Arena® Tutorial

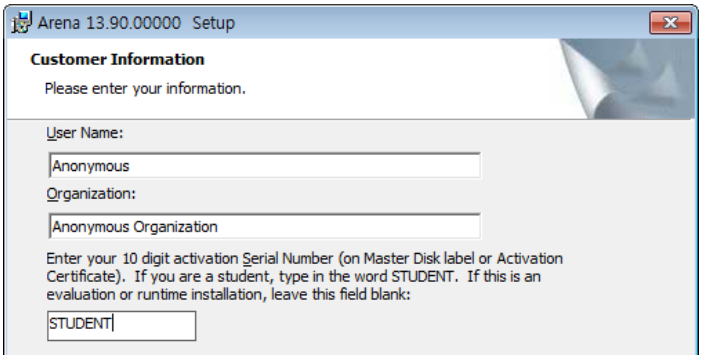
This Arena® tutorial aims to provide a minimum but sufficient guide for a beginner to get started with Arena®. For more details, the reader is referred to the Arena user's guide, which can be found in Arena program (*Help >Product Manuals>Arena User's Guide*).

1. Installation

You can download the student version of Arena software from the link below:

http://arenasimulation.com/downloadarena

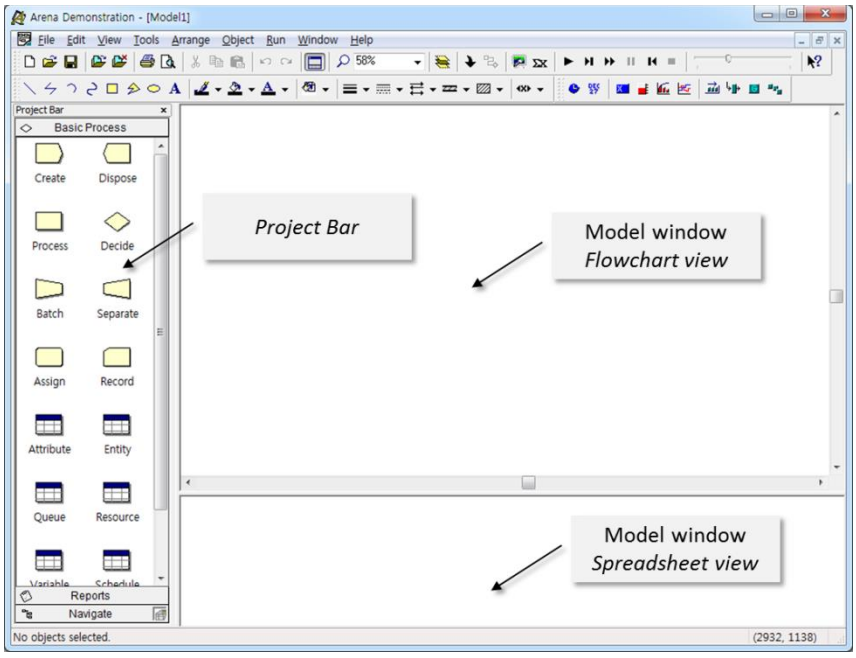
To proceed with the download, you have to register your account with your valid email address. Once registered, you can log into the download site and follow the download instructions provided at that site. During the installation, customer information will be asked to enter with the serial number. In that case, you have to enter **STUDENT** in the serial number field as shown below.



2. Overall Features of Arena®

2.1 Arena Window Structure

You can run Arena from the *Window Start* menu and navigate to *Program* > *Rockwell Software* > *Arena*. If a warning message will prompt, click **OK** to go on. The Arena will bring you the new modeling environment as follows:



In the Arena window, you will face with the three regions where you'll work for building a simulation model.

1) Model Window (Flowchart view)

   The flowchart view is a canvas to draw the process flow of entities using modules from the project bar. It can also have the animation and other drawing elements

2) Model Window (Spreadsheet view)

   The spreadsheet view displays the properties of selected module in the flowchart view or the project bar.

3) Project bar

   The project bar holds some panels that provide the various objects so as to help you build the simulation model and reports

   - **Basic Process panel**: holds modeling commands called modules that are used to model your system.
   - **Reports panel**: provides a road map to the results of a simulation run
   - **Navigate panel**: allows to display different view of a model

   The Arena also provides additional panels that provide various types of objects such as advanced process, advanced transfer panels and so on. In order to use these panels, you need to attach a panel located in Arena's template folder by selecting a panel file (ends with "tpo" extension) from *File* > *Template Panel* > Attach. In reverse, if you don't need it any more, you can detach from the project bar from *File* > *Template Panel* > *Detach*.

2.2 Modules

In Arena, modules are basic building blocks (or objects) that consist of Arena models. There are two types of modules: flowchart modules and data modules. All the modules can be found in the project bar.

1) Flowchart Modules:

   The flowchart modules are used to describe the flow of entities and placed in the flowchart view of the model window.

   In the *Basic Process* panel, you can find the following flowchart modules:

Name	Description
Create	Entities enter the simulation here.
Dispose	Entities are removed from the simulation here.
Process	An activity, usually performed by one or more resources and requiring some time to complete.
Decide	A branch in entity flow. Only one branch is taken.
Batch	Collect a number of entities before they can continue processing
Separate	Duplicate entities for concurrent or parallel processing, or separating a previously established batch of entities
Assign	Change the value of some parameter (during the simulation), such as the entity's type or model variable.
Record	Collect a statistic, such as an entity counter or cycle time.

2) Data Modules:

The data modules are used to define parameters associated with elements of the model, such as resources, entities, queues and so on. The data module can be accessed from the project bar by double-clicking a module and it will be shown on the spreadsheet view of the model window.

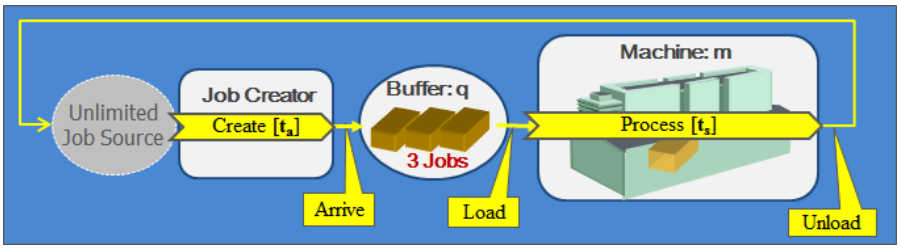
In the *Basic Process* panel, you can find the following data modules:

Name	Description
Entity	Define the various entity types and their initial picture values in a simulation. Costing information is also defined for the entity.
Resource	Define the resources in the system including costing information and resource availability.
Queue	Define the queues in the system
Schedule	With the *Resource* module, define an operating schedule for a resource or with the *Create* module, define an arrival schedule.
Set	Define various types of sets, including resource, counter, tally, and entity type and entity picture.
Attribute	Define the entity's attributes which consist of type, dimensions and initial value.
Variable	Define the variables used through the modules in the model.

3. Building Models with Arena

Throughout this section, the process of building an Arena model of a single server system will be explained with the details.

3.1 Reference Model (Single Server System)



1) Entity: Job arrives every t_a minutes (ta ~ Exp(5))
2) Active Resource: Machine
3) Passive Resource: Buffer (unlimited)
4) Activity: service time t_s ~ triangular1(1, 3, 6)

3.2 Defining each Data Module

Before modeling the flow of the entity, the entities and resources are defined using Entity and Resource data modules.

1) Entity module:

In *Basic Process* panel of the project bar, click the *Entity* module. Double-click the spreadsheet view to define a new entity. Enter the entity type with "Job" and change the initial picture to "Picture.Box" which will be used to animate the entity flow during the simulation.

Entity - Basic Process

	Entity Type	Initial Picture	Holding Cost / Hour	Initial VA Cost	Initial NVA Cost	Initial Waiting Cost	Initial Tran Cost	Initial Other Cost	Report Statistics
1 ▶	Job	Picture.Box	0.0	0.0	0.0	0.0	0.0	0.0	☑
	Double-click here to add a new row.								

2) Resource module:

In *Basic Process* panel of the project bar, click the *Resource* module. Double-click the spreadsheet view to define a new resource. Enter the name with "Machine".

Resource - Basic Process

	Name	Type	Capacity	Busy / Hour	Idle / Hour	Per Use	StateSet Name	Failures	Report Statistics
1 ▶	Machine	Fixed Capacity	1	0.0	0.0	0.0		0 rows	☑
	Double-click here to add a new row.								

3.3 Constructing a Flowchart Model

In Arena, the flowchart represents the flow of entity in the system. In the single server system, the entity, a job, 1) enters the system and waits in the queue. 2) The job will be processed by the machine when the machine becomes idle. 3) The processed job will leave the system.

1) Create jobs

The starting point of the flowchart is always the Create module. Drag the *Create* module from the *Basic Process* panel into the flowchart view of the model window.

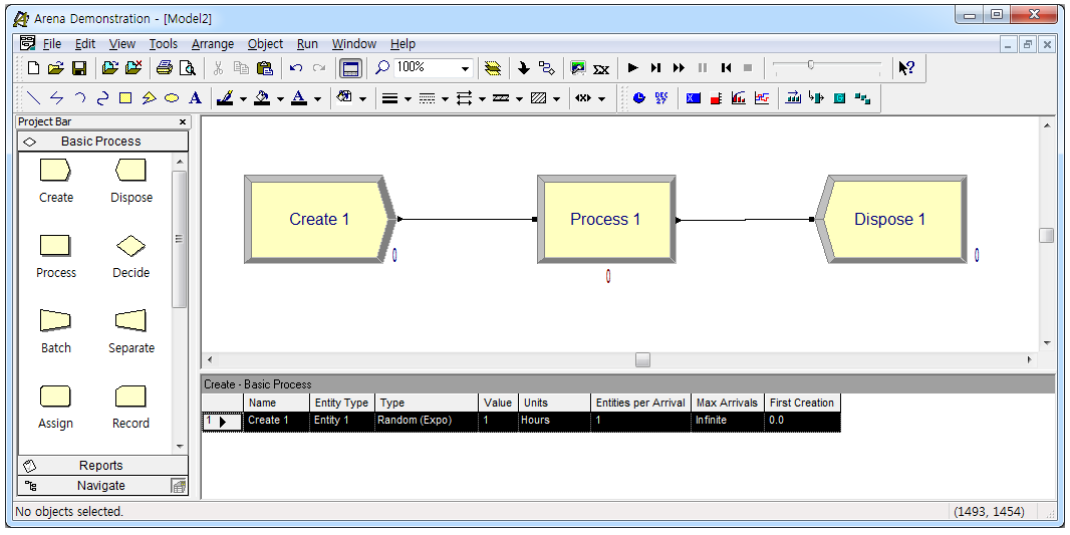
2) Process jobs

Drag the Process module from the Basic Process panel into the flowchart view, placing it to the right of the "Create 1" module. If the "Create 1" module is selected before dragging, the connection will be automatically established from "Create 1" to Process module. For this, check ***Object*** > ***Auto-Connect*** menu is activated.

If the connection is not made, click the ***Object*** > ***Connect*** menu or the ***Connect*** toolbar button ( ) to draw a connection manually. Start the connection by clicking the exit point (►) of the Create module, and then click the entry point (■) of the Process module to complete the connection.

3) Dispose jobs

Select the "Process 1" module and Drag the *Dispose* module from the *Basic Process* panel into the flowchart view, placing it to the right of the "Process 1" module.



3.4 Defining each Flowchart Module

1) Create Module

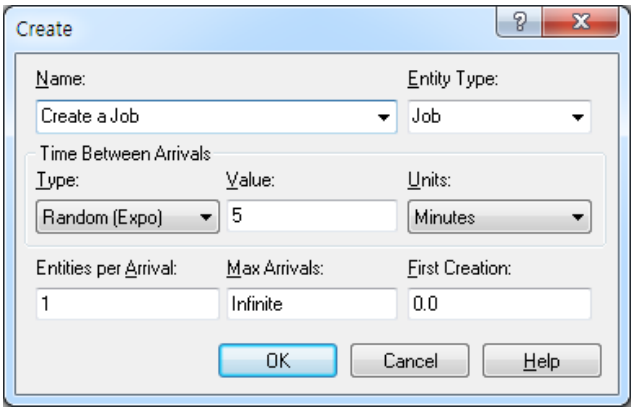
Double-click the "Create 1" module to open a dialog box so as to edit its properties.

(1) Type "Create a job" in the *Name* field.

(2) Select or type "Job" to name the entities in the *Entity Type* field.

(3) Type "5" in the *Value* field of the *Time Between Arrivals* section and select "Minutes" in the Units field

(4) Click *OK* to close the dialog box.



2) Process Module

Next is the "Process 1" module. In this module, the behavior or flow of an entity at buffer and machine will be defined. The newly created job waits at the buffer until the resource (machine) becomes idle. If there is an idle resource, the entity *seizes* the resource and holds for a time *delay* (representing resource's processing of the entity), and then it releases the resource for next processing of the entity.

Double-click the "Process 1" module to open a dialog box so as to edit its properties.

(1) Type "Process a Job" in the *Name* field.

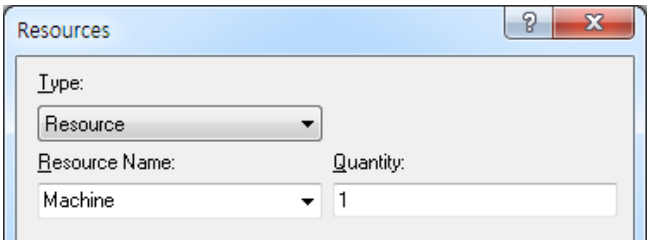
(2) Select "Seize Delay Release" in the *Action* field of the *Logic* section.

Action field defines the behavior of an entity in this module.

- ***Seize Delay Release***: the arriving entity seizes some number of units of a resource, then is delayed for a time, and then releases the resource
- ***Delay***: the arriving entity is simply delayed for some time and no resource is required
- ***Seize Delay***: seizes the resource and then is delayed, but does not release the resource
- ***Delay Release***: assuming that the resource is seized previously, the entity is delayed and then the resource is released

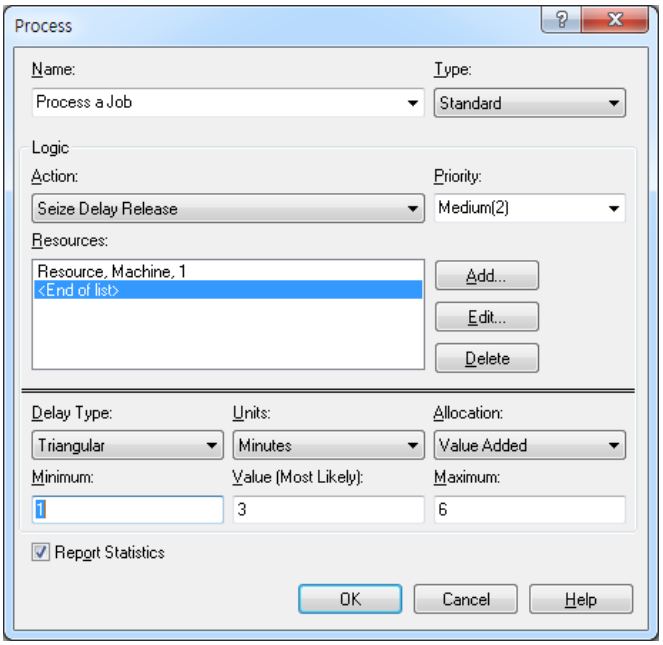
(3) Click "Add..." button in the Resources filed of the *Logic* section to add a resource for this module. The dialog box for Resources will be opened. Select "Machine" in the Resource Name field. Click *OK* button to close the *Resources* dialog box.

Resources field defines the resources to be seized or released. It can be a Resource or Set (a set of resources). The *Quantity* field indicates the number of resources to be seized or released.



(4) To specify the time delay (service time) that follows the triangular distribution of (1, 3, 6), select "Triangular" in the *Delay Type* field and type 1, 3 and 6 in Minimum, Value (Most Likely), and Maximum fields, respectively. Also select "Minutes" in the *Units* field.

The **time delay** for the Process module can be Constant, Normal, Triangular, Uniform, and Expression.



3) Dispose Module

This module represents the ending point of the entity's flow in the model. Nothing special is mentioned here.

4. Running Simulation with Arena

4.1 Setting the run conditions

Prior to run the model, you need to specify the run conditions including project information and the length of the simulation run. This is done in *Run Setup* dialog box from ***Run*** > ***Setup*** menu.

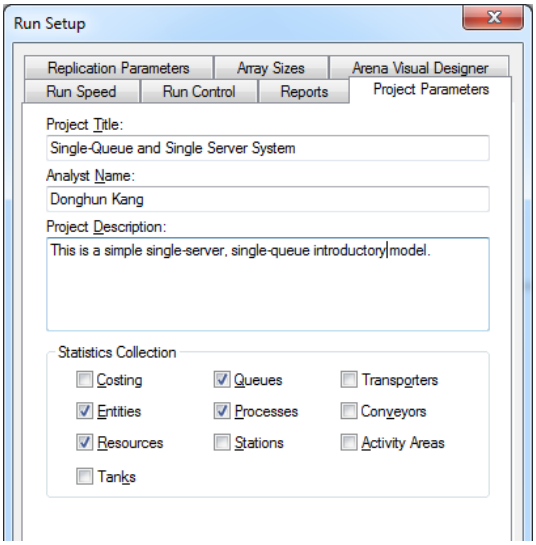
1) Project Parameters

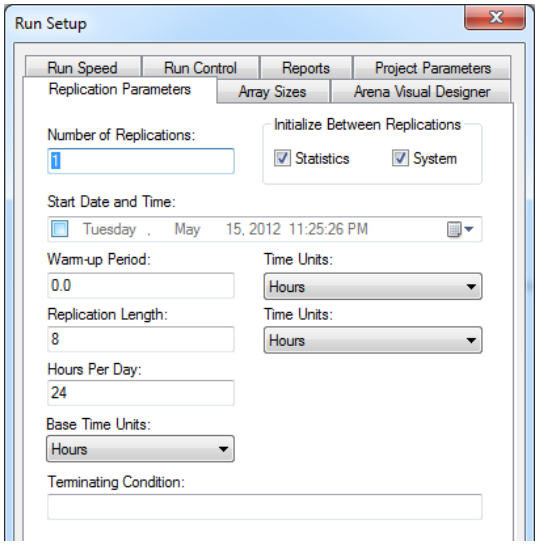
In Run Setup dialog box, select *Project Parameters* tab to specify the general project information with Project Title, Analyst Name, and Project Description. You can also specify for which categories you would like to collect statistics during the simulation in the Statistics Collection field. Here, check the boxes of Queues, Entities, Processes, and Resources of the Statistics Collection field.

2) Replication Parameters

In Run Setup dialog box, select Replication Parameters tab to specify how many times the simulation runs and how long each simulation runs.

- *Number of Replications*: defines numbers of simulation runs to execute. Here, type **1**.
- *Replication Length*: defines the length of a single replication in a specified time unit. Here, type **8** and select **Hours** in its *Time Units* (directly to the right of *Replication Length*)
- *Base Time Unit*: defines time units for reporting, status bar, simulation time and animated plots. All time delays, replication length will be converted to this base time unit. Here, select **Hours**.

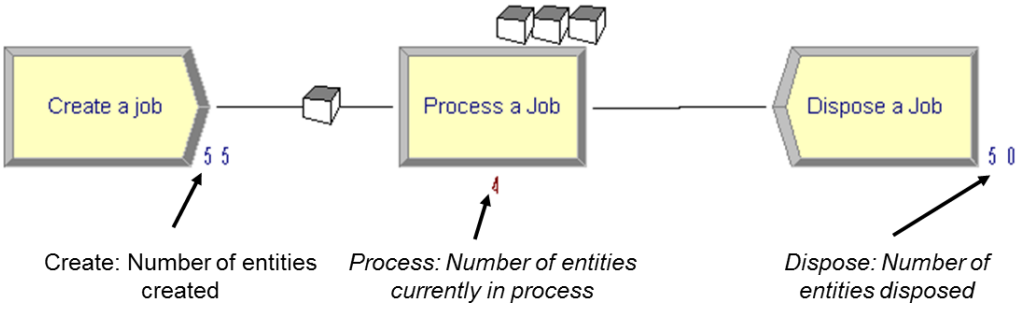




4.2 Running a simulation

You can start the simulation run simply by clicking the **Go** (▶) button in the standard toolbar or clicking the ***Run*** > ***Go*** menu. If you have a valid model, then Arena continues to run the simulation. If your model is not valid, Arena lets you know that with error messages.

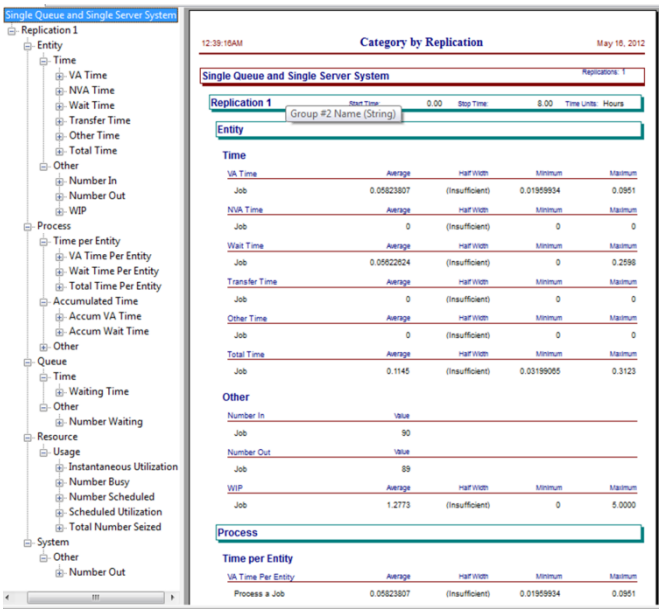
Once the simulation starts to run, some animation will be displayed as the simulation progresses. As shown in the following figure, entities in a box shape (as specified in Entity data module) move from one module to another. Below the each module, number of entities created, in processing, and disposed are displayed. At the top of the *Process* module, displayed is the status of the queue of the resource (number of waiting entities) with entity pictures. In this figure, there are four entities in *Process* module, among them, one entity is actually being processed by the resource and three entities are waiting at the queue.



If you don't want to see the animation anymore during the simulation run, click the ***Fast Forward*** (⏩) button to run the simulation as fast as possible without animation update. Also you can start the simulation run via the ***Run*** > ***Fast-Forward*** menu.

4.3 Reviewing the output reports

At the end of the simulation run, a message box will prompt to ask you whether you would like to view the reports. Clicking **Yes** displays the reports as shown below.



In the *Reports* panel, you can see the list of reports provided by Arena. By clicking one of them, you can see the corresponding report. The above figure shows the *Category by Replication* report which provides the output results for each replication. As we specified in Run Setup > Project Parameter, statistics are collected in four categories (Entity, Process, Queue, and Resource) in addition to the system category (default statistics collected by Arena).

The statistics provided in Arena's reports can be classified into three types of statistics:

- **Tally statistics**: it refers to the statistics such as average, minimum, or maximum of a series of numbers. For example, the average and maximum of the total time in the system of entities are 0.1145 hour and 0.3123 hour, respectively.
- **Time-persistent statistics**: it refers the statistics such as time average, minimum, or maximum of a plot of something during the simulation run. The time average is the accumulated area under the plotted curve divided by the simulation length. For example, one of time-persistent statistics is the average of the number of entities in the queue at the machine that can be found in the *Queue* → *Other* → *Number Waiting* of the report tree located to the left of the report. Also, the instantaneous utilization of the resource (*Resource* → *Usage* → *Instantaneous Utilization*) is one of the time-persistent statistics.
- **Counter statistics**: it refers to the statistics of accumulated sum of something. One of the counter statistics is the number of entities that entered or left the system which can be found in *Entity* → *Other* → *Number In* or *Number Out* of the report tree. According to the figure above, ninety jobs entered the system and eighty-nine of them left the system.