Manufacturing System Analysis Experiment

Push and Pull

1. Experiment Overview

- Title

Comparing PUSH and PULL system in production system

- Objective
  - Understand the concept of PUSH and PULL system
  - Measure and compare the order waiting time, CT, WIP for each system

2. Theoretical Background

- Basic Terminology
  - PUSH systems schedule work releases based on demand, and PULL systems authorize work releases based on system status.
  - In PUSH systems, a job is entered into the production process when it is required by the work releases. The timing of input does not change depending on the process.
  - In PULL systems, a job is allowed to enter into the shop floor only when a signal indicates that the changes in a production line occurs. The signal shows if a certain job is finished in a production line like Kanban.

3. Experiment Design

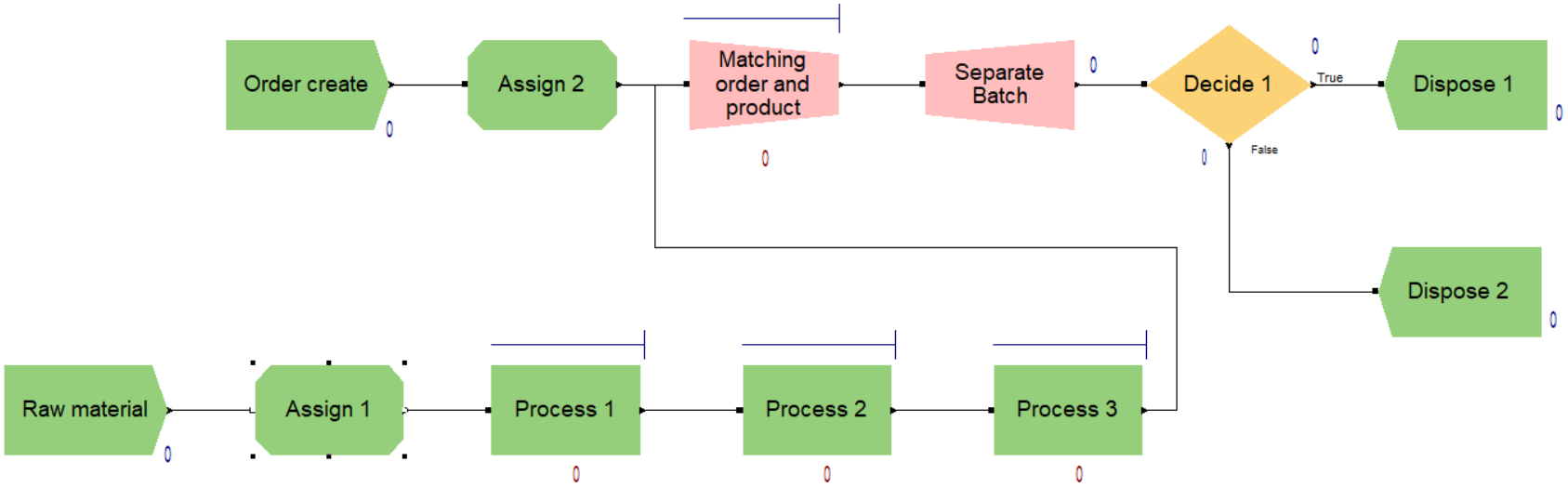
Yonsei Co. has a production line with 3 stations, and each machine processes one product at a time. Information of each station is given below.

<Table 1>	Workstation 1	Workstation 2	Workstation 3
# of Machine (Resource Capacity)	1	1	1
Processing Time	EXPO(4) min/job	EXPO(3) min/job	EXPO(4) min/job

Simulation runs for 1000 minutes, and for system stabilization and statistic accuracy, set warm-up time as 100 minutes.

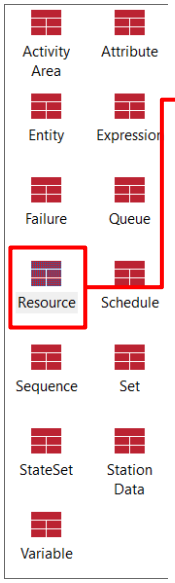
4. Experiment Procedure (1: push case)

- **Step 1-1. Creating a simulation model and resources setting**
  - Basic simulation model is as the picture shown below
  - Modules used: 2 Create, 3 Process, 2 Assign, 1 Batch, 1 Separate, 1 Decide, 2 Dispose



4. Experiment Procedure (1: push case)

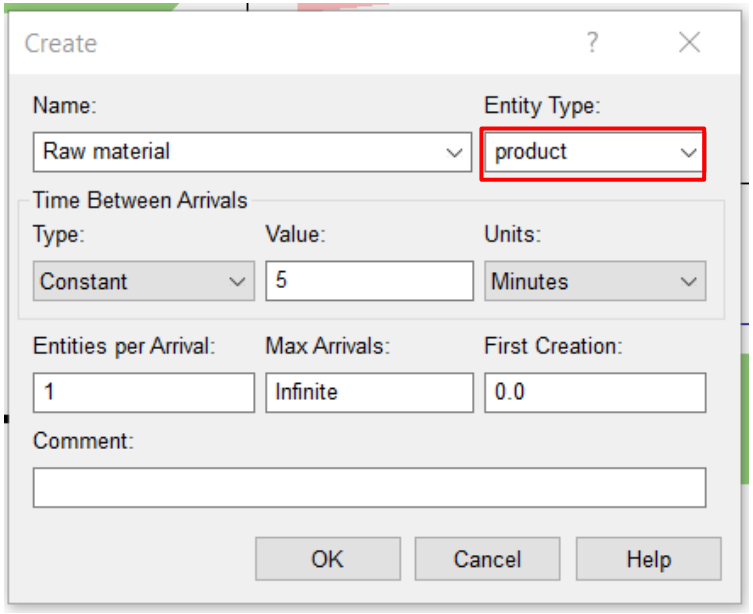
- **Step 1-1. Creating a simulation model and resources setting**
  - Click the resource icon in the Basic Process Panel, and ass resource by double-clicking Module Settings UI.
  - Set up name and capacity (station ID and #of machine) of each resource (machine).

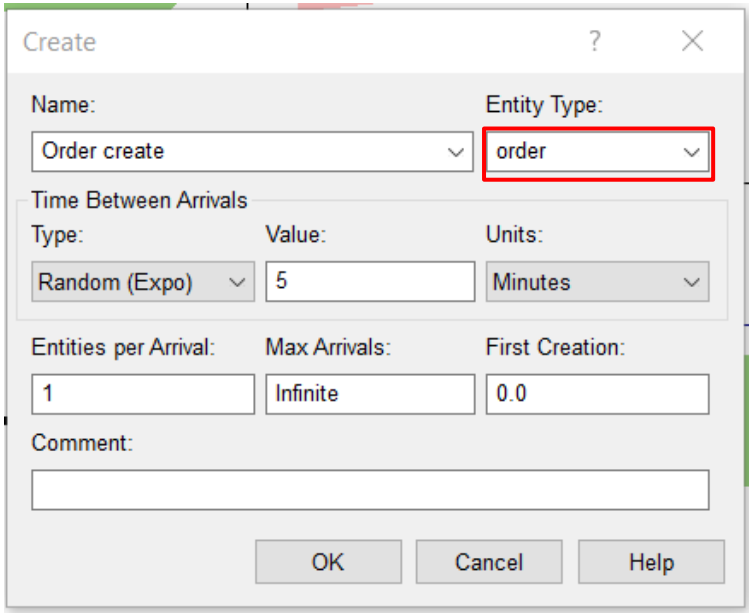


	Name	Type	Capacity	Busy / Hour	Idle / Hour	Per Use	StateSet Name	Failures	Report Statistics	Comment
1	Resource 1	Fixed Capacity	1	0.0	0.0	0.0		0 rows	☑	
2	Resource 2	Fixed Capacity	1	0.0	0.0	0.0		0 rows	☑	
3	Resource 3	Fixed Capacity	1	0.0	0.0	0.0		0 rows	☑	

4. Experiment Procedure (1: push case)

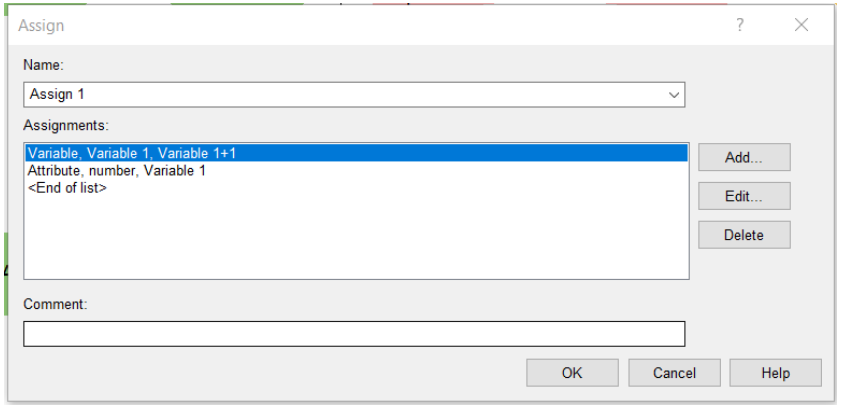
- **Step 1-2. Create module settings (Double-click Create module)**
  - Create module creates the entity going into the production system, and Yonsei Co. has two different kinds of entity: **raw material** and **order**.
  - Time Between Arrivals sets the input rate of entity, and the values will be changed for the further experiments. (1st Create: Raw material, 2nd Create: Order release)

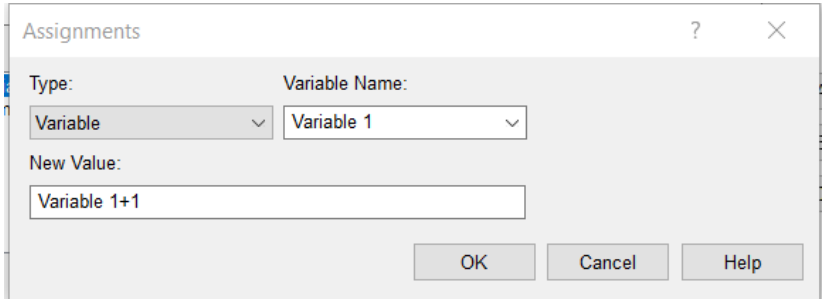


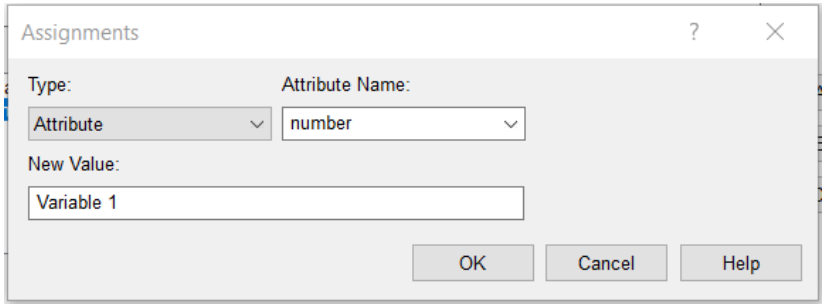


4. Experiment Procedure (1: push case)

- **Step 1-3. Assign module settings (Double-click Assign module)**
  - Place Assign modules for raw material Create module and order Create module
  - For **raw material Assign module**, define and add one variable and one attribute.
  - Remember that this is the process to match the order number and the product number.

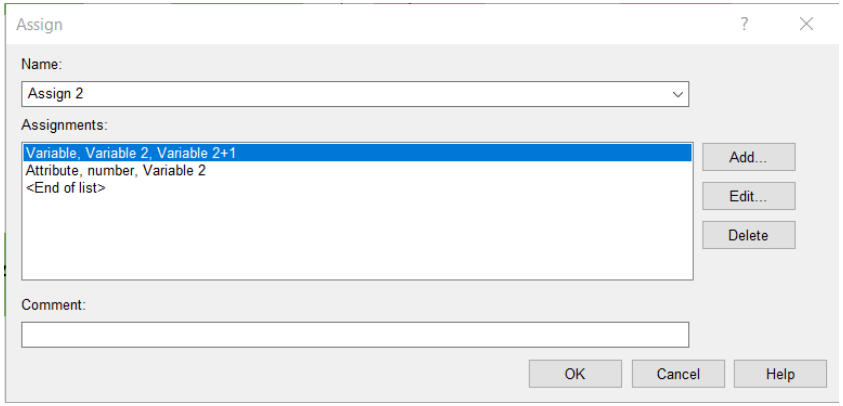


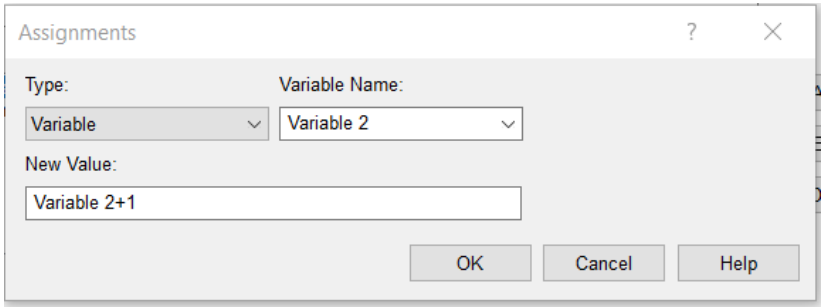


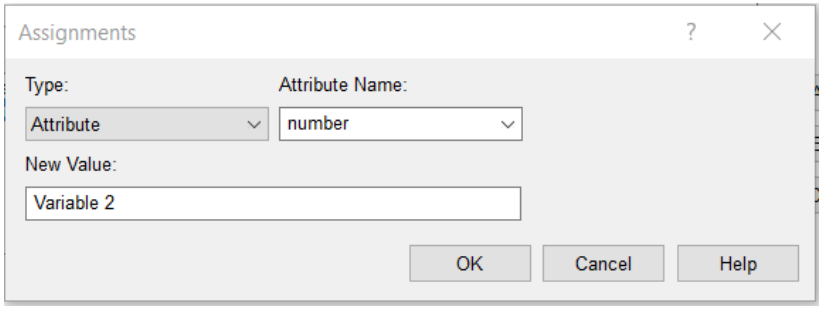


4. Experiment Procedure (1: push case)

- **Step 1-3. Assign module settings (Double-click Assign module)**
  - For **order Assign module**, define and add one variable and one attribute.

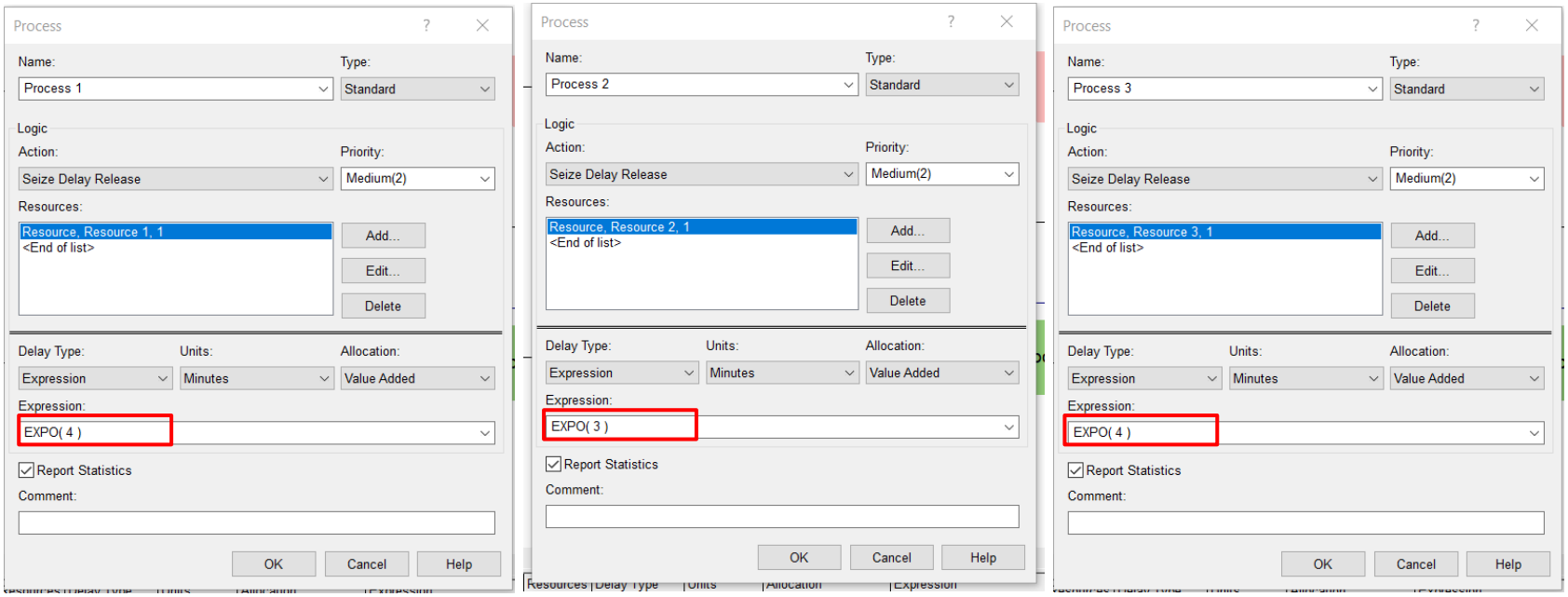






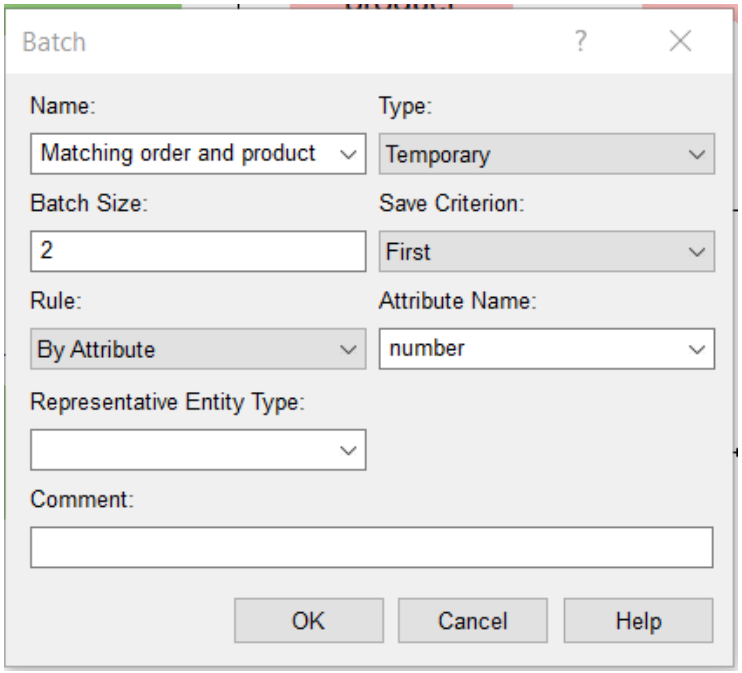
4. Experiment Procedure (1: push case)

- **Step 1-4. Process module settings (Double-click Process module)**
  - Define 3 processes, and details are shown below.



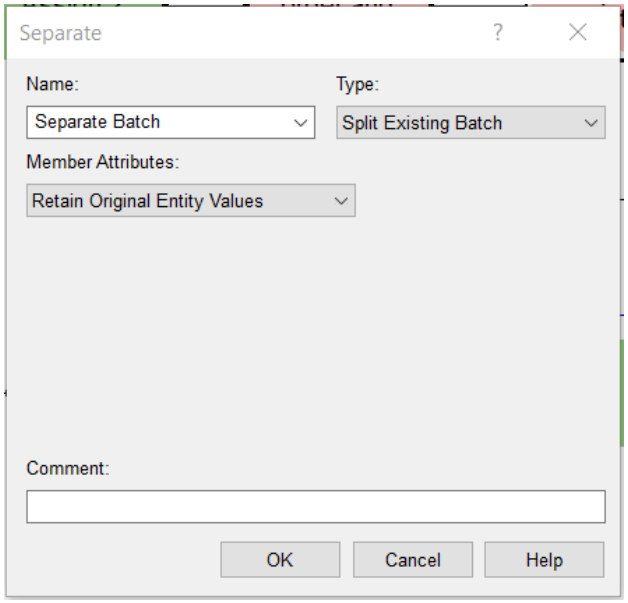
4. Experiment Procedure (1: push case)

- **Step 1-5. Batch module settings (Double-click Batch module)**
  - Set up Batch module as shown below, Batch size is 2.
  - When order comes in, it matches a manufactured product at that moment to the order number and leaves the system as a batch of a order and a product.



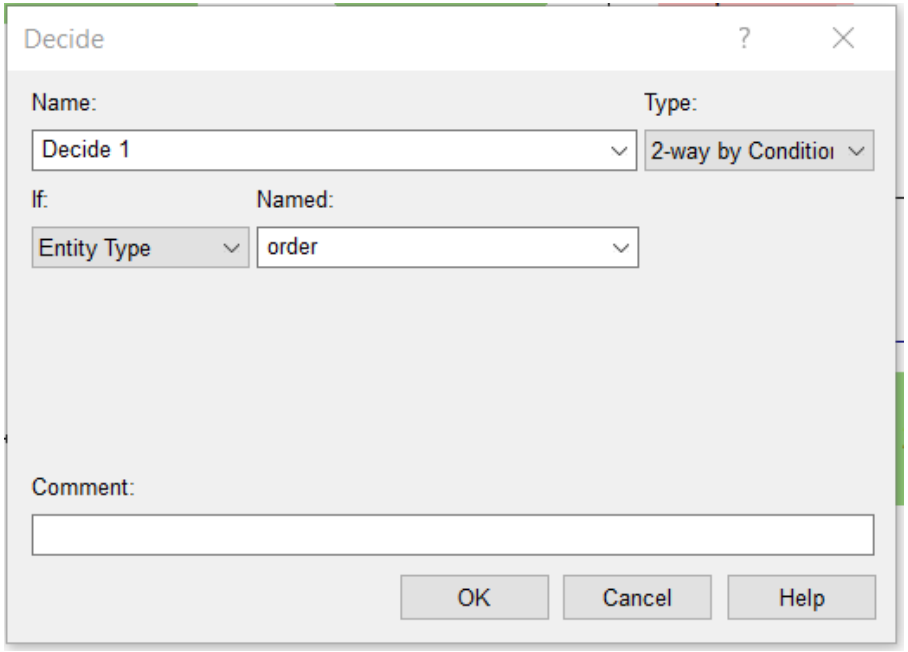
4. Experiment Procedure (1: push case)

- **Step 1-6. Separate module settings (Double-click Separate module)**
  - Separate module splits an order and a product which are batched together from the Batch module.
  - It is a technical step to calculate the number of the order and products, and settings are shown below.



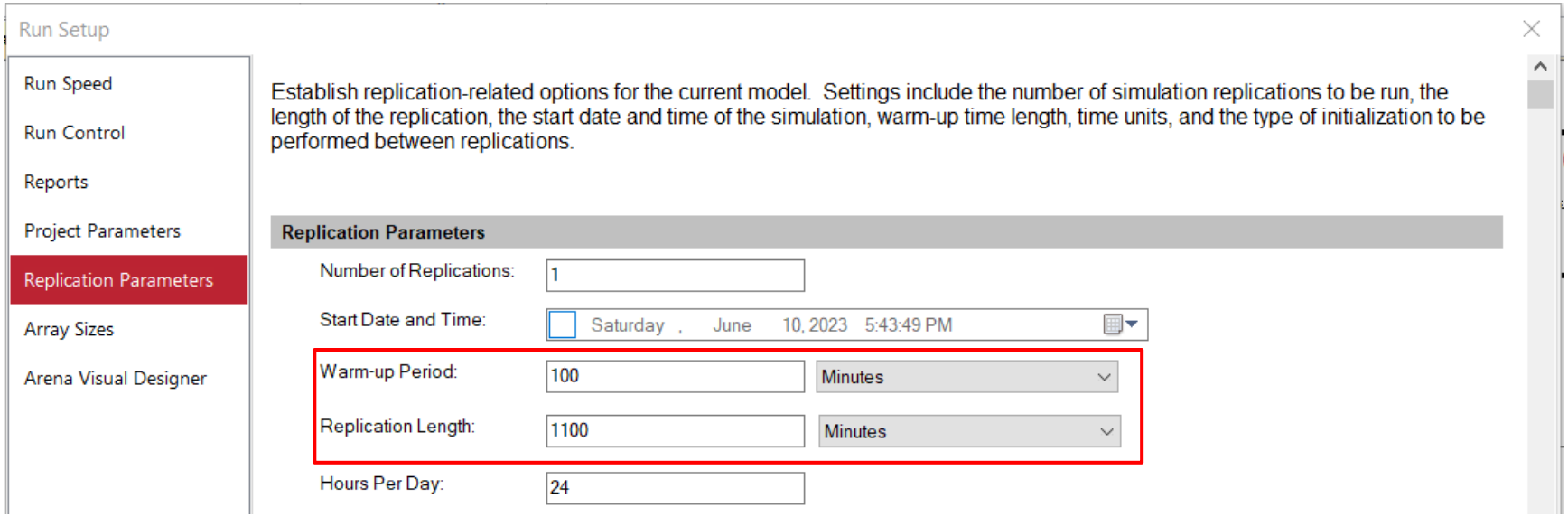
4. Experiment Procedure (1: push case)

- **Step 1-7. Decide module settings (Double-click Decide module)**
  - Decide module divides the order entity and product entity
  - As a result, order waiting time, product cycle time, system WIP information will be shown in the report for each entity



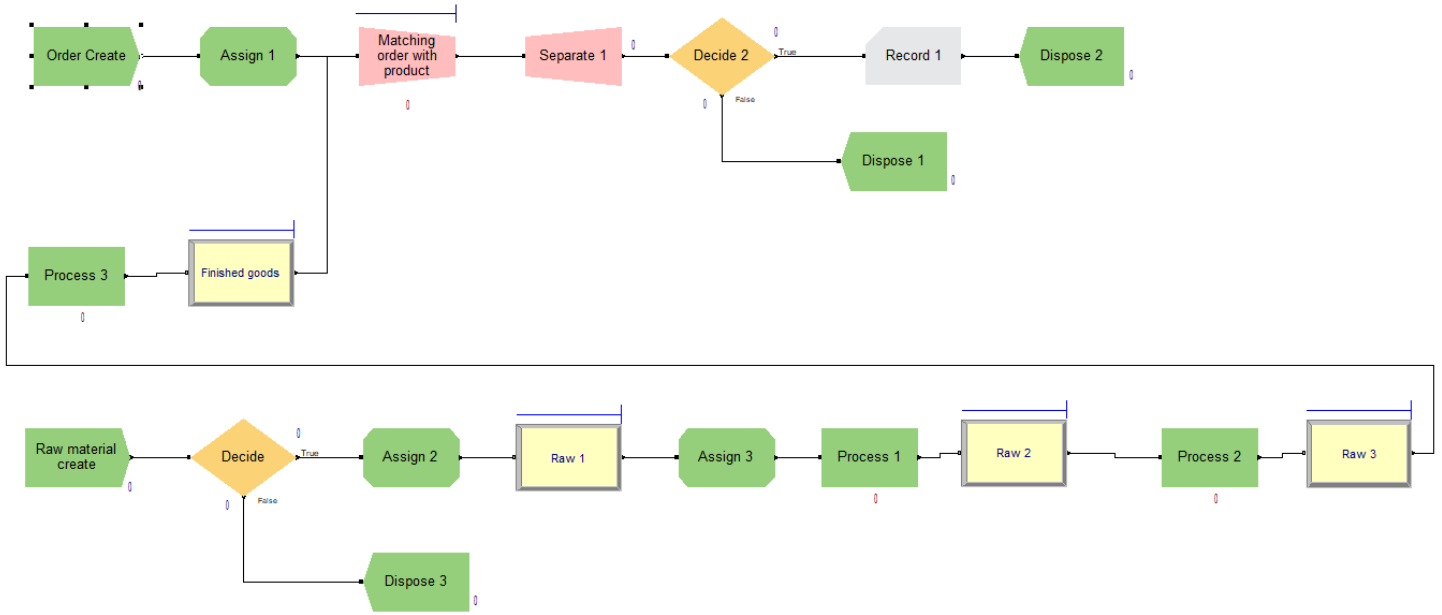
4. Experiment Procedure (1: push case)

- **Step 1-8. Run Setup**
  - 100 minutes of Warm-up Period for system stabilization, 1000 minutes of actual simulation time, total of 1100 minutes of the run time. (Run Tab → Setup → Replication parameters)



4. Experiment Procedure (2: pull case)

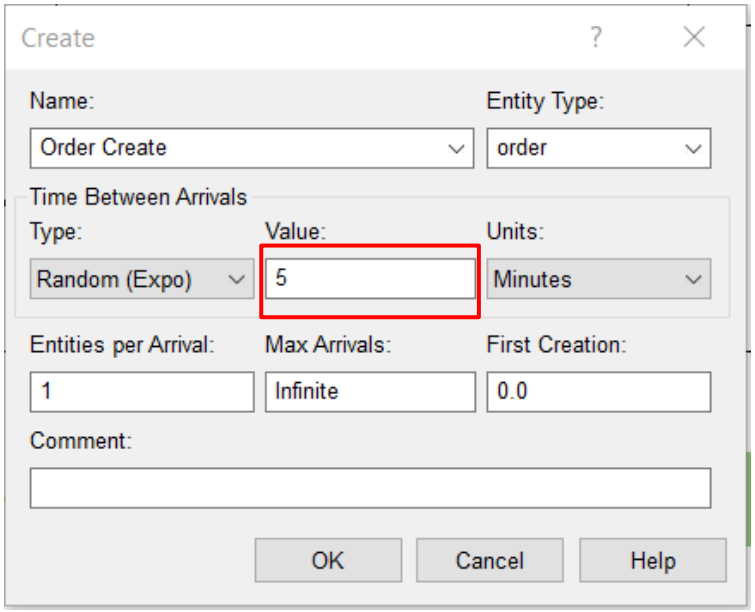
- **Step 2-1. Creating a simulation model and resources setting**
  - Basic simulation model is as the picture shown below (Raw 1~3 & Finished goods module = Hold module)
  - The system is divided into two parts where **generating an order** and **actual production**.

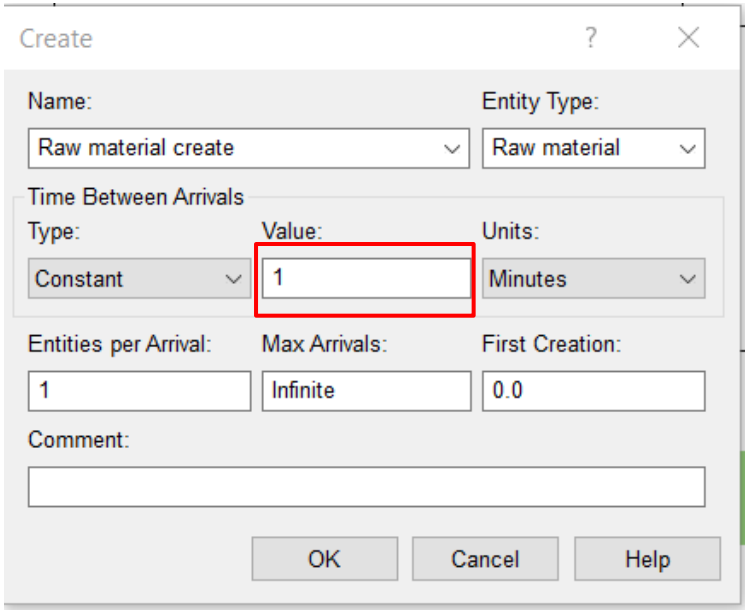


4. Experiment Procedure (2: pull case)

- **Step 2-2. Create module settings (Double-click Create module)**
  - Create module has a setting similar to the PUSH case.
  - Time between arrivals of the raw material is changed to 1 minute.

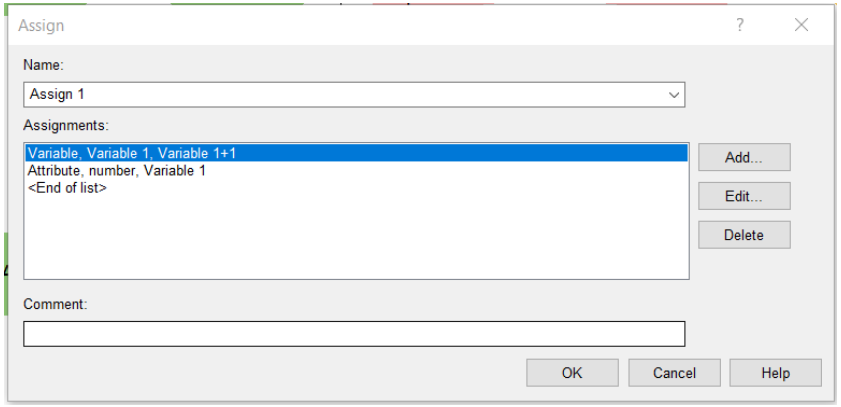
    (1st Create: Order release, 2nd Create: Raw material create)

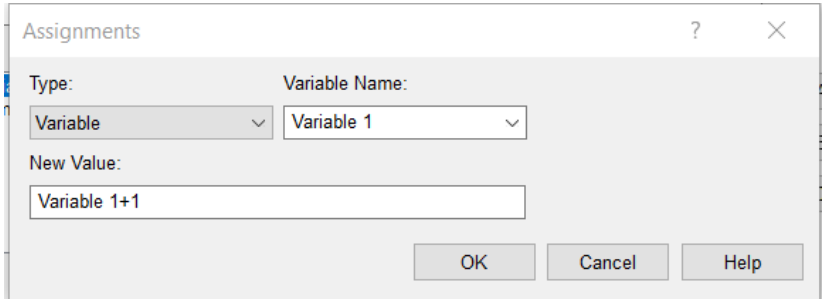


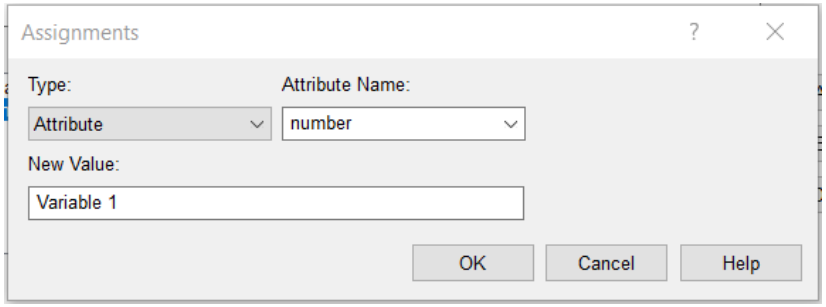


4. Experiment Procedure (2: pull case)

- **Step 2-3. Assign module settings for order**
  - Assign the attribute “number” to the order entity.
  - Once again! Remember that this is the process to match the order number and the product number.

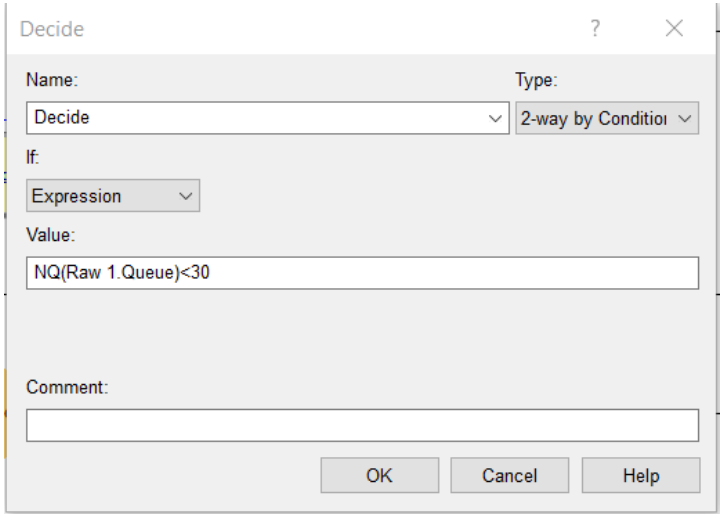






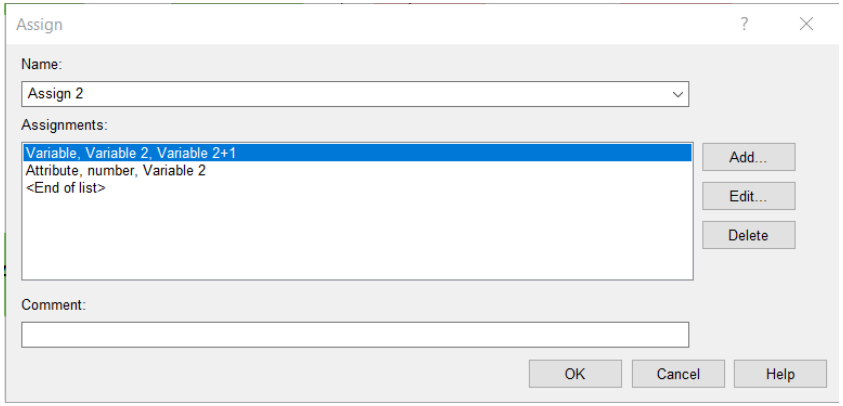
4. Experiment Procedure (2: pull case)

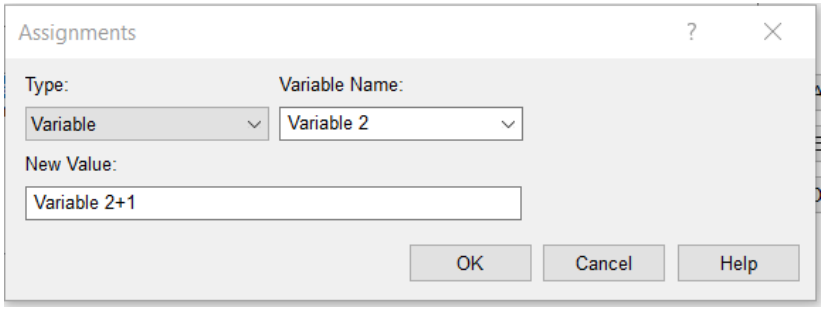
- **Step 2-4. Decide module settings (process of actual PULL production)**
  - Arena is time-based simulation which cannot produce an entity with signal or specific condition, so modeling of the PULL system is implemented in front of the actual production.
  - Raw material entity is moving to the buffer in front of the first process, assume that first buffer(Raw 1) to arrive can only have **less than 30 of the raw material**.
  - Type in the constraint for Raw 1.Queue in Decide module.
  - Buffer in front of each process will be presented using Hold module (advanced process).

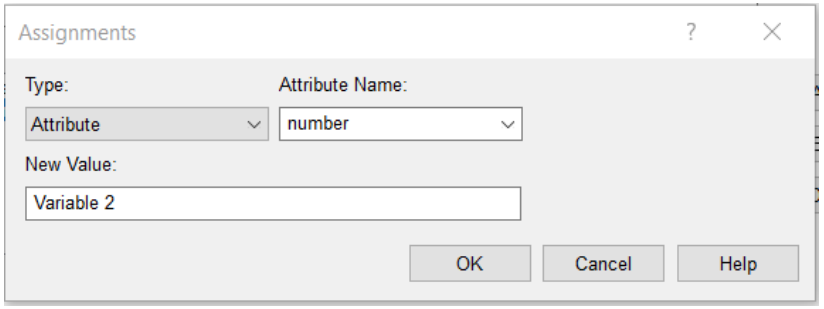


4. Experiment Procedure (2: pull case)

- **Step 2-5. Assign module settings for raw material**
  - If queue of Raw 1 is less than 30, raw material entity is assigned with the attribute value.
  - Variable and attribute is defined and added to Assign 2 module just like Assign 1 module.





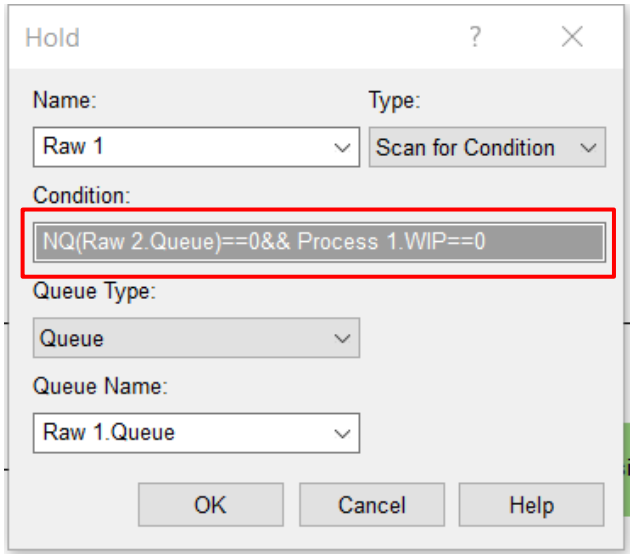


4. Experiment Procedure (2: pull case)

- **Step 2-6. Hold module settings**
  - Buffer of each station is represented with the **Hold** module.

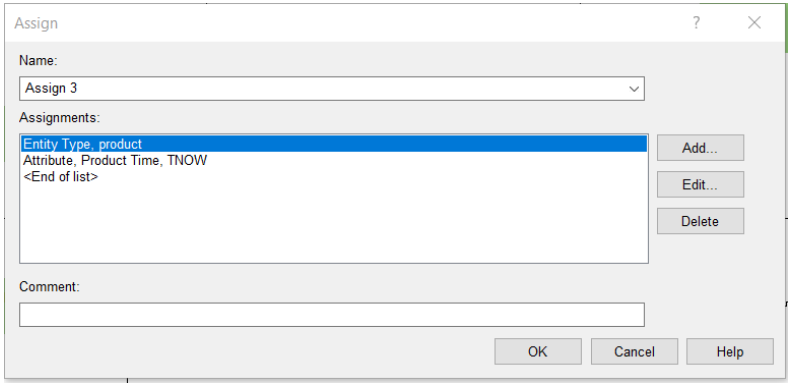
→ Due to the nature of the PULL production to transfer the entity in the buffer by the certain condition or the signal.

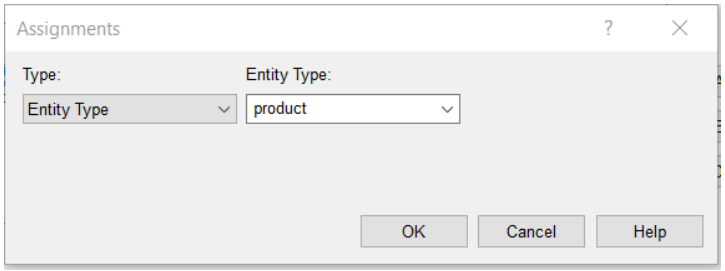
→ Hold module is set up as shown below, and proceed with this process when process 1 is idle and buffer(Raw 2) in front of the next process does not have any entity waiting.

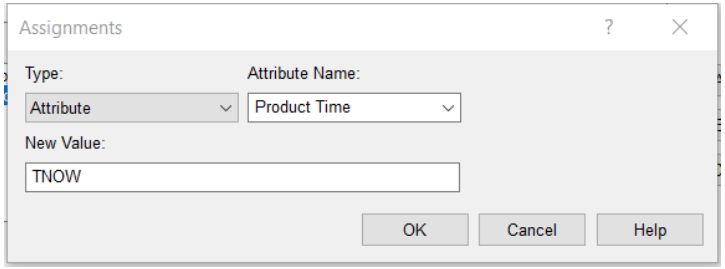


4. Experiment Procedure (2: pull case)

- **Step 2-7. Assign module settings (Raw material → Product)**
  - Through Step 2-6 set up for the PULL system, CT and WIP of the actual production system needs to be measured from this point.
  - Using the settings shown below to replace the entity from the raw material to product, and assign TNOW value to measure the actual production time.

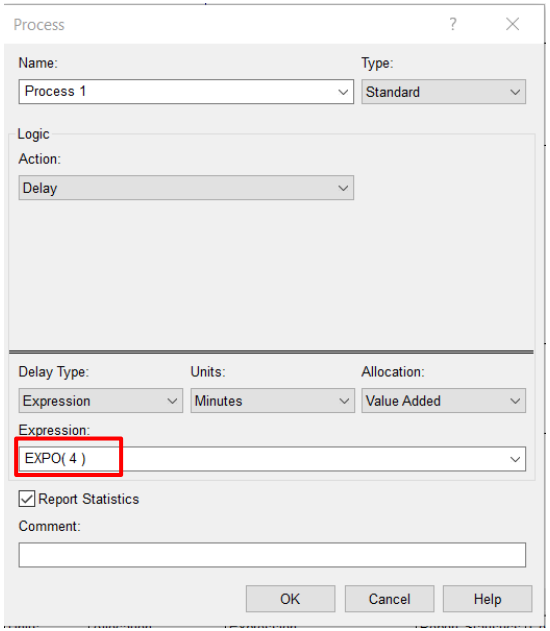


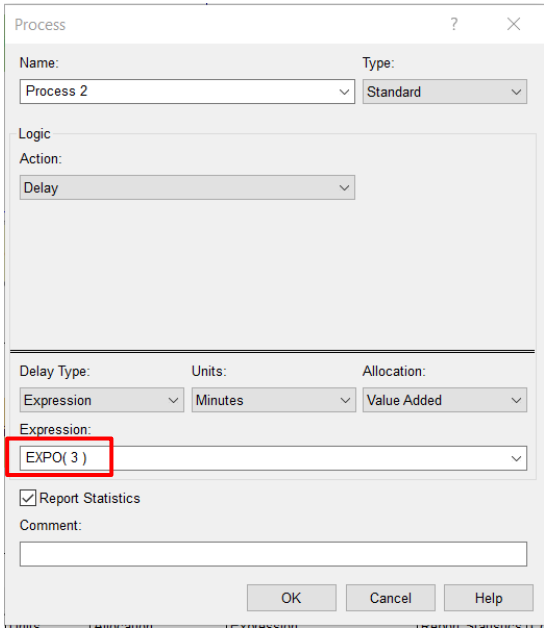


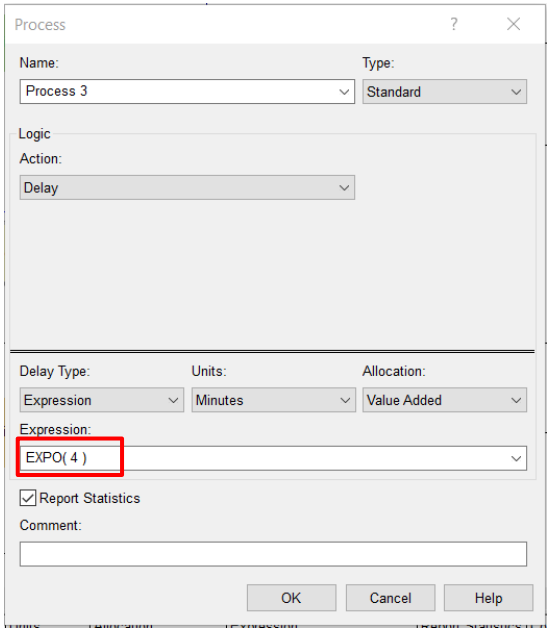


4. Experiment Procedure (2: pull case)

- **Step 2-8. Process module settings**
  - Define 3 Process, and use simply Delay as action.

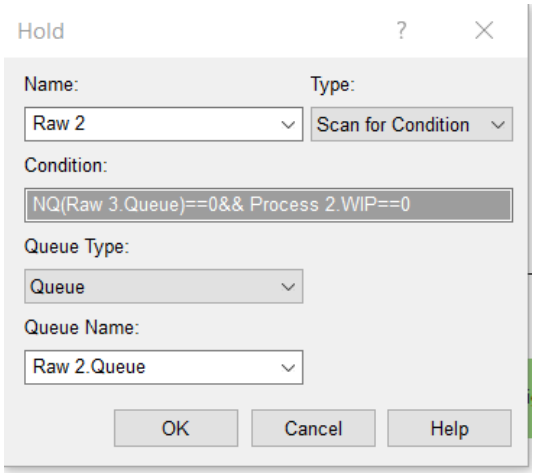


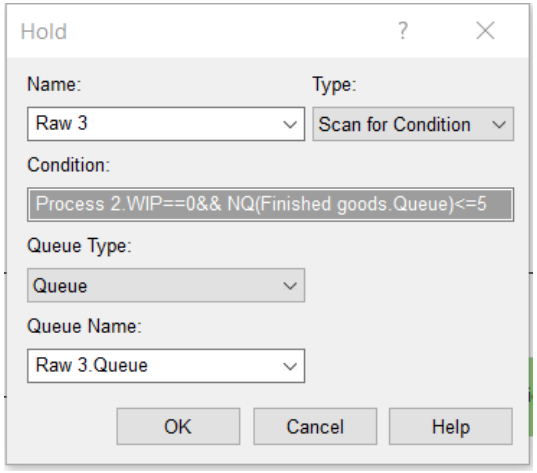


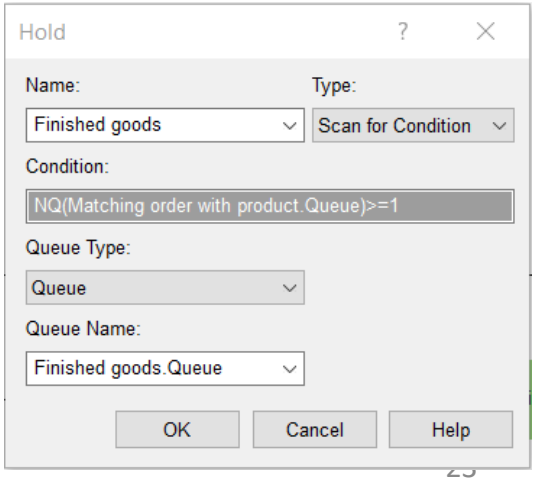


4. Experiment Procedure (2: pull case)

- **Step 2-9. Hold module settings**
  - After Process 1, entity waits at Raw 2, and move on when process 2 is idle and buffer(Raw 3) in front of the next process is empty.
  - After Process 2, entity waits at Raw 3, and move on when process 3 is idle and inventory of the finished product is less than or equal to 5.
  - Completed entity waits at the Hold module “Finished goods” for an order, and it is processed when an order entity arrives at the Batch module.

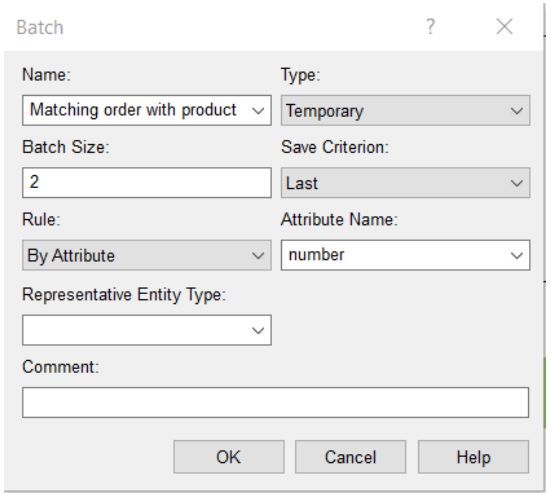






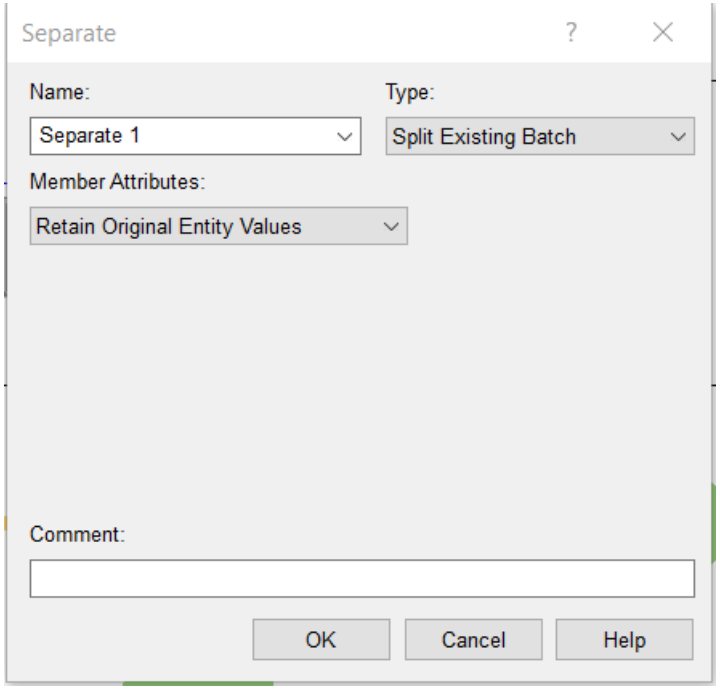
4. Experiment Procedure (2: pull case)

- **Step 2-10. Batch module settings**
  - Order with an attribute assigned is sent to the Batch module, and it is processed right away if there is a finished product, otherwise it waits at Batch module's queue for a product to be finished.
  - Batch module is set up as shown below, and Batch size is 2.
  - It is to match a produced good with its order number at the moment of the order, and an order and a product is bundled into one batch.



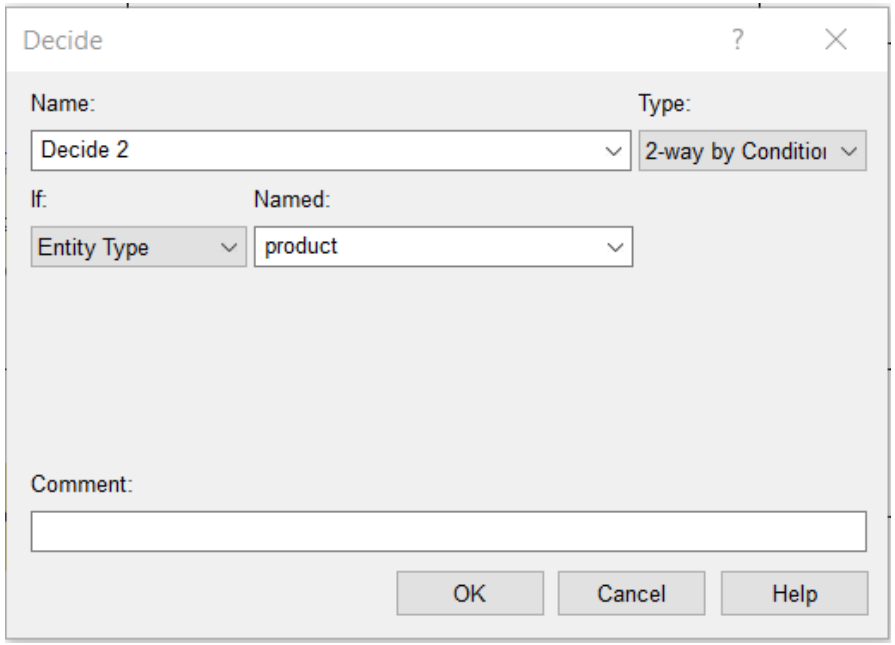
4. Experiment Procedure (2: pull case)

- **Step 2-11. Separate module settings**
  - Separate module separates the bundle of an order and a product formed in Batch module.
  - It is a technical step to calculate the number of the order and products, and settings are shown below.



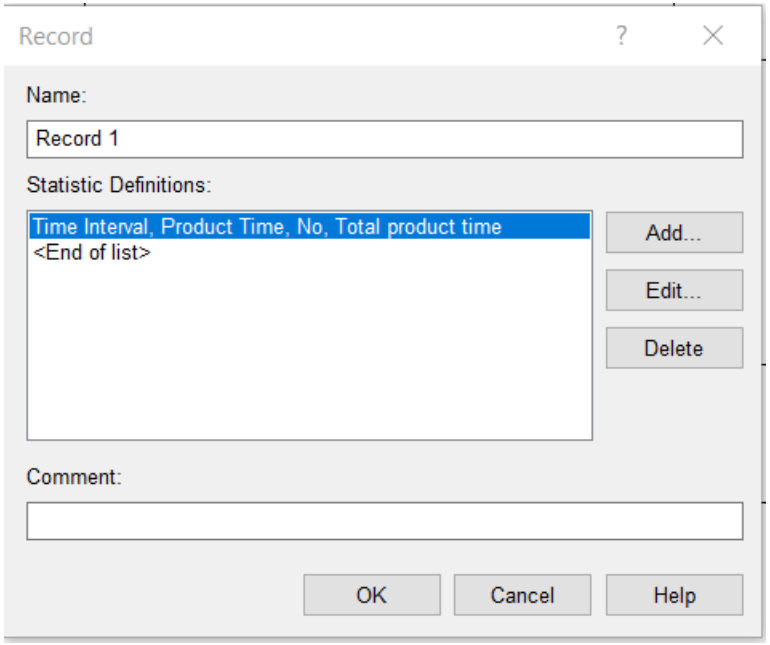
4. Experiment Procedure (2: pull case)

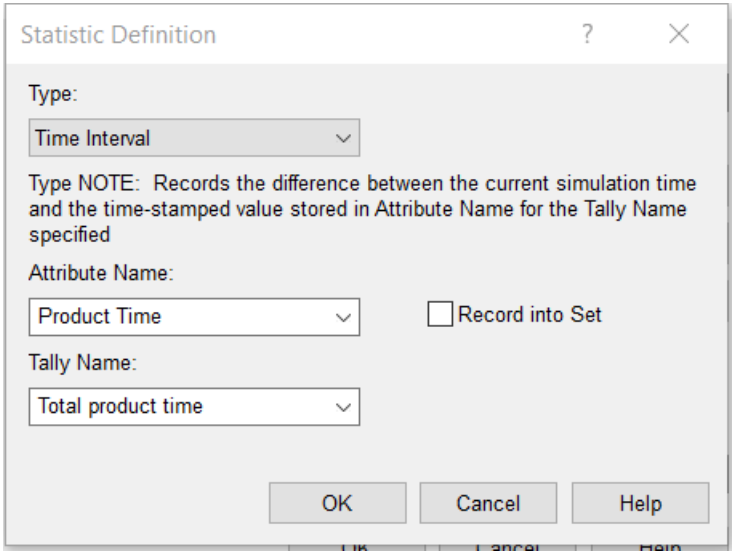
- **Step 2-12. Decide module settings**
  - To measure the CT of a product from inputting into the actual production until order is processed, use the Decide module to separate the entity with entity type as product.



4. Experiment Procedure (2: pull case)

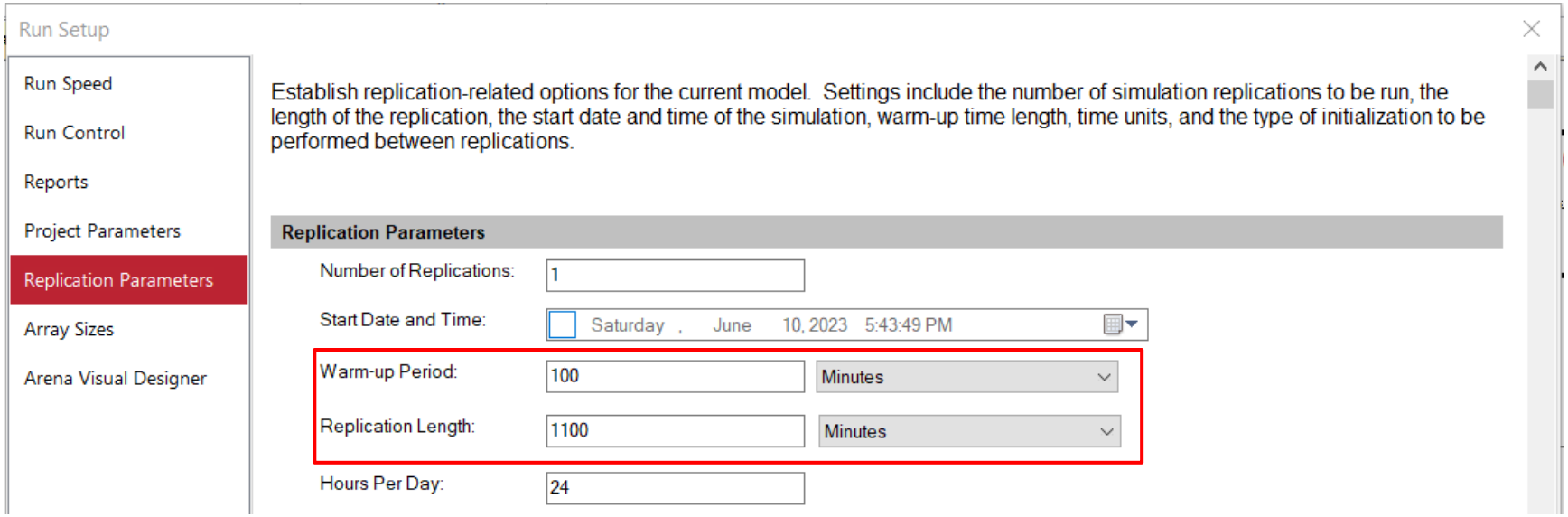
- **Step 2-13. Record module settings**
  - TNOW for each entity assigned before passing Process 1 is used to calculate the Time interval and record the Total product time.
  - Entity finished with recording time is disposed.





4. Experiment Procedure (2: pull case)

- **Step 2-14. Run Setup**
  - 100 minutes of Warm-up Period for system stabilization, 1000 minutes of actual simulation time, total of 1100 minutes of the run time. (Run Tab → Setup → Replication parameters)



Q & A