IE251 Spring 2024 Tecnomatix Plant Simulation Session No. 1

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- 2. In-Class Exercises
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1. Overview of Functionalities





Overview Functionalities - Model Creation

Click [Creation New Model] - [2D]

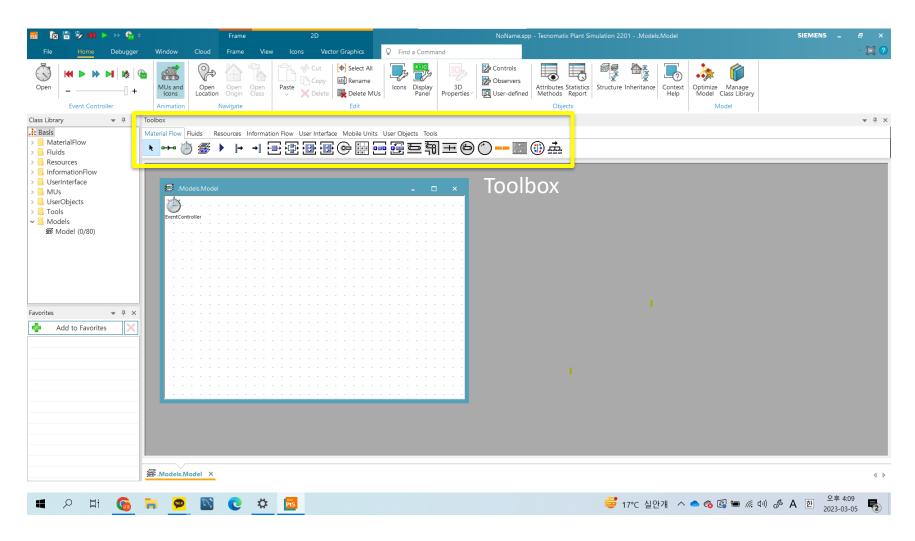






Overview Functionalities - Toolbox

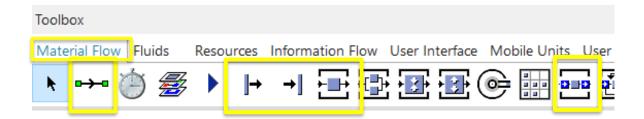
Using a toolbox can make it easier for users to utilize objects effectively.







Overview Functionalities - Basic object[1/2]





Connector: establishes connections between two objects



Source: produces parts(job)



Drain: removes the parts from the plant



Station: processes parts

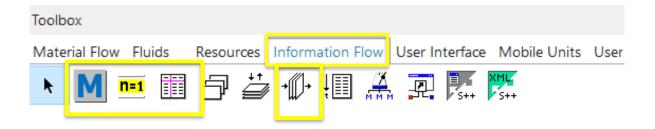


Buffer: temporarily holds parts





Overview Functionalities - Basic object[2/2]





Method: is used to control other objects in programming.



Variable: is global variable that other objects can access



DataTable: is a list with two or more columns



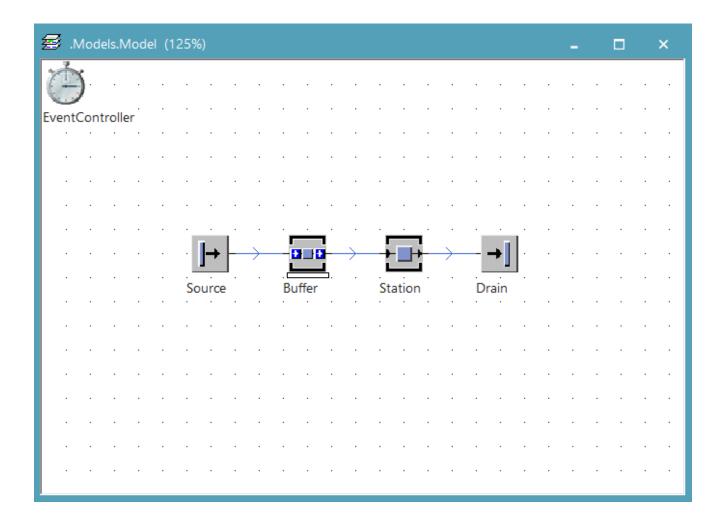
Dataqueue: a list with one column

In the toolbox, you can create any object on the map by dragging and dropping it onto the map.





Overview Functionalities - Sandbox Model

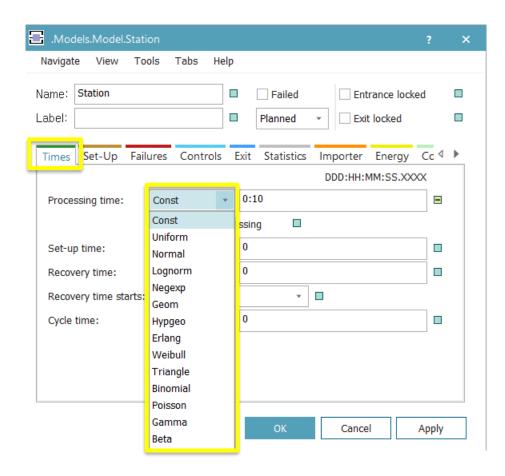




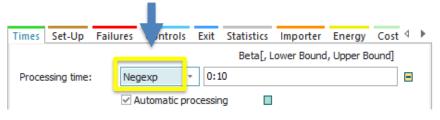


Overview Functionalities - Processing time setting

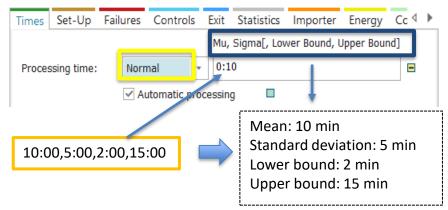
Double click the Station icon on the map



EX1. Exponential distribution



EX2. Normal distribution

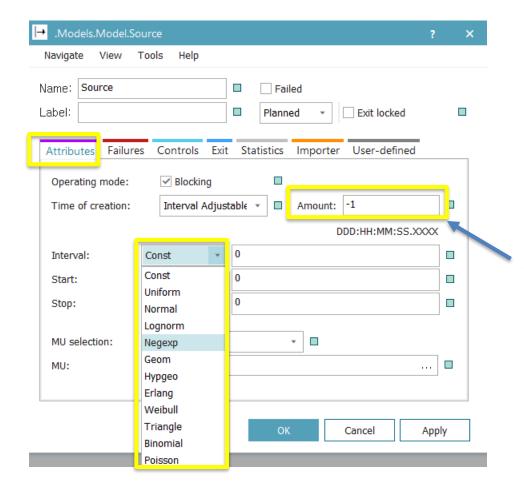






Overview Functionalities - Arrival time setting

Double click the Source icon on the map It is same as processing time setting



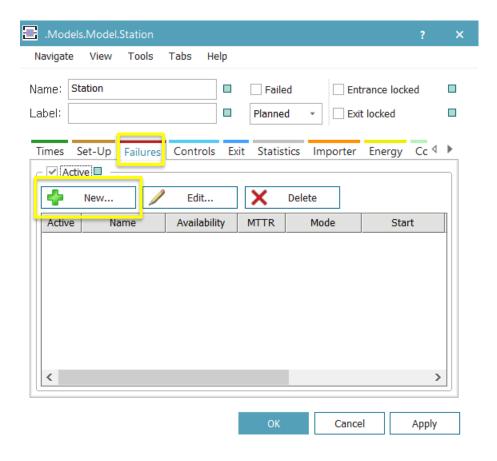
You can also set the number of parts that Source generates. '-1' means infinite.





Overview Functionalities - Failure setting[1/2]

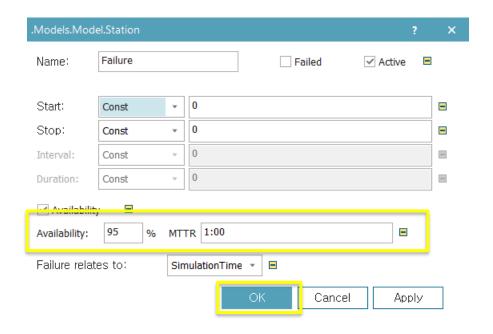
Double click the station icon on the map







Overview Functionalities - Failure setting[2/2]



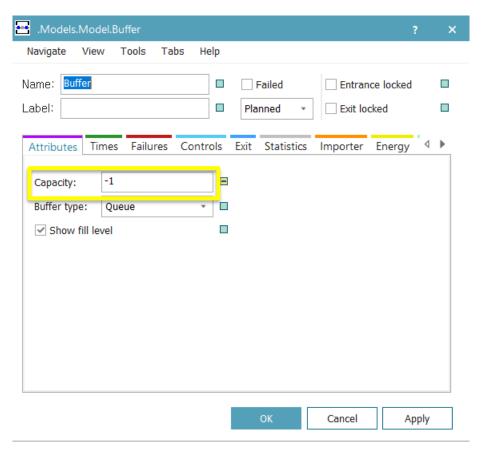
You can set MTTR and Availability, then automatically MTTF is determined.





Overview Functionalities - Buffer Setting

Double click the Buffer icon on the map

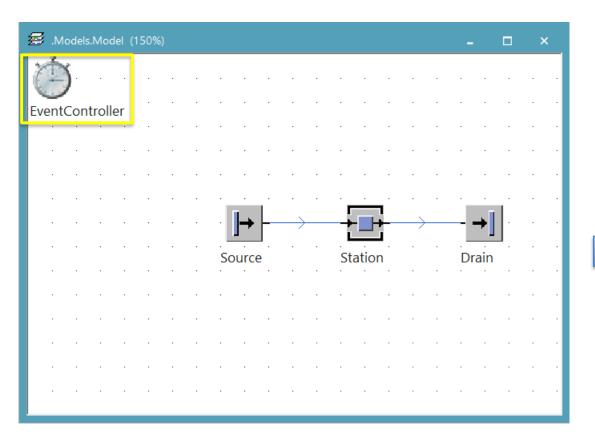


You can specify the capacity of the buffer. To allow for unlimited capacity, enter a value of -1.

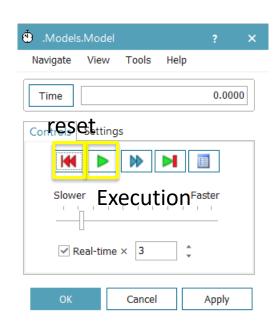




Overview Functionalities - Simulation Execution





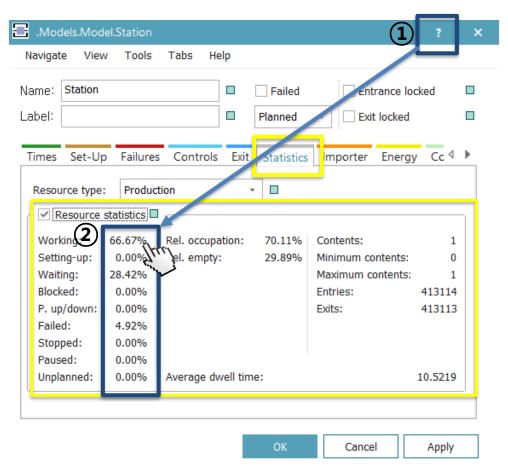






Overview Functionalities - Statistics

You can view the statistics for each object in the [statistics] tab.



To view the exact definition of each item, click the [?] button located in the upper-right corner of the window, and then click data of item you're interested in.





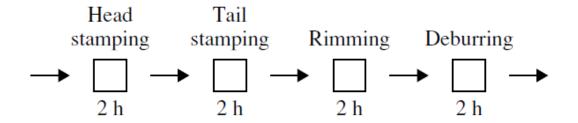
2. In-Class Exercises





Task 1 - Penny Fab — Exponential Distribution

 Penny Fab is as illustrated below, and processing times follow exponential distribution. Each machine takes two hours on average to process.

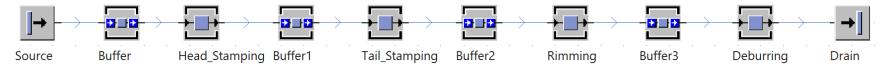


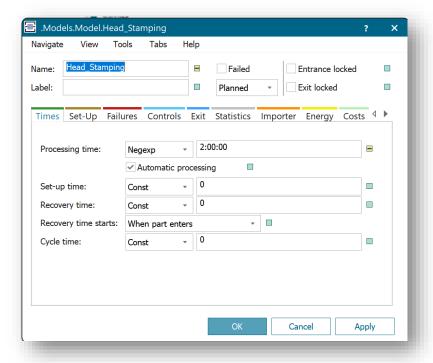


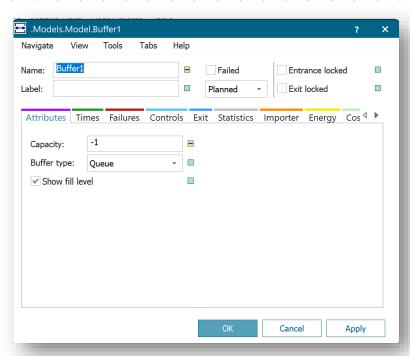


Task 1 - Penny Fab One









- Use F2 to rename the workstations
- For all workstations, select 'Negexp' and 2:00:00 (exponential, 2h average)
- Buffers don't need to be changed
- Connect Sources, Buffers, Workstations, and Drain using Connectors

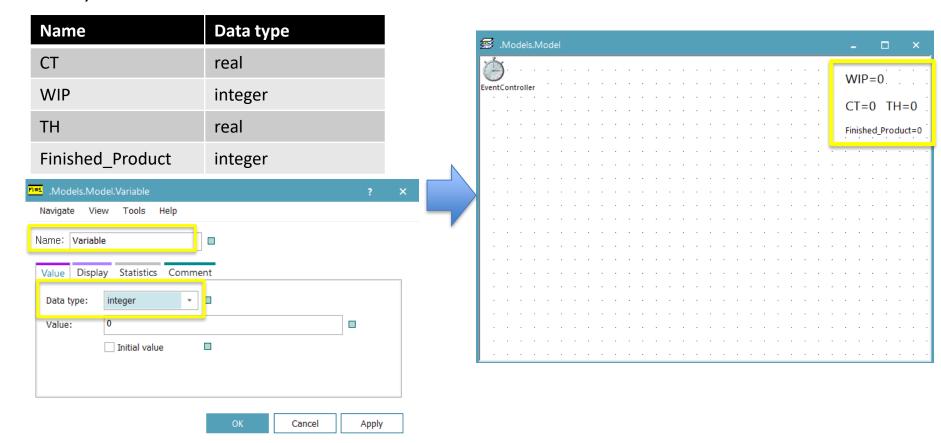




Task 1 - Object setting – Variable

Create a Variable object on the map and double-click it. Follow the table to change the name and data type of the Variable. These Variables show cycle time, WIP, TH and the number of processed products.

(If you want to view them in a larger size, click on 'display' tab and then select 'Font size'.)

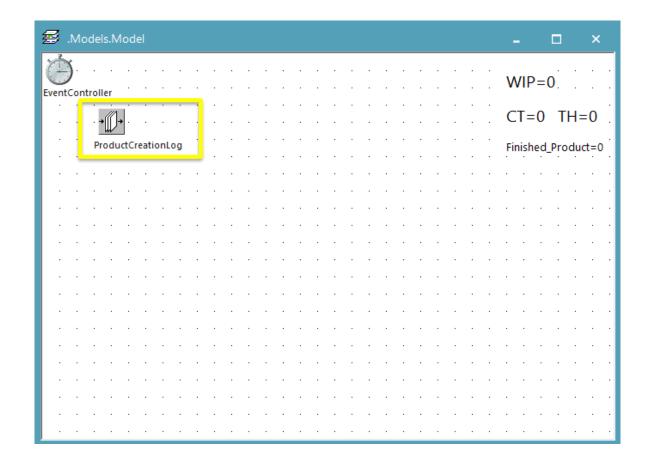






Task 1 - Object setting - Product creation log[1/2]

Create a DataQueue object on the map, right-click it and select 'Rename'. Change the name to 'ProductCreationLog'.

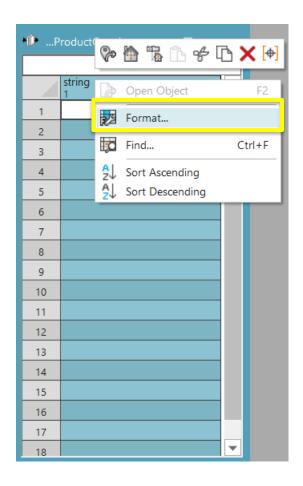




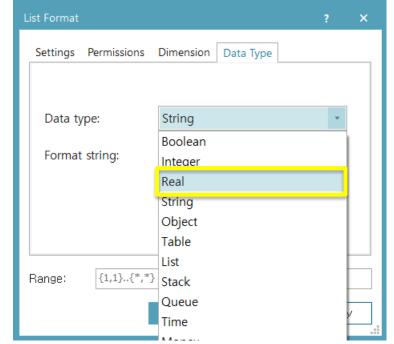


Task 1 - Object setting - Product creation log[2/2]

Double-click on the object, then right-click on the header of the first column and select 'Format' to change the data type to 'real'.





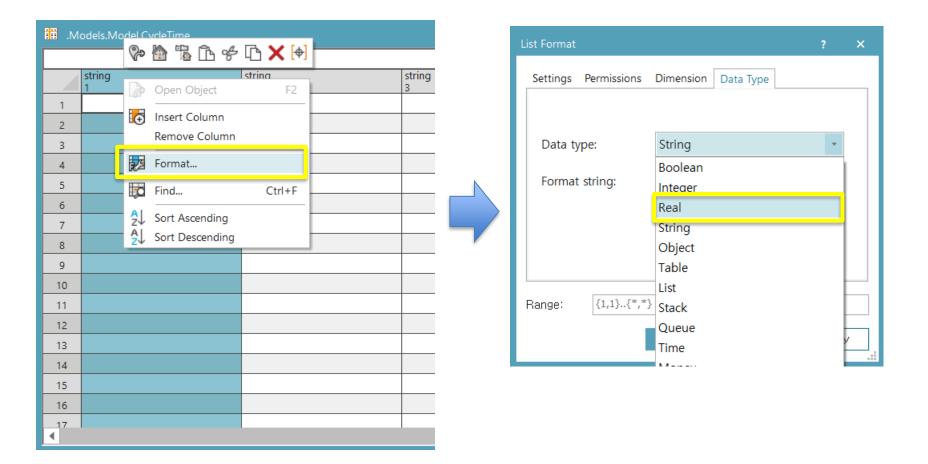






Task 1 - Object setting – Cycle time

Create a DataTable object on the map in the same way as before, and rename it to 'CycleTime'. Then, change the data type of the first column to 'real'. This DataTable is used to store the cycle time of all parts.

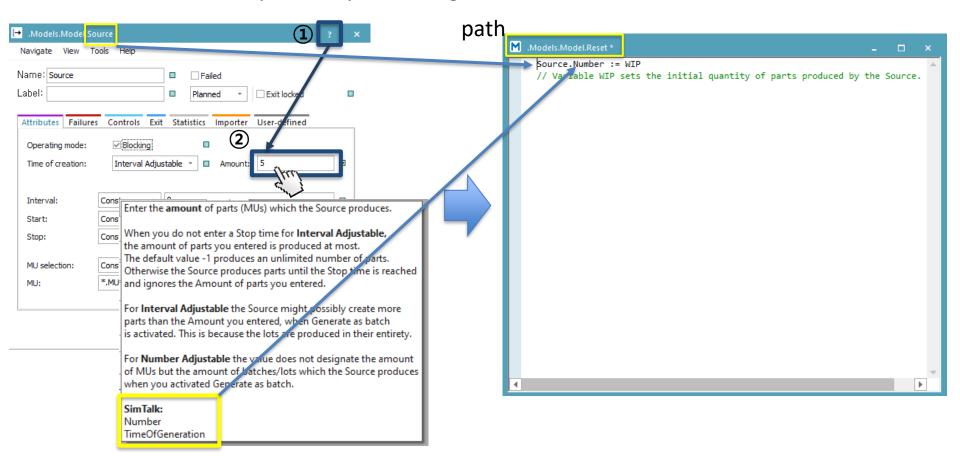






Task 1 - Object Setting - SimTalk

SimTalk is a programming language utilized in Plant Simulation that allows for a more precise configuration of the simulation environment. Every object has its own unique properties and functions, and you can access the syntax for these by clicking on the [?] button. Here is a simple example of using SimTalk

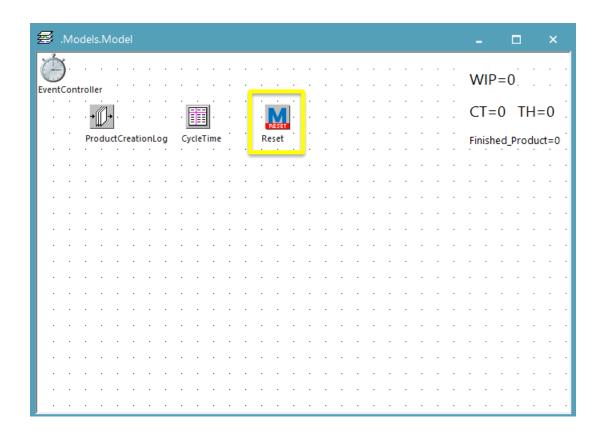






Task 1 - Object Setting - Reset method[1/2]

Create a Method object on the map in the same way as before and rename it to 'Reset'. This will change the icon of the object.

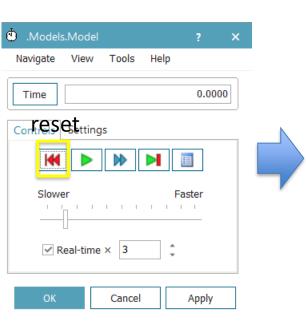






Task 1 - Object Setting - Reset method[2/2]

Double-click on the object and write the following code in the Reset method, which is explained in more detail in the comments below. This code will be executed when you click the 'reset' button of the 'EventController' object. You can think this as initialization



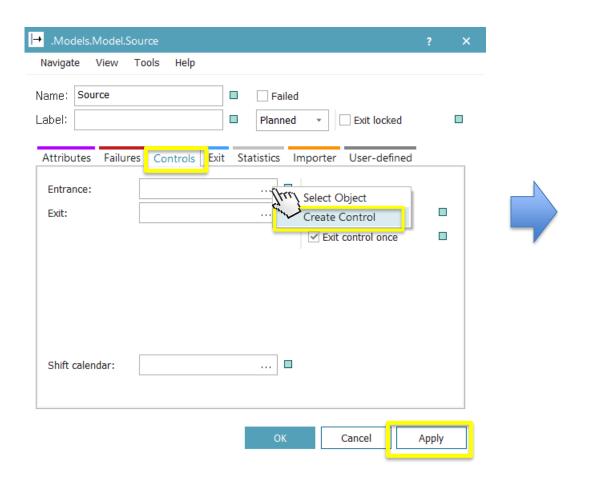
```
Finished Product := 0
TH := 0
CT := 0
// All Variables are cleared.
ProductCreationLog.deleteContents
CycleTime.deleteContents
// All the recorded values is cleared.
Source.Number := WIP
// Variable WIP sets the initial quantity of parts produced by the Source.
```

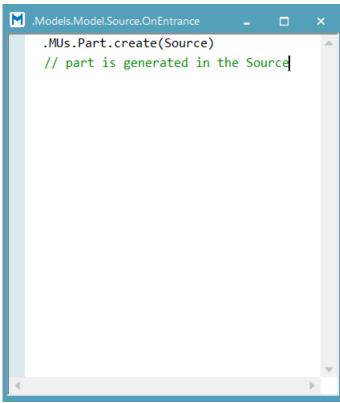




Task 1 - Method setting - Source[1/2]

Double-click the 'Source' icon on the map, go to the 'Controls' tab, and click the '...' button in the 'Entrance' section to create a method. Then, write the following code in the method. The 'Entrance' method is executed when a job arrives at this object.









Task 1 - Method setting - Source[2/2]

Create a method in the 'Exit' section following the same steps as before. Write the following code in the method. The 'Exit' method is executed when a job leaves this object.

```
.Models.Model.Source.OnExit *
 print time to num(EventController.SimTime)
 ProductCreationLog.push(time to num(EventController.SimTime))
 // "EventController.SimTime" means the present simulation time.
 // "time to num" means converting the time form into a number form.
 // ".push" means adding this number to the DataQueue.
 @.move -- Remove this, if the exit control is rear triggered!
 // "@" refers to the part (object) within this object (Source).
 // At the exit, the part should move to the next station or object.
```





Task 1 - Method setting - Drain

Double-click the 'Drain' icon on the map. Create a method in the 'Entrance' section following the same steps as before. Write the following code in the method.

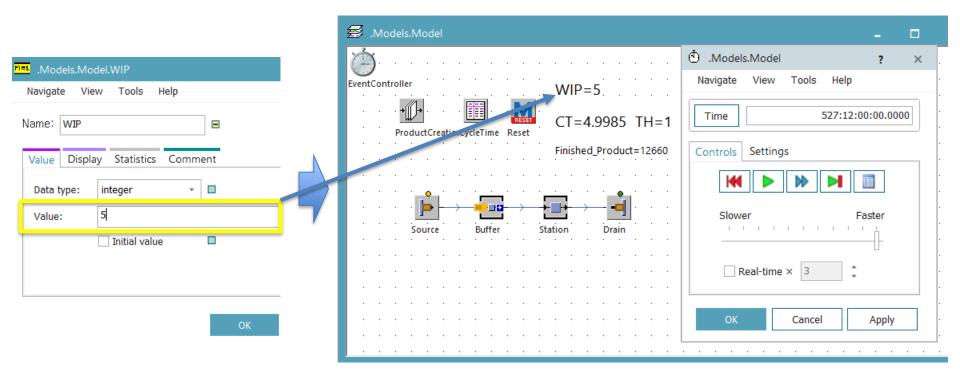
```
.Models.Model.Drain.OnEntrance
     Source.OnEntrance
     // call Source.OnEntrace method
     Finished_Product += 1
     TH := round((Finished Product / time to num(EventController.SimTime))*(60*60),4)
     //Cycle Time in hour
     CycleTime.appendRow((time_to_num(EventController.SimTime) - ProductCreationLog.pop)/(60*60))
     //".appendRow" adds this number to the DataTable.
     var cycle: real := 0
  - for var i := 1 to Finished_Product
         cycle += CycleTime[1,i]
   ∟ next
     // Compute the sum of CT
     CT := round((cycle / Finished Product),4)
     // Calculate the average cycle time
```





Task 1 - Setting Completion

Now we have created a model with a constant WIP. If you want to change the WIP, simply update the value of the 'WIP' Variable and run the simulation again! You can think of the 'WIP' Variable as the input, and the 'CT', 'TH', and 'Finished_product' Variable as the output.



For our simulation sessions:

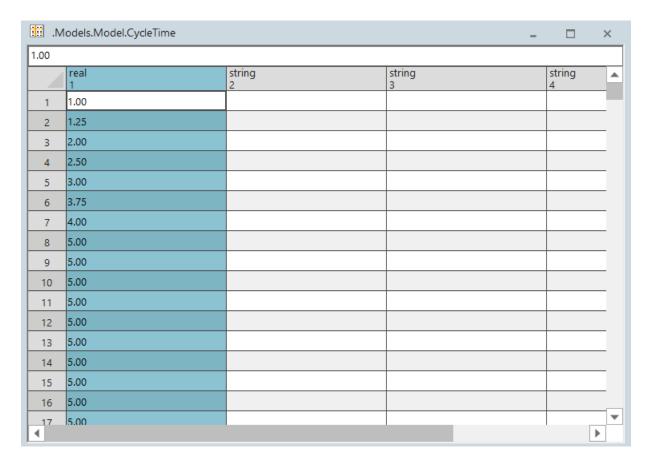
If not explained otherwise, create at least 10.000 finished products





Task 1 - Data Access

If you want to view the cycle time values, you can check them in the 'CycleTime' object. Additionally, if you wish to analyze the data further, Excel can be a useful tool.

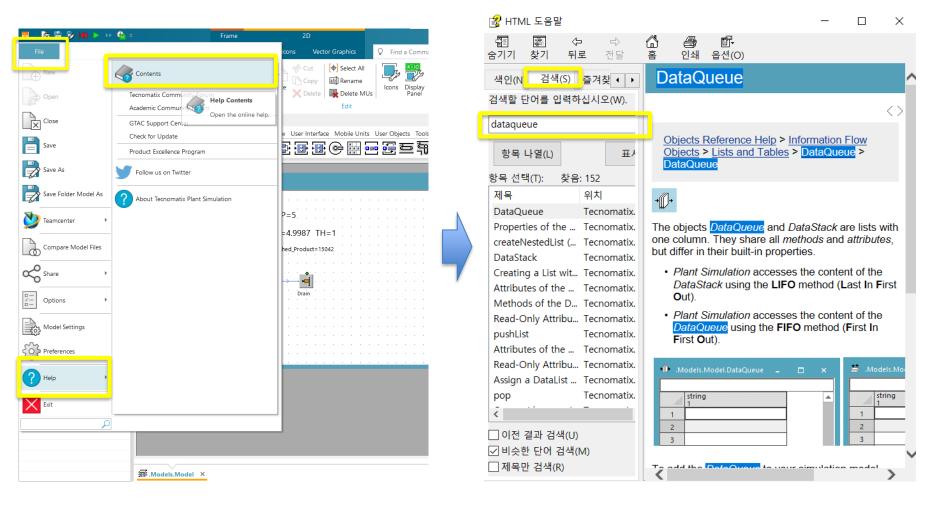






Task 1 - Help

If you want to figure out anything that is not clear or if you want to learn more, try utilizing the help function.







Task 1 – Warm up

Let's shortly discuss: The way we have set up our simulation model: Which of the scenarios does it reflect?

A: The best-case scenario

B: The worst-case scenario

C: The practical worst-case scenario

D: None of these





Task 1 – Warm up

Let's shortly discuss: The way we have set up our simulation model: Which of the scenarios does it reflect?

A: The best-case scenario

B: The worst-case scenario

C: The practical worst-case scenario

D: None of these





Task 1 – Warm up

- Let's shortly discuss: If we remove the Buffer before Rimming and use a Connector connecting the Tail Stamping and Rimming directly. What will happen to the overall CT and the overall TH and why?
- Set WIP to 1 and to 8 and capture the differences in TH and CT when comparing the buffer vs. the non-buffer configuration before Rimming.
- Explain the results using the term 'blocking', (Hint: [station] [statistics tab])

	TH	СТ
WIP = 1, Buffer existing		
WIP = 1, Buffer removed		
WIP = 8, Buffer existing		
WIP = 8, Buffer removed		





3. Homework





Task 1 - Penny Fab – Exponential Distribution

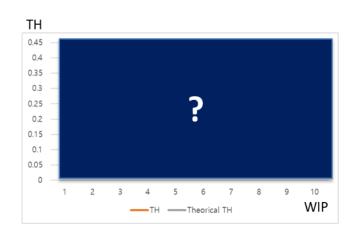
Take the simulation model from the warm-up. Increase WIP level from 1 to 10, draw two graphs, TH vs. WIP and CT vs. WIP, and analyze the result. Is it consistent with the values obtained by PWC equation in our textbook? & Explain: Why or why not?

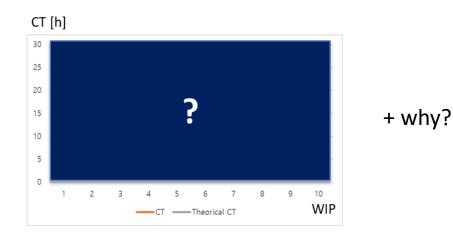
Definition (Practical Worst-Case Performance): The practical worst-case (PWC) cycle time for a given WIP level w is given by

$$CT_{PWC} = T_0 + \frac{w - 1}{r_h}$$

The PWC throughput for a given WIP level w is given by

$$TH_{PWC} = \frac{w}{W_0 + w - 1} r_b$$





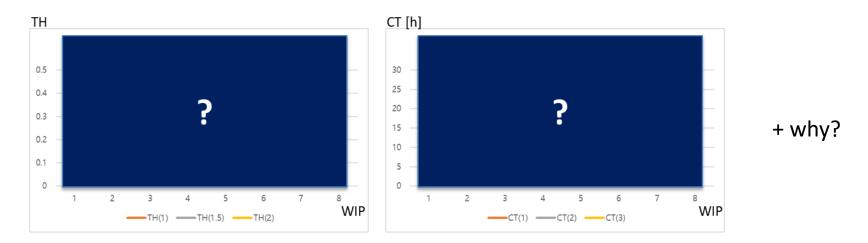




Task 2 - Penny Fab - Normal Distribution

This time, Penny Fab is as illustrated in figure, and processing times follow normal distribution. Each machine takes an average of two hours to complete its task and has a lower bound and upper bound processing time limit of 0 and 20 hours respectively.

(a) For each standard deviation, which includes 1 hour, 1.5 hours, and 2 hours, increase WIP level from 1 to 8 and draw TH vs. WIP in one graph. Analyze the result. Is there a tendency in the graph? Explain why.



b) Compare the performance when the WIP level is at 6 with the "practical worst-case" described in problem 1.





Thank you

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