Module 5



Process Improvement Principles A Concise Guide for Managers

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Process Improvement Principles Workshop

Process Improvement Principles



E-book can be found in Simio: Support>Books

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Learning from PIPs



- We will study a few PIPs to learn about the principles
- While doing that we will practice some Simio concepts we already know and learn a few more that we don't yet know.
- We will only do a few of these,



Variation degrades performance.

- Explore variability
- Interactive run
 - Simio Interface
 - Run/Fast Forward
 - Results/Interactive Pivot Grid
- Experimentation
 - Responses
 - Controls/Referenced Properties

10/9/2020



Setup/Interactive Run

- Place Source, Server, Sink
- Connect with 2 Paths from blue to gray
- Source: Set Interarrival Time to 60 minutes
- Server: Set Processing Time to 55 minutes
- Run Ribbon: Set Speed Factor to 100





Explore Experiment Window

- Navigation > New Experiment
- Replications
- Experiment properties
 - Multi-processor support
- Run (Fast Forward)
- Enhanced Pivot Grid
- Did everyone get identical results?





Prepare for Experimentation

- Convert Paths to Connectors (right click)
- Source: Create referenced property named InterarrivalTime (right click)
- Server: Create referenced property named ProcessingTime (right click)





Setup Experiment

- Controls It's magic!
- Create Scenarios
 - ConstantConstant, 60, 55
 - RandomConstant, Random.Exponential(60), 55
 - RandomRandom,

Random.Exponential(60), Random.Exponential(55)

Scenario		Replications	Controls				
1	Name	Completed	InterarrivalTime (Minutes)	ProcessingTime (Minutes)			
	ConstantConstant	100 of 100	60	55			
1	RandomConstant	100 of 100	Random.Exponential(60)	55			
1	RandomRandom	100 of 100	Random.Exponential(60)	Random.Exponential(55)			



Create Responses

Responses are KPIs

Create Throughput Response

	1111							
P	Properties: ThroughPut (Response)							
	Show Commonly Used Properties Only							
	General							
	Name	ThroughPut						
	Display Name	ThroughPut						
	Expression	Sink1.TimeInSystem.NumberObservations						
	Unit Type	Unspecified						
	Objective	None						
	Lower Bound							
	Upper Bound							

General

A response has an expression that is evaluated and recorded at the end of each replication of each scenario. The expression typically involves statistics recording during the run.



Create More Responses

Waiting Time and Utilization Responses

P	Properties: WaitingTime (Response)								
Show Commonly Used Properties Only									
General									
	Name	WaitingTime							
	Display Name	WaitingTime							
	Expression	Server1.InputBuffer.Contents.AverageTimeWaiting							
	🗉 Unit Type	Time							
	olume	Mana	<u> </u>						

11.00				1						
•	Properties: Utilization (Response)									
	Show Commonly Used Properties Only									
🗆 General										
		Name	Utilization							
		Display Name	Utilization							
		Expression	Server1.Capacity.Utilized.Average							
		Unit Type	Unspecified							
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Lessons Learned

Run the experiment

Scenario		Replications	Controls		Responses			
V	Name	Completed	InterarrivalTime (Minutes)	ProcessingTime (Minutes)	ThroughPut	WaitingTime (Hours)	Utilization	
	ConstantConstant	100 of 100	60	55	1024	0	0.916667	
V	RandomConstant	100 of 100	Random.Exponential(60)	55	1018.44	4.57785	0.912119	
V	RandomRandom	100 of 100	Random.Exponential(60)	Random.Exponential(55)	1014.55	9.39315	0.913334	



Search for and eliminate sources of variation in your system.



Higher utilization increases WIP & Waiting

- Explore effect of high utilization
- Predicting utilization for validation
- Pivot Grid Features
- Experimentation



Verification & Validation

- Verification: Does your model work as you think it does? (Implementation errors)
- Validation: Does your model behave like the real system? (Bad assumptions)
- Estimated Utilization = ServiceTime/TimeBetweenCreations



Setup Experiment

- Set InterarrivalTime to Random.Exponential(.25) minutes
- Create scenarios with mean values for ProcessingTime of:
 - .14, .20, .22, .24
- What are expected utilizations?
- Run experiment

Pivot Table



Filter

- Any values in any column
- Sort, Categorize
- Name reports (views)
- Change units
- Export Summaries and Details



Lessons Learned

InterarrivalTime (Minutes)	ProcessingTimeServer (Minutes)	Throughput	WIP	Utilization
Random.Exponential(.25)	Random.Exponential(.14)	5752.27	1.27186	0.559607
Random.Exponential(.25)	Random.Exponential(.16)	5755.37	1.77788	0.640437
Random.Exponential(.25)	Random.Exponential(.18)	5749.94	2.56991	0.718976
Random.Exponential(.25)	Random.Exponential(.2)	5748.58	3.95511	0.798884
Random.Exponential(.25)	Random.Exponential(.22)	5746.45	7.26462	0.878532
Random.Exponential(.25)	Random.Exponential(.24)	5733.66	21.663	0.956261



Avoid driving high WIP through highly utilized resources.



Principle 3 CONWIP strategy has less WIP for the same throughput

- Explore parallel servers
- Entity destination
- Routing choices
- Node Lists



Simio Forward Thinking

Problem setup

Place Source, 3 Servers, and Sink

Connect with Paths

Source: Set Interarrival time to Random.Exponential(4) Seconds



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Principle 3 Node Routing

Shortest Path

Select the link that is on the shortest pathway to the <u>specified</u> destination (if any).

By Link Weight

Select the link randomly using Selection Weights assigned to each link. Probability = $W_i / \sum W$







Principle 3 Explore routing behavior with Link Simio Weights

- Try Selection Weights of 5 for all 3 paths
- Try with Selection Weights of 1, 2, & 3
- What values would result in 10% to Server1 and 90% to Server3





Create List for Destination

- Extended selection (using Ctrl-Click)
- Highlight 3 input nodes
- Right-click, Add to Node List named Servers





Principle 3 Explore routing behavior with Shortest Path



- Set Node List Name to Servers
- Examine Selection Goals (Cyclic, Random)
- Examine Selection Goal to Smallest Value





Convert to CONWIP System

- Source: Set Arrival Mode to On Event
- Source: Set Initial Number Entities to 6
- Source Set Triggering Event to Input@Sink1.Entered
 Properties: Source1 (Source)





A single queue decreases WIP

Compare parallel servers to multi-capacity server



Principle 4 Problem setup



Place Source, Server, and Sink

Source: Set Interarrival time to Random.Exponential(4.5) Seconds

Server: Set Initial Capacity to 3





Buffer space in a flow line increases throughput and decreases WIP

- Explore use of buffers
 - Input, output
 - Finite/infinite/zero
- More Server options
 - Secondary resources
 - Financials
- Status animation



- Buffer Capacities
- Reliability Logic
- State Assignments
- Secondary Resources
- Financials
- Add-On Process Triggers
- Advanced Options
- 🗄 General
- Animation

Server Capabilities





Arriving entities seize/release the Server.

- The Server Allocation Queue is ranked; selection is based on first in queue or the Dynamic Selection Rule.
- The Server has a *Fixed* capacity or follows a *Work* Schedule.
- Failures include Calendar Time Based, Usage Time Based, Usage Count Based, and Event Count Based.

Secondary resource during processing or individually seized/released.

Principle 8 Model setup



- Place Source, 3 Servers, Sink, connected by Connectors
- Ctrl-Select all servers and set Input and Output Buffers to 0
- Click on Server2, Status Pie > ResourceState and draw rectangle on facility view

