[current, %States]
```

Standard Objects of Plant Simulation


Dialog

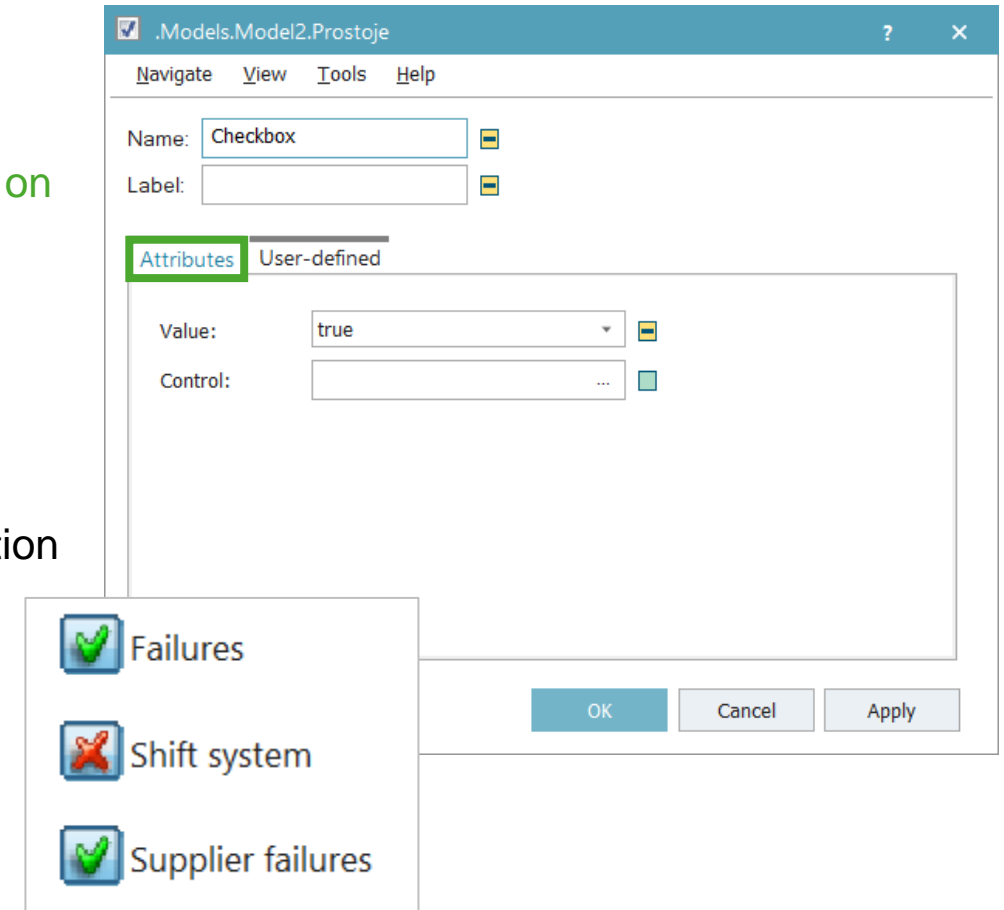
- Icon 
- It allows to **create dialog interface** for more complex models that users can work with. In this way, the PS model gets important information for the right run of simulation experiment.
- The interface **prevents from accessing** the model and making incorrect changes by **uninformed users**.



Standard Objects of Plant Simulation




Checkbox

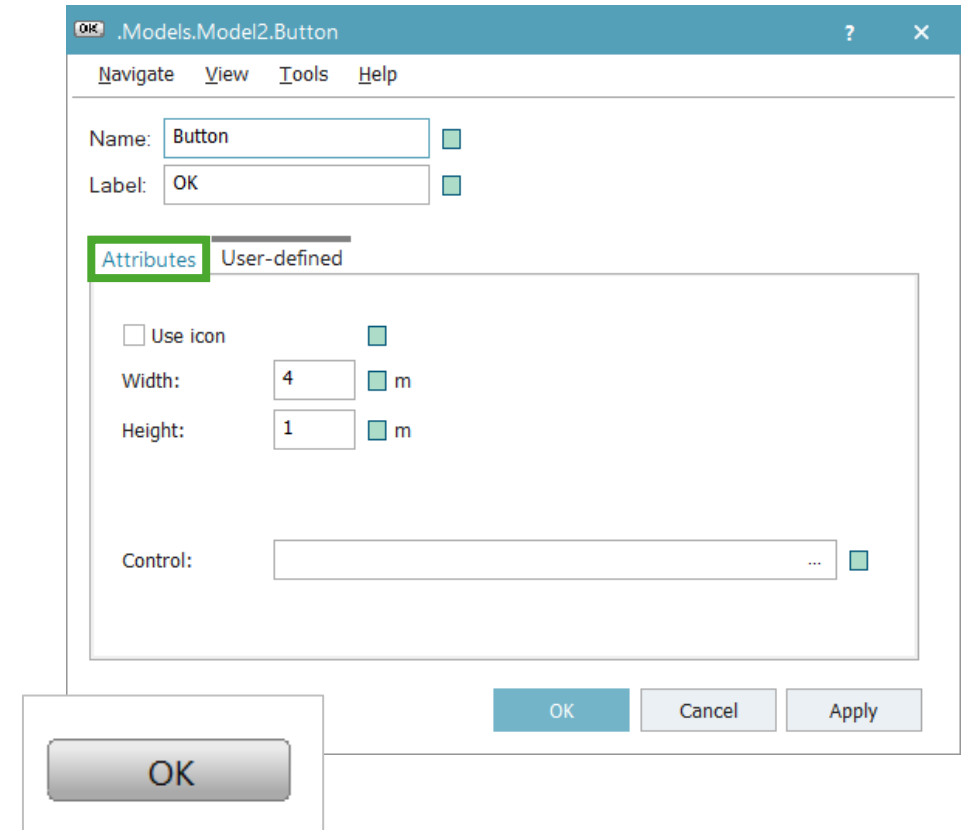
- Icon 
- Allows to define **quick interface**, which allows to change variable parameters (and even the conditions in the model) **by just one click on box**.
- Variable is “**Boolean**” type, i.e. “True/False”.
- It is **an individual option for PS user**, i.e. possibility of programming “Checkbox” functionalities by form of method are quite wide.
- In case of simulation tests it is possible to enter whether the simulation experiment will respect Failures (YES), Shift system (NO), Supplier failures (YES).



Standard Objects of Plant Simulation


Button

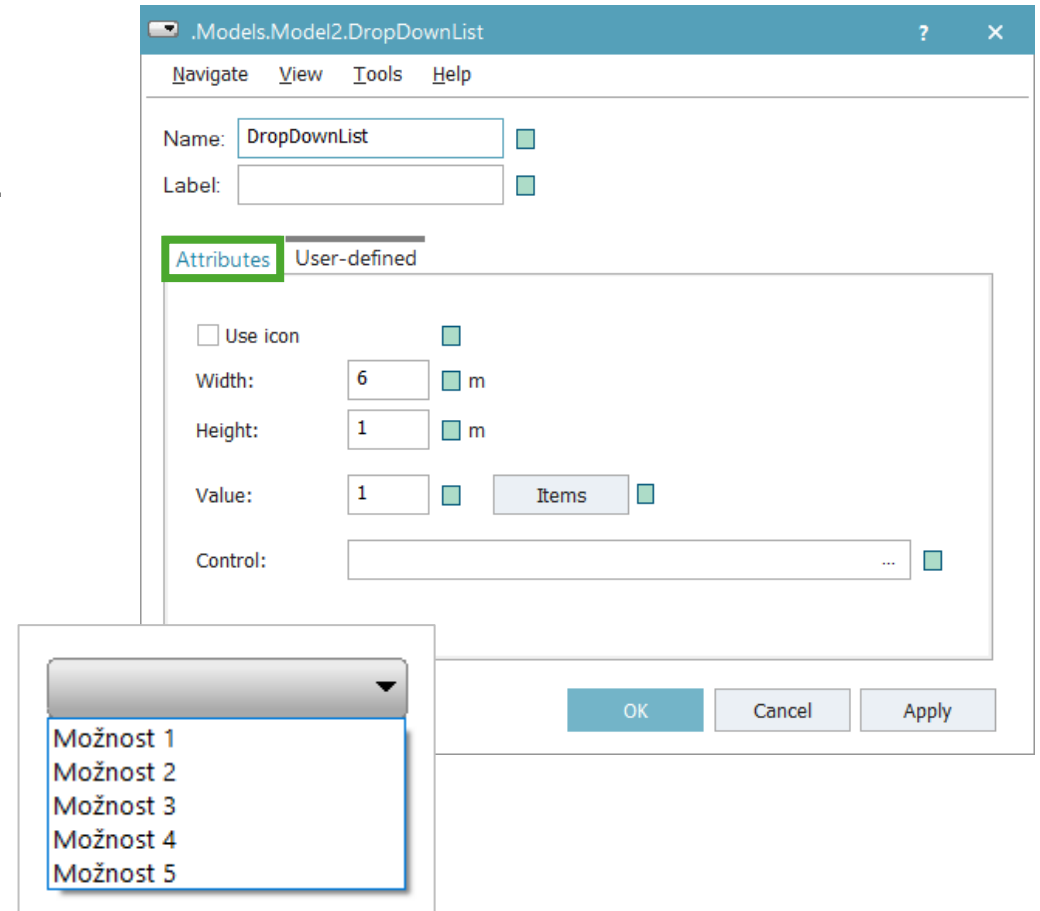
- Icon 
- The button allows to do action, **programmed via method**, which is entered in the dialog box Control.
- It is useful **to change the icon image**:
 - e.g. to start video 
 - and to stop video 



Standard Objects of Plant Simulation


DropDownList

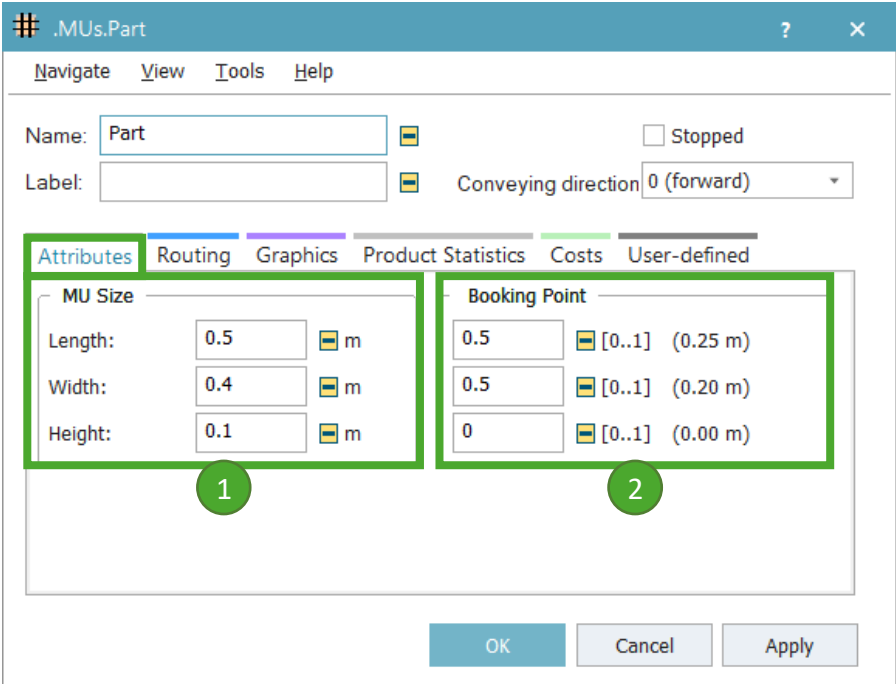
- Icon 
- Characteristics are similar as the “Checkbox” has, but with the possibility to define more variants, which can be changed by user. Typically, it can be different variants of input data or different management strategies for a given production area.
- It is individual option of PS user, i.e. possibilities of programming “User Interface” functionalities by form of method are quite wide.



Standard Objects of Plant Simulation

Part


- Icon 
- Object of the group “Mobile Units”.
- Basic object, which represents a moving material object, without the possibility to carry some other objects.
- We can consider this object as:
 - Product.
 - Part.
 - Component part.
- “Part” has defined length, width and height (1).
- “Booking Point” (2) define the point from which the “Part” is identified by other objects as incoming. It is important parameter of length-oriented objects and it is often located in the center of the “Part”.

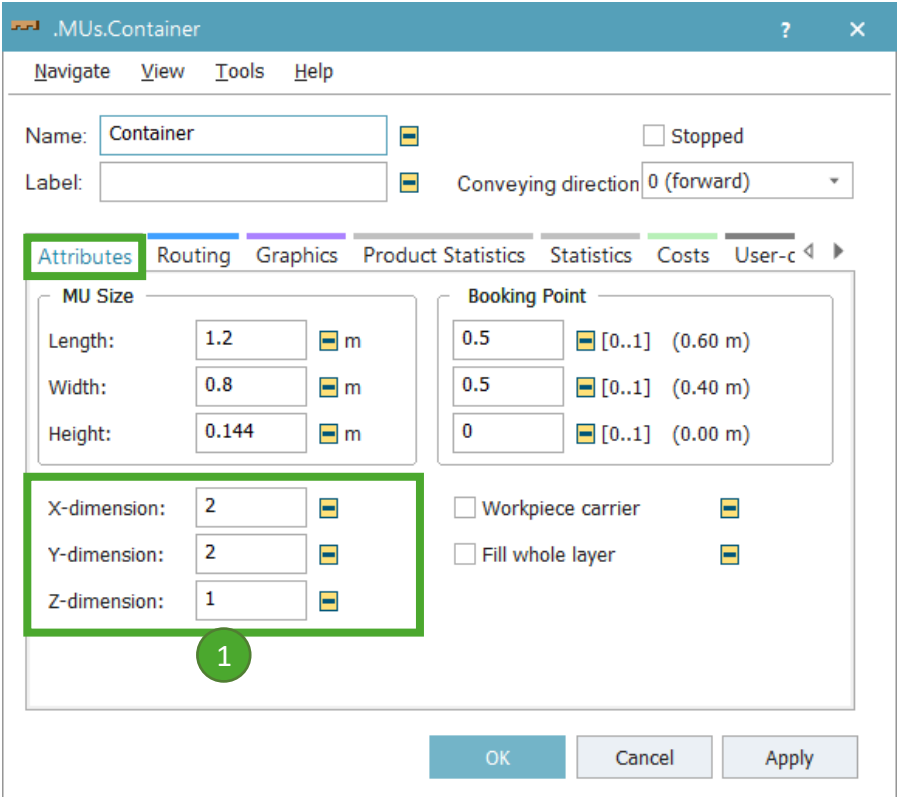


The screenshot shows the configuration window for a Mobile Unit (MU) of type 'Part'. The 'Attributes' tab is selected, and two sections are highlighted with green boxes and numbered 1 and 2. Section 1, 'MU Size', contains three input fields: Length (0.5 m), Width (0.4 m), and Height (0.1 m). Section 2, 'Booking Point', contains three input fields: 0.5 [0..1] (0.25 m), 0.5 [0..1] (0.20 m), and 0 [0..1] (0.00 m). The 'Name' field is set to 'Part' and the 'Conveying direction' is set to '0 (forward)'. There are 'OK', 'Cancel', and 'Apply' buttons at the bottom.

Standard Objects of Plant Simulation


Container

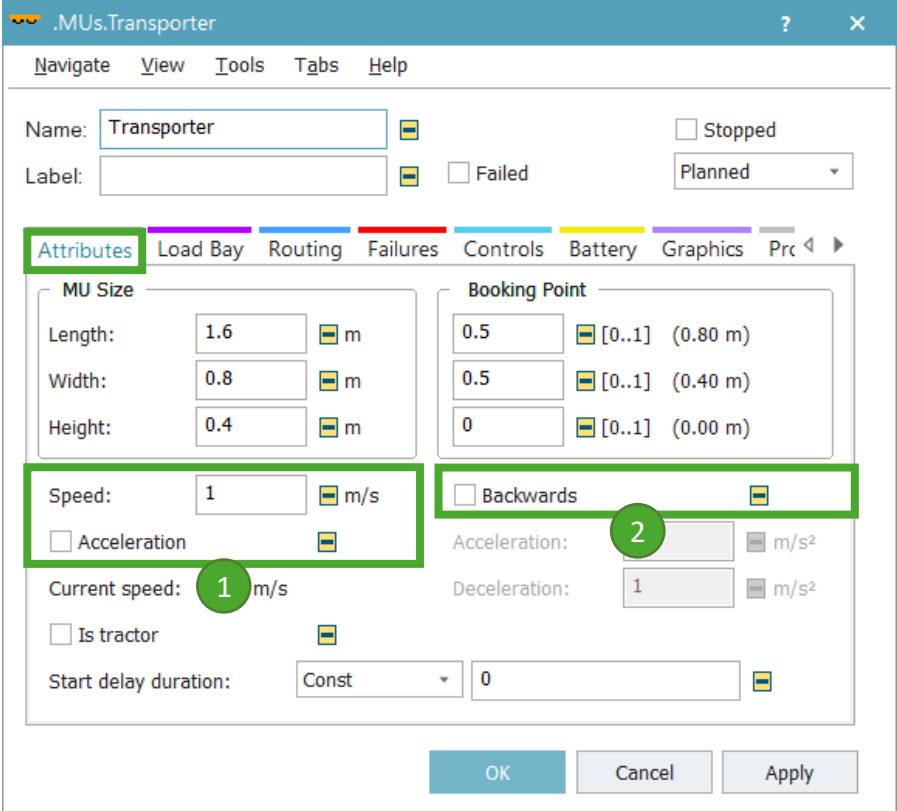
- Icon 
- Object of the group “Mobile Units”.
- “Container” represents a moving object, which is possible to carry some other objects of “Part” or “Container” type.
- We can consider this objects as:
 - Pallet.
 - Crate.
 - Box.
- The capacity carried by the “Container” is defined by “X-dimension”, “Y-dimension” and “Z-dimension” (1) of the loading space.



Standard Objects of Plant Simulation

Transporter

- Icon 
- “Transporter” is an active object of the material flow.
- It moves itself on the **length-oriented objects** (forwards or backwards):
 - “Track”.
 - “TwoLineTrack”.
- It is **able to carry** “Part”, “Container” or another “Transporter”.
- The object has several **parameters** such as:
 - Speed and acceleration (1).
 - Backward drive (2).
 - Use as a "Tractor" (for pull and push transport systems).
 - Automatic finding of a path.



.MUs.Transporter

Navigate View Tools Tabs Help

Name: Transporter Stopped

Label: Failed Planned

Attributes Load Bay Routing Failures Controls Battery Graphics Prc

MU Size

Length: 1.6 m

Width: 0.8 m

Height: 0.4 m

Booking Point

0.5 [0..1] (0.80 m)

0.5 [0..1] (0.40 m)

0 [0..1] (0.00 m)

Speed: 1 m/s Acceleration

Backwards Acceleration: 2 m/s² Deceleration: 1 m/s²

Current speed: 1 m/s

Is tractor

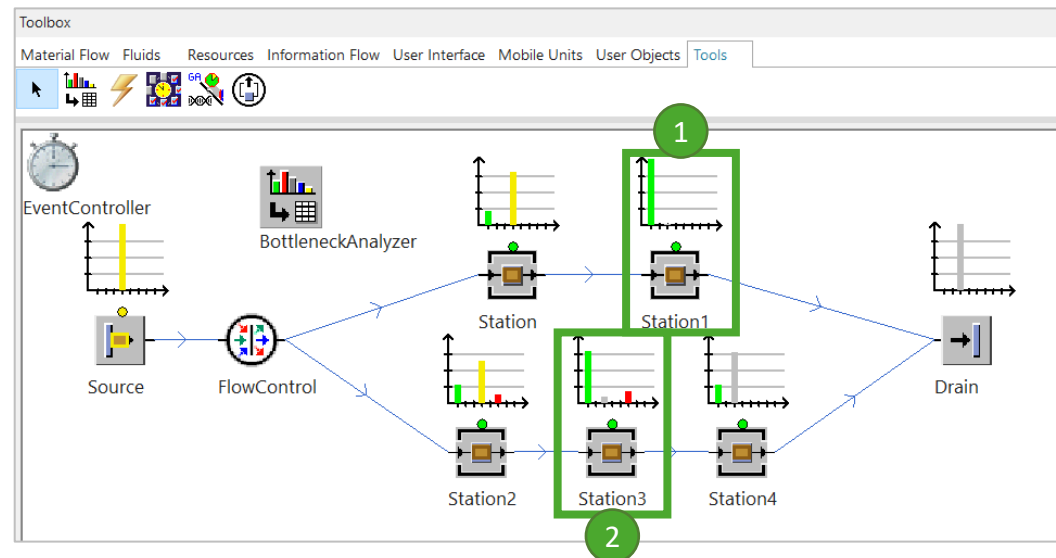
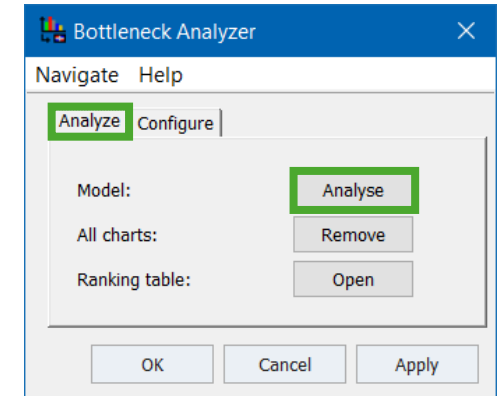
Start delay duration: Const 0

OK Cancel Apply

Standard Objects of Plant Simulation


BottleneckAnalyzer

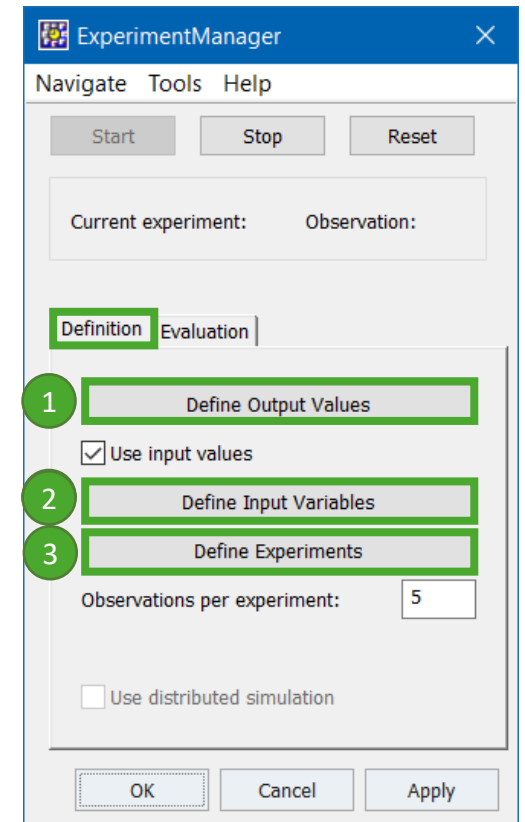
- Icon
- Object of the group “Tools”.
- The objects displays static statistical data of simulation in the form of charts (1) and (2). It is not possible to monitor these data during the simulation run, only after its end.
- In the figure, objects Station1 and Station3 are probably the bottleneck places of individual branches of production flow (they use 100% of processing time and cause waiting at previous workplaces). We can assume that by speeding up processing on the bottleneck places, the throughput of the system, as a whole, is increased (up to the limit of another bottleneck).



Standard Objects of Plant Simulation

ExperimentManager

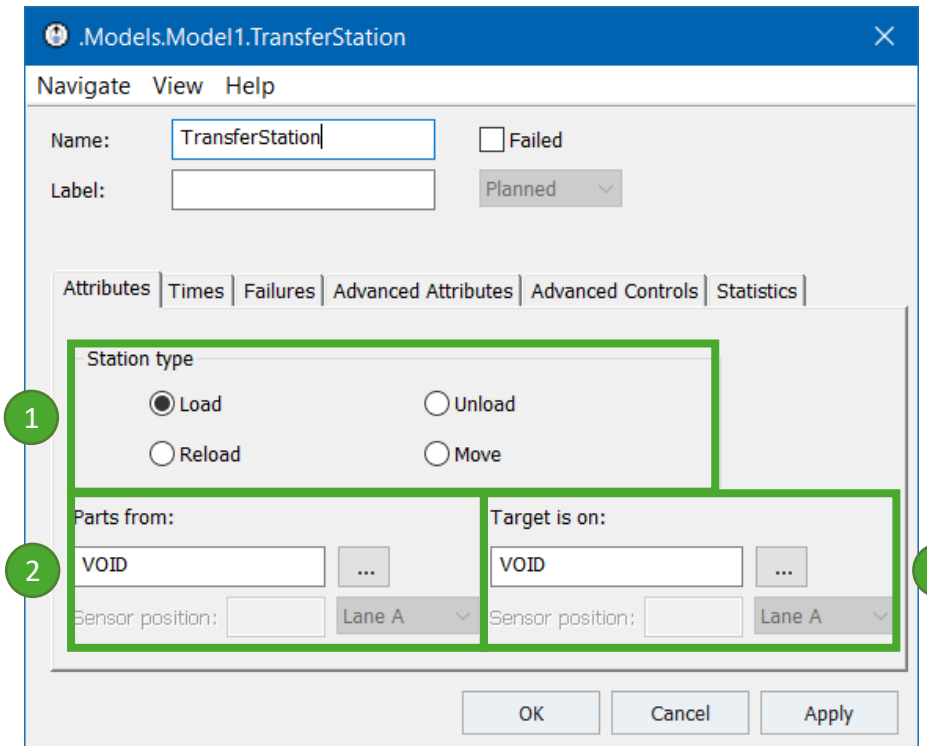
- Icon 
- Object of the group “Tools”.
- An effective tool for **running** large-scale **experiments**.
- **Useful** when:
 - we are searching different variants of inputs,
 - we want to achieve statistically significant results.
- A typical use is to define experiments and run simulation experiments overnight (only one license is needed).
- For right **functionality** it is necessary to define:
 - Output values (1).
 - Input values (2).
 - Matrix of experiments (3).



Standard Objects of Plant Simulation

TransferStation

- Icon
- Object of the group “Tools”.
- Object “TransferStation” represents **transfer station** or **robot**.
- It has these **functionalities**:
 - “**Load**” (1) – is used for loading of parts from source station on “Container” or “Transporter”.
 - “**Unload**” (1) – is used for unloading of parts from “Container” or “Transporter” objects to target station.
 - “**Reload**” (1) – is used to reload part between two objects of “Container” or “Transporter”.
 - “**Move**” (1) – is used to move part from one station to another one.
 - “**Parts from**” (2) and “**Target is on**” (3) defines places “from – on” MUs should be loaded, unloaded or reloaded.





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Thank you for attention

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