Simio Basics

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Overview

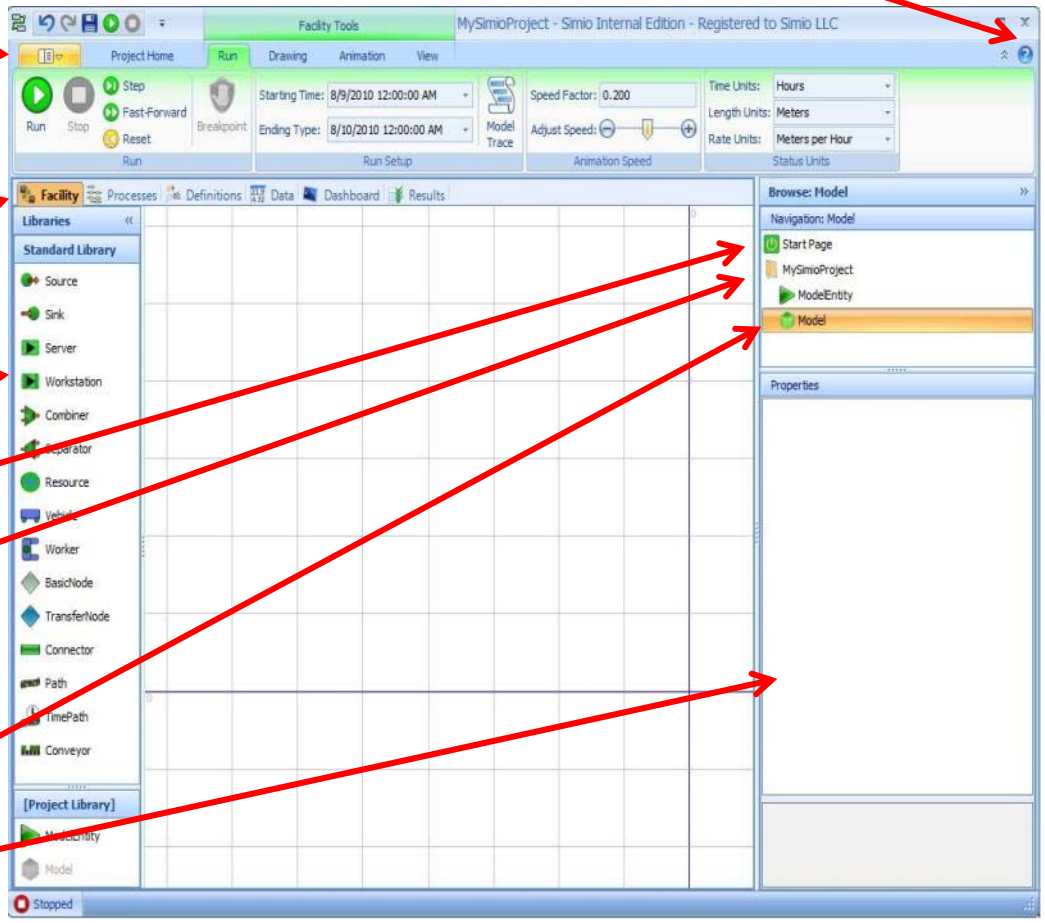
- We now move to the design and analysis of dynamic systems that evolve through time.
- We will use **Simio** which is one of several popular “discrete-event” simulation software packages.

Simio World View

- Simio takes the *process interaction* world view.
- Entities/tokens flow through a network of objects and processes.
- A network of objects usually represents a physical shape of a system and is automatically animated.
- A network of add-on processes describes logical behaviors behind the network of objects.

Simio User Interface

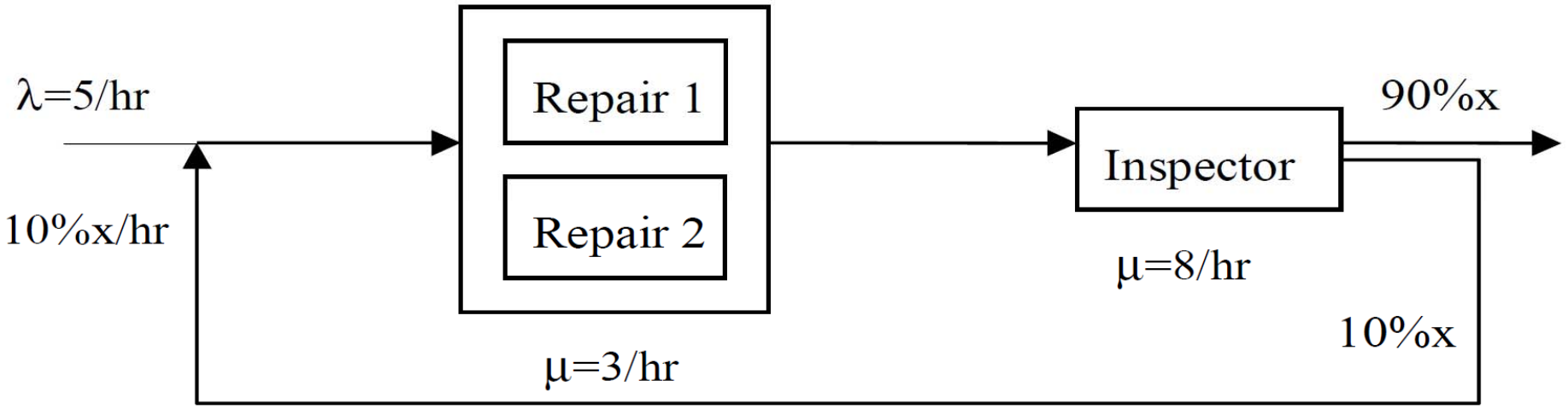
- App Menu
- Ribbons
- Project Tabs
- Library
- Start Page
- Project
- Current Model
- Properties



Example: Repair and Inspection

- A repair and inspection facility consists of two stations: a repair station with two technicians, and an inspection station with 1 inspector.
- Each repair technician works at the rate of 3 items per hour; the inspector can inspect 8 items per hour.
- Approximately 10% of all items fail inspection and are sent back to repair station (This percentage holds even for TV that have been repaired two or more times.)
- We assume (i) TV arrive at the rate of 5 per hour, (ii) the arrival process is a Poisson arrival process and (ii) service times are exponentially distributed
- OBJECTIVE: What are utilization, average number in the system, average times in waiting lines of each station?

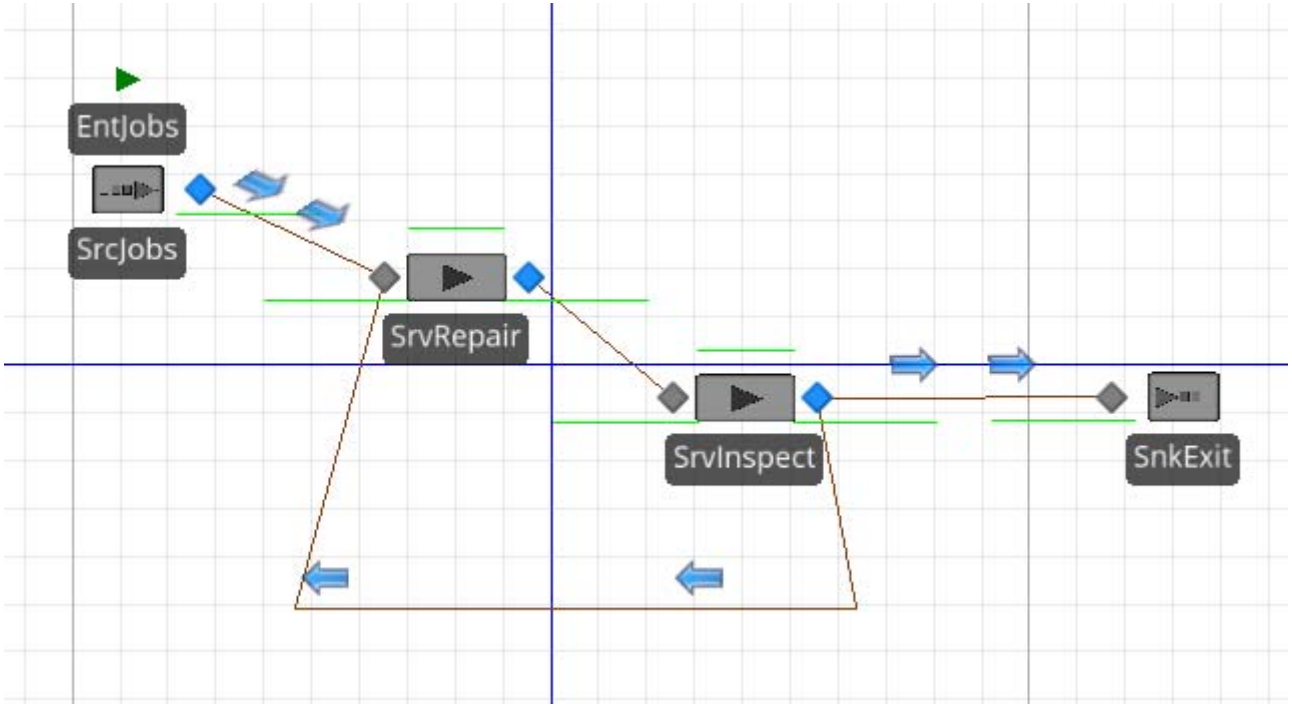
Example: Repair and Inspection



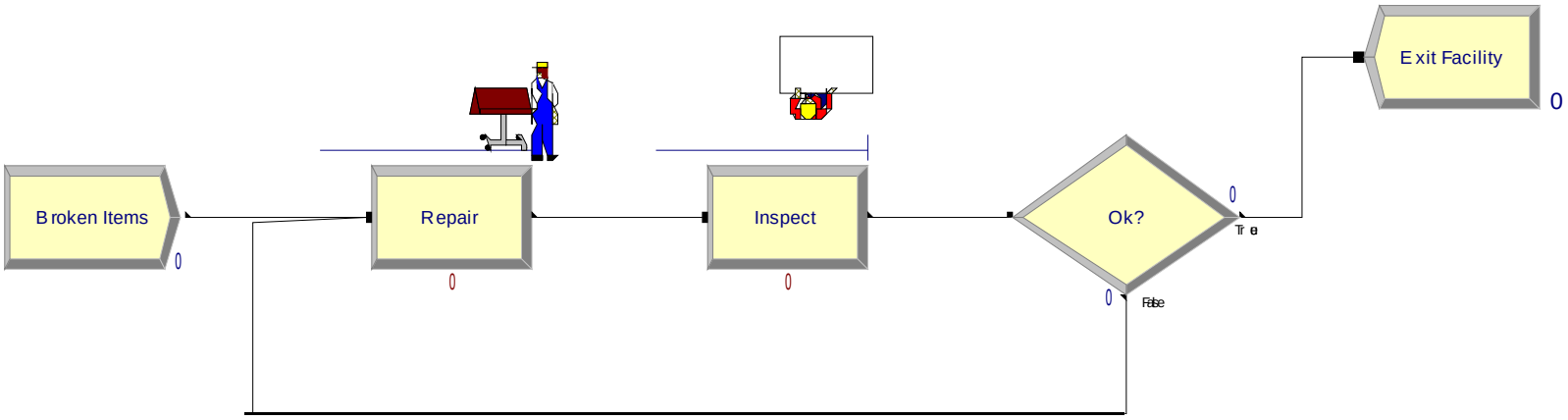
Analytic Results

Arrival Rate (per hr)	5			
Interarrival Time (hours)	0.2			
Rework Rate	10%			
	Repair	Inspect	Overall	
Split	111.1%	111.1%		
Capacity	2	1		
Process Time (hour)	0.3333	0.125	0.45830	hours
Process Rate (per hr per unit)	3.0	8.0		
Utilization	92.6%	69.4%		
Num at Station (L)	12.5	2.3	14.8	units
Time at Station (W - hours)	2.33	0.41	2.7	hours
Num in Queue (LQ)	11.1122	1.5782828	12.7	units
Time in Queue (WQ)	2.000	0.2840909	2.3	hours

First Simio Model



Comparison to Arena Model



Interface

- Project Library contains the objects that become a part of your Simio project.
- Navigation identifies the components of your simulation model.
- Property Inspector displays properties of the object selected in the navigation panel. “Show Commonly Used Properties Only” is to screen out certain properties.
- Right click + up/down : Zoom in 2D and 3D
- Right click + right/left: Zoom in but Rotate in 3D
- Left click + right/left: Move around in 2D and 3D

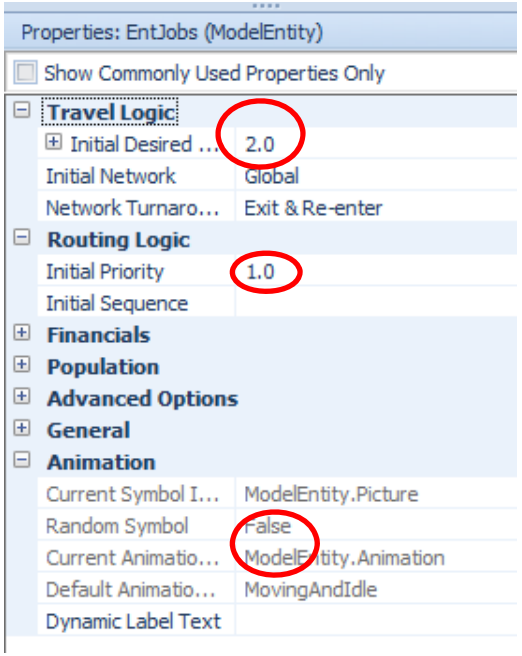
Standard Object Library

- An object is placed into the facility view of a ***model***.
- An object represents a physical component of the system – such as a worker, machine, vehicle, or pathway.

- Fixed Objects
  - Source, Server, Sink, Combiner, Separator, Resource, WorkStation.
- Links
  - Connector, TimePath, Path, Conveyor
- Nodes
  - BasicNode, TransferNode
- Transporters
  - Vehicle, Worker

Model Entity

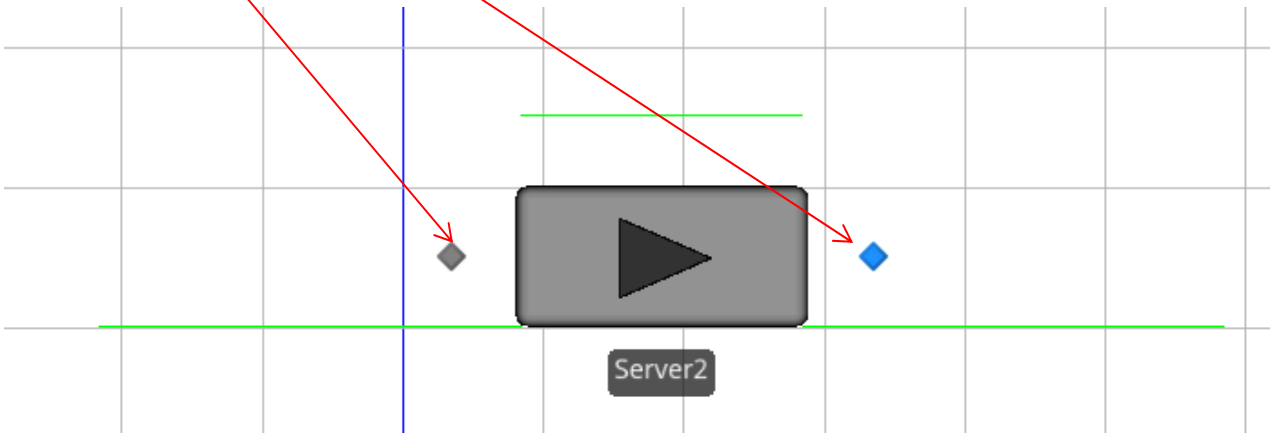
- ModelEntity creates entities that move through our model while Model will contain positioned objects and the flow of entities.

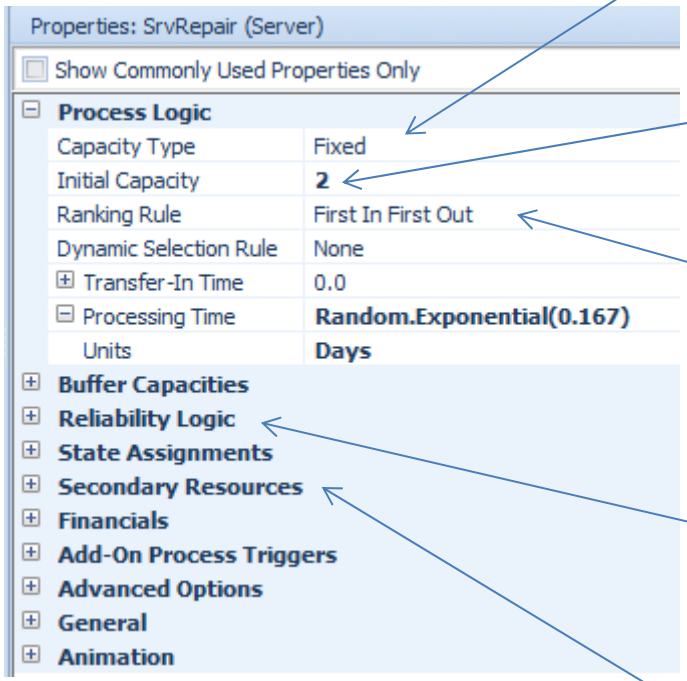


- Should be connected with a Source object.

Server

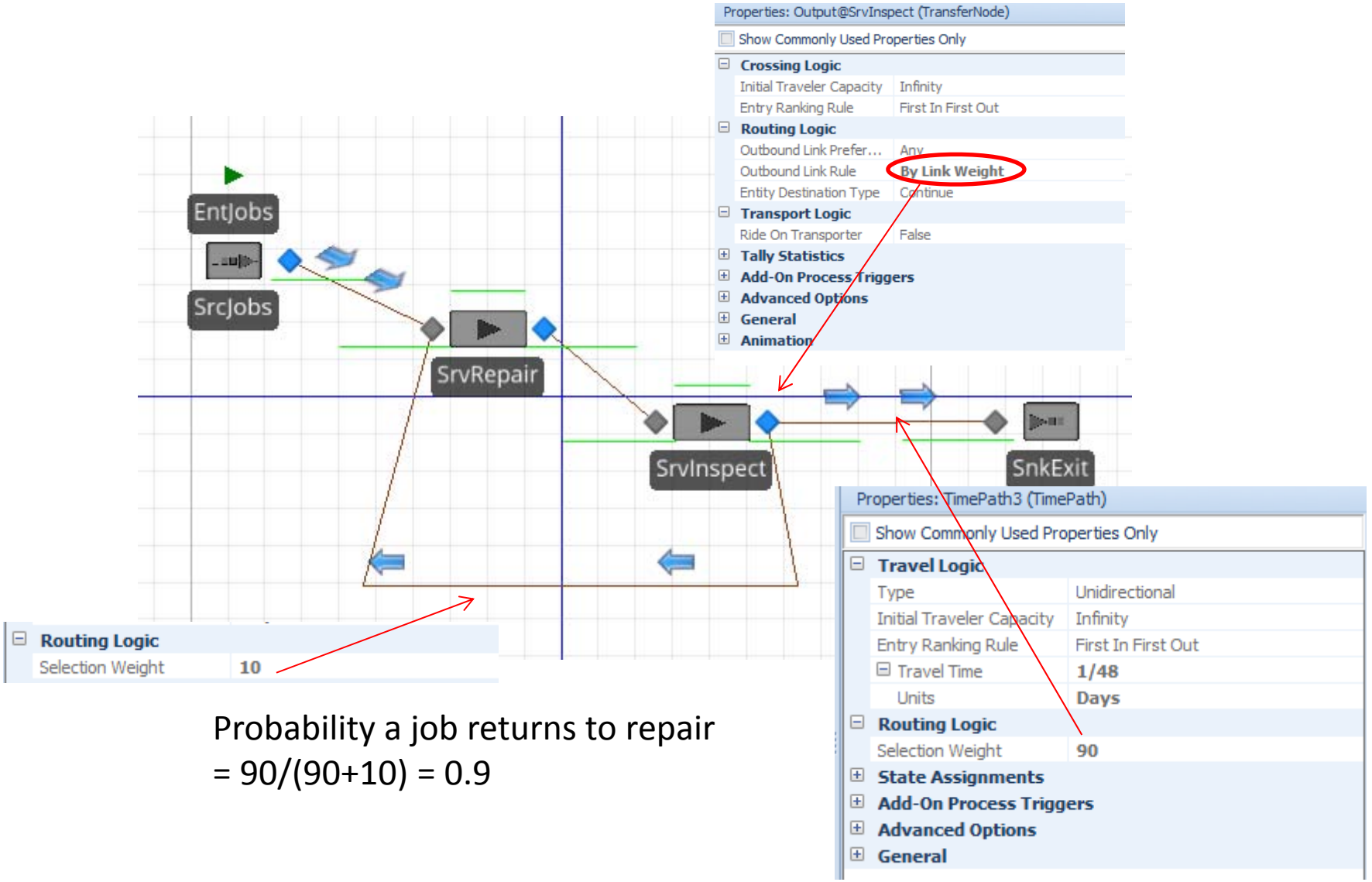
- Inputbuffer.Contents, Processing.Contents, OutputBuffer.Contents
- Blue diamond: Output node (TransferNode)
- Gray diamond: Input node (BasicNode)





- Can have a schedule rather than a fixed capacity
- Initial Capacity: # of parallel servers
- Ranking Rule: FIFO, LIFO, smallest value first, largest value first
- Failure time can be modeled in Reliability Logic
- Can seize secondary resources

Links



Probability a job returns to repair
= 90/(90+10) = 0.9

Results - ModelEntity

ModelEntity	TV	[Population]	Content	NumberInSystem	Average	15.0451
					Maximum	47.3800
			FlowTime	TimeInSystem	Average (Ho...	2.9988
					Maximum (Ho...	20.5116
					Minimum (Ho...	0.0367

Results - Sink

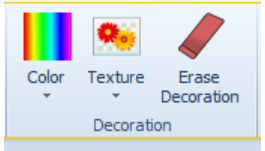
Sink	Sink1	[DestroyedObjects]	FlowTime	TimeInSystem	Average (Ho...	2.9988
					Maximum (Ho...	20.5116
					Minimum (Ho...	0.0367
					Observations	2,484.9500

Results - Server

Server	Inspector	InputBuffer	Content	NumberInStation	Average	1.5488
					Maximum	16.5100
			HoldingTime	TimeInStation	Average (Ho...	0.2796
					Maximum (Ho...	2.3724
					Minimum (Ho...	0.0000
		Processing	Content	NumberInStation	Average	0.6890
					Maximum	1.0000
			HoldingTime	TimeInStation	Average (Ho...	0.1247
					Maximum (Ho...	1.0374
					Minimum (Ho...	0.0000
	RepairMan	InputBuffer	Content	NumberInStation	Average	10.9224
					Maximum	43.0700
			HoldingTime	TimeInStation	Average (Ho...	1.9531
					Maximum (Ho...	7.5396
					Minimum (Ho...	0.0000
		Processing	Content	NumberInStation	Average	1.8477
					Maximum	2.0000
			HoldingTime	TimeInStation	Average (Ho...	0.3339
					Maximum (Ho...	2.9063
					Minimum (Ho...	0.0001

Basic Animation – Entity & Server

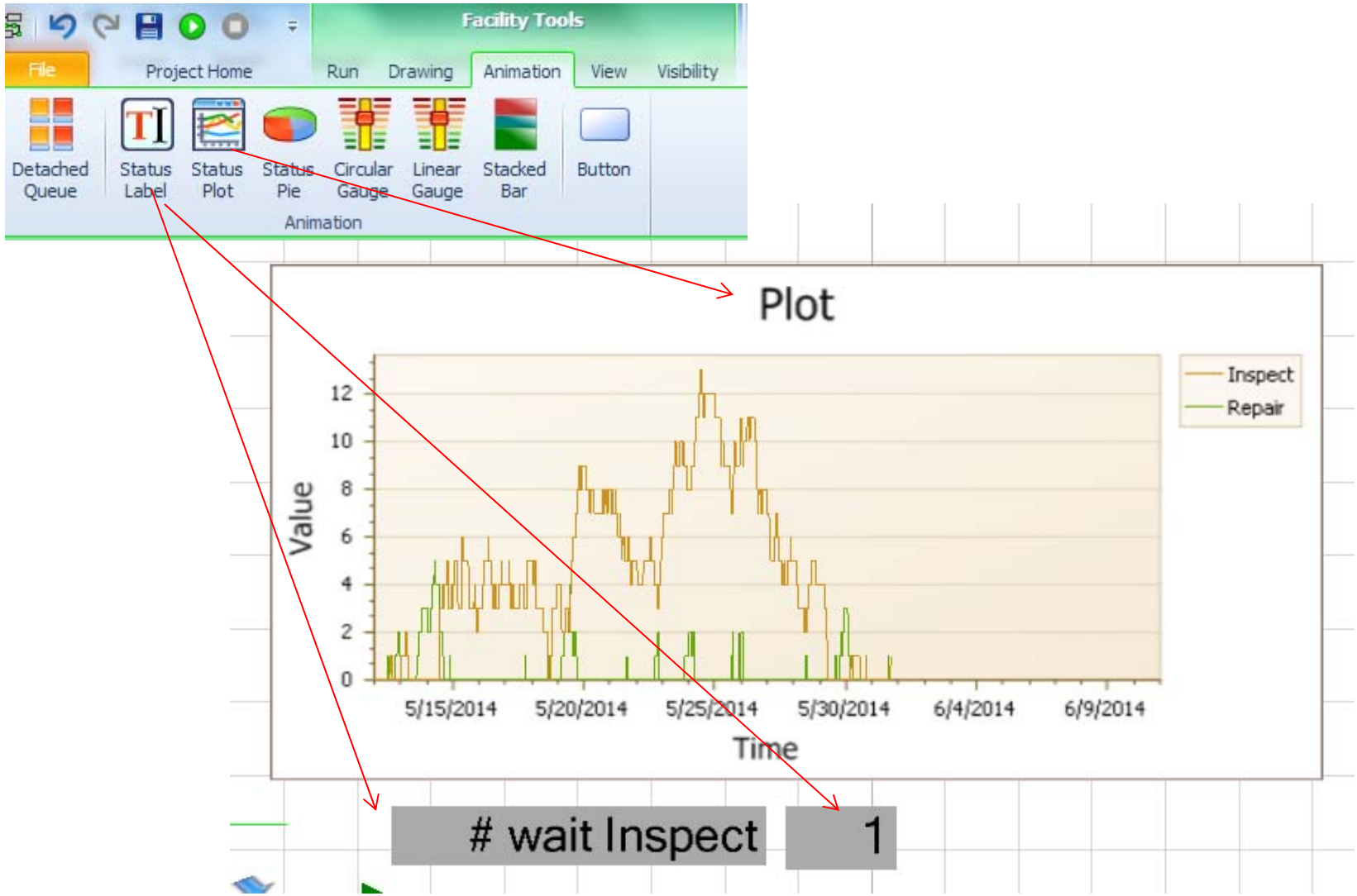
- We can change colors of entities/servers using Color in the Decoration ribbon tab.



- We can add more pictures of entities/servers using Add Additional Symbol in the Additional symbols ribbon tab.

- New symbols can be uploaded.

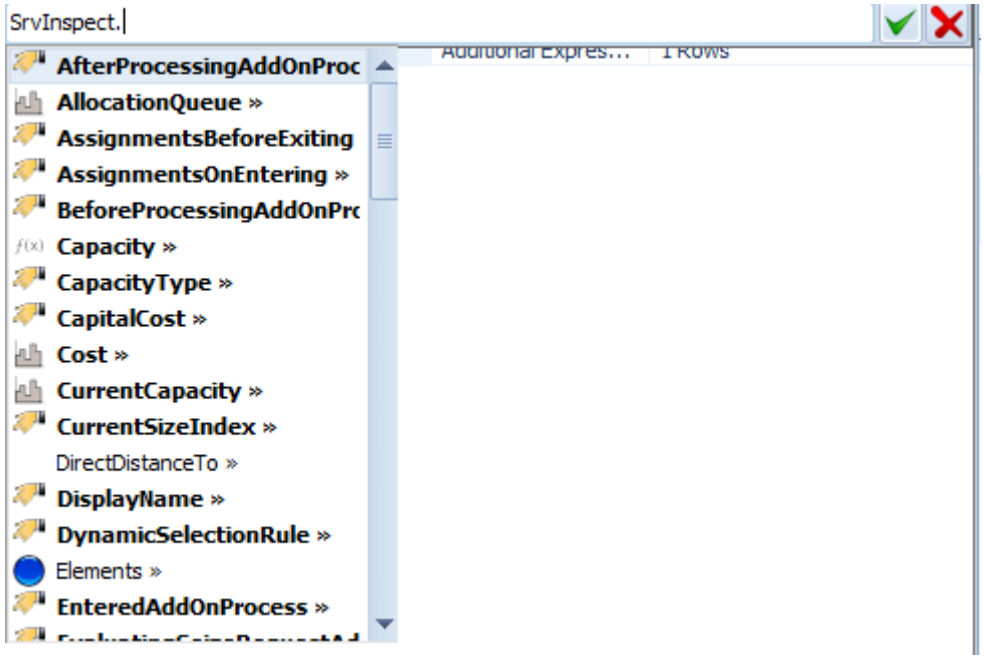
Plots


Facility Tools
File
Project Home
Run
Drawing
Animation
View
Visibility
Detached Queue
Status Label
Status Plot
Status Pie
Circular Gauge
Linear Gauge
Stacked Bar
Button
Animation
Plot
Inspect
Repair
Value
12
10
8
6
4
2
0
5/15/2014
5/20/2014
5/25/2014
5/30/2014
6/4/2014
6/9/2014
Time
wait Inspect
1

Expression Builder for Variables

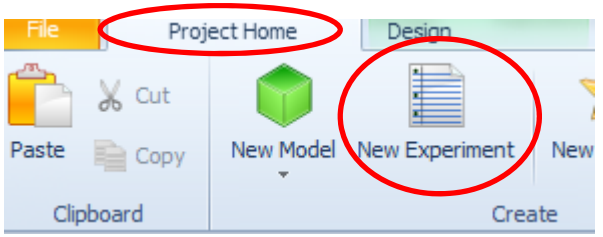
Expression builder is useful in finding appropriate variable/statistic names.

- # waiting in queue: ServerName.InputBuffer.Contents.NumberWaiting
- Max queue length: ServerName.InputBuffer.Contents.MaximumNumberWaiting
- Current simulation clock: Run.TimeNow

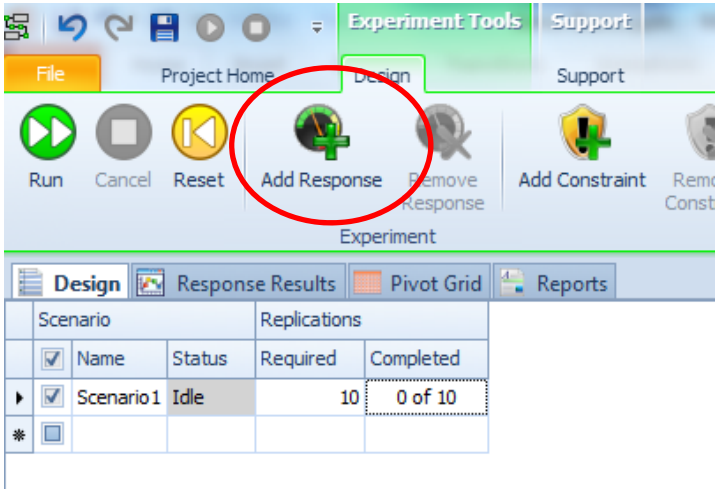


Making Multiple Replications

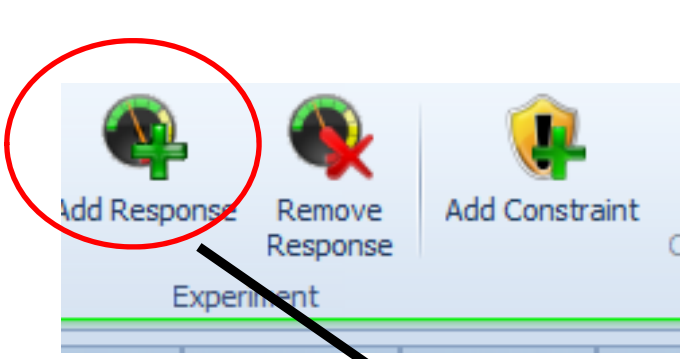
- Project Home > New Experiment

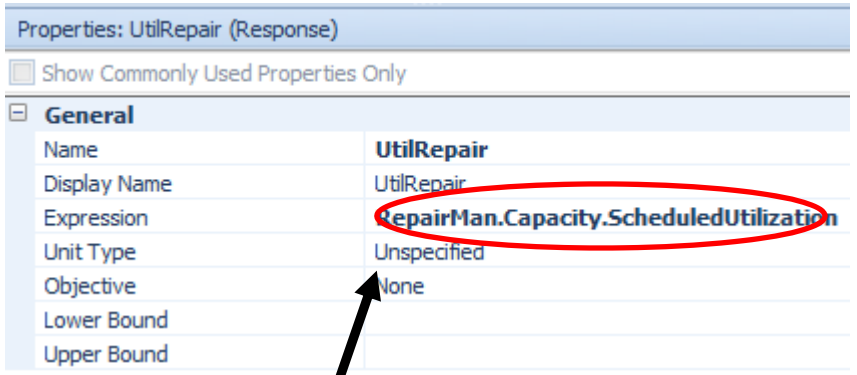


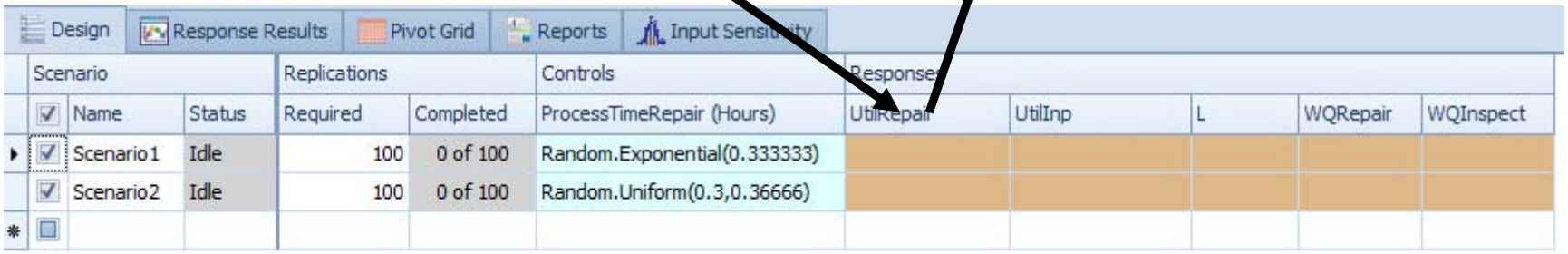
- Set # of replications and performance measures using Design > Add Response



Checking Measures over Multiple Replications

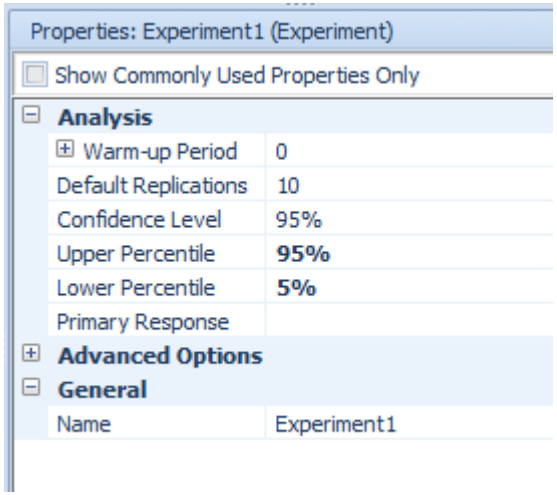






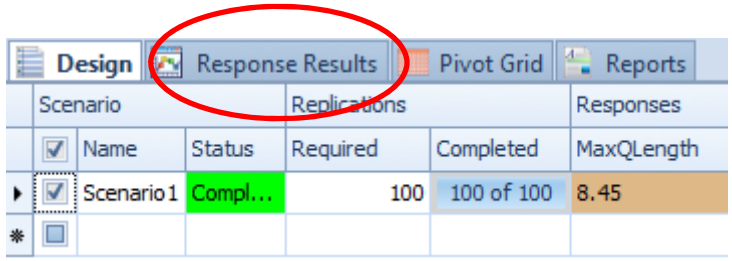
Built-in Output Statistics

Performance Measures	Simio Output Statistics
Time in system	EntityName.Population.TimeInSystem.Average
Lq	ServerName.InputBuffer.Contents.AverageNumberWaiting
Wq	ServerName.InputBuffer.Contents.AverageTimeWaiting
Server utilization	ServerName.ResourceState.PercentTime(1)
Max queue length	ServerName.AllocationQueue.MaximumNumberWaiting

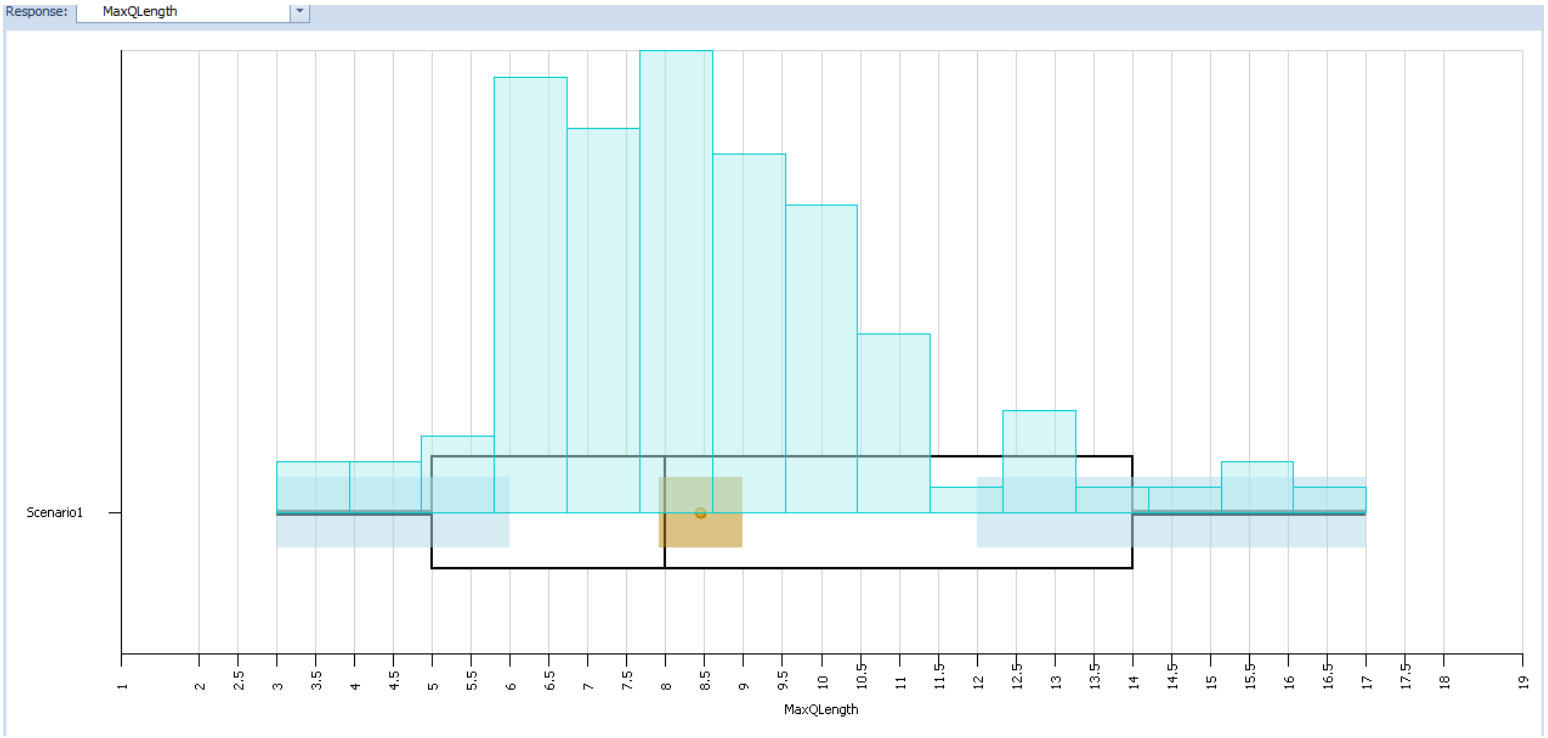


Set up Warm-up Period if needed.
Set Upper Percentile and Lower Percentile levels. Defaults are [25% , 75%] but better to use [10%, 90%] or [5%, 95%].

SMORE Plots

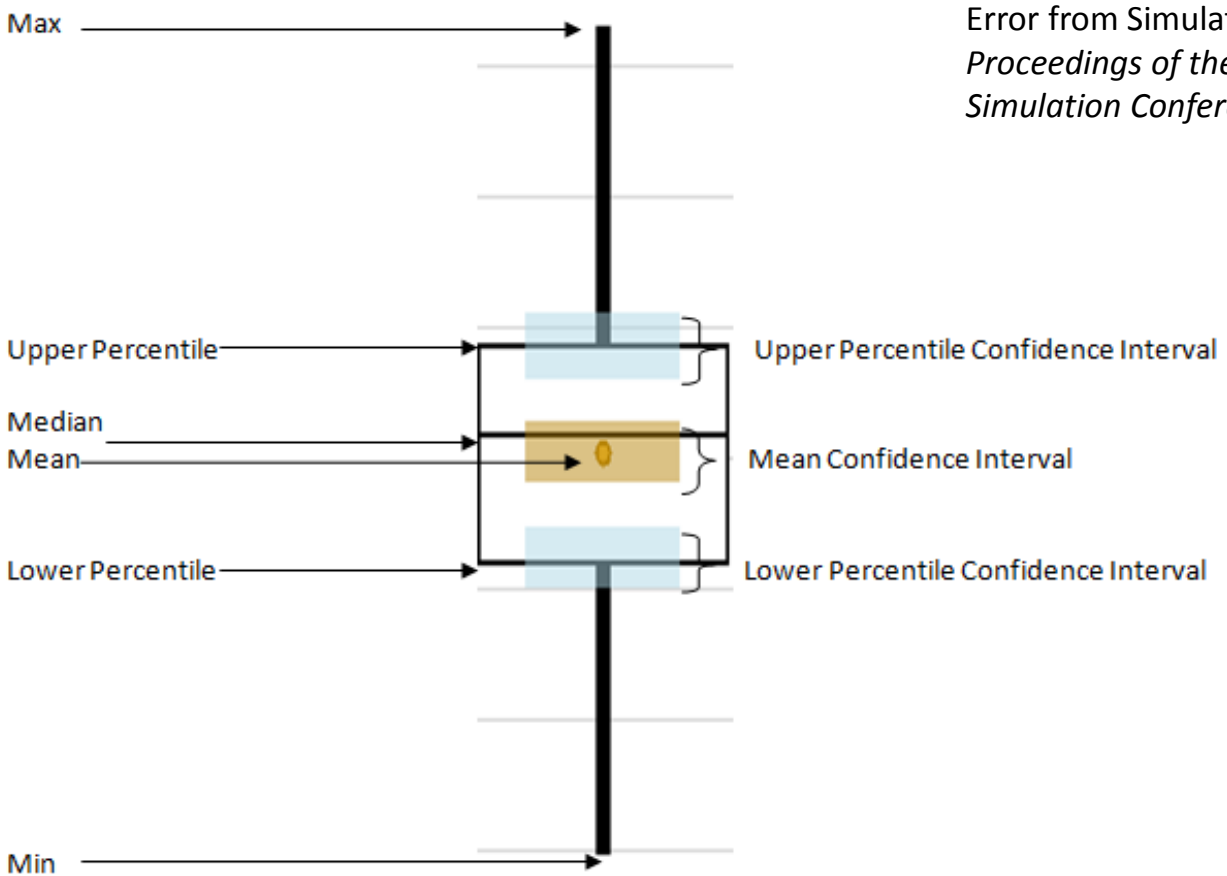


Click the Response Results tab for Simio MORE plots.



SMORE Plots

Nelson, B.L., "The MORE Plot: Displaying Measures of Risk and Error from Simulation Output," *Proceedings of the 2008 Winter Simulation Conference*

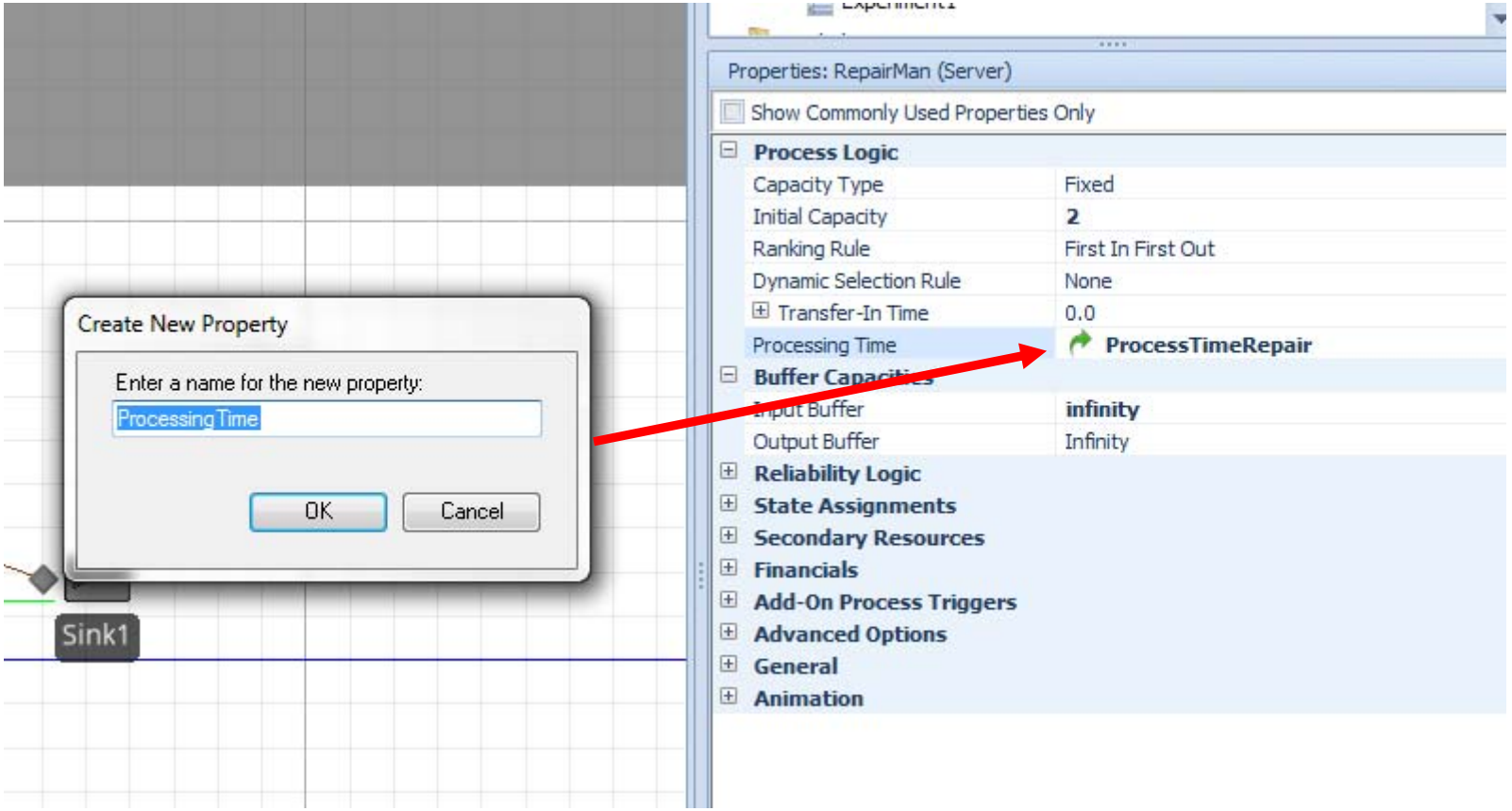


Example: Repair and Inspection2

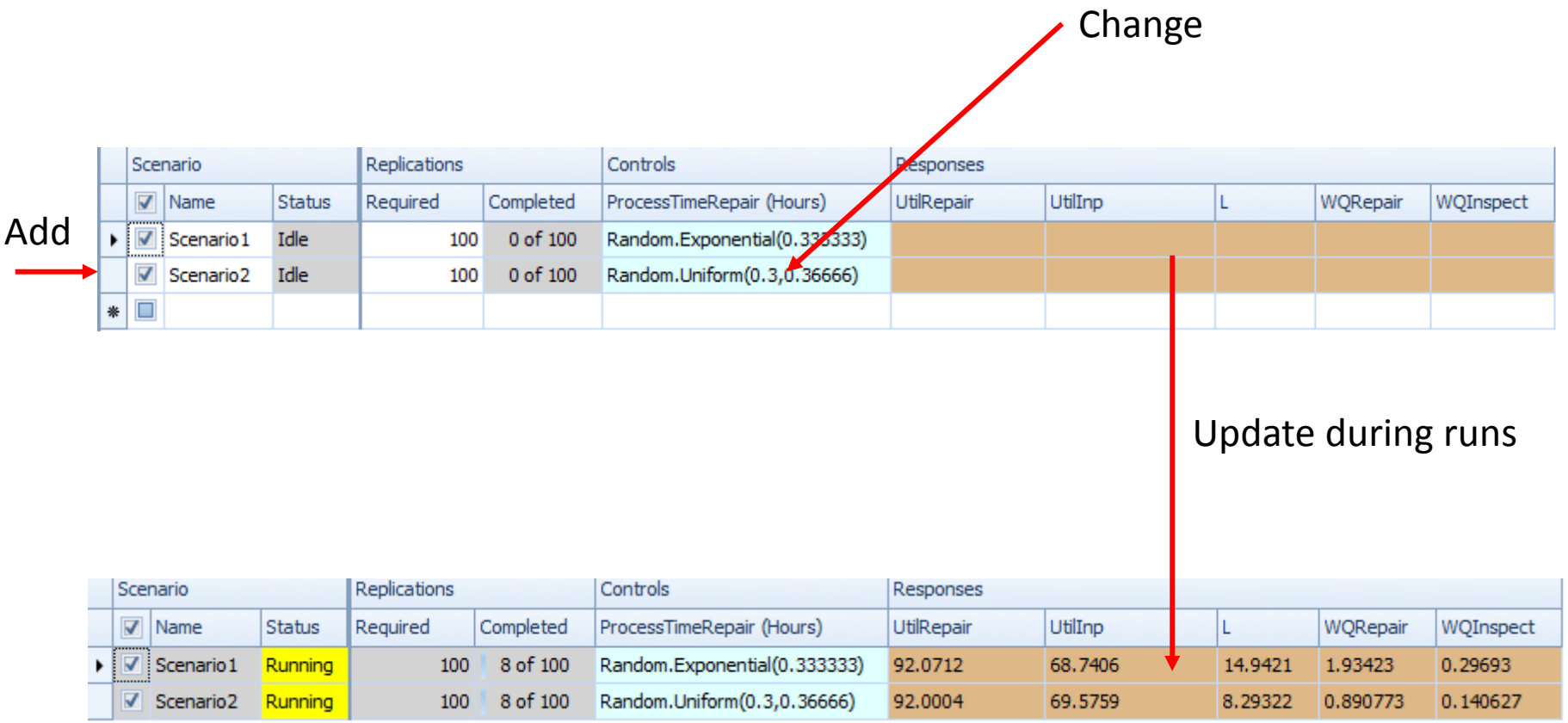
Now, we want to reflect the new service time data in the repair station which is uniformly distributed with minimum 0.3 and maximum 0.36666.

- OBJECTIVE: Can we check the difference between the original model and the new model based on the same measures?

Setting Referenced Property



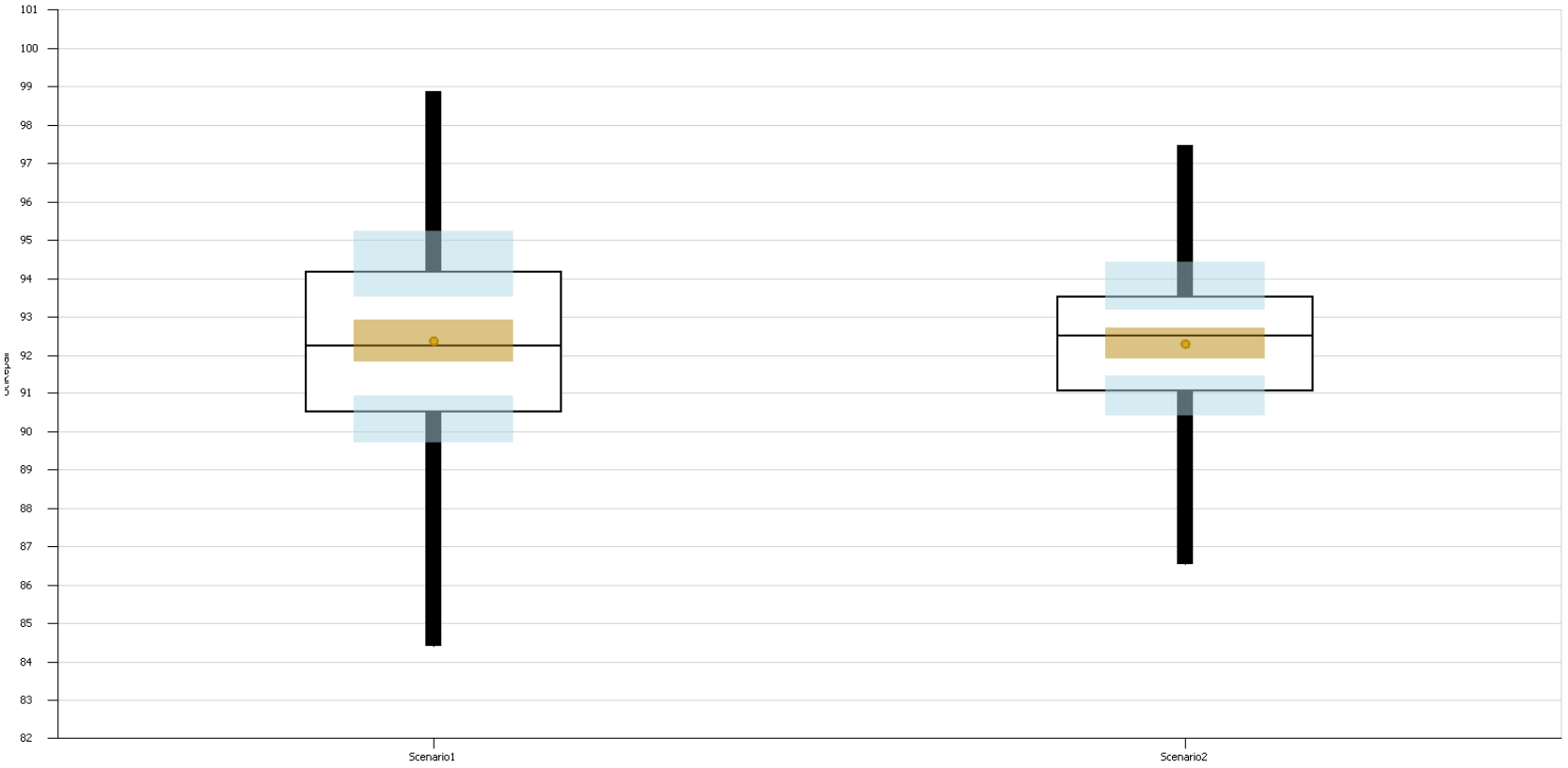
Designing New Experiments



Scenario		Replications		Controls	Responses				
Name	Status	Required	Completed	ProcessTimeRepair (Hours)	UtilRepair	UtilInp	L	WQRepair	WQInspect
Scenario1	Idle	100	0 of 100	Random.Exponential(0.333333)					
Scenario2	Idle	100	0 of 100	Random.Uniform(0.3,0.36666)					

Scenario		Replications		Controls	Responses				
Name	Status	Required	Completed	ProcessTimeRepair (Hours)	UtilRepair	UtilInp	L	WQRepair	WQInspect
Scenario1	Running	100	8 of 100	Random.Exponential(0.333333)	92.0712	68.7406	14.9421	1.93423	0.29693
Scenario2	Running	100	8 of 100	Random.Uniform(0.3,0.36666)	92.0004	69.5759	8.29322	0.890773	0.140627

Check the Results



Next Class (Week 9)

More SIMIO stuffs…

- Properties & States
- Variables & Tables