Manufacturing System Analysis Experiment

Batching

1. Experiment Overview

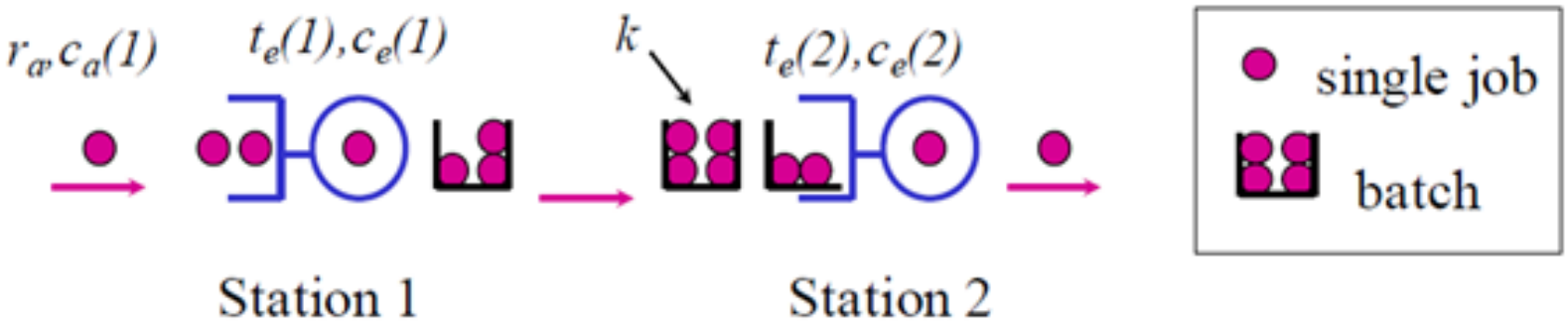
- Title

Effects of batching on production system

- Objective
  - Model move batching and process batching, which are seen a lot in the industry, using the simulation
  - Consider how changes in batch size within a given variation affects each batching system

2. Theoretical Background

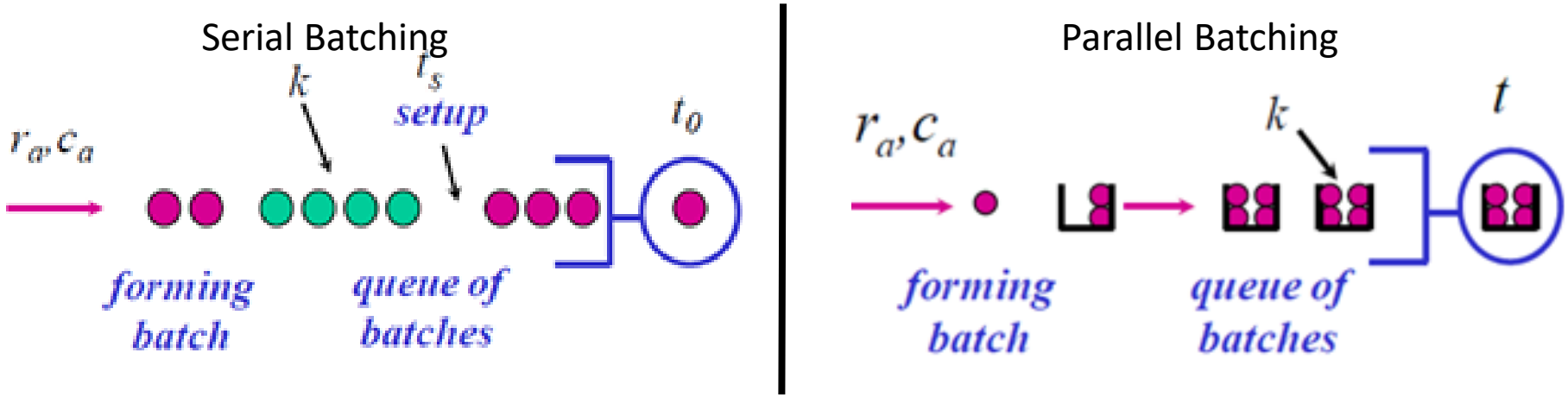
- Move (transfer) Batches



- $CT(batching) = CT(batching)\frac{k-1}{2u(1)}t_e + \frac{k-1}{2}t_e(2) = CT(batching) + \frac{k-1}{2}\left(\frac{t_e(1)}{u(1)} + t_e(2)\right)$

2. Theoretical Background

- Process Batches (Parallel Batching)



- $CT = WTBT\ (Wait\ To\ Batch\ Time, Batch\ forming\ time) + CT_q(waiting\ time) +$

$$t(working\ time) = \frac{k-1}{2r_a} + \left(\frac{\frac{c_a^2}{k}+c_e^2}{2}\right)\left(\frac{u}{u-1}\right)t + 1 = \frac{k-1}{2ku}t + \left(\frac{\frac{c_a^2}{k}+c_e^2}{2}\right)\left(\frac{u}{1-u}\right)t + t$$

➢ Batching reduces the variability of the production system

3. Experiment Design

Yonsei Electronics has two production lines using batching:

1) Move batching

2) Process batching

Decide the appropriate batch size by calculating the cycle time and variability with the machine performance given below.

	Entity Create	**Process time**
Move Batching	15 min/unit	Expo (15 min)
Process Batching	15 min/unit	Expo (15 * batch size)

4. Experiment Procedure

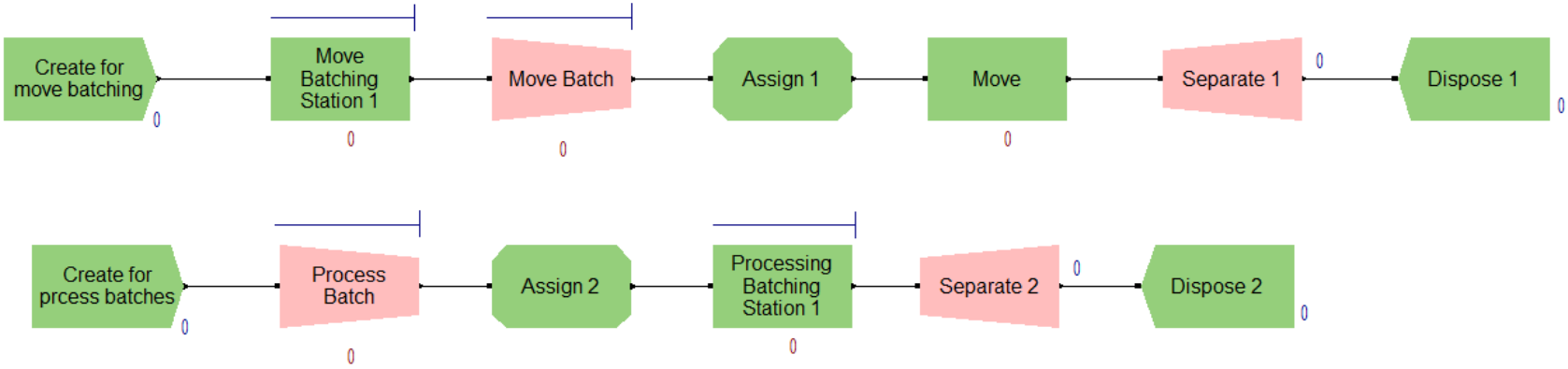
- **Step 1-1. Simulation summary**
  - Simulation consists of two batch methods:

    1) move (transfer) batch

    2) process batch
  - Each model is a simple system: create, batch, process, and dispose
  - Simulation runs for one day (24 hrs) and is repeated 10 times (Run Setup settings)

4. Experiment Procedure

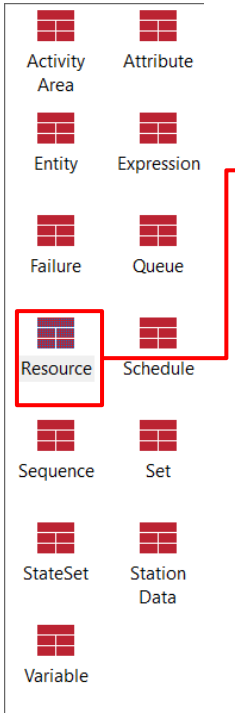
- **Step 1-2. Creating the model**
  - Basic simulation model is as the picture shown below
  - Modules used: Create, Process, Batch, Separate, Dispose, Assign



<Picture 1> Models window with simulation modules

4. Experiment Procedure

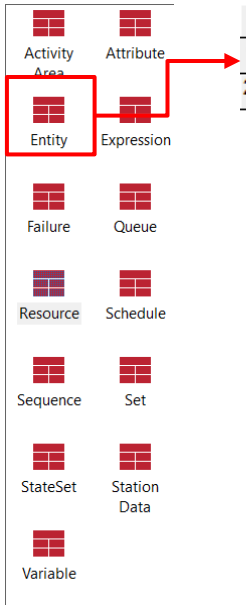
- **Step 1-2. Creating the model (cont.)**
  - Create one resource each for move batching and process batching



	Name	Type	Capacity	Busy / Hour	Idle / Hour	Per Use	StateSet Name	Failures	Report Statistics
1	MB station 1 mc	Fixed Capacity	1	0.0	0.0	0.0		0 rows	☑
2	PB station 1 mc	Fixed Capacity	1	0.0	0.0	0.0		0 rows	☑

4. Experiment Procedure

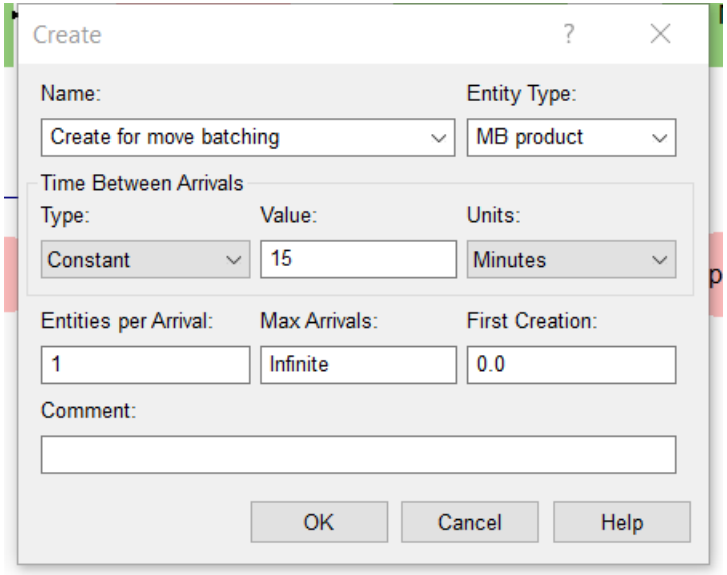
- **Step 1-2. Creating the model (cont.)**
  - Set ‘Initial Picture’ for each product to see the product moving through the line during simulation

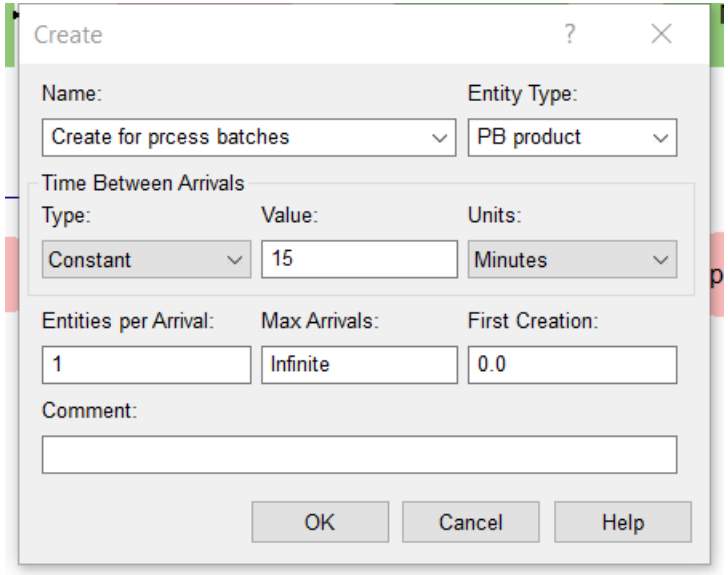


	Entity Type	Initial Picture	Holding Cost / Hour	Initial VA Cost	Initial NVA Cost	Initial Waiting Cost	Initial Tran Cost	Initial Other Cost	Report Statistics
1 ▶	MB product	Picture.Green Ball	0.0	0.0	0.0	0.0	0.0	0.0	☑
2	PB product	Picture.Green Ball	0.0	0.0	0.0	0.0	0.0	0.0	☑

4. Experiment Procedure

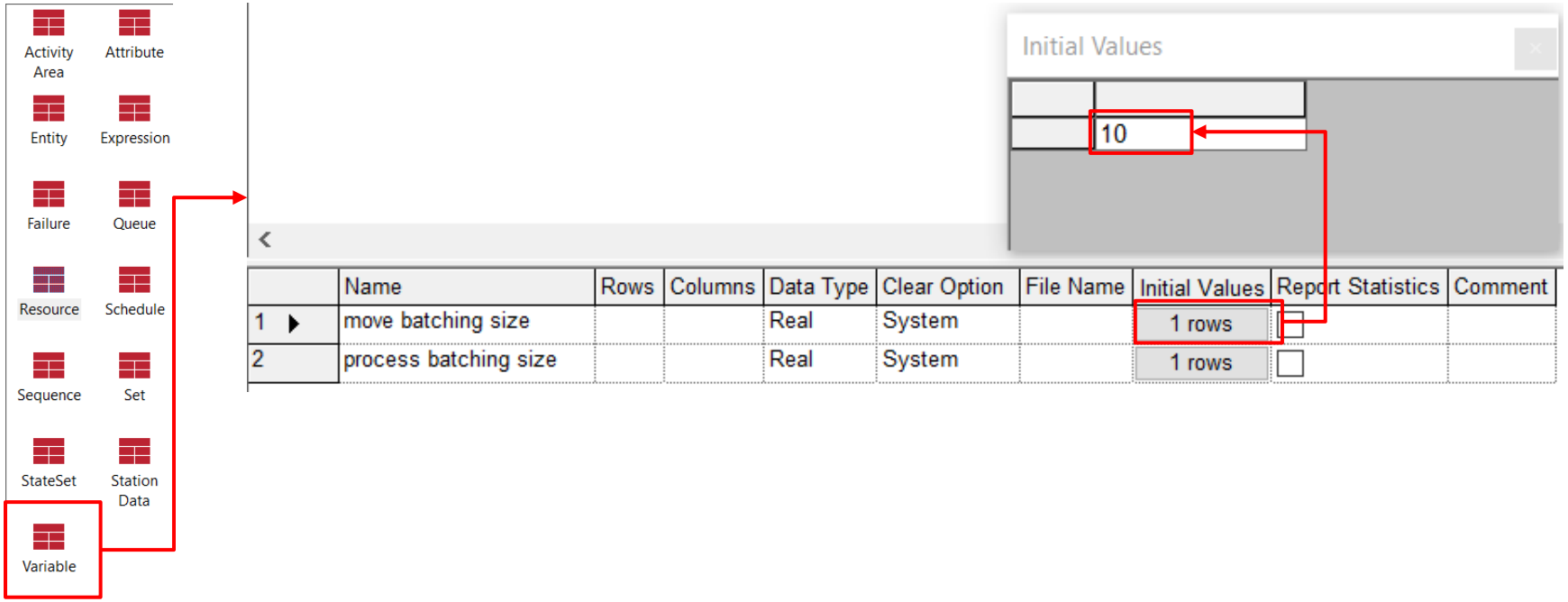
- **Step 1-2. Creating the model (cont.)**
  - Set Create module
  - Move batching and process batching has the same constant arrival, as the objective is to see the effects of batch size





4. Experiment Procedure

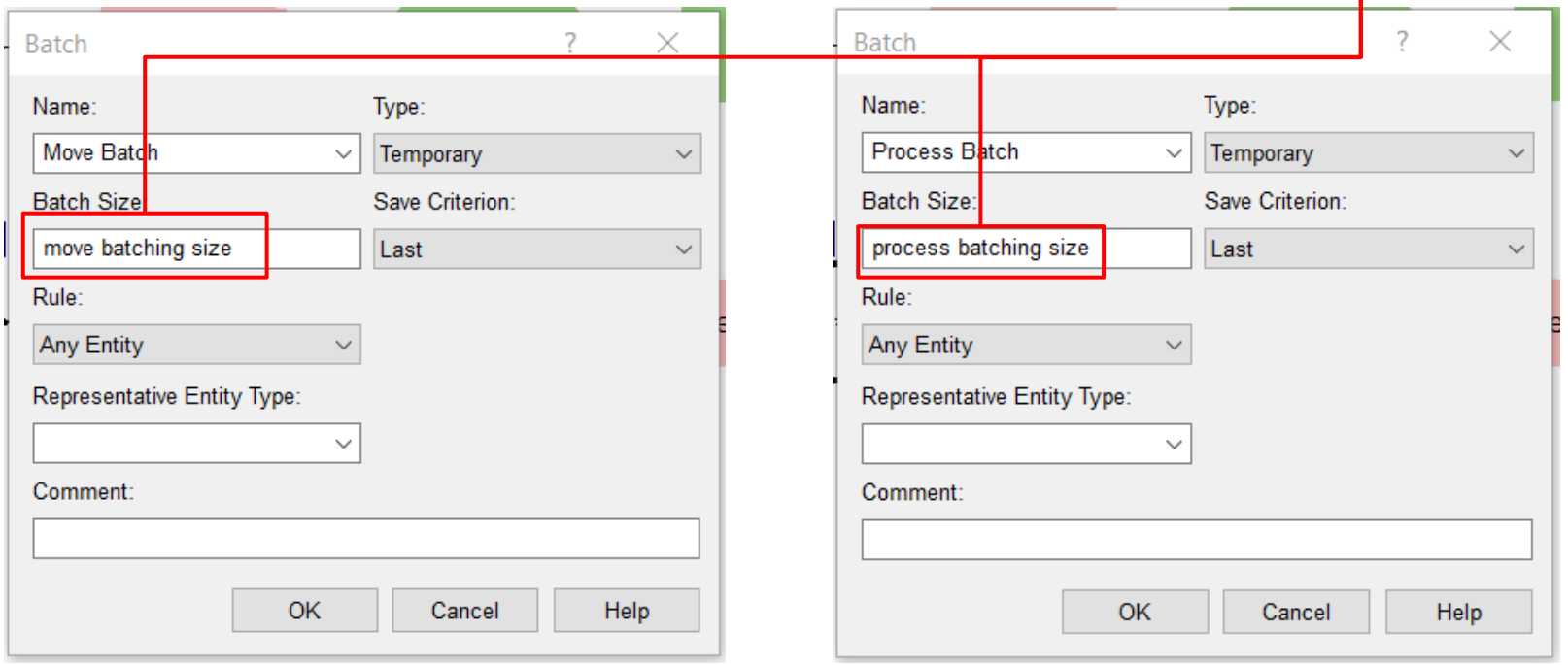
- **Step 1-2. Creating the model (cont.)**
  - Define variables to set batch size
  - Useful when experimenting through changing batch size



4. Experiment Procedure

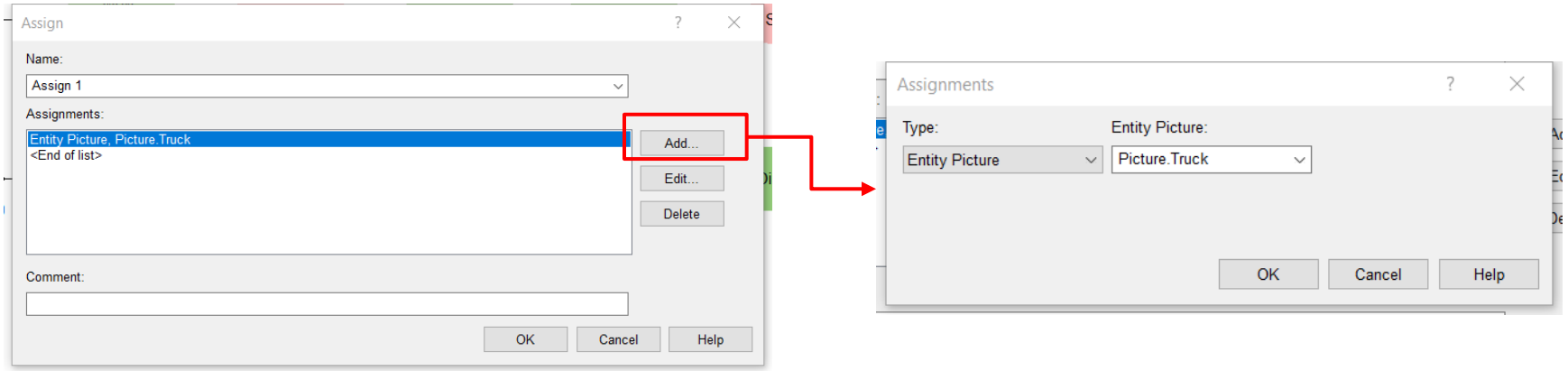
- **Step 1-2. Creating the model (cont.)**
  - Set Batch modules
  - Use the name typed in Variable module for batch size

Variables representing the batch size



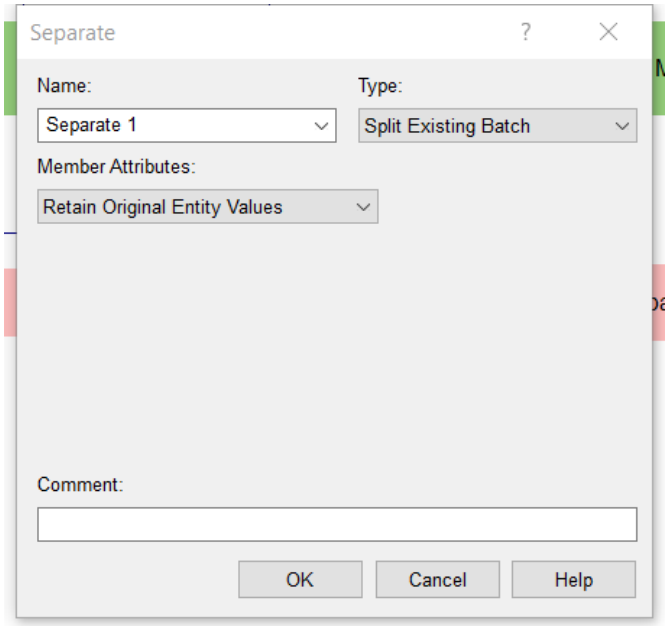
4. Experiment Procedure

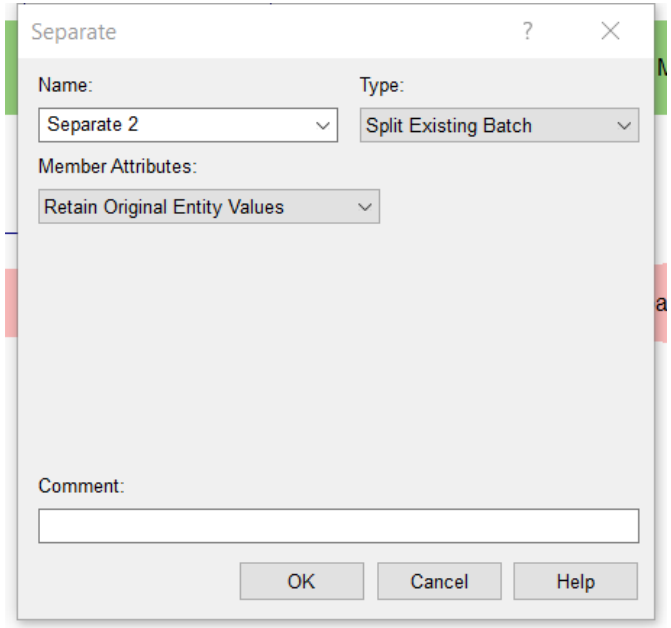
- **Step 1-2. Creating the model (cont.)**
  - Assign new pictures for entity to see products batching
  - Use the add button to select the picture



4. Experiment Procedure

- **Step 1-2. Creating the model (cont.)**
  - Set Separate module as shown for both system
  - Move Batching is separated by definition
  - Process Batching is separated for the experiment purpose





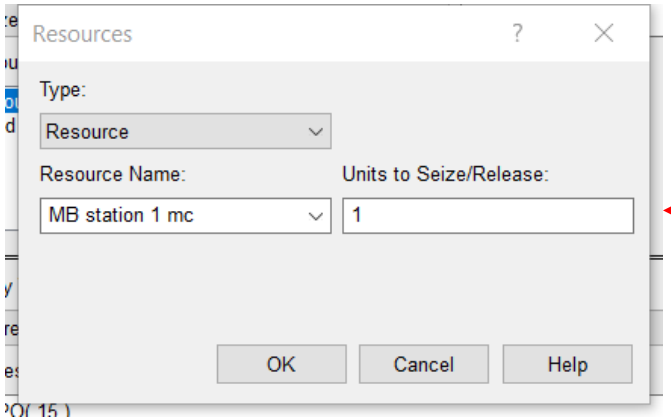
4. Experiment Procedure

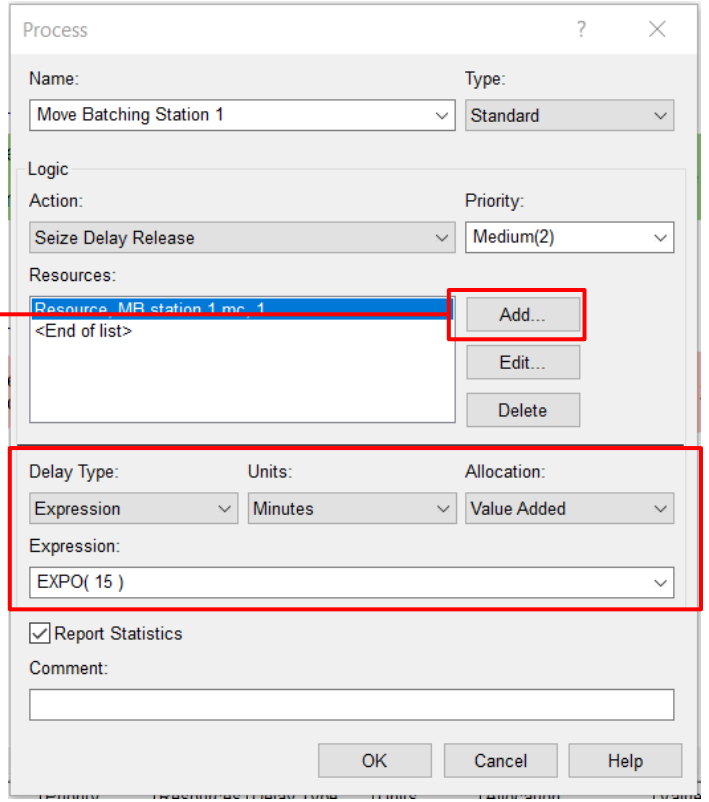
- **Step 1-2. Creating the model (cont.)**

  1. Move Batching

  - Set action as ‘Seize Delay Release’

    = Station seize, process, and return the resource
  - Use Add button to assign resources
  - Delay time = exponential (15)



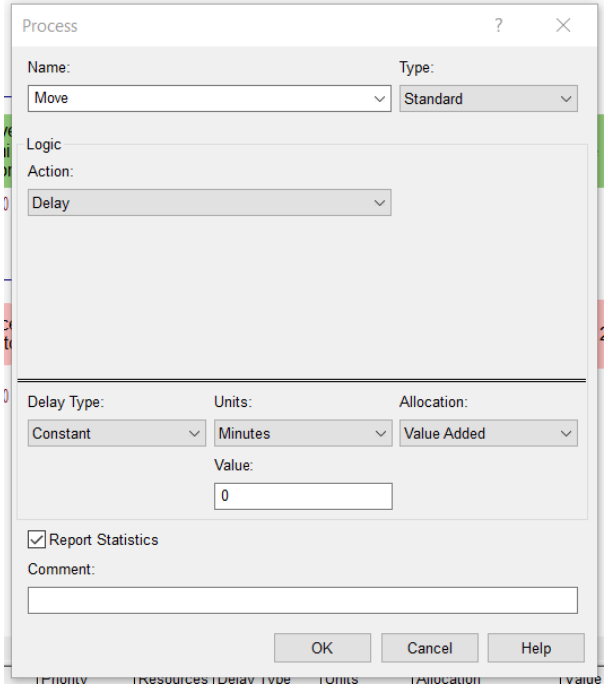


4. Experiment Procedure

- **Step 1-2. Creating the model (cont.)**

  1. Move Batching

  - Use a Process module to express the moving to the next process
  - Set Action as Delay and Delay Type value to 0 as we do not consider the moving time



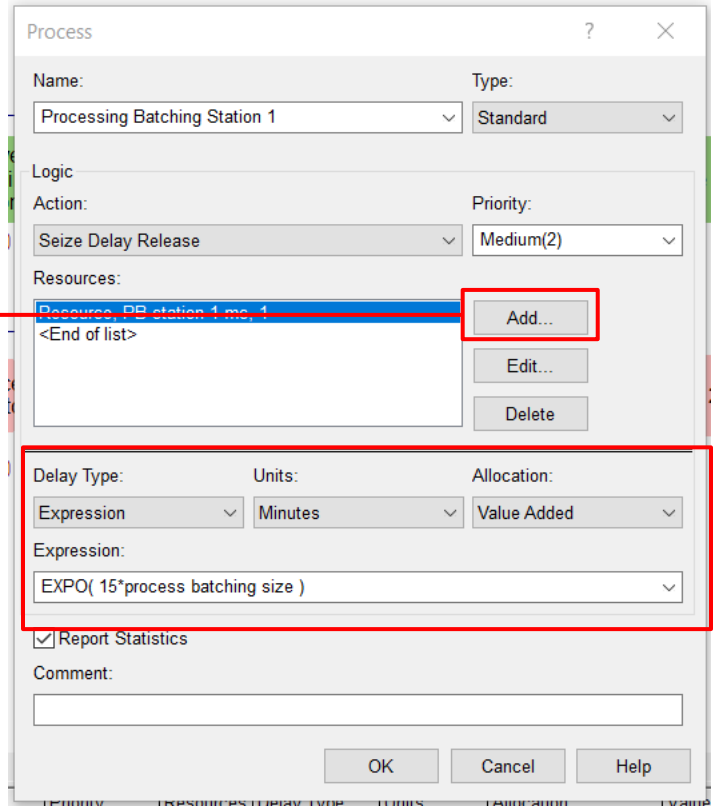
4. Experiment Procedure

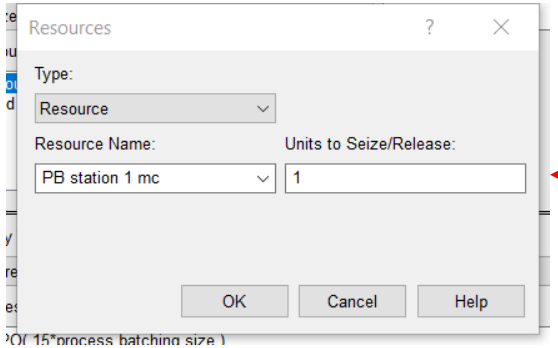
- **Step 1-2. Creating the model (cont.)**

2. Process Batching

- Set action as ‘Seize Delay Release’
- Use Add button to assign resources
- Delay time = EXPO (150) or (15 * batch size variable)

- Describes the work arriving at the process after batching





4. Experiment Procedure

- **Step 2. Analyze the result report**
  - To analyze the variability of two machines, use [Waiting time / U x t]

    - Waiting time ≈ V x U xt_e

    - V ≈ Waiting time / U x t

    - V = variability, U = utilization (u/(1-u)), t_e= production time

- **Step 3. Change batch size & analyze the variability**
  - Change Batch size from 1 to 10 to analyze the performance

Q & A