

# Systems Modelling and Simulation (Lab session 3)

After this session you should understand

1. How to model resource failures.
2. How to schedule resources.
3. How to add animations
  - Resource pictures
  - Entity pictures
  - Variables and dynamic plots



# Resource states

Arena defines four resource states;

- **Idle**
  - *Free and available. An arriving part needs not wait.*
- **Busy**
  - *Available but working on a part. An arriving part has to wait.*
- **Inactive**
  - *Can work but not available.*
- **Failed**
  - *Available but cannot do any work - broken*

Arena keeps track of these states automatically;

- **They are available as built in variables (state constants,-1 to -4)**
  - *IDLE\_RES, BUSY\_RES, INACTIVE\_RES and FAILED\_RRES*

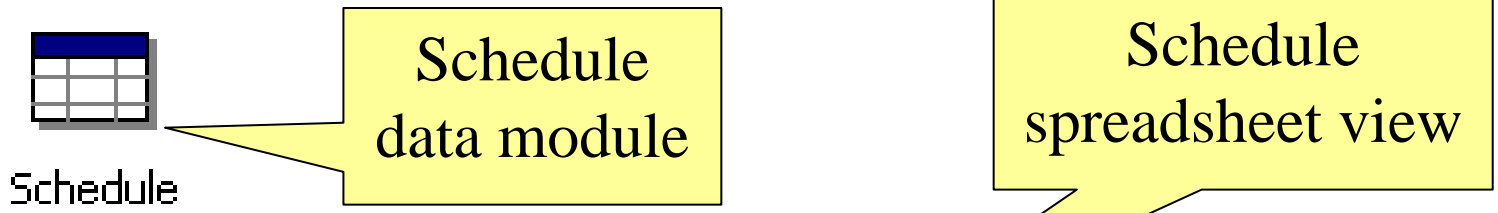


# Resource capacity and schedule rules

- Arena has two types of resource capacity settings;
  - **Fixed capacity**
    - *Does not change during the simulation run*
  - **Capacity based on schedule**
    - *Variable capacity based on time*
- Schedule rules (determines when actual capacity change occurs)
  - **Wait:** wait until ongoing process completed, then take full break
  - **Ignore:** wait until ongoing process completed, and lose part of break.
  - **Pre-empt:** Ongoing process is interrupted immediately and continued when resource becomes available.

# Resource schedules

- Schedules are created using the schedule data module in the basic process panel.



Schedule - Basic Process

	Name	Format Type	Type	Time Units	Scale Factor	Durations
1	Machine 1 Schedule	Duration	Capacity	Hours	1.0	0 rows
2	Schedule 2	Duration	Capacity	Hours	1.0	0 rows
3	Schedule 3	Duration	Capacity	Hours	1.0	0 rows
4	Schedule 4	Duration	Capacity	Hours	1.0	0 rows

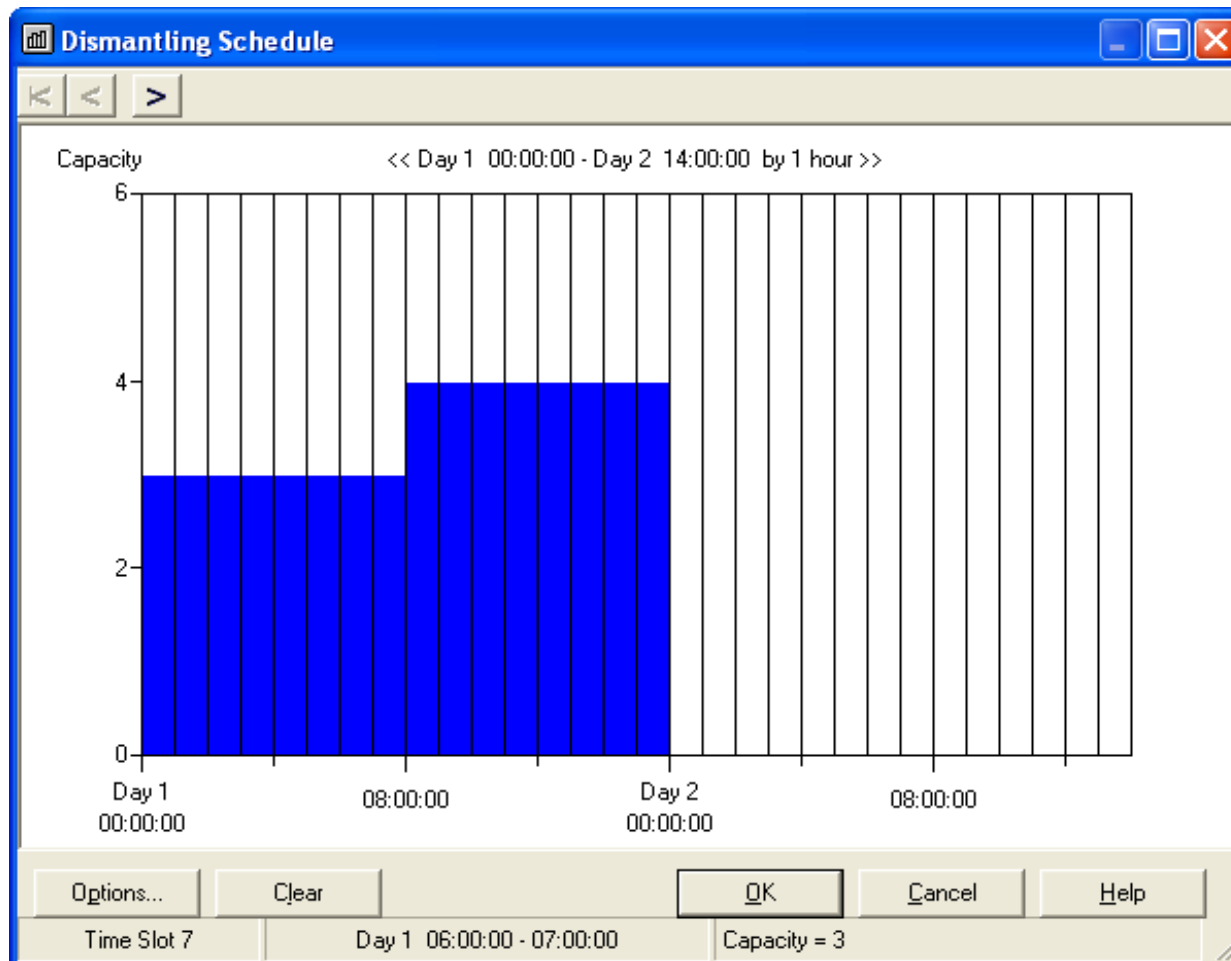
Double-click here to add a new row.



# Resource schedules

- Format type may be;
  - **Calendar:** defined using option in “Edit” menu
  - **Duration:** defined using “durations” button in spreadsheet view
- Schedule type may be;
  - **Capacity**
  - **Arrival**
  - **Other**

# The graphical schedule editor



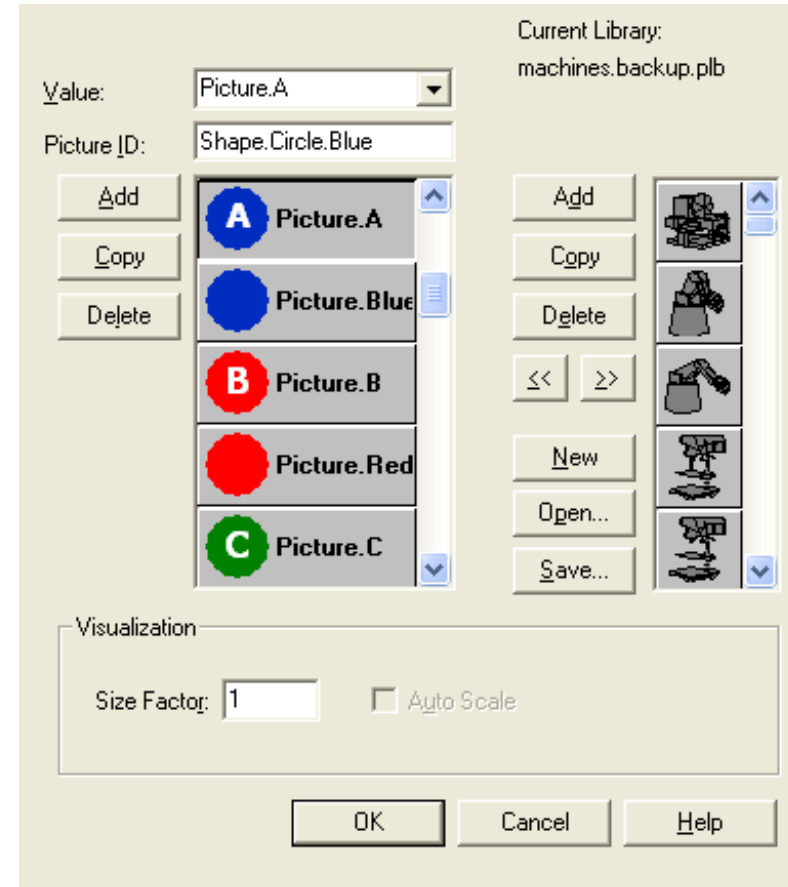


# Resource failures

- **To model resource failures in Arena, you require;**
  - **Failure name**
  - **Type**
    - *Count*
    - *Time*
  - **Uptime:** length of time resource stays in working condition
  - **Down time:** length of time resource remains in failed state
  - **Failure rule**
    - *Wait*
    - *Ignore*
    - *Pre-empt*


# Changing entity pictures

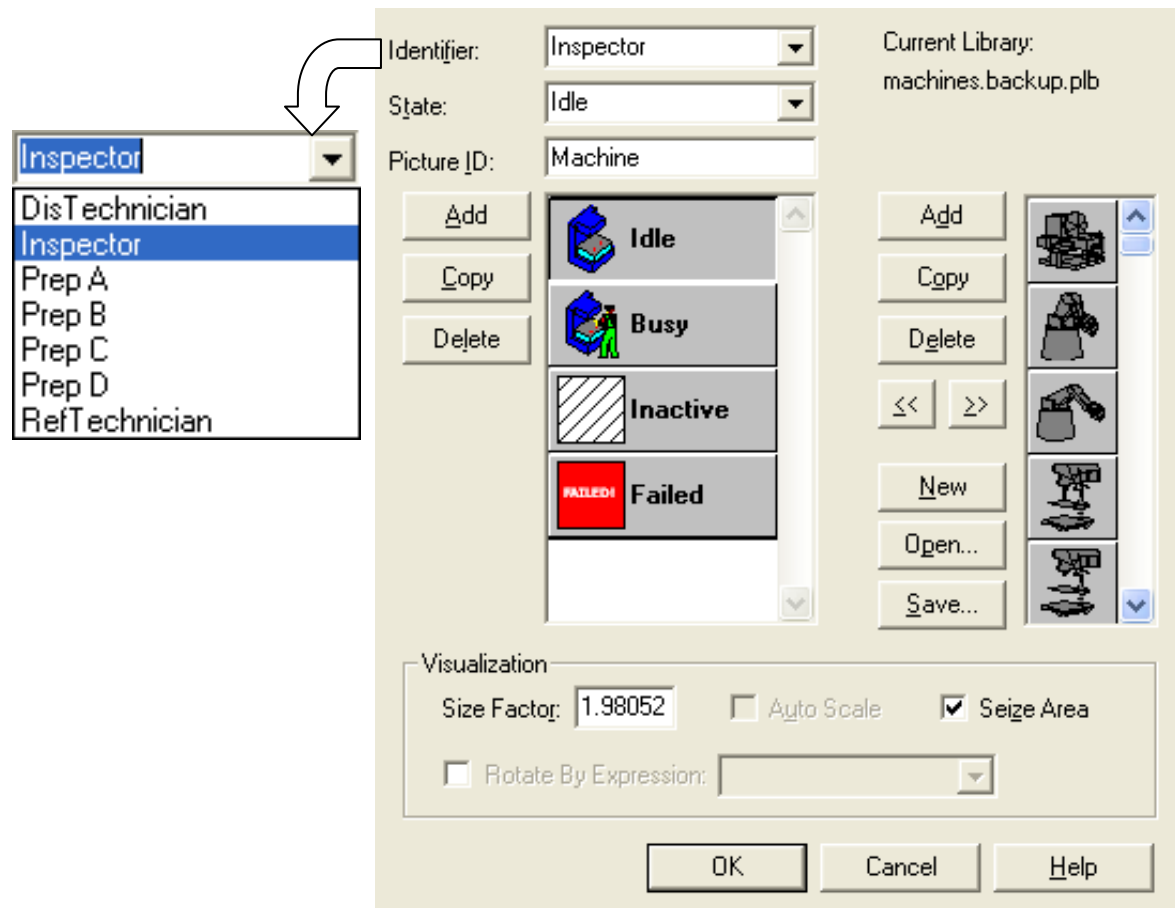
- To create or edit entity pictures,
  - Click the “Edit” menu
  - Select “Entity pictures”
  - Add or edit an entity’s picture
  - This will then become available in the spreadsheet and assign modules





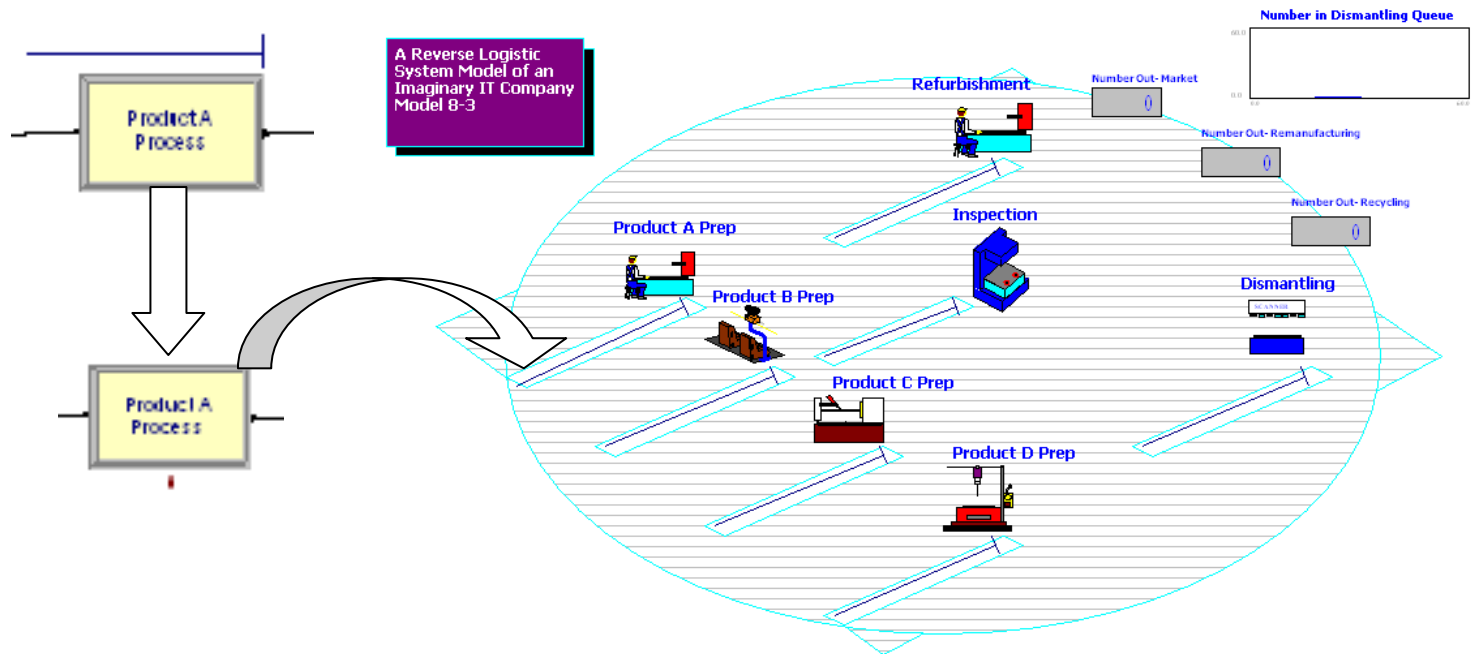
# Adding resource pictures

- To create, edit or assign a resource picture,
  - Click the resource button (  )
  - This displays the resource placement window



# Animating queues

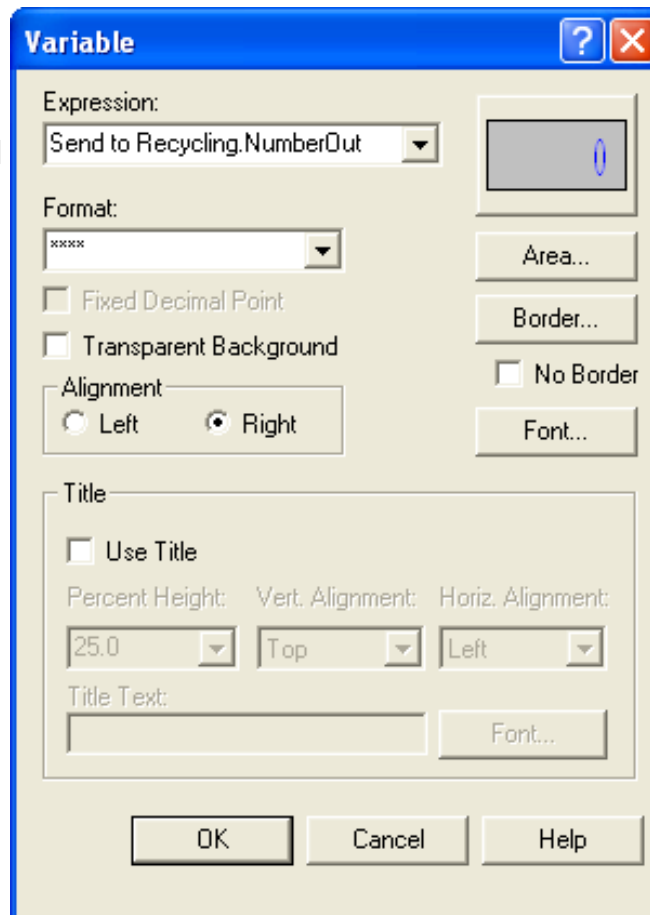
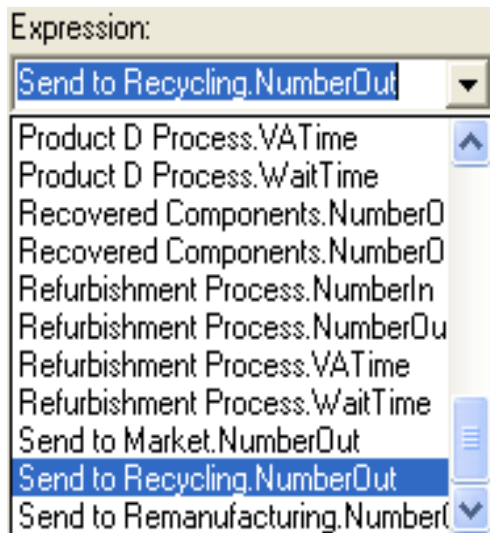
- To animate any queue, simply cut the queue from your model and paste at the required place in your animation.




- You may edit the parameters of the queue object by double-clicking on it.

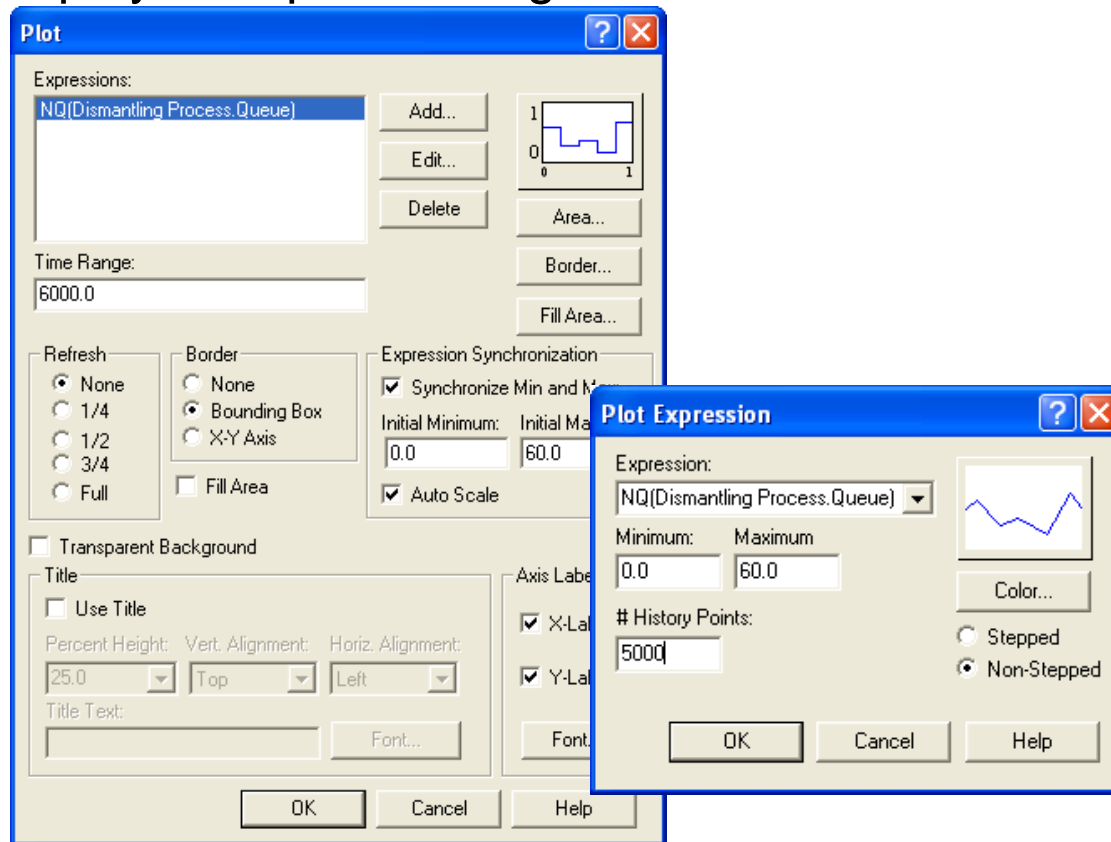
# Adding variables and plots

- To add a variable animation,
  - Click on the variable button (0.0)
  - This displays the variables dialog



# Adding dynamic plots

- To add a dynamic plot,
  - Click the plots button (  )
  - This displays the plots dialog shown



- Select expression to plot from the expression dialog box.



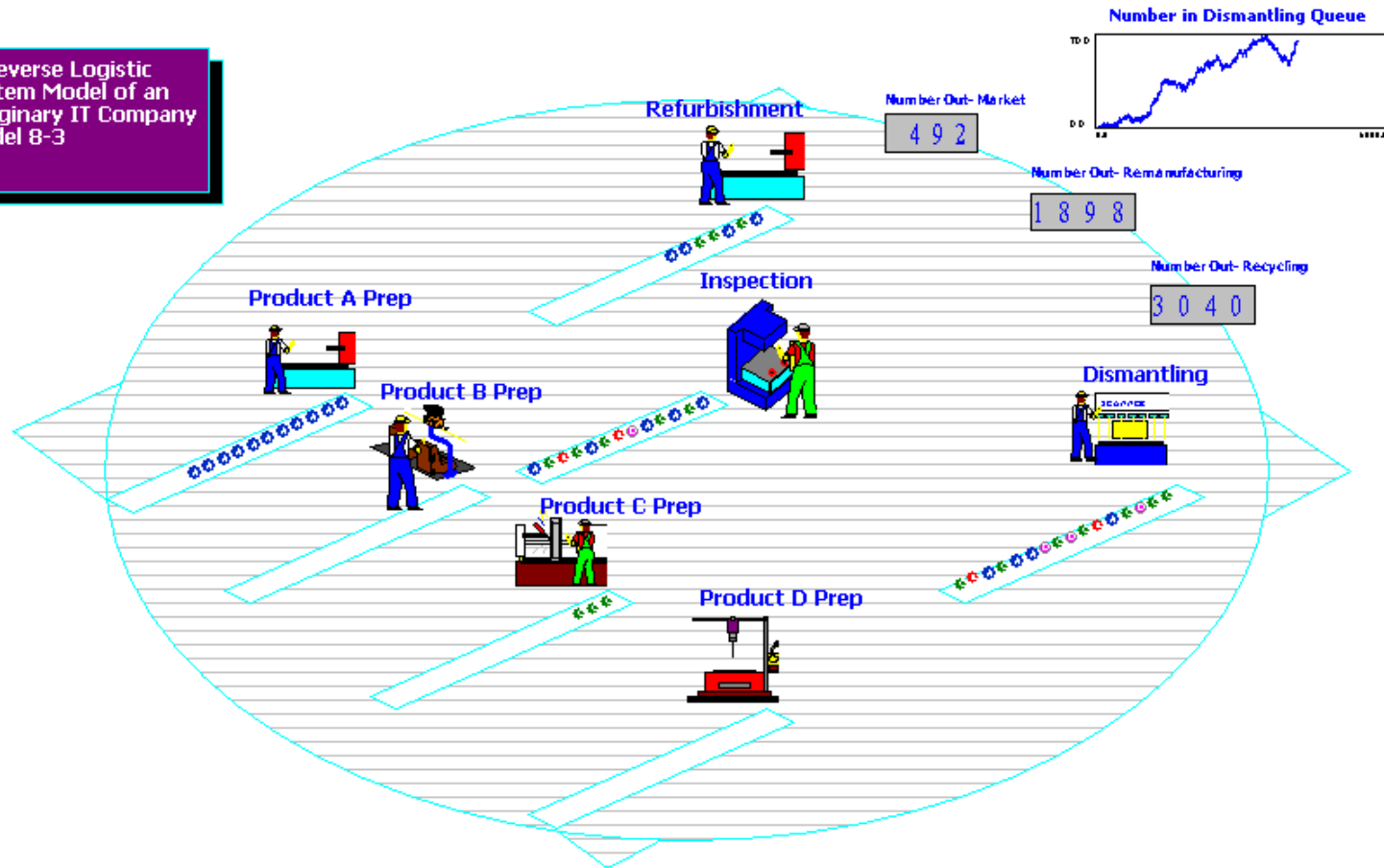


# Designing the animation

- Once you know how to add pictures for entities, resources, variables, plots and queues, how your animations looks is entirely up to you.
- The only advice is the more realistic the animation, the better.
- And the only warning is don't waste too much time doing this because it does not add to the accuracy of the model.

# Our example

A Reverse Logistic System Model of an Imaginary IT Company Model 8-3





# Now do it yourself.

- Enhance the last model by adding an animation that includes entity pictures for each product, resource pictures, animated queues, variables and dynamic plots
- Any observations about the current animation?



# Comparing model 8-1 and 8-2

<b>Result</b>	<b>Model 8-1</b>	<b>Model 8-2</b>
<b>Average Waiting Time in Queue</b>		
Dismantling Process	726.29	504.94
Inspection Process	26.89	39.23
Product A Process	14.89	38.23
Product B Process	0.73	0.75
Product C Process	0.43	3.66
Product D Process	1.90	2.41
Refurbishment Process	4.10	14.11
<b>Average Number Waiting in Queue</b>		
Dismantling Process	132.32	69.88
Inspection Process	8.15	12.09
Product A Process	2.10	5.04
Product B Process	0.02	0.02
Product C Process	0.43	0.36
Product D Process	0.10	0.12
Refurbishment Process	0.36	1.72

# Comparing model 8-1 and 8-2 cont.

Parameters	Model 8-1	Model 8-2
Hours per Day	24	16 (2x 8hour shifts)
Replication Length	32	10 days
Failure at process	None	Inspection
<b>Resource capacities:</b>		
DisTechnician	1	3 (shift 1), 4(shift 2)
Inspector	1	1
Prep A	1	1
Prep B	1	1
Prep C	1	1
Prep D	1	1
RefTechnician		