

**Problem 4.2:**

Based on a M/M/1 queue with  $\lambda = 120$  and  $\mu = 190$ ,

- $\rho = \lambda / \mu = 63.16\%$
- $L = \rho / (1 - \rho) = 1.71$  units
- $W = L / \lambda = 0.0143$  hours or 0.8571 minutes
- $W_q = W - E(S) = 0.0090$  hours or 0.5422 minutes
- $L_q = \lambda * W_q = 1.08$  units

Based on Simio model with  $\lambda = 120$ ,  $\mu = 190$ , 120 hour total run time with 20 hour warmup

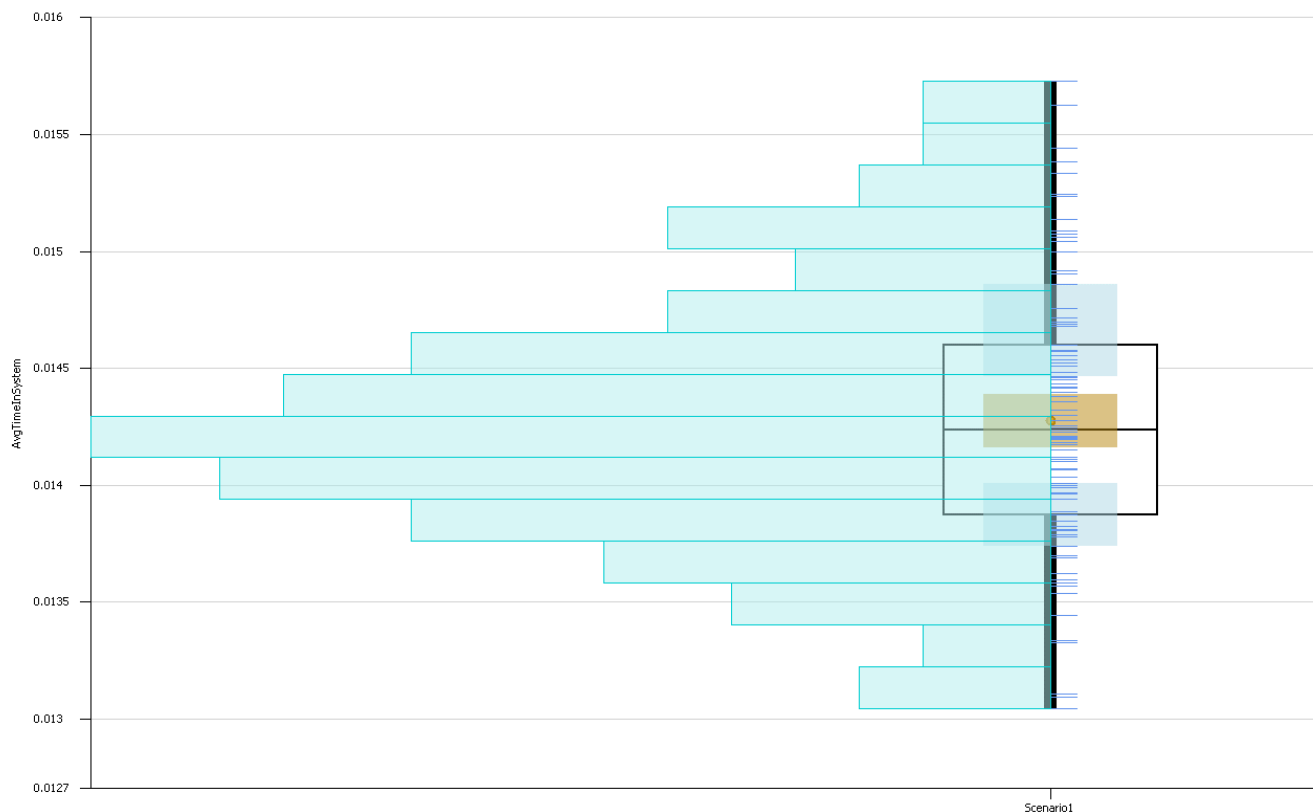
- Steady state time entities spend in system = 0.0152 hours
- Expected number of entities processed (NumberDestroyed) = 12001

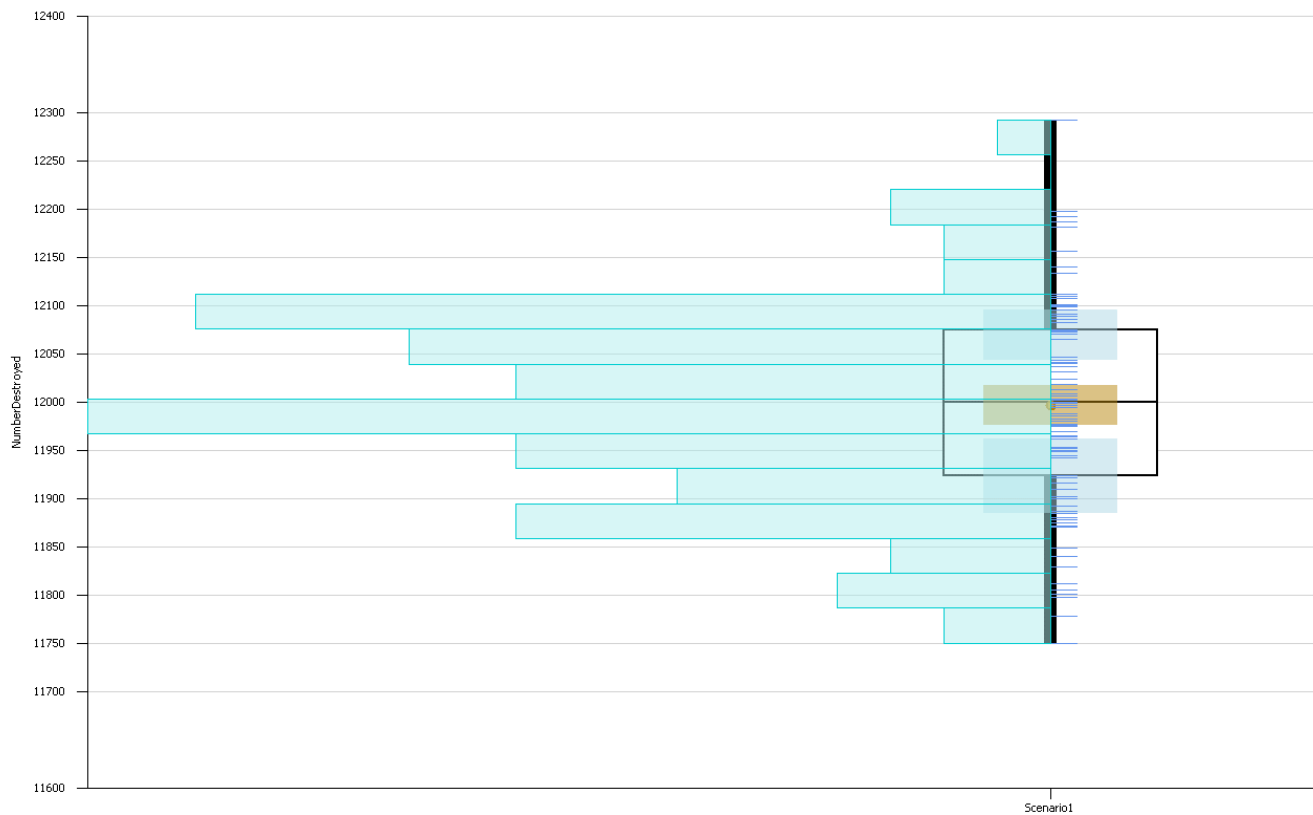
Scenario			Replications		Responses		
<input checked="" type="checkbox"/>	Name	Status	Required	Completed	AvgTimeInSystem	NumberDestroyed	AvgUnitsInSystem
<input checked="" type="checkbox"/>	Scenario1	Compl...	1	1 of 1	0.0152375	12001	1.82852

**Problem 4.3:**

Based on Simio experiment with  $\lambda = 120$ ,  $\mu = 190$ , 120 hour total run time with 20 hour warmup, 100 replications

Scenario			Replications		Responses		
<input checked="" type="checkbox"/>	Name	Status	Required	Completed	AvgTimeInSystem	NumberDestroyed	AvgUnitsInSystem
<input checked="" type="checkbox"/>	Scenario1	Compl...	100	100 of 100	0.0142738	11997.6	1.71269





#### Problem 4.9:

The processes-based simulation completed much more quickly than the previous simulation, and the results were within the confidence intervals, i.e. statistically the same.

<div>Design</div> <div>Response Results</div> <div>Pivot Grid</div> <div>Reports</div> <div>Input Analysis</div>									
Drop Filter Fields Here									
<div>Average</div> <div>Minimum</div> <div>Maximum</div> <div>Half Width</div>						Scenario <span>▲</span>			
						Scenario1			
Object Type <span>▲</span>	Object Name <span>▲</span>	Data Source <span>▲</span>	Category <span>▲</span>	Data Item <span>▲</span>	Statistic <span>▲</span> <span>▼</span>	Average	Minimum	Maximum	Half Width
Model	Model	CurrentWIP	UserSpecified	StateValue	Average	1.7256	1.5630	1.8937	0.0227
					FinalValue	1.6400	0.0000	9.0000	0.5963
					Maximum	17.7800	13.0000	32.0000	1.0441
		TimeInSystem	UserSpecified	TallyValue	Average (Ho...	0.0144	0.0131	0.0157	0.0002
					Maximum (Ho...	0.1143	0.0860	0.2309	0.0070
					Minimum (Ho...	0.0000	0.0000	0.0000	0.0000
					Observations	12,010.5600	779.0000	293.0000	28.4961
Resource	Resource 1	[Resource]	Capacity	ScheduledUtilization	Percent	63.2948	61.7512	65.5164	0.2216
				UnitsAllocated	Total	12,010.3400	779.0000	292.0000	28.4686
				UnitsScheduled	Average	1.0000	1.0000	1.0000	0.0000
					Maximum	1.0000	1.0000	1.0000	0.0000
				UnitsUtilized	Average	0.6329	0.6175	0.6552	0.0022
					Maximum	1.0000	1.0000	1.0000	0.0000
			ResourceState	TimeBusy	Average (Ho...	0.0143	0.0134	0.0157	0.0001
					Occurrences	4,417.6600	161.0000	611.0000	26.1321
					Percent	63.2948	61.7512	65.5164	0.2216
					Total (Hours)	63.2948	61.7512	65.5164	0.2216
				TimeIdle	Average (Ho...	0.0083	0.0081	0.0086	0.0000
					Occurrences	4,417.4000	160.0000	612.0000	26.2094
					Percent	36.7052	34.4836	38.2488	0.2216
					Total (Hours)	36.7052	34.4836	38.2488	0.2216

**Problem 4.12:**

