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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:

  - Material Flow,

  - Resources,

  - Information Flow.

Standard Objects of Plant Simulation

Structure of the lecture

- Standard objects of group "Material Flow":
    - Connector.
    - EventController.
    - Frame, Interface.
    - Source, Drain.
    - Station, ParallelStation.
    - AssemblyStation, DismantleStation.
    - PickAndPlace.
   - Store, PlaceBuffer, Buffer, Sorter.
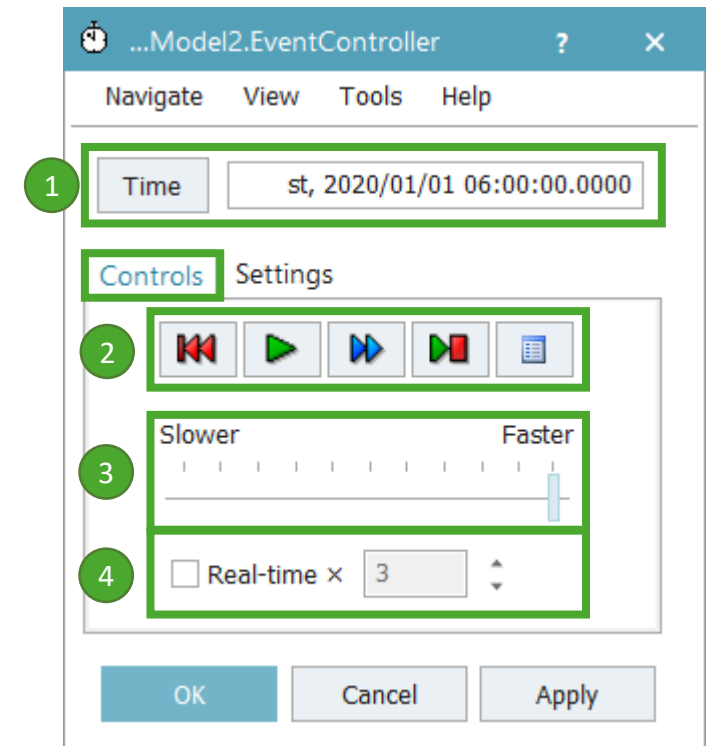
Standard Objects of Plant Simulation

Connector

- Icon

- It is used for connecting of material flow objects and it is not possible to use it as an individual object. This connection is necessary for transport of MU from one object to another (does not apply to cases when we are able to solve these movements i.e., using the "move" method - see the lecture dedicated to programming in SimTalk).

- To connect two objects, activate the object Connector in the Toolbox in the Material Flow bar. Click once on the default object connection and then click on the target object (1).

- It is also possible to create a non-straight connection (2) – firstly, click on the default object and then on the empty spot, where the refraction should be (if we want right-angled connections, hold down the SHIFT button) – even multiple times, after that click on the target object.

- If we want to link multiple objects at once, activate the copy mode - hold down the CTRL key while linking.
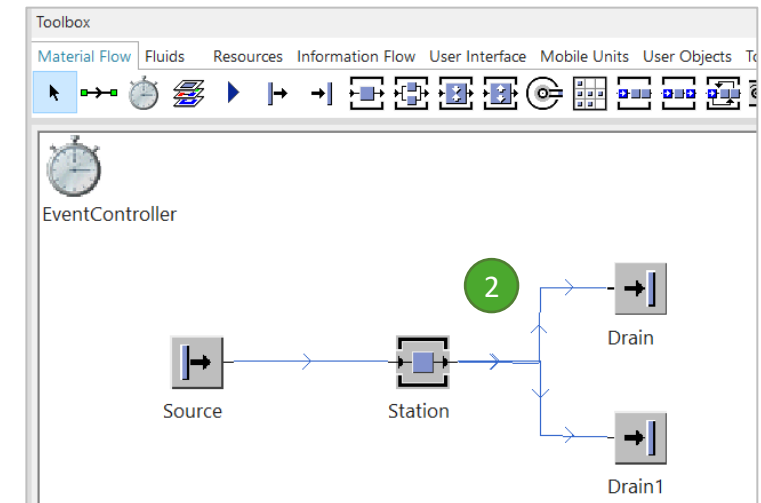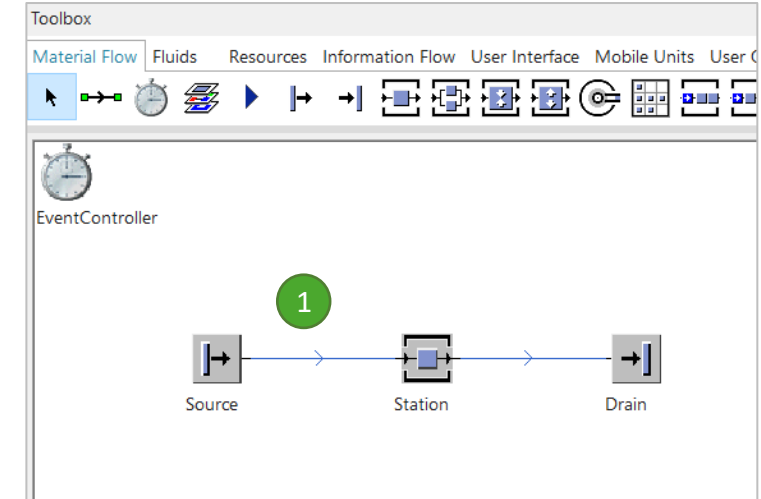
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EventController

- Icon

- Object of the category "Material Flow". It has zero capacity.

- It is used to keep time tracking (counting) when simulation runs.

- The "Time" button switches Absolute simulation time vs. Relative simulation time (1).

- Buttons (2) are used to reset settings, start/stop simulation run, run simulation without animation, proceeding through the model step by step on events using Debugger.

- The simulation speed (3) can be easily set by dragging the slider on the speed bar.

- If the "Real time" box (4) is activated, the simulation run can be observed in multiple variants (10x, 100x faster, etc.).
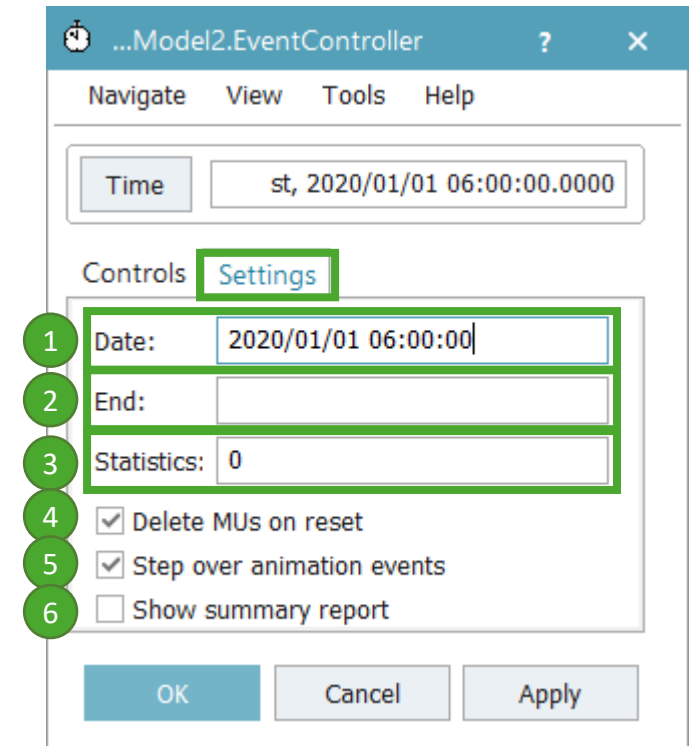
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EventController

- Icon

- The "Date" field (1) means the date and time of the simulation start (datetime format).

- The "End" field (2) means the date, duration, or end time of the simulation (datetime format).

- If you enter a time in the "Statistics" (3) field, the internal statistics will be reset after this time (to avoid bias in the statistics caused by the model run).

- The "Delete MUs on reset" (4) setting is convenient for most models because it automatically deletes all MUs in the model. This setting of the EventController object is default and can be deactivated, if necessary.

- "Step over animation events" (5) allows stepping by individual events.

- "Show summary report" (6) allows to generate a statistical report at the end of the simulation.

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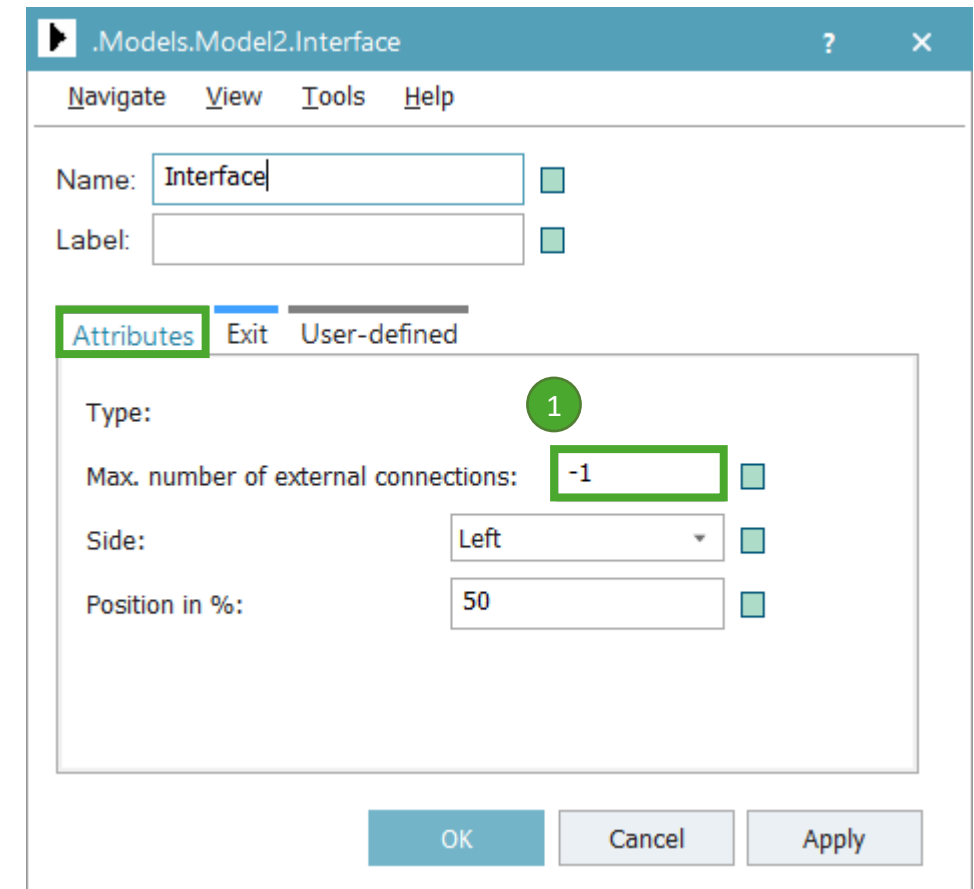
Frame

- Icon

- Object of the category "Material Flow". It has zero capacity.

- It is used for creating of hierarchical model structures by grouping the object on the object itself. It is a basic definition of the object, area or the whole model (according to the hierarchical structure in which the "Frame" is located).

- The "Interface" object is used to connect "Frame" objects and thus create a hierarchical model.

.MaterialFlow.Frame

Area for inserting objects
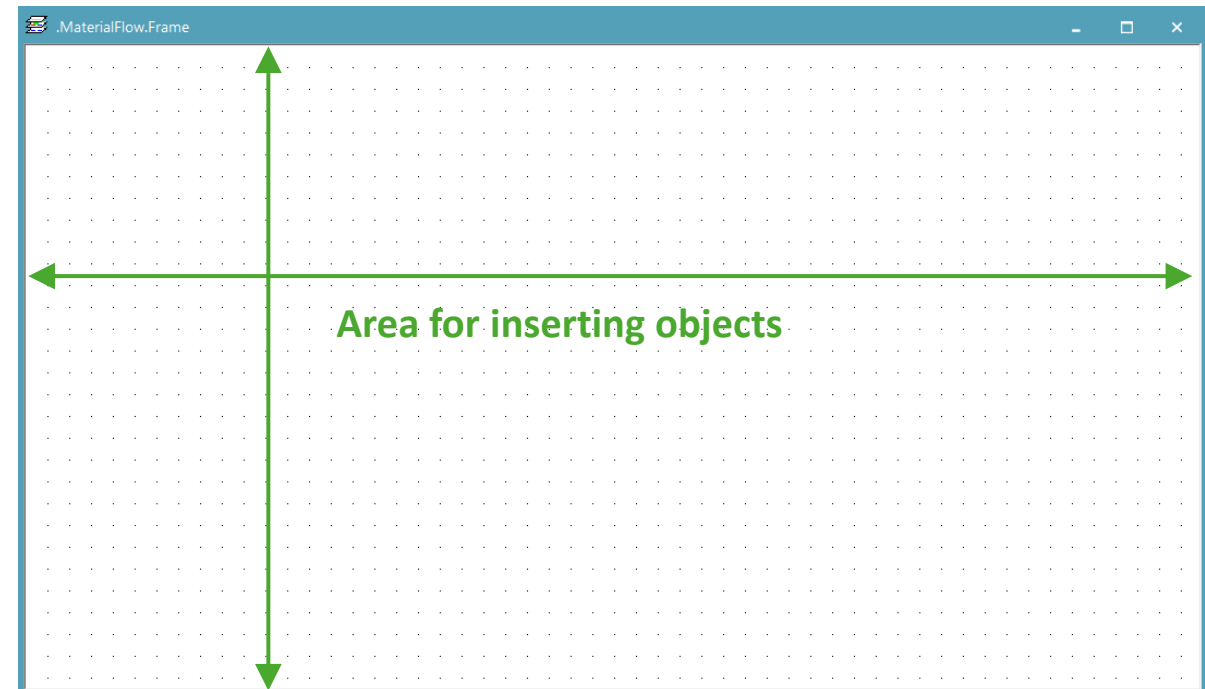
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Interface

- Icon

- Object of the category "Material Flow". It has zero capacity.

- It is used for connecting of "Frame" objects. It is therefore a transition in the structure of the model.

- The maximum number of connections (1) can be defined for it.

- Value -1 = in PS environment = ∞.

- The "Interface" object shows its status through the following icon graphics:

  - If the object is not connected to any object it has this icon. ▷

  - If the object is missing some connection, it has this icon. ▷

  - In case of correct connection to other objects. ▶

Standard Objects of Plant Simulation

Source

- Icon

- Active object from the group "Material Flow".

- Capacity = 1 and processing time = 0.

- Source produces mobile units - MUs (according to its settings). It generates the same or different units and by that creates the sequence of units entering into the system.

- Time of MU creation:

  - According to the set interval (1).

  - Fixed number (2).

  - Created according to the delivery table (3), where the delivery time, MU type and various MU information are given.

  - According to the pulses of the "Trigger" generator (4).
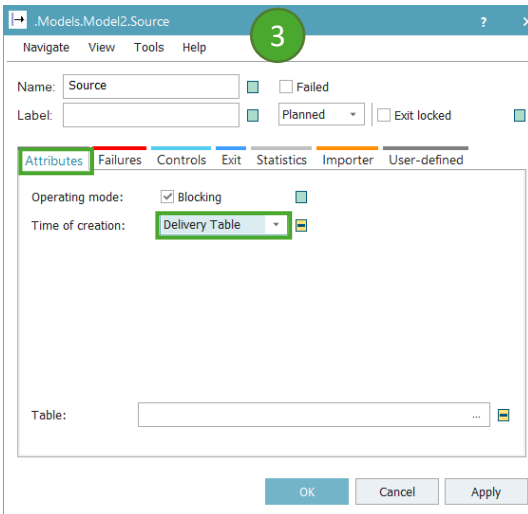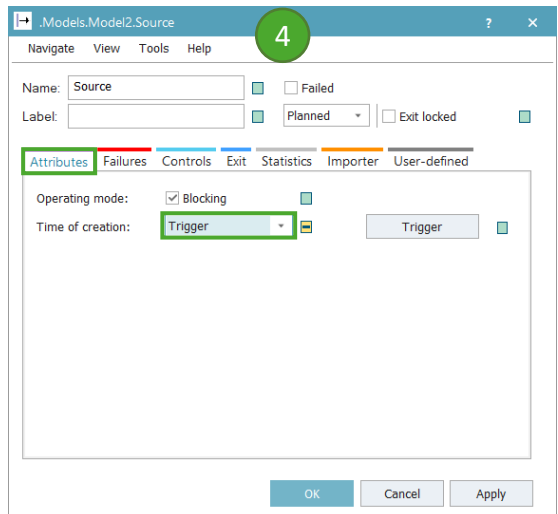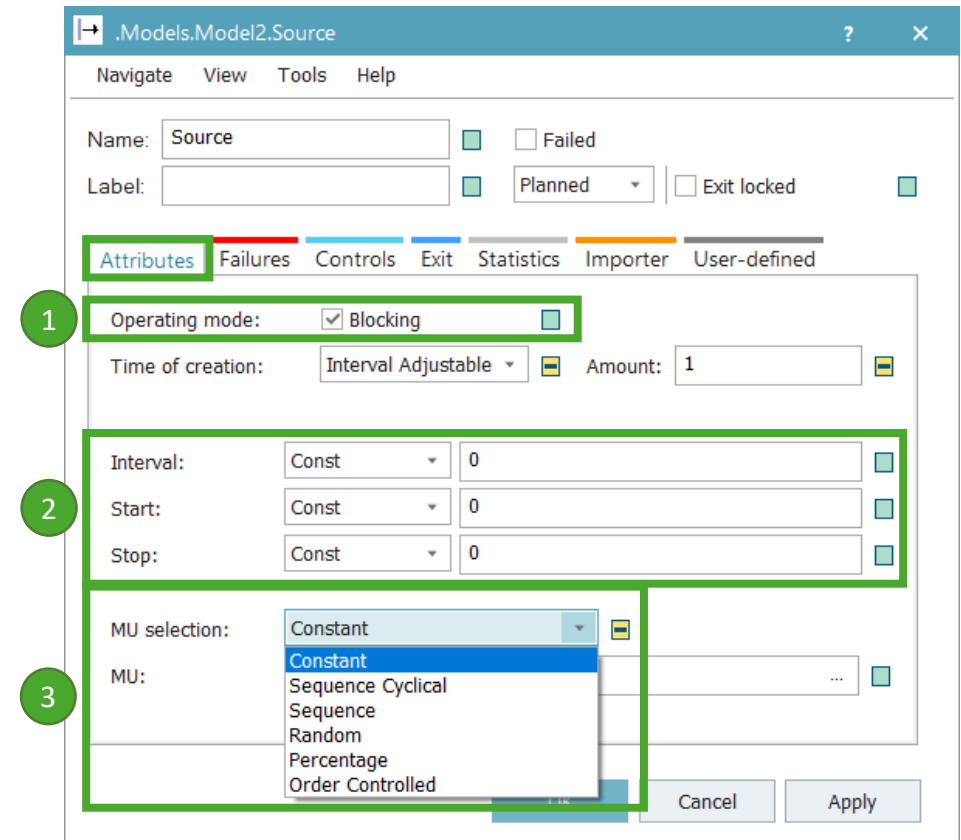
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Source
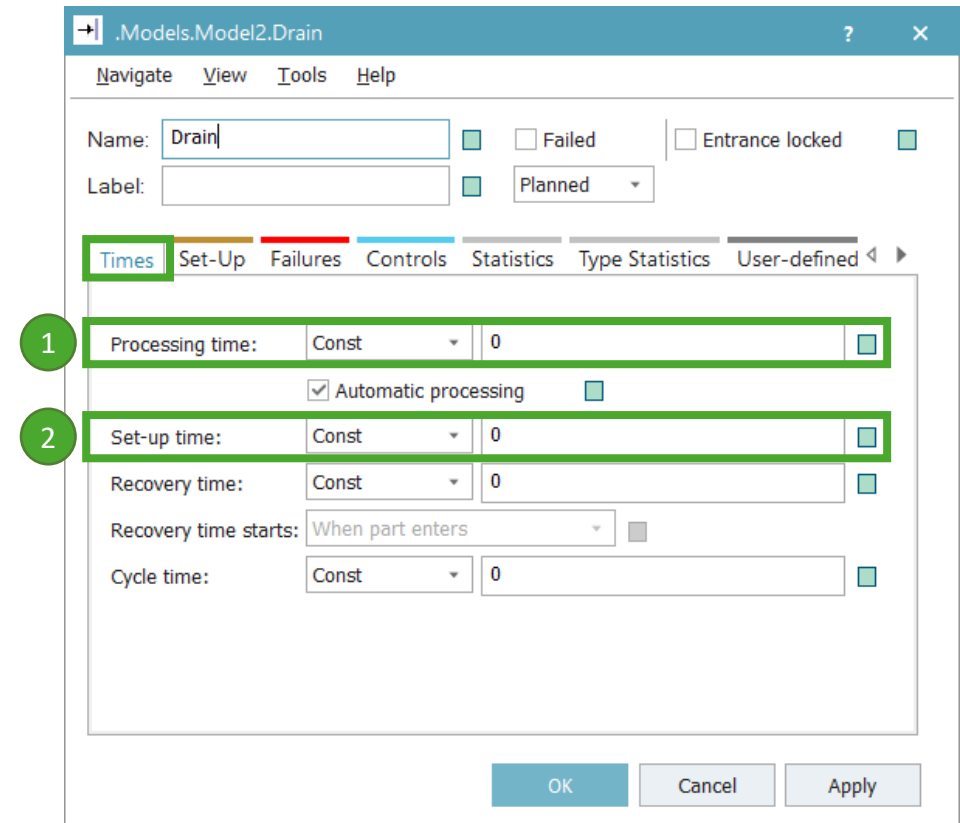
- Icon

- The active box "Blocking" (1) means that in case of blocking of the resource because of the impossibility to pass it on, the object remembers this and will generate the unit at the first possible opportunity (i.e., when it is no longer blocked). Otherwise, the resource generates units exactly at the defined time.

- The "Interval" (2) option determines the time interval between the generation of two following MUs. The limits can be set by "Start" and "Stop" (Start - lower limit; Stop - upper limit).

- Defining the "MU selection" option (3) determines the type of MUs selection when generating them.

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Drain

- Icon →|

- Active object from the group "Material Flow".

- Capacity = 1.

- It is used to remove MU after a certain time period. It means that the units that were generated by "Source" can be removed by "Drain".

- Setting of individual working times:

  - Processing time (1) – time during which the MU is proceeded.

  - Set-up time (2) – time required for adjustment during the change of two MU types.
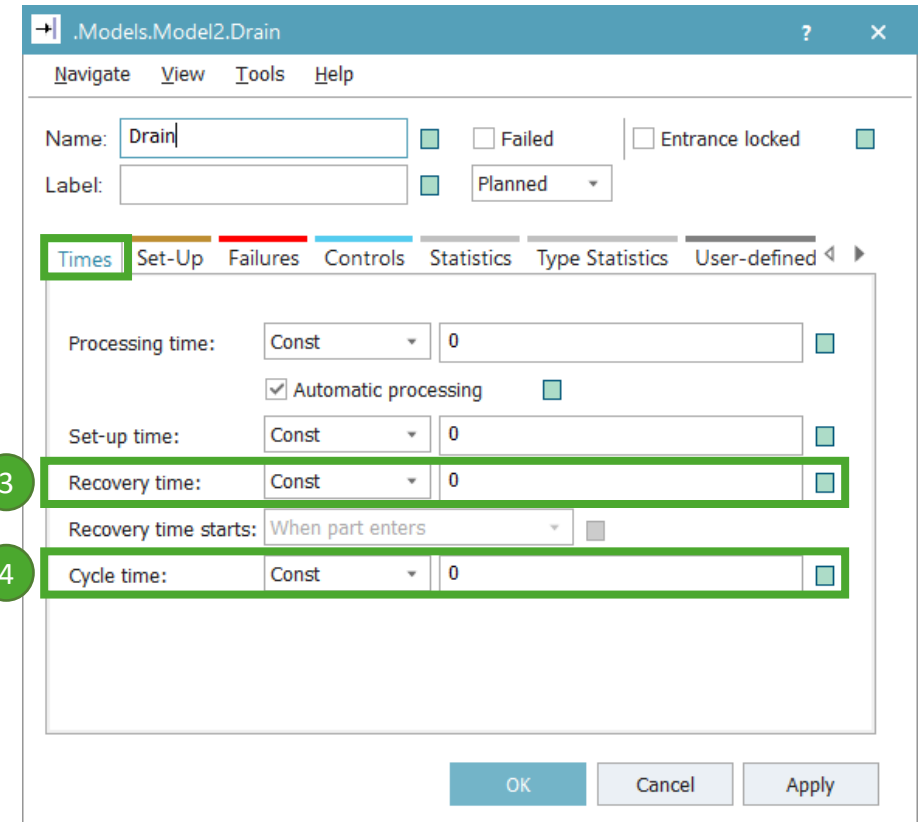
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Drain

- Icon ![drain icon]

- Setting individual working times:

  - Recovery time (3) – time needed for preparation before the processing. For example, the time needed to load or unload parts.

  - Cycle time (4) – it is used in cases when the object entrance is closed and open regardless of the entering unit. This can be partially useful when modeling a chain conveyor that has a fixed pitch of the carriers and therefore the input is only opened when a new carrier is reached. The option can be used for synchronizing of the production line.
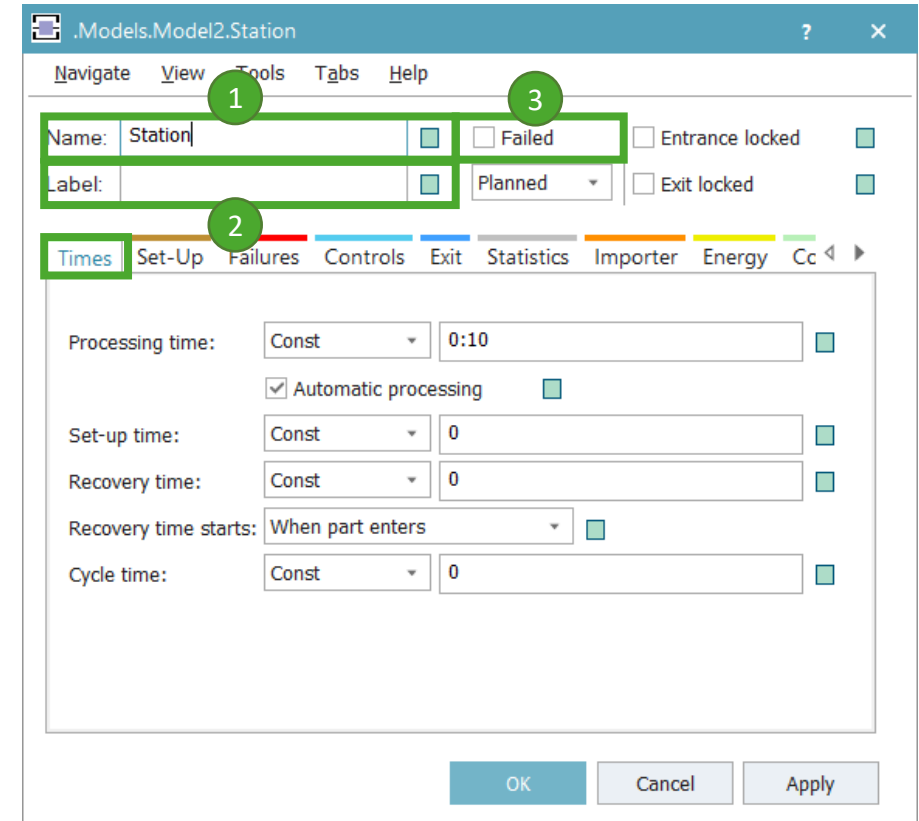
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Station (Times)

- Icon

- Active object from the group "Material Flow".

- Capacity = 1.

- Key object of PS. "Station" takes parts from a predecessor, processes it and passes it on to a successor.

- Name (1) – a unique name within the frame.

- Label (2) – optional description (can be the same for many objects within the frame).

- Failed (3) – using this box, it is possible to manually trigger a failure on the "Station" object. The processing time on the "Station" is extended by the duration of the failure.

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Station (Times)

- Icon

- When the downtimes could happen (4):

  - Planned – downtimes during work shift.

  - Unplanned – outside of the working hours.

  - Paused – for interruption of the processing time because of a downtime.

- Entrance (5) and exit (6) lock.

- Recovery Time (7) starts when the unit entered the object.

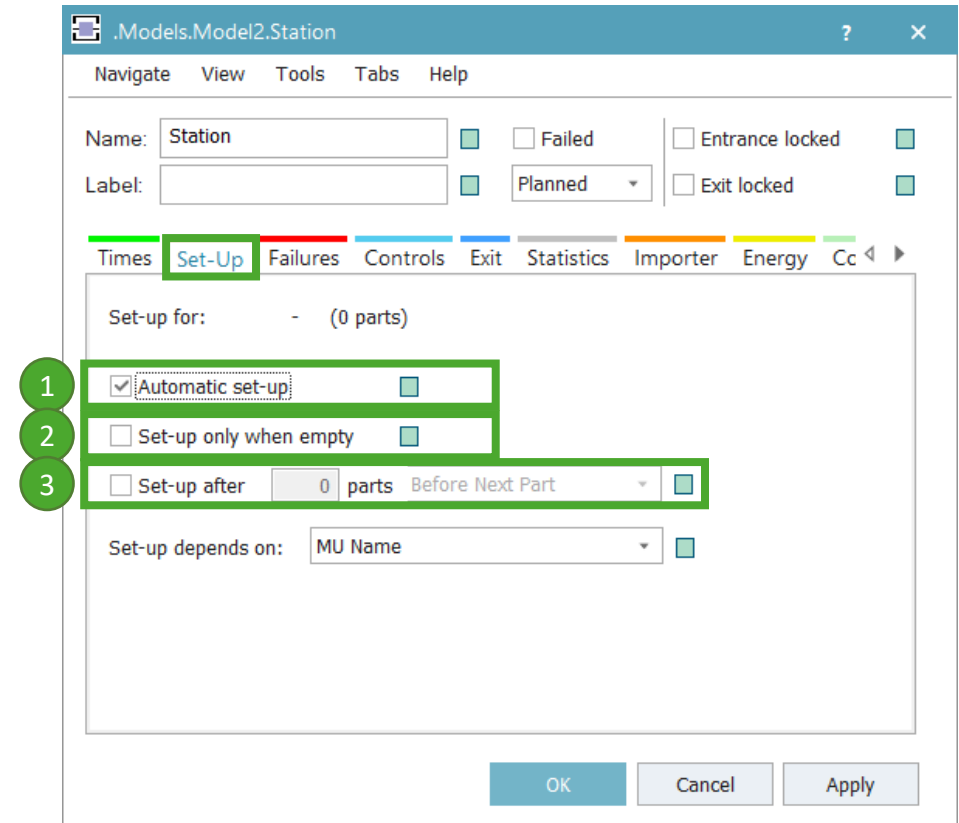- The setting of the other times is identical to the Drain object.

Standard Objects of Plant Simulation

Station (Set-up)

- Icon

- The "Set-up" option defines the options for setting up of the device before processing the next type of product (or just because it needs to be set-up after a certain number of pieces). For example, it can be a different type of product, device calibration, material preparation, etc.

- The automatic adjustment is provided by option (1) immediately after the MU arrival to the station. In case that option is empty, we are able to control set-up through user-defined method.

- Option "Set-up only when empty" (2) means that the device adjustment is performed only when the device is empty. Another MU can't enter during the adjustment time.

- The "Set-up after" option (3) defines the batch after which the machine must be set-up.

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Station (Failure)

- Icon

- Failures are used to realize irregularities resulting from technical or organizational usability of real devices in the simulation model.
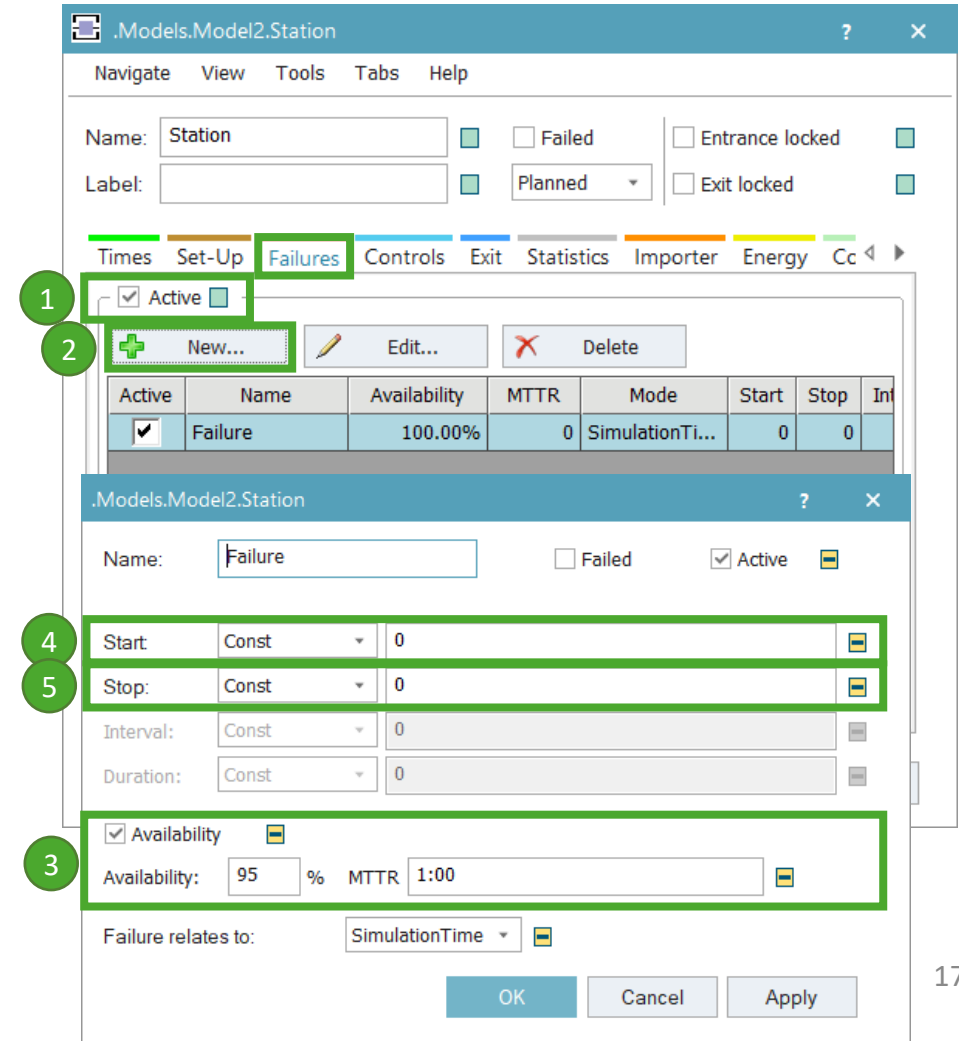
- Failures significantly affect the system dynamics, its throughput and also, for example, the way the model is managed. They should have sufficient attention.

- The status of each component is switched from "operational/ready" to "failed/failure". The processing time or the time spent on the object is extended by failure duration.

- Failures can be defined for all objects of the material flow that have a non-zero capacity. They are represented by the red point on the top edge of the object.

- It is possible to save any icon and named it as "failed" in the icon editor. If the "Use State Icons" setting is activated, then if the object fails, the icon with the name "failed" will be automatically switch to the current view.

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Station (Failure)

- Icon

- The tab "Failures" deals with device downtime that occurs randomly (normal state) or that we are able to create manually (testing certain states).

- "Active" (1) for the use of random downtime according to a certain distribution, this item must be enabled. The "New" (2) button adds a new failure.

- The "Availability" option must be enabled in case of entering the availability by percentage (3). Otherwise, we will have to enter MTTR ("Duration") and MTBF ("Interval"). "Availability" is set in percentage.

- MTTR (Mean time to repair) has the syntax: "random number stream, mm:ss".

- "Start" (4) defines the time when the failure should start.

- "Stop" (5) when the failure will appear for the last time.
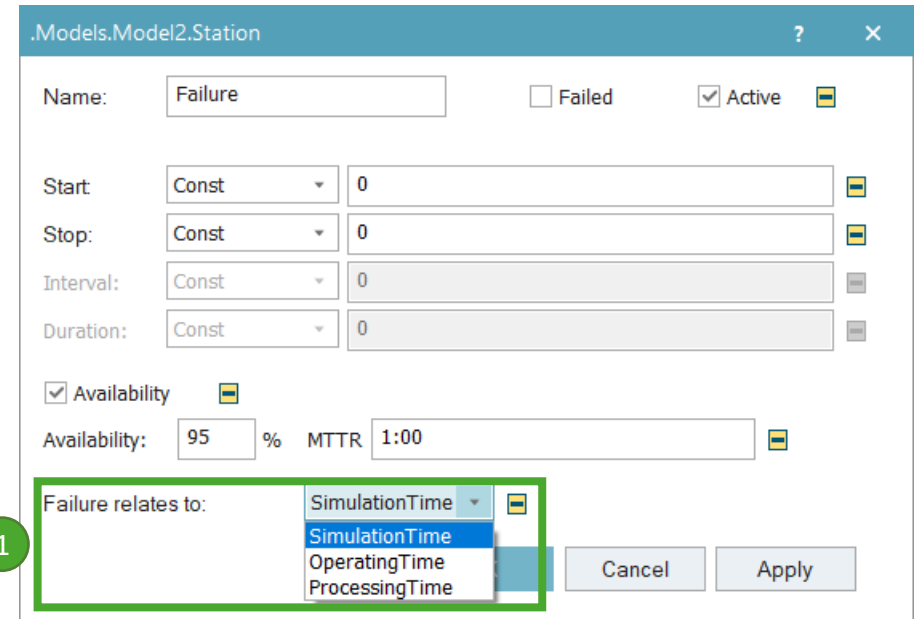
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Station (Failure)

- Icon

- You can choose the time to which the failures will be applied (1):

    - SimulationTime – the failures counts throughout the whole simulation run, regardless of the object status.

    - ProcessingTime – failures are calculated only when the object is in the "working" status (breaks and waiting times are not counted).

    - OperatingTime – failure calculation takes part when the object does not have a break time (break time is not counted, but waiting time is counted).

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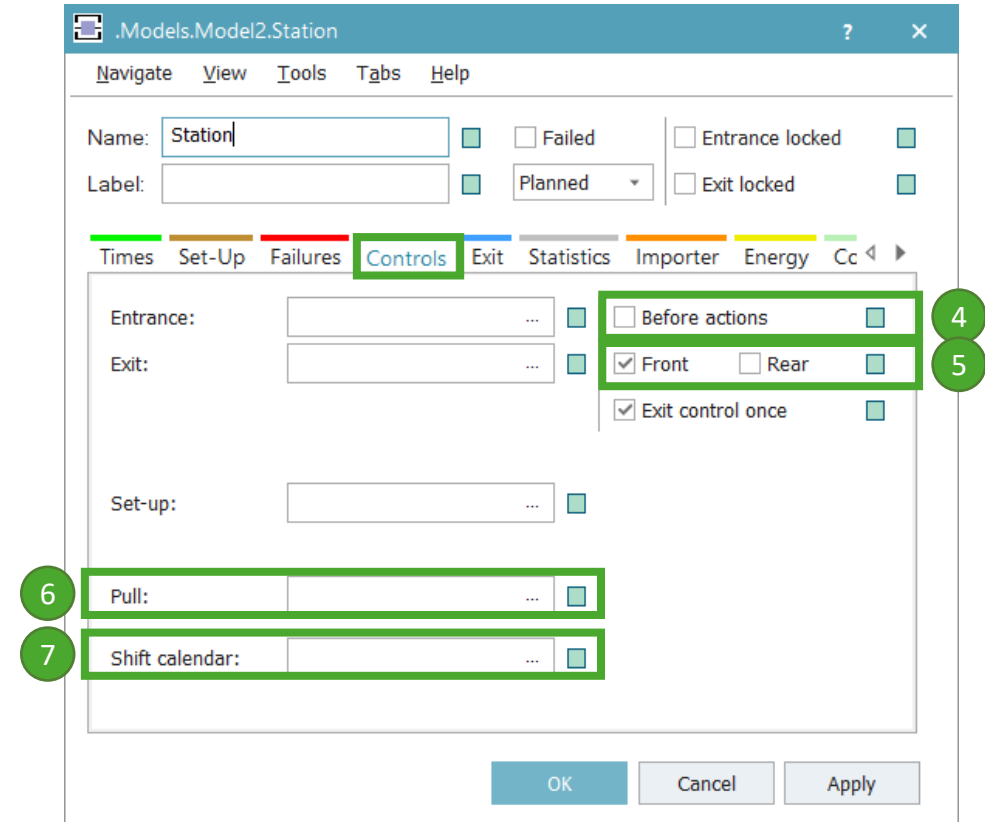
Station (Controls)

- Icon

- Using the tab "Controls", it is possible to influence the behavior of the item according to the user-defined criteria.

- "Entrance" (1) defines the condition when unit enters, i.e. the method programmed by the user will be started as soon as the MU enters the object.

- The "Exit" (2) option defines the possibilities of controlling the item by the method on its exit.

- The "Set-up" (3) option is used to define the adjustment via the method.
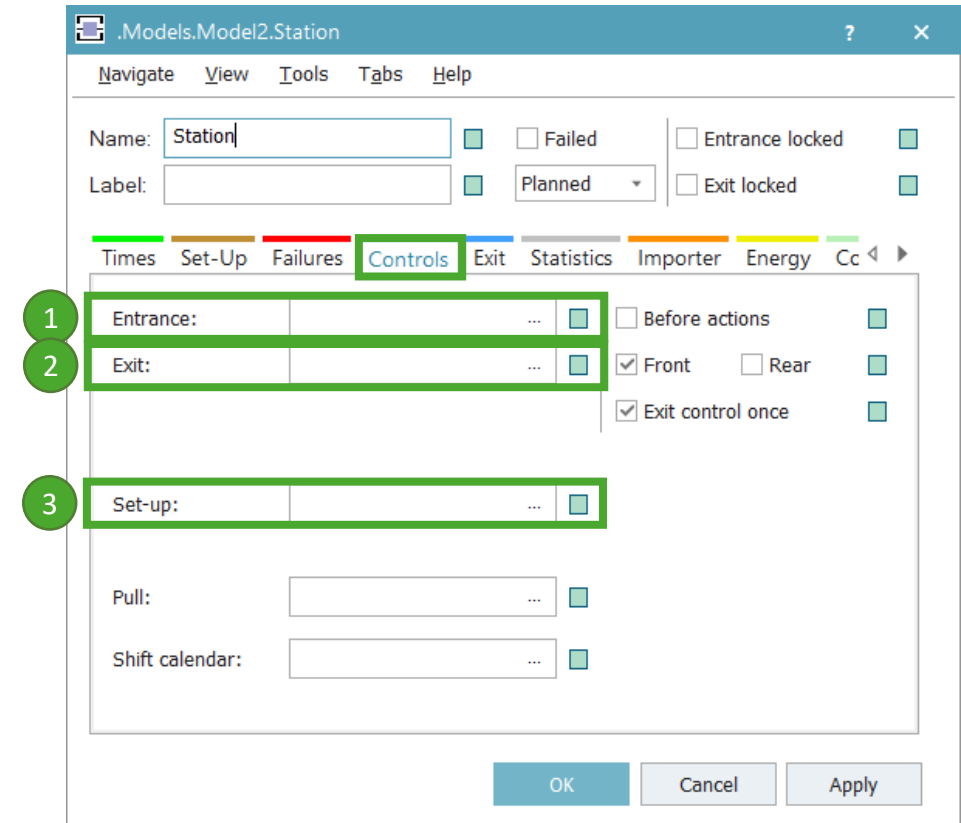
# Standard Objects of Plant Simulation

Station (Controls)

- Icon

- Check-box "Before actions" (4) allows to change e.g. Processing time by the method during the MU entrance. Otherwise, it is not possible!

- Options "Front" and "Rear" (5) define, whether the method is initialized by
the front or the rear part of MU.

- "Pull" (6) defines, which one of the waiting MU should be transferred from
the predecessor onto the "Station".

- The "Shift calendar" (7) option is used to assign the shifts and breaks to the object.

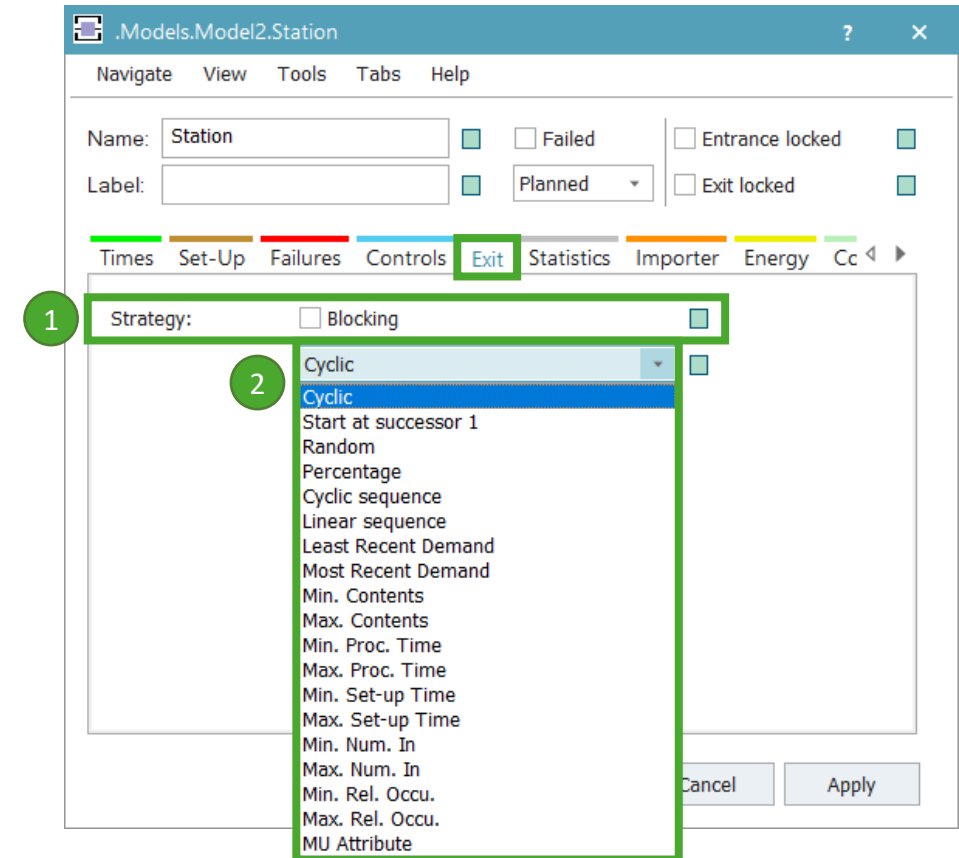# Standard Objects of Plant Simulation

Station (Exit)

- Icon

- In tab "Exit " of the material flow objects, the type or strategy of MU transfer is set for the following objects.

- The box "Blocking" (1) determines whether the transfer of MU is blocked or it is not. If the box is inactive, it means that if the currently assigned successor cannot accept the MU at the moment (e.g. it is busy), the next successor in line will be tested. If the box is active, the transfer is waiting until the successor is able to accept the MU.

- The default setting is "Cyclic" (2).

Standard Objects of Plant Simulation

Station (Exit)

- Icon

- Cyclic – transfer in the order of object connections.

- Start at successor 1 – the transfer attempt always starts at successor 1.

- Random – the successor is chosen randomly.

- Percentage – allows percentage distribution.

- Cyclic sequence – successor is selected from the sequence specified by the table, the next successor is specified by the next row in the table.

- Linear sequence – the selection of successor always starts at the first row in the table.

- Least/Most Recent Demand – as the successor it is selected the object that has been waiting for MU for the longest/shortest time.

- Other options consider determined or statistical parameters (e.g. the successor is an object with minimum/maximum contents, minimum/maximum processing time, etc.).
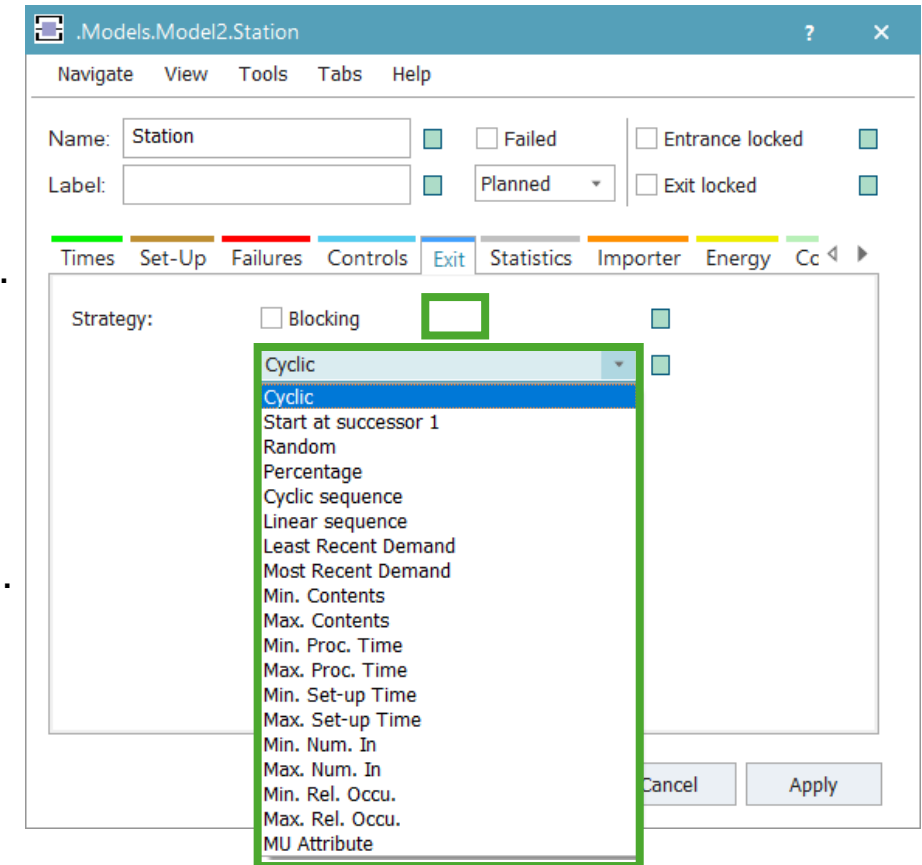
Standard Objects of Plant Simulation

Station (Statistics)

- Icon

- Tab „Statistics" allows you to view offline statistics of the object. The statistics are always related to the time of opening these statistics.

- The percentages of the individual device statuses are shown in statistic (1). It is thus possible to see how much time an object spent in processing, adjusting and waiting.

- The second group of statistics (2) provides information on the occupancy rate. Firstly, how long the object was empty and what is its relative occupancy.

- The third group of statistics (3) shows current, minimum and maximum occupancy. It also informs about the number of MUs that entered and exited the object.
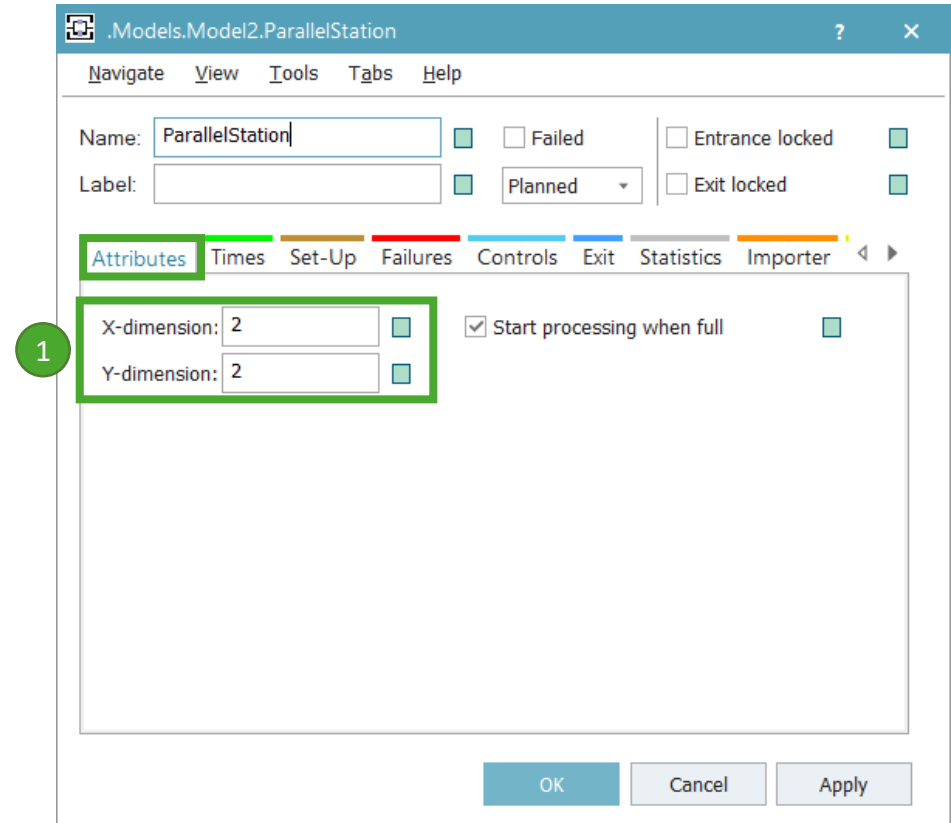
Standard Objects of Plant Simulation

ParallelStation

- Icon

- Object of the material flow.

- Capacity – any, matrix oriented (1).

- A parallel station can receive more MUs and process them in parallel.

- Each mobile unit occupies only one of the free places of the parallel station.

- MUs can enter the object one after another, the Processing time runs individually for each MU.
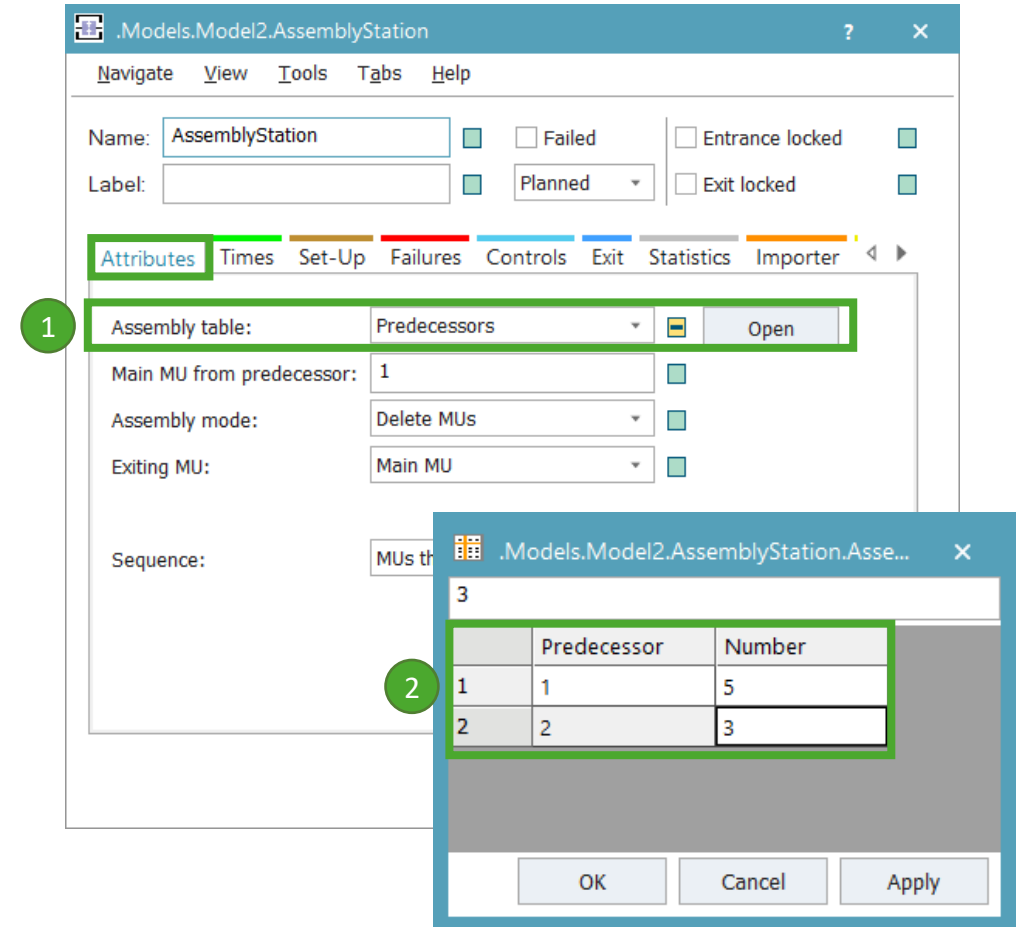
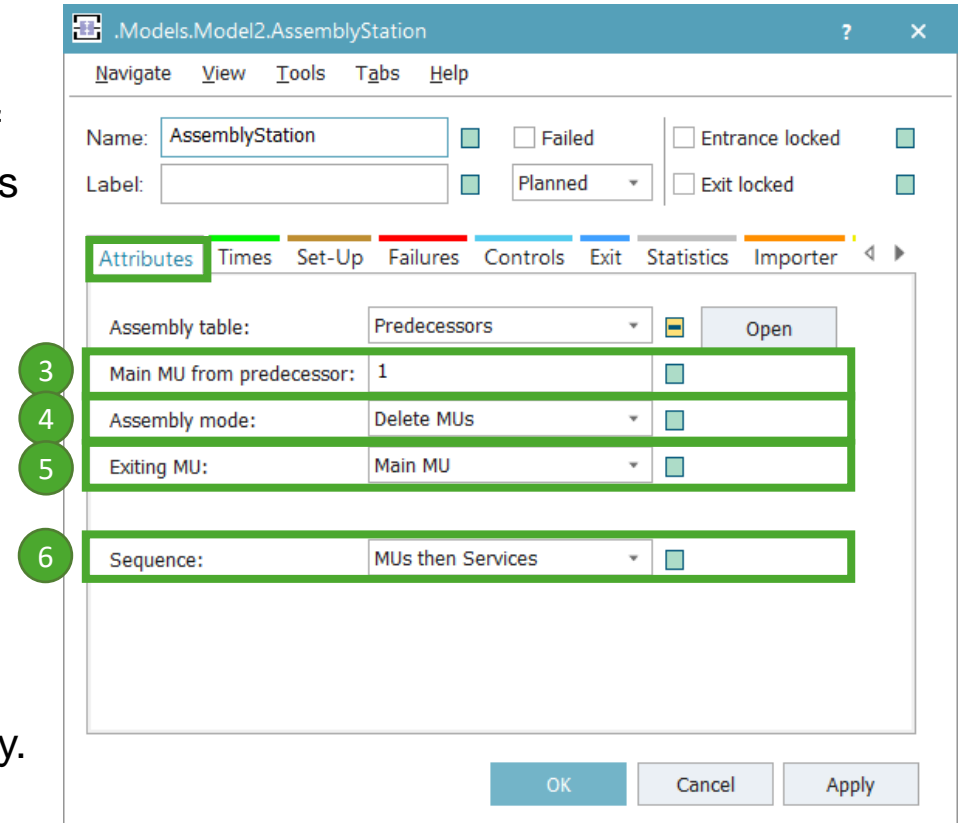# Standard Objects of Plant Simulation

AssemblyStation

- Icon

- Object of the material flow.

- Capacity – 1 main unit, assembled units.

- The assembly station allows the illustration of assembly and loading processes through the relations of previous objects or types of mobile units.

- It is possible to work with the "Assembly table" (1), where the information is stored about a number of parts and predecessors from which it is necessary to take them for the assembly of the main part.

- In the table can be selected "Predecessors" or "MU Types" – click on Open and enter the predecessor numbers or MU type names and the mounted number into the table (2).

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AssemblyStation

- Icon

- "Main MU from predecessor" (3) - enter the number of predecessor of the assembly station from which the main mobile unit (which continues further in the flow) comes.

- In the "Assembly mode" (4) it can be set whether the assembled parts are destroyed after assembly or continue as ones loaded onto the main part. If "Delete MUs" selected (the assembled parts are "destroyed" after assembly) or "Attach MUs" (to load the part onto the main part, but in this case the main part must be a Container type, or a transport vehicle.

- "Exiting MU" (5) – in exception to the main unit, any MU can be selected as a new unit that leaves the assembly station after assembly.

- "Sequence" (6) - defines the order in which requests for "MU" and "Service" (worker) are handled.

Standard Objects of Plant Simulation

DismantleStation
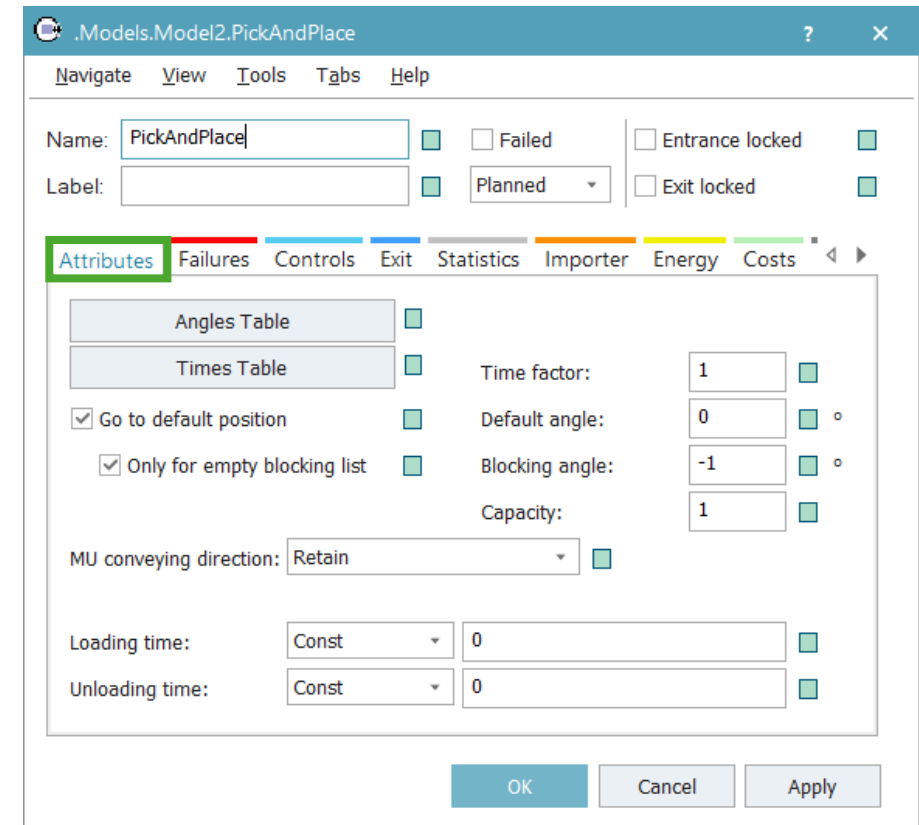
- Icon

- Object of the material flow.

- Capacity – 1 main unit, dismantled units.

- The dismantle station allows the illustration of dismantling and unloading processes.

- The dismantled units are either passed on to the flow or new units are created.

- On tab "Attributes", the required settings for the disassembly process are set. The logic is similar to that of the assembly station.

Standard Objects of Plant Simulation

PickAndPlace

- Icon

- Object of the material flow.

- Capacity – 1.

- The object (robot) is used to load one unit at the first station, rotate with the unit and unload it at another station.

- In tab "Attributes" it is possible to set for the robot:

  - Table of rotation angles.

  - Table of rotation times.

  - Speed constant.

  - Standard rotation angle.

  - Disabled rotation angles.

  - Return to starting position.
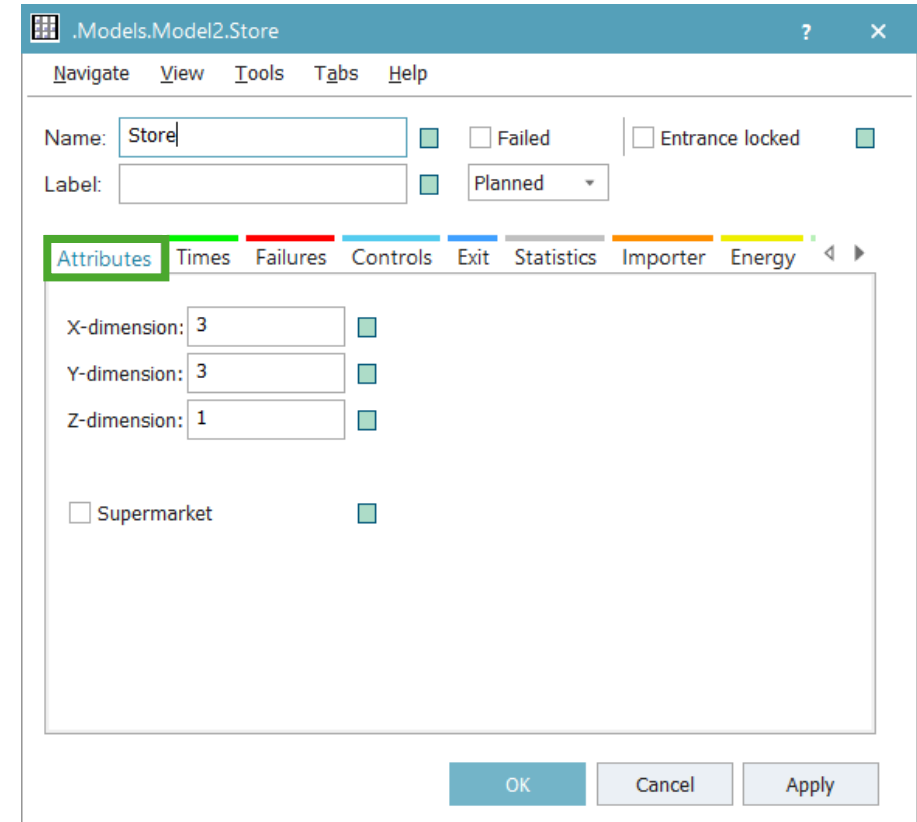
Standard Objects of Plant Simulation

Store

- Icon

- Object of the material flow.

- Capacity – any, matrix oriented.

- MUs stay in the store until they are taken out (from the outside, via the method).

- MUs will occupy any free space in the coordinate matrix.

- The store does not accept any MUs during a failure.
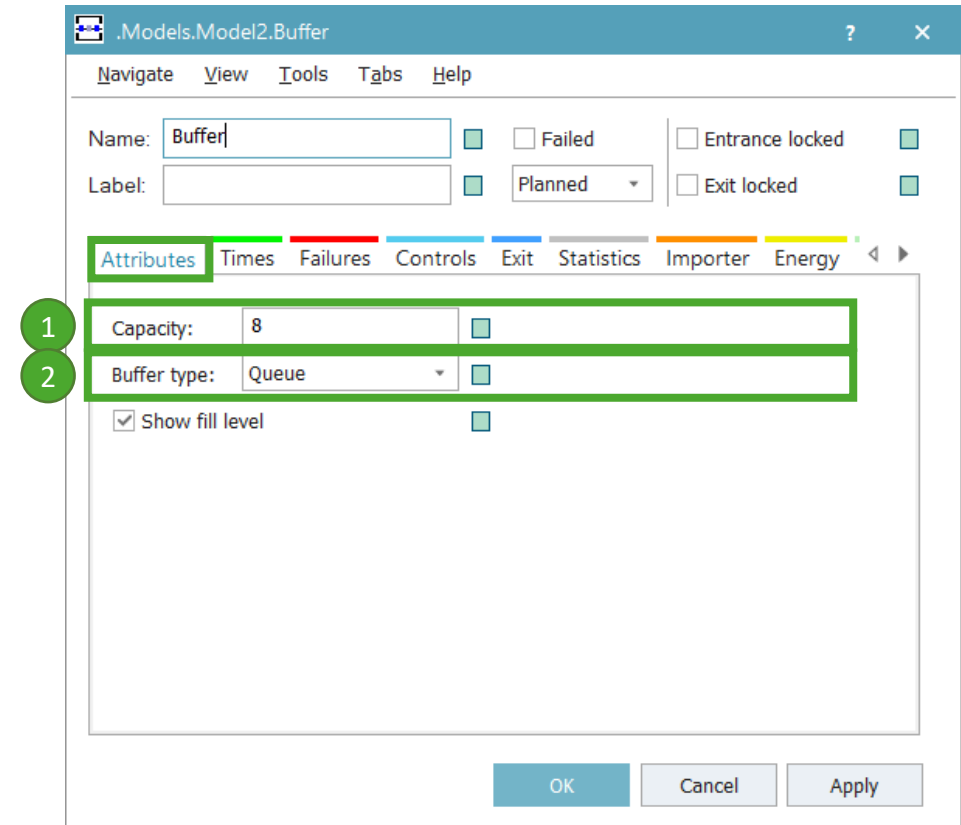
Standard Objects of Plant Simulation

PlaceBuffer

- Icon

- The buffer represents the individual locations, arranged in series, where the processing or intermediate storage of MUs' run.

- Buffer is a capacity-oriented object.

- Capacity – any (1).

- If a capacity -1 (unlimited) is entered, it is very easy to evaluate (according to the occupancy over time) the required capacity of the object.

- Individual MUs can't overtake each other.

- It is possible to "touch" an individual place in the buffer.

- You can set the "Processing time" - the time it takes for the MU to pass through all places in the stack. It can also be set to zero.
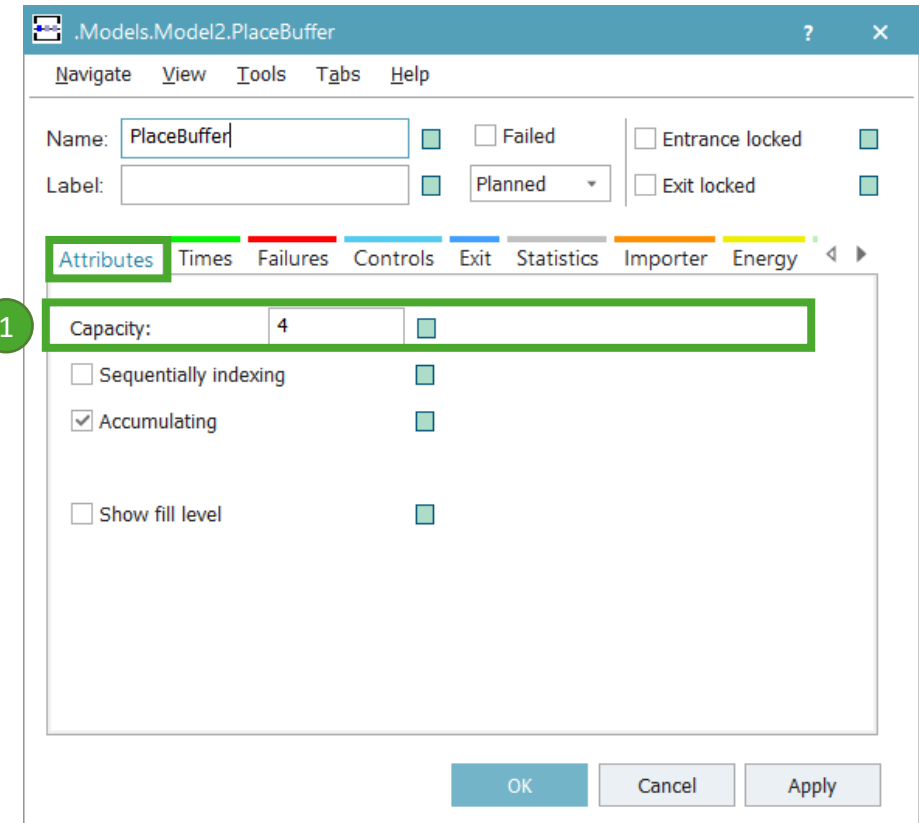
Standard Objects of Plant Simulation

Buffer

- Icon

- Buffer is a capacity-oriented object.

- Capacity – any (1).

- It is transferring the MUs on the successor objects by FIFO (Queue) or LIFO (Stack) stratégy (2).

- Suitable for receiving many of MUs.

- Does not have length size.

- It is very fast in terms of simulation speed.

- There is no possibility to touch individual places in the buffer.

- Can be set the „Dwell time"– the minimum time an individual MU spends in the buffer.

Standard Objects of Plant Simulation

Sorter

- Icon

- It is used for sorting of MUs according to criteria that can be set, such as:

  - Time spent in an object.

  - MU attribute list – ascending or descending.

    - If it is sorted by MU attributes, it is possible to use attributes (length, capacity, speed) or other statistic values such as time remaining until battery recharge.

- Capacity – any.
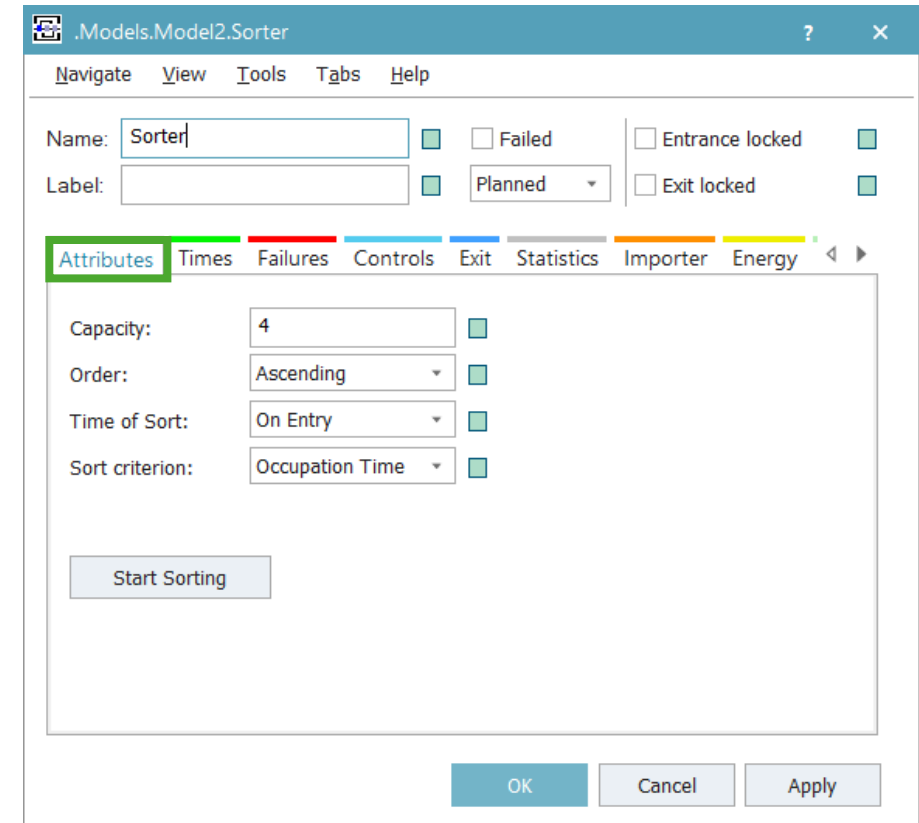
Thank you for attention

Jan Fábry

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