

Computer Simulation

Module 5: Arena

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Details on the Process

Module

Lesson Overview

Last Lesson: Learned about the Create-Process-Dispose modules.

This Lesson: We'll learn more goodies about the Process module.

Idea: It allows you to grab servers, use them, and then let them go for the next guy to use. And along the way, it automatically sets up a queue!

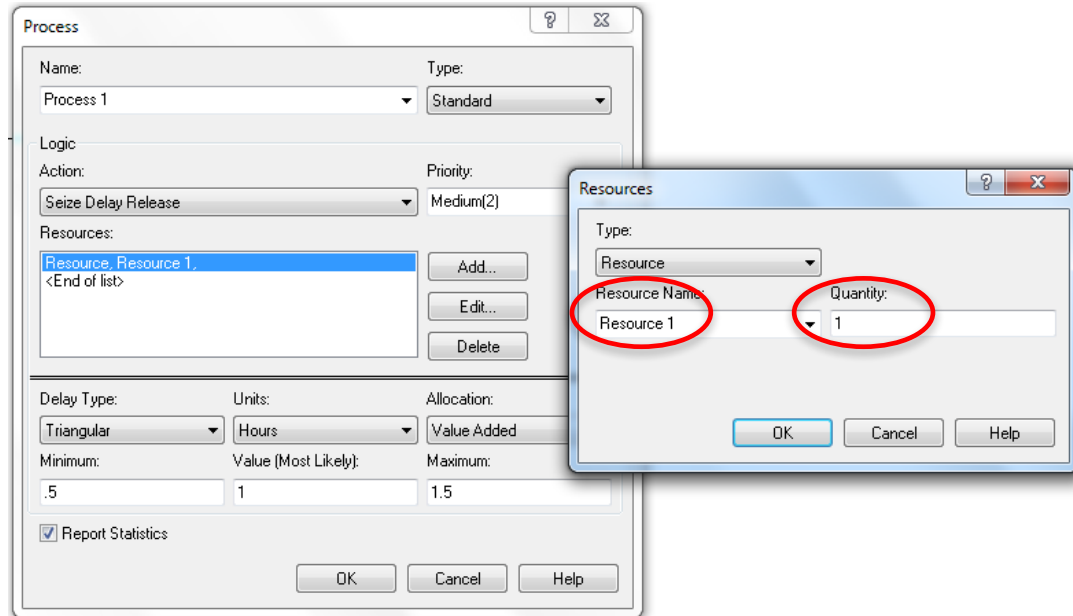
• Seize-Delay-Release

You'll take one of the following “actions” in the Process module:

- **Delay:** Spend time in the Process (self-service).
- **Seize-Delay-Release:** Grab at least one resource (server), spend time getting served, and then free the server for the next customer. If you Seize and the server isn't available, you may have to wait in a **queue**. www.youtube.com/watch?v=eAyVgPtC5Zc
- **Seize-Delay:** Grab at least one resource and spend time getting served. Remember to Release the server sometime later, else he gets deadlocked and a giant line will form!
- **Delay-Release:** Use a previously Seize'd server for a while, and then free him for the next guy to use.

• Resource Dialog Box

If you do a Seize / Release, a dialog box pops up asking which and how many resource(s) you want to **Add** (do the Seize / Release action).



• Resource Dialog Box (cont'd)

Example:

- A customer walks into the Process module, and does a Seize-Delay-Release to grab and use **one** unit of the resource Barber.
- Hit the **Add** button, name the resource Barber, and set Quantity = 1.
- The Process is given a default name of “Process 1” and includes the resource as well as the default queue “Process 1.Queue” (talk about later).
- **Process = Resource + Queue**

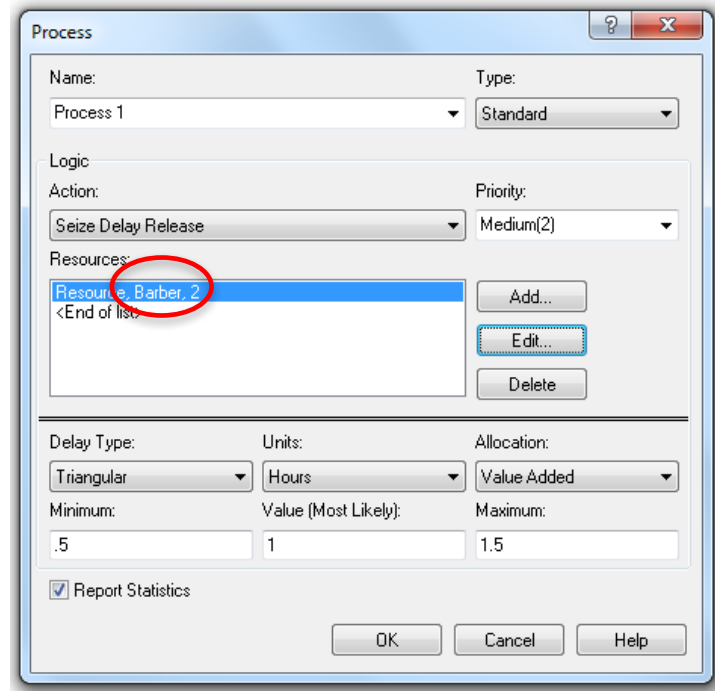
The screenshot shows the 'Process' dialog box with the following details:

- Name:** Process 1 (circled in red)
- Type:** Standard
- Logic:**
 - Action:** Seize Delay Release
 - Priority:** Medium(2)
- Resources:**
 - Resource: Barber, 1 (circled in red)
 - <End of list>
 - Buttons: Add..., Edit..., Delete
- Delay Type:** Triangular
- Units:** Hours
- Allocation:** Value Added
- Minimum:** .5
- Value (Most Likely):** 1
- Maximum:** 1.5
- ☒ Report Statistics
- Buttons: OK, Cancel, Help

• Resource Dialog Box (cont'd)

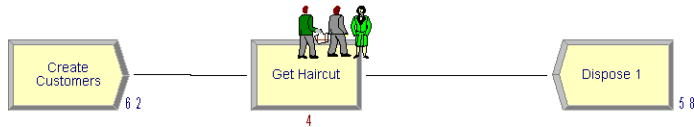
Slightly Different Example: Now every customer uses **TWO** barbers. (They all have lots of flowing locks like your gentle teacher). How to do?

- Set Quantity = 2 in Add or Edit box.
- Distinction: There may be 5 barbers in the store, but each customer needs exactly 2 of them. We'll show in the next lesson how to use the Resource Spreadsheet to set the Barber's "capacity" to 5.



Demo Time!

- Different permutations of Seize-Delay-Release
- Notice that a queue magically pops up!



- Multiple resources
- Warning about deadlocks

Summary

This Time: Learned lots more about the Process module, including the Seize-Delay-Release sequence and the associated queue that magically gets set up.

Next Time: We'll finally take a look at some Arena spreadsheets: Resource, Schedule, and Queue.

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Resource, Schedule, and
Queue Spreadsheets

Lesson Overview

Last Lesson: Talked about the Seize-Delay-Release functionality of the Process module – how do you reserve and use servers?

This Lesson: Now it's time to look at some of those spreadsheets you may have noticed.

You can change resource capacities, the types of queues, etc.

Resource Spreadsheet



Click on the spreadsheet in the Basic Process template, and you get a list of the resources that the model is using (at the bottom of the screen).

- Example: Two resources, Barber and Pedicurist. The resource Barber has fixed capacity 4 (four barbers on duty); there's only 1 Pedicurist.

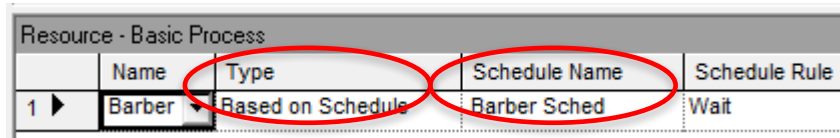
Resource - Basic Process								
	Name	Type	Capacity	Busy / Hour	Idle / Hour	Per Use	StateSet Name	Failures
1 ▶	Barber	Fixed Capacity	4	0.0	0.0	0.0		0 rows
2	Pedicurist	Fixed Capacity	1	0.0	0.0	0.0		0 rows

- Reminder: Capacity is the number of the resource's servers on duty, not necessarily the number of the servers that a customer requests.
- Note: A resource's servers are regarded as [identical and interchangeable](#).
- The resources are automatically sent to the spreadsheet when we define them in the Process module. Or, we can just double-click a new row and define a resource right there in the spreadsheet.
- Can change [fixed capacity](#), or make a [schedule](#) that varies the capacity over time.

Schedule Spreadsheet

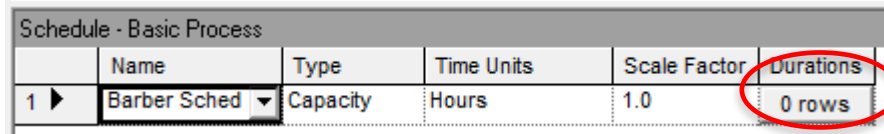
Can set schedules for [servers](#).

- Example: Go to the Resource Spreadsheet and change the Type to “Based on Schedule”. The dialog box will change slightly to accommodate a schedule name (which we’ve called “Barber Sched”).



Resource - Basic Process				
	Name	Type	Schedule Name	Schedule Rule
1 ▶	Barber	Based on Schedule	Barber Sched	Wait

- Now go over to the Schedule Spreadsheet and you’ll see that Barber Sched is already there, waiting for your input.



Schedule - Basic Process					
	Name	Type	Time Units	Scale Factor	Durations
1 ▶	Barber Sched	Capacity	Hours	1.0	0 rows

- The key is to enter stuff into the “Durations” box.

Schedule Spreadsheet

Can set schedules for [arrivals](#).

- Example: Go to a Create module and change the Type to “Schedule”. The dialog box will change slightly to accommodate a schedule name (which we’ve called “Arrival Sched”).
- Now go over to the Schedule Spreadsheet and you’ll see that Arrival Sched is already there, waiting for your input.
- We’ll see in the demo how to enter stuff into the “Durations” box.

Create

Name: Create 1 Entity Type: Entity 1

Time Between Arrivals

Type: Schedule Schedule Name: Arrival Sched

Entities per Arrival: 1 Max Arrivals: Infinite

OK Cancel Help

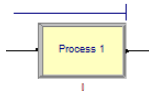
Schedule - Basic Process					
	Name	Type	Time Units	Scale Factor	Durations
1	Barber Sched	Capacity	Hours	1.0	0 rows
2	Arrival Sched	Arrival	Hours	1.0	0 rows

Demo Time!

- Resource Spreadsheet
- Resource and Arrival Schedules
- Queue Spreadsheet
- Resource Animation
- Queue Animations



Queue



Summary

This Time: Discussed the Resource, Schedule, and Queue Spreadsheets, along with some of their ramifications.

Next Time: We'll discuss the Decide module, which allows us to make probabilistic and conditional decisions that affect the entities' paths through the model.

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The Decide Module

Lesson Overview

Last Lesson: The Resource,
Schedule, Queue Spreadsheets

This Lesson: The Decide module,
which allows customers to make
probabilistic and conditional
choices about their paths.

Idea: A flexible module enabling
you to go this way and that way!

www.youtube.com/watch?v=z4uWfs3sH7s

Decide Module

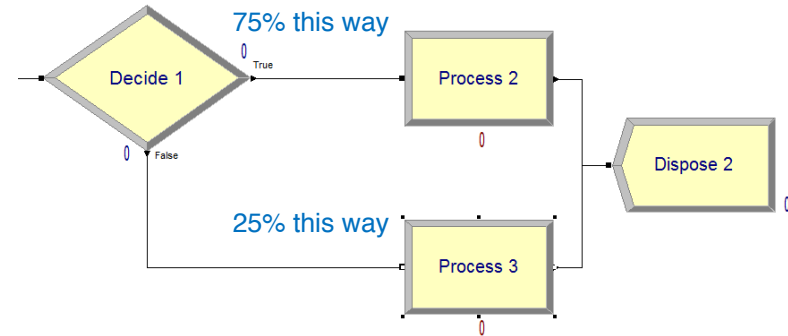
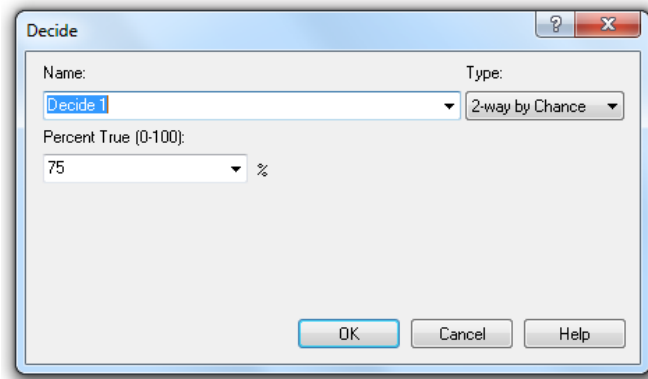


Decide

- When an entity gets to a Decide module, he can...
 - Randomly go to either of two locations (“2-way by Chance”) (probabilities are given in percentages)
 - Randomly go to any of various locations (“N-way by Chance”)
 - Go to either of two locations if a condition is satisfied (“2-way by Condition”)
 - Go to any of various locations if a condition is satisfied (“N-way by Condition”)

Decide Module

- Example: Go to Process 2 with prob 0.75, and Process 3 w.p. 0.25.



- Demo Time!

Summary

This Time: The Decide module, which gives customers lots of choices about moving through the model.

Next Time: The Assign module, which allows us to give values to attributes and variables, and even assign graphics to entities.

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The Assign Module

Lesson Overview

Last Lesson: The Decide module, which makes probabilistic and conditional decisions about where customers go.

This Time: The Assign module, which allows us to give values to attributes and variables, and even assign graphics to entities.

Idea: Very power, general tool.

The Next Few Lessons

Cover material that'll eventually allow us to simulate multi-channel customer flows:

- The Assign Module ← now
- Attribute, Variable, Entity Spreadsheets
- Arena Internal Variables
- Displaying Stuff
- Batch, Separate, Record
- Run Setup and Control
- Two-Channel Mfg Example

Attributes

Each customer passing through the system has various properties (**attributes**).

- Tom is 6' tall, weighs 160 lbs, loves baseball, and has LDL cholesterol = 108.
- Justin B. is 4'11" tall, weighs 280 lbs, loves eating lard, and has LDL = 543.
- Both guys have 4 attributes, though other guys may have different numbers of attributes.
- Attributes need to be **numerical**; for example, BB = 11 and lard = 28.

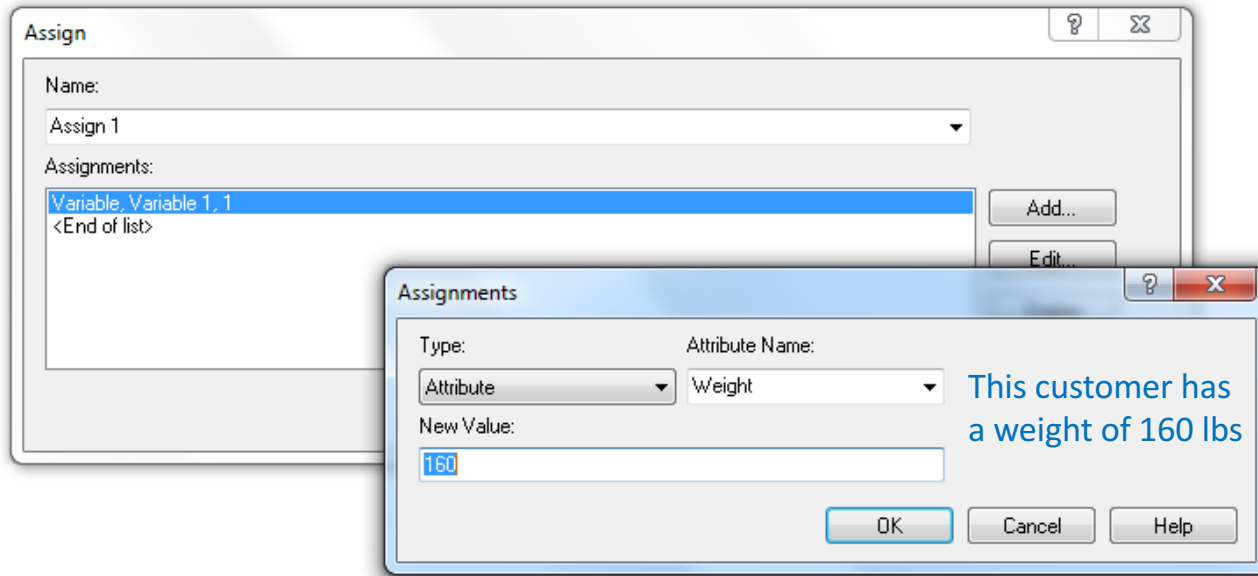
Variables

- Unlike attributes, whose values are specific to each customer, **variables are global**.
- If you change a variable anyplace in the Arena program, it gets changed everywhere.
- Example: WIP might be incremented when an entity is Create'd, and decremented if it's Dispose'd – these events could occur anywhere.

Assign Module

Assign

- So how can you change attributes, variables, and other stuff?
- Use the very powerful and flexible **Assign** module.



Demo Time!

- Use of Assign for attributes and variables
- Use of Assign for entity pictures
- Using Decide and Assign together

Summary

This Time: Talked about Attributes, Variables, and then the Assign module.

Next Time: The Attribute, Variable, and Entity Spreadsheets.

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Attribute, Variable, and Entity
Spreadsheets

Lesson Overview

Last Lesson: Discussed the Assign module, and how it can be used to (i) give values to attributes and variables, and (ii) change entity graphics.

This Lesson: The Attribute, Variable, and Entity spreadsheets.

Spreadsheets



Attribute



Variable



Entity

- The **Attribute Spreadsheet** keeps track of existing **attributes** that you might define in an Assign.
- Can make your own (double click).

	Name	Rows	Columns	Data Type	Initial Values
1 ▶	height	3		Real	3 rows
Double-click here to add a new row.					

- Can be vectorized.

Initial Values	
1	1.3
2	1.2
3	1.8

- Variable Spreadsheet** pretty much the same.
- Entity Spreadsheet** allows you to set initial picture.
- Demo Time!

Entity Type	Initial Picture
Entity 1 ▼	Picture.Report

Summary

This Time: Easy discussion about the Attribute, Variable, and Entity Spreadsheets.

Next Time: We'll discuss a few Arena "internal" variables that are automatically calculated as the simulation proceeds. These have a great variety of uses.

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Arena Internal Variables

Lesson Overview

Last Lesson: The Attribute, Variable, and Entity Spreadsheets.

This Lesson: Talk about Arena's so-called “internal” variables that are automatically calculated as the simulation proceeds.

Idea: Incredibly useful. Help you make decisions based on the simulation's current state.

Internal Variables

- Dirty Little Secret: Arena keeps track of and continuously updates lots of stuff as the simulation runs.
- Good for making decisions, drawing graphs, etc.
- Examples:
 - `TNOW` = current simulated time
 - `NR(Barber)` = # of resource Barber's servers now working
 - `NQ(Process 1.Queue)` = # customers in that queue
 - `Create 1.NumberOut` = # of customers who have so far left the module named Create 1
- Huge list is available if you sniff around Build Expression.
- **Demo Time!** Go to the shortest line.

Summary

This Time: Introduced internal variables such as TNOW, NR(), etc. They're constantly updated and provide lots of relevant info.

Next Time: How to display variables, graphs, and results.

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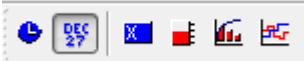
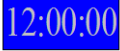




Displaying Variables, Graphs,
and Results

Lesson Overview

Last Lesson: Talked about some useful internal variables that Arena constantly updates.

This Lesson: How can we display the values of certain variables in real time, construct graphs, and produce output result files?

Getting Information

- How to display information as the simulation is running?
 - Arena provides lots of capability.
 - For example, consider the toolbar... 
 - You can get an analog or digital clock. 
 - Calendar 
 - Variable displays, which keep track of the values of variables in real time. 
 - Histograms 
 - Graphs 
- When the simulation is over, it will automatically generate an **output report** giving info on server usage, queue length, customer waits and cycle times, and other user-defined quantities.
- **Demo time**, including drill press example!

Summary

This Time: Discussed ways to display the values of certain variables in real time, construct graphs, and produce output files.

Next Time: A quick tutorial on the Batch, Separate, and Record modules.

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- When the simulation is over, it will automatically generate an **output report** giving info on server usage, queue length, customer waits and cycle times, and other user-defined quantities.

- **Demo time**, including drill press example!

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