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# 5 PROMODEL'S OUTPUT MODULE

*I am not discouraged, because every wrong attempt discarded is another step forward.*

—Thomas Edison

In this chapter we discuss ProModel's Output Program Manager in detail with examples.

## L5.1 The Output Program Manager

The ProModel Output Program Manager, also called Output Viewer 3DR (three-dimensional report), can be run either as a stand-alone application by choosing View Statistics from the Output menu or from within the Windows Program Manager by choosing Results Viewer. This allows us to view ProModel output files at any time, with or without starting ProModel. The Results Viewer has two options—3DR, and Classic. The default output viewer can be selected in the Tools → Options menu in ProModel. The Classic output viewer uses a proprietary binary file format that works faster. However, the 3DR output viewer produces much nicer output. Some examples of the output view in the 3DR mode are shown in Figures L4.13, L4.26, and L4.33. The output viewer simplifies the process of generating and charting graphs and reports and analyzing the output data. We encourage you to use the ProModel's online help to learn more about the Output Program Manager.

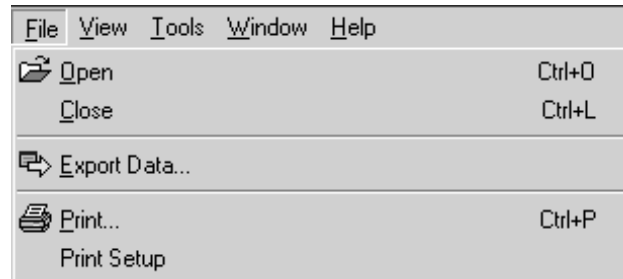
The File menu (Figure L5.1) allows the user to open one or more output databases for review, analysis, and comparison. It also allows the user to export raw data to a common delimited format (\*.CSV), to keep reports and graphs for all subsequent runs, to print, and to set up printing.

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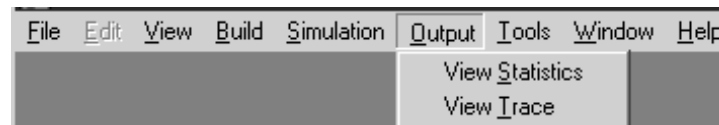
**FIGURE L5.1**

File menu in the 3DR  
Output Viewer.



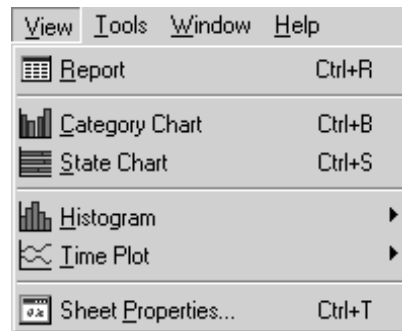
**FIGURE L5.2**

Output menu options  
in ProModel.



**FIGURE L5.3**

View menu in the 3DR  
Output Viewer.



The Output menu in ProModel (Figure L5.2) has the following options:

- *View Statistics*: Allows the user to view the statistics generated from running a simulation model. Selecting this option loads the Output Viewer 3DR.
- *View Trace*: Allows the user to view the trace file generated from running a simulation model. Sending a trace listing to a text file during runtime generates a trace. Please refer to Lab 8, section L8.2, for a more complete discussion of tracing a simulation model.

The View menu (Figure L5.3) allows the user to select the way in which output data, charts, and graphs can be displayed. The View menu has the following options:

- a. Report
- b. Category Chart
- c. State Chart
- d. Histogram
- e. Time Plot
- f. Sheet Properties

**FIGURE L5.4**

3DR Report view of the results of the ATM System in Lab3.

General	Locations	Location States Multi	Location States Single/Tank	Resources	Resource States	Node Entries	Failed Arrivals
<b>General for atmsys~1, Normal Run</b>							
<b>Name</b>	<b>Value</b>						
Run Date/Time	11/6/2002 7:59:24 AM						
Model Path/File	C:\WINDOWS\DESKTOP\ATMSYS~1.MOD						
Model Title	ATM System						

### L5.1.1 Report View

The report view (Figure L5.4) of the Output Viewer 3DR is similar to the Classic view of the output report. A major difference is that there are tabs for various parts of the report as follows:

- |                                |                     |
|--------------------------------|---------------------|
| a. General                     | i. Entity Activity  |
| b. Locations                   | j. Entity States    |
| c. Location States Multiunit   | k. Variables        |
| d. Location States Single/Tank | l. Location Costing |
| e. Resources                   | m. Resource Costing |
| f. Resource States             | n. Entity Costing   |
| g. Node Entries                | o. Logs             |
| h. Failed Arrivals             |                     |

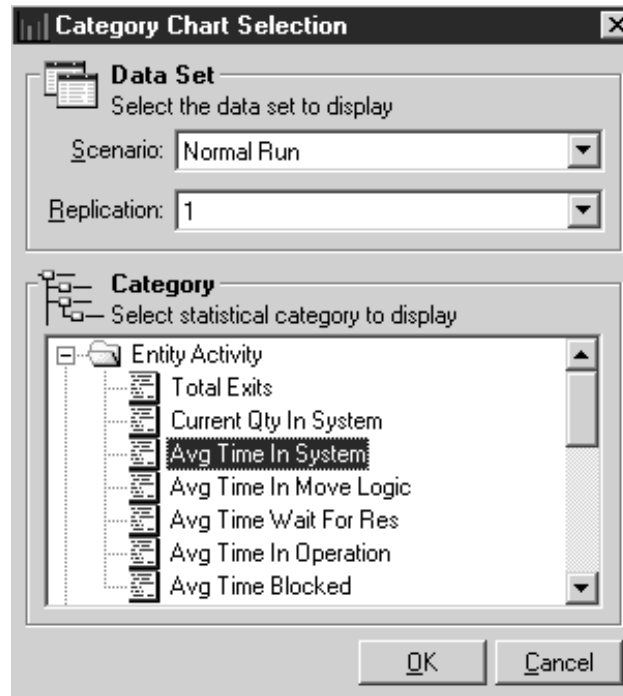
### L5.1.2 Category Chart

The category chart (Figure L5.5) is a graphical representation of the status of the category of data selected at the end of the simulation run. Here are some of the data categories available for charting:

- |   |                       |
|---|-----------------------|
| a. Entity Activity                        | d. Locations          |
| i. Total exits                            | i. Total entries      |
| ii. Current quantity in system            | ii. Average contents  |
| iii. Average time in system (Figure L5.6) | e. Logs               |
| b. Location States Multi                  | i. Minimum value      |
| i. Pct. empty                             | ii. Average value     |
| ii. Pct. full                             | f. Resource States    |
| c. Location States Single                 | i. Pct. idle          |
| i. Pct. idle                              | ii. Pct. in use       |
| ii. Pct. waiting                          | g. Variables          |
| iii. Pct. blocked                         | i. Minimum value      |
|   | ii. Average value     |
|   | iii. Maximum contents |

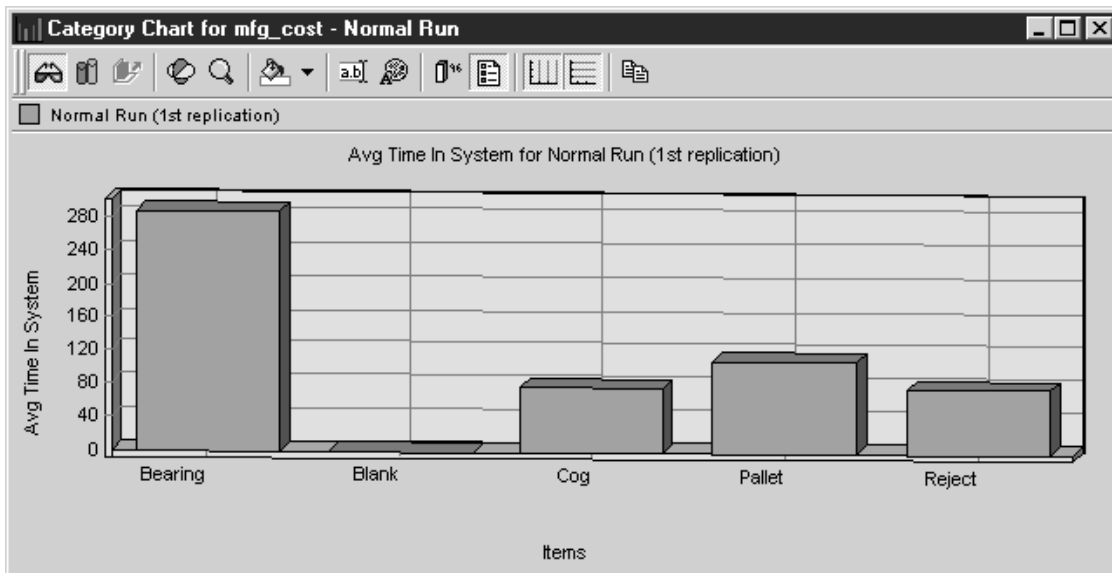
**FIGURE L5.5**

*Categories of charts available in the Category Chart Selection menu.*



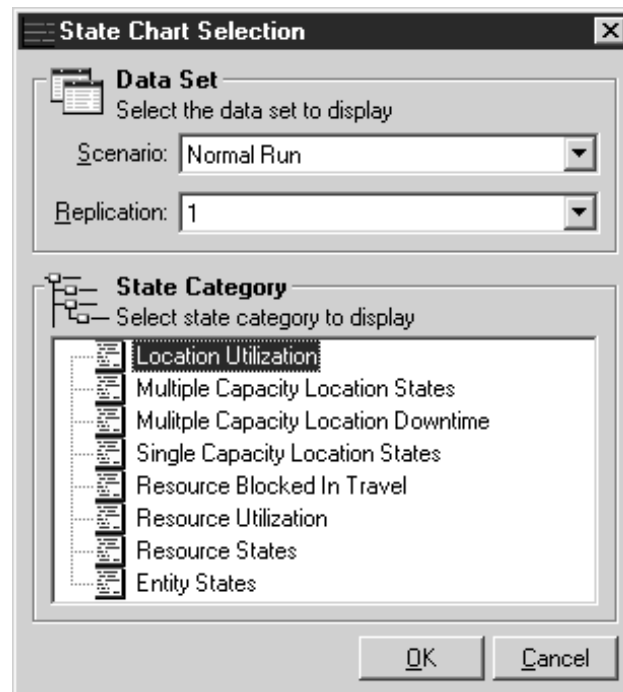
**FIGURE L5.6**

*An example of a category chart presenting entity average time in system.*



**FIGURE L5.7**

Categories of charts available in the State Chart Selection menu.



### L5.1.3 State Chart

In ProModel the state and utilization graphs produce an averaged state summary for multiple replications or batches. By selecting State or Utilization Summary, it is possible to select the type of graph in the dialog shown in Figure L5.7.

The Output Program allows you to create seven different types of state and utilization graphs to illustrate the percentage of time that locations and resources were in a particular state: operation, waiting, blocked, down, or the like.

- *Location Utilization:* Location Utilization graphs show the percentage of time that each location in the system was utilized. ProModel allows you to see this information for all of the locations in the system at once (Figure L5.8).
- *Location State:* Single and Multiple Capacity Location State graphs show the percentage of time that each location in the system was in a particular state, such as idle, in operation, waiting for arrivals, blocked or down (Figure L5.9). ProModel shows this information for all of the locations in the system at once. For further enhancement of a particular location you can create a pie chart. To create a pie chart from a state graph double click on one of the state bars (alternatively you can right-click on a bar and select Create Pie Chart from the pop-up menu) for that location (Figure L5.10).

FIGURE L5.8

State chart representation of location utilization.

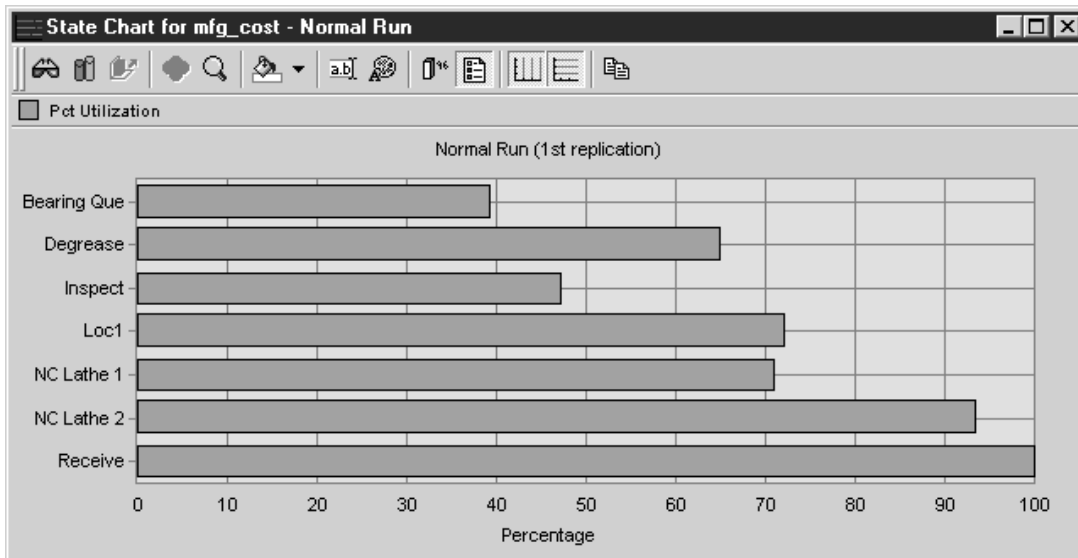
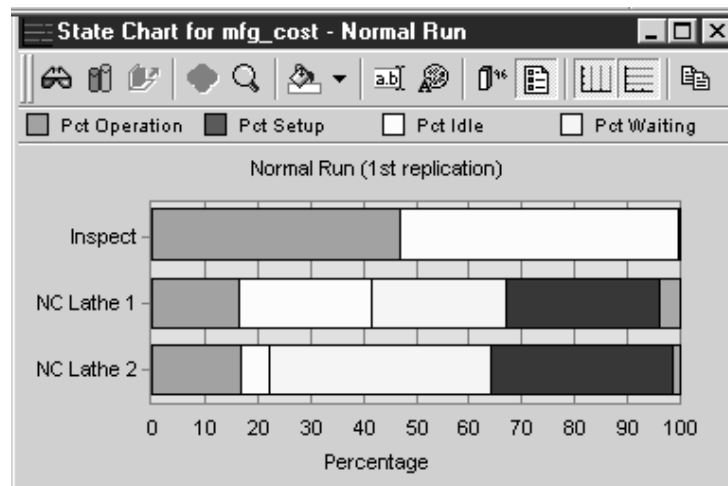


FIGURE L5.9

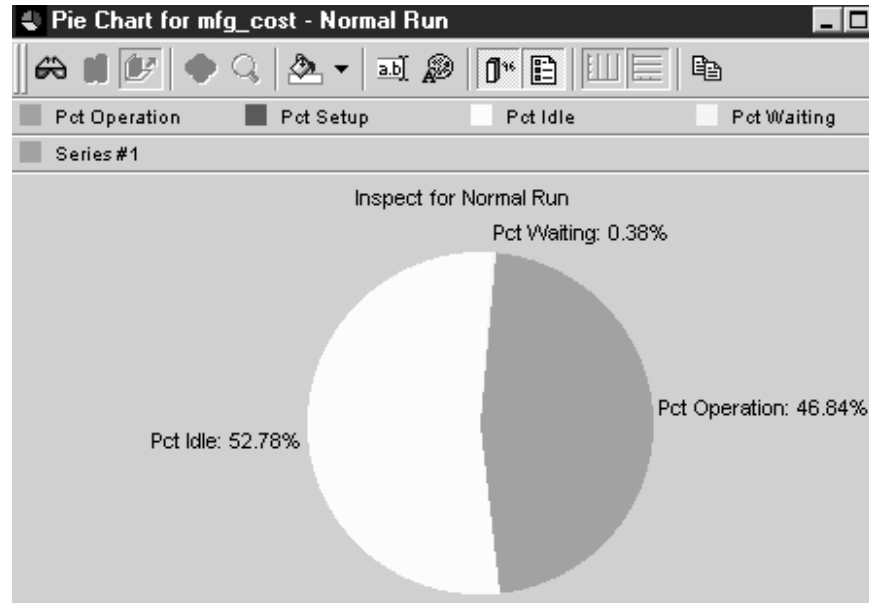
A state chart representation of all the locations' states.



- *Multiple Capacity Location Downtime*: Multiple Capacity Location Downtime graphs show the percentage of time that each multicapacity location in the system was down. A pie chart can be created for any one of the locations.
- *Resource Blocked in Travel*: Resource Blocked in Travel graphs show the percentage of time a resource was blocked. A resource is blocked if it is unable to move to a destination because the next path node along the route of travel was blocked (occupied).

**FIGURE L5.10**

A pie chart representing the states of the location *Inspect*.

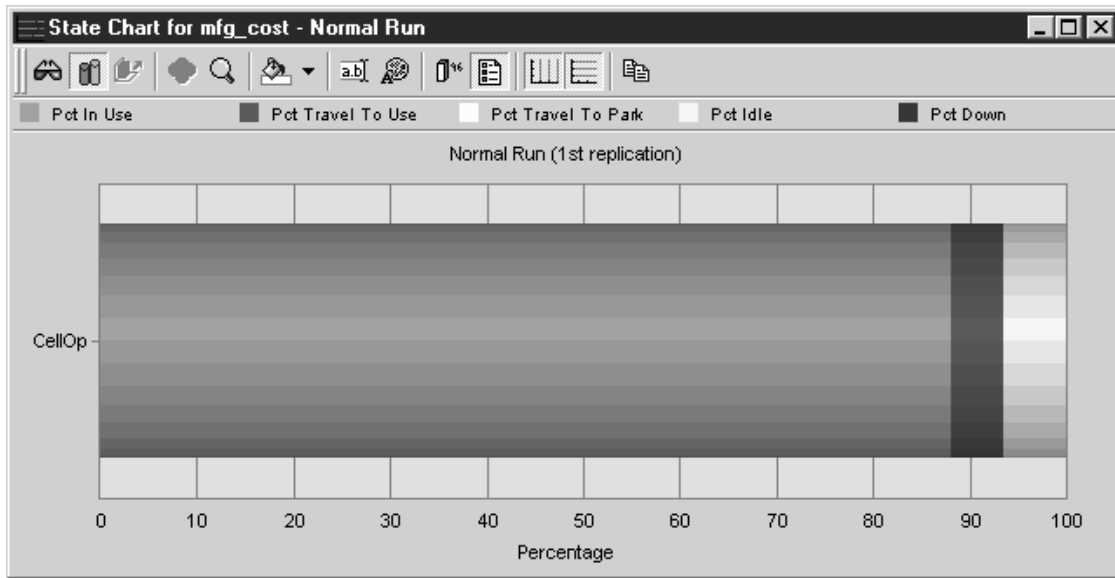


- *Resource Utilization:* Resource Utilization graphs show the percentage of time that each resource in the system was utilized. A resource is utilized when it is transporting or processing an entity or servicing a location or other resource. ProModel shows this information for all resources in the system at once.
- *Resource State:* The following information is contained in the report for each resource (Figure L5.11).

Resource Name	The name of the resource.
Scheduled Hours	The total number of hours the resource was scheduled to be available, which excludes off-shift time and scheduled downtime.
Pct. in Use	The percentage of time the resource spent transporting or processing an entity, or servicing a location or other resource.
Pct. Travel to Use	The percentage of time the resource spent traveling to a location or resource to transport, process, or service an entity, location, or resource. This also includes pickup and deposit time.
Pct. Travel to Park	The percentage of time the resource spent traveling to a path node to park.
Pct. Idle	The percentage of time the resource was available but not in use.
Pct. Down	The percentage of time the resource was unavailable due to unscheduled downtime.

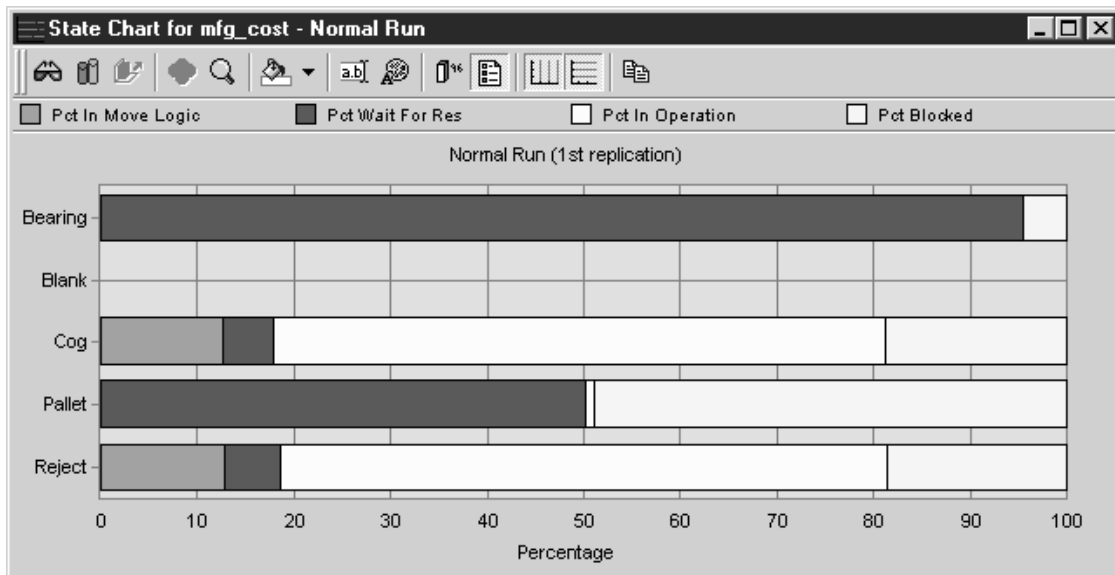
**FIGURE L5.11**

State chart for the Cell Operator resource states.



**FIGURE L5.12**

State chart representation of entity states.





- *Entity State*: The following information is given for each entity type (Figure L5.12)

Pct. in Move Logic	The percentage of time the entity spent traveling to the next location, either in or out of a queue or with a resource.
Pct. Wait for Res	The percentage of time the entity spent waiting for a resource or another entity to join, combine, or the like.
Pct. in Operation	The percentage of time the entity spent in processing at a location or traveling on a conveyor.
Pct. Blocked	The percentage of time the entity spent waiting for a freed destination.

#### L5.1.4 Histogram and Time Plot

Time series statistics can be collected for locations, entities, resources, and variables. By selecting one of the Time Series menu item choices, one can select the values to graph and the options to customize the appearance of the graph (Figure L5.13).

- *Time series histogram* (Figure L5.14): Selecting Edit from the Options menu displays the Graph Options dialog that lets you select time units, bar width, and other options to modify the look of the graph.
- *Time plots*: Time plots (Figure L5.15) give a different perspective from histograms. One can track global variables such as total work-in-process inventory, contents of a queue or location, and total items produced. Figure L5.15 is a time plot of the status of the work-in-process inventory over 900 minutes of simulation of the *mfg\_cost.mod* model in the Demo subdirectory. Figure L5.16 is a time plot of the contents of the Part\_Conveyor over about 515 minutes of simulation of the *pracmod.mod* model in the Training subdirectory.

Notice by clicking on the time-plot menu, there are actually three different types of values that can be plotted over time. One is Time-weighted values in which the values that are plotted are weighted by time. So if you want to display the contents of a location for each 15-minute interval of the simulation, it will plot the time-weighted average value for each 15-minute interval. The other two are Simple Values which takes a simple average when plotting by time interval, and Counts which plots the number of times a value changed per time interval.

- *Export plots/histograms*: When you plot one or more model elements using a plot or histogram, ProModel allows you to export these data to an Excel spreadsheet. When you export the plot or histogram data, ProModel creates a new spreadsheet and defines a new layer for each data element.

FIGURE L5.13

Dialog box for plotting a histogram.

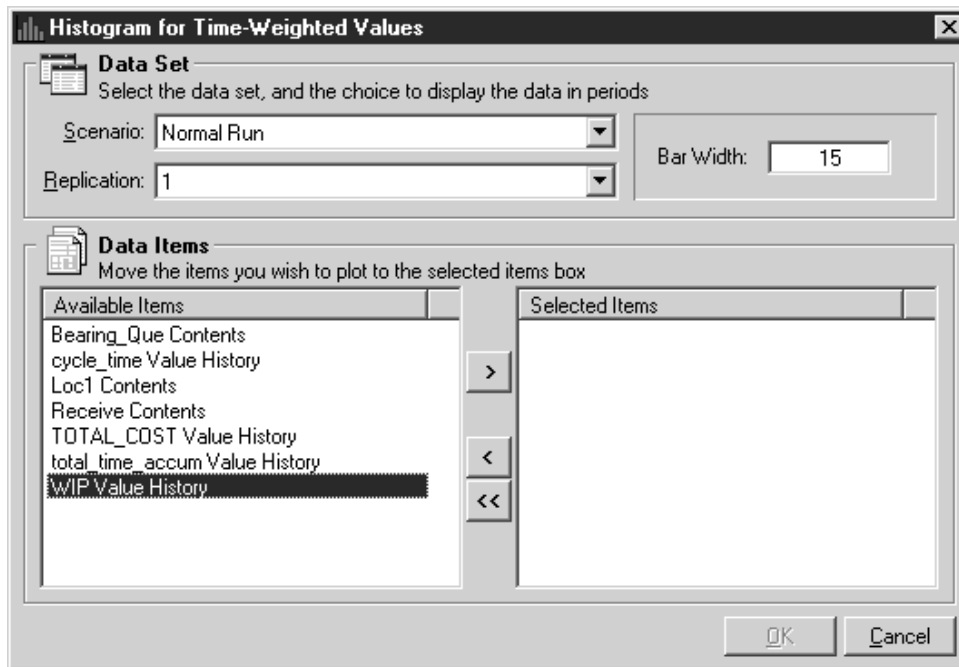


FIGURE L5.14

A time-weighted histogram of the contents of the Bearing Queue.

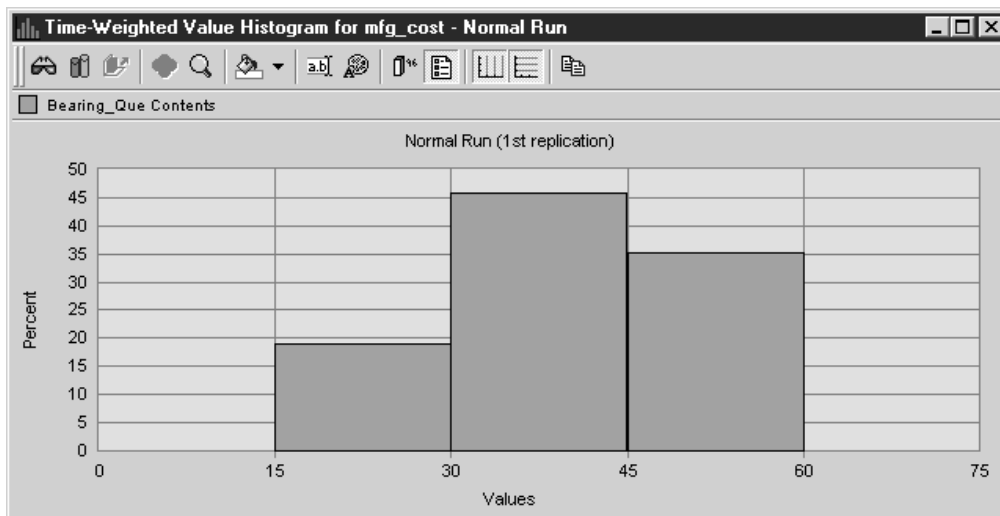


FIGURE L5.15

A time series plot of the Bearing Queue contents over time.

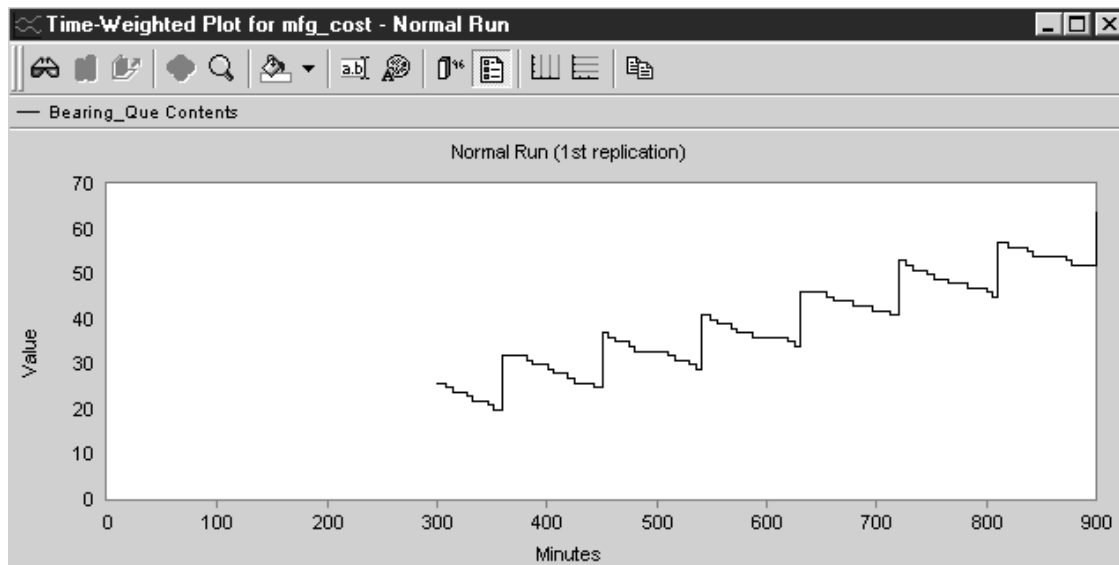
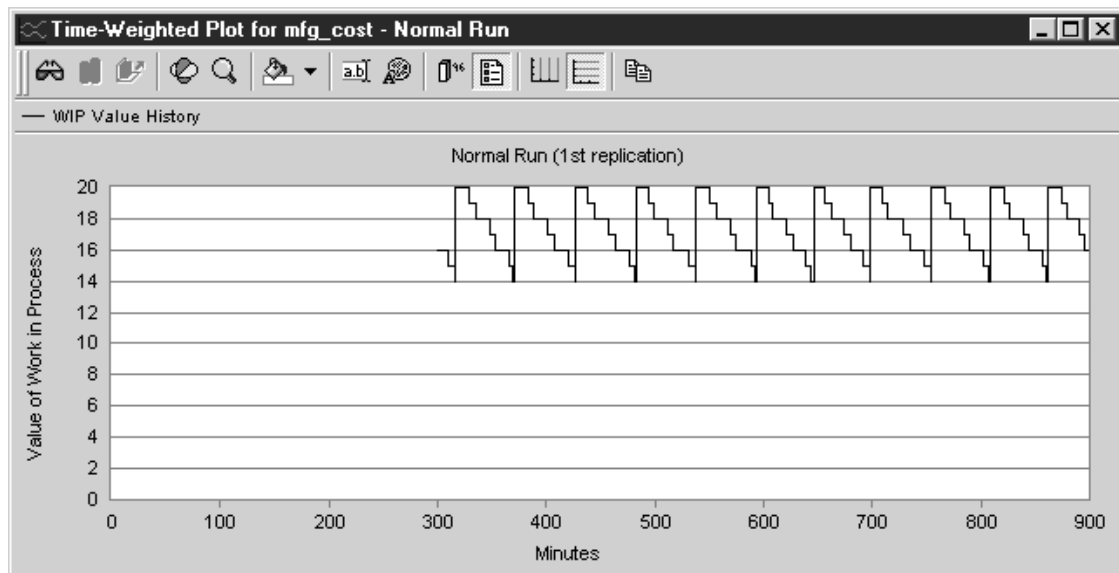


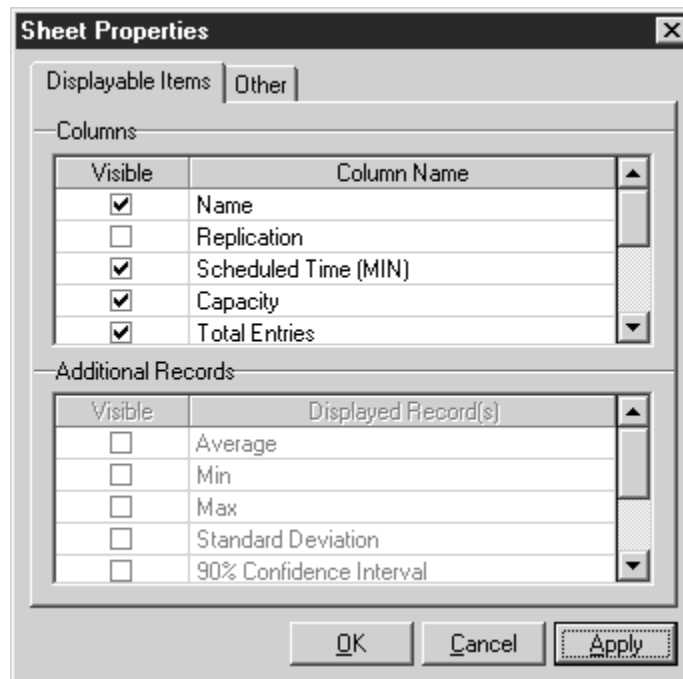
FIGURE L5.16

A time series plot of WIP.



**FIGURE L5.17**

*Sheet Properties menu  
in the Output Viewer.*



### L5.1.5 Sheet Properties

The Sheet Properties menu in the View menu allows the user to customize the columns in the report view (Figure L5.17). The headings and gridlines can be turned on and off. The font type, size, and color of the column headings can be selected here. The time unit of the columns with time values can be selected as seconds, minutes, hours, days, or weeks.

## L5.2 Classic View

The output view in the Classic mode for the example in Section L4.3 is shown in Figure L5.18. The View menu in the Classic output viewer consists of the following options (Figure L5.19):

- a. *General Stats*: Creates a general summary report. If there are only one scenario, one replication, and one report period, the report will be generated automatically.
- b. *Selected Stats*: The Selected Stats report allows you to create a replication, batch mean, or periodic report with only the specific statistics and elements you want in the report. The Selected Stats report is available only if there are multiple replications, periods, or batches.

Lab 5 ProModel's Output Module

**FIGURE L5.18**

The results of Poly Furniture Factory (with Oven) in Classic view.

```

General Report
Output from C:\My Documents\ProModelBook_New\Lab_L_3_E.MOD [Poly Furniture Fact
Date: May/07/2002   Time: 01:42:13 PM
-----
Scenario       : Normal Run
Replication    : 1 of 1
Simulation Time: 10 hr
-----

LOCATIONS

Location          Scheduled   Total      Average
Name              Hours      Capacity  Entries   Per Entry
-----
Receiving Dock    10         999999     61        188.04
Splitter Saw      10         1          22        26.27
Lathe             10         1          86        5.90
Paint Booth       10         10         85        4.80
Painted Log Store 10         1          81        0.0
Oven              10         10         84        20.00
Average Contents 19.11
Maximum Contents 39

LOCATION STATES BY PERCENTAGE (Multiple Capacity)

Location          Scheduled   % Partially  % Full  % Down
Name              Hours      Empty        Occupied
-----
Receiving Dock    10         1.67         98.33   0.0    0.0
Paint Booth       10         42.63        57.37   0.0    0.0
Oven              10         2.86         97.14   0.0    0.0

LOCATION STATES BY PERCENTAGE (Single Capacity/Tanks)

Location          Scheduled   % Operation  % Setup  % Idle  % Waiting  % Blocked  % Down
Name              Hours
-----
Splitter Saw      10         11.38        0.0     3.67    0.0     81.95    0.0
Lathe             10         81.57        0.0     15.43   0.0     0.0     0.0
Painted Log Store 10         0.0         0.0     100.00  0.0     0.0     0.0

FAILED ARRIVALS

Entity Location      Total
Name   Name             Failed
-----
Logs   Receiving Dock    0

ENTITY ACTIVITY

Entity          Total   Current   Average   Average   Average   Average   Average
Name           Exits  Quantity  Minutes  In Move   Wait For   Minutes  Minutes
-----
Logs           0      40        -         -         -         -         -
Piece          0      1         -         -         -         -         -
Rounds         0      1         -         -         -         -         -
Painted Logs   81     3        221.25   5.00     0.0     35.04   181.20

ENTITY STATES BY PERCENTAGE

Entity          % In Move  % Wait For  % In Operation  % Blocked
Name           Logic     Res, etc.
-----
Logs           -         -          -              -
Piece          -         -          -              -
Rounds         -         -          -              -
Painted Logs   2.26     0.0       15.84         81.90

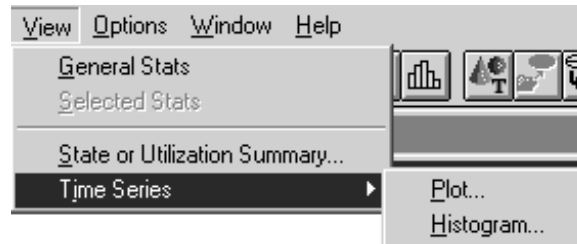
```

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**FIGURE L5.19**

View menu in the  
Classic output viewer.



- c. *State or Utilization Summary*: In ProModel, the state and utilization graphs produce an averaged state summary for multiple replications or batches.
- d. *Time Series Plot/Histogram*: In previous versions, time series plots and histograms were known as throughput, content, value, and duration plots and histograms. These charts can now be combined on one chart for improved comparisons. You must specify Time Series statistics for the desired model element to view this information.

The Options menu in the Classic output viewer allows the user to display the dialog box for various options pertaining to the current report or graphs. Also, the most recently viewed reports and graphs can be automatically opened.

### L5.2.1 Time Series Plot

The numbers of customers waiting for Barber Dan in Lab 4, Section L4.1, over the eight-hour simulation period are shown in Figure L5.20 as a time series plot. The number of customers waiting for a haircut varies between zero and one for the first hour. In the second hour, the number of customers waiting grows to as many as four. After dropping back to zero, the number of customers waiting grows again to as many as eight. However, it drops down to zero again toward the end of the day.

### L5.2.2 Time Series Histogram

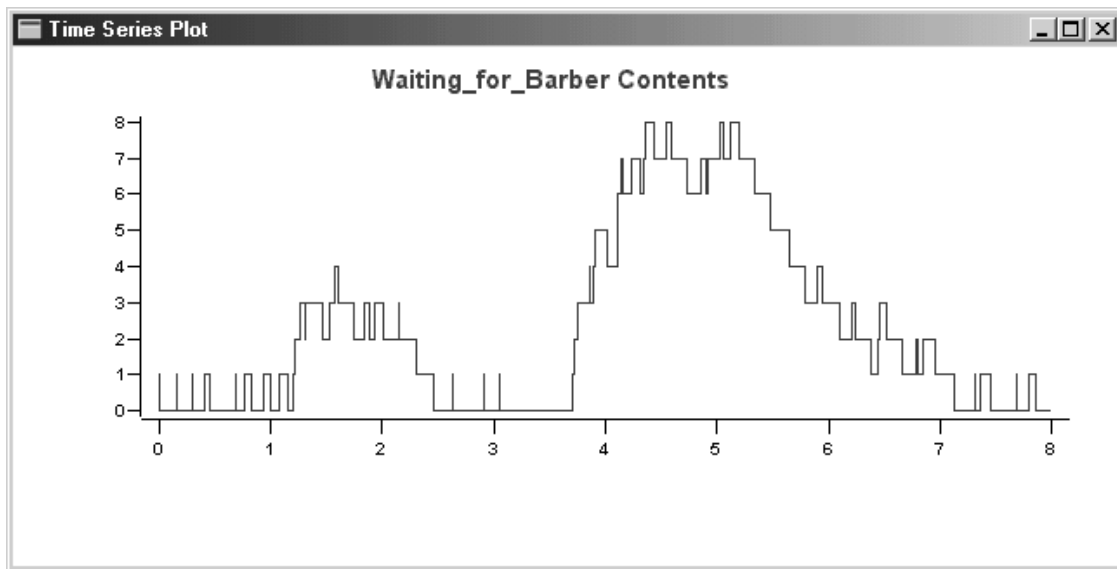
The number of customers waiting for a haircut at Fantastic Dan (Lab 4, Section L4.1) is shown in Figure L5.21 as a histogram. For about 63 percent of the time (simulation run time) the number of customers waiting varies from zero to three, and for 20 percent of the time this number varies from three to six. For about 17 percent of the time the number of customers waiting for haircuts varies from six to nine.

### L5.2.3 Location State Graphs

The utilization of all the locations at the Poly Furniture Factory in Lab 4, Section L4.3, with unit capacity is shown in Figure L5.22. The different location

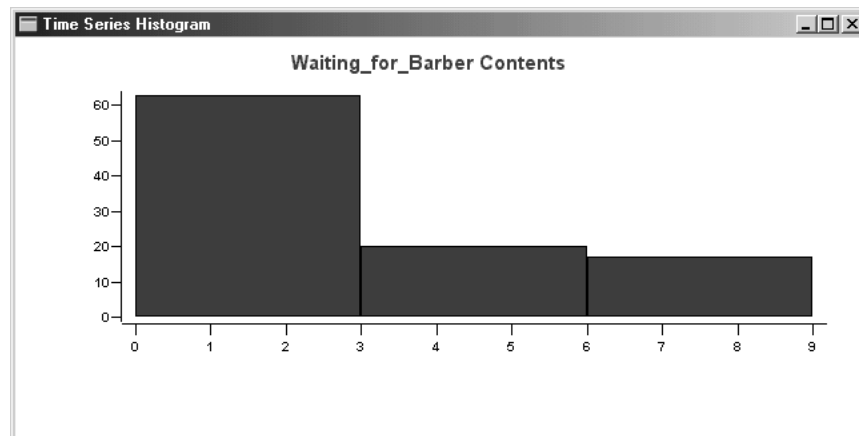
**FIGURE L5.20**

*Time series plot of customers waiting for Barber Dan.*



**FIGURE L5.21**

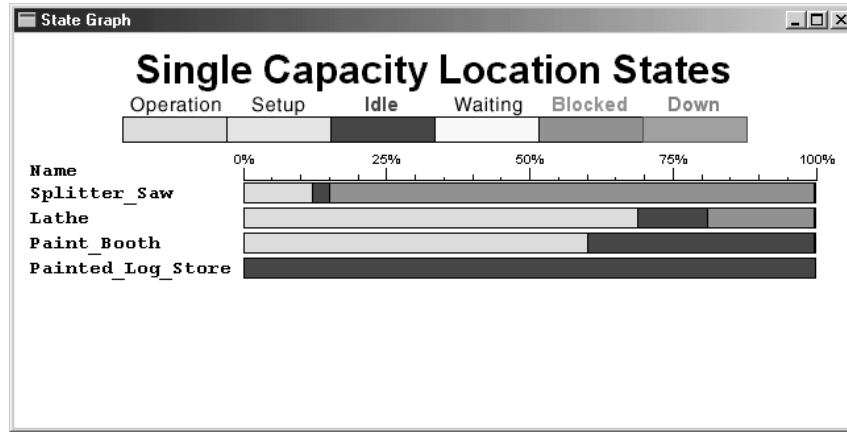
*Time series histogram of customers waiting for Barber Dan.*



states are Operation, Setup, Idle, Waiting, Blocked, and Down. The location states for the Splitter Saw are shown in Figure L5.23 as a pie graph. The utilization of multiple capacity locations at Poly Furniture Factory is shown in Figure L5.24. All the states the entity (Painted\_Logs) is in are shown in Figure L5.25 as a state graph and in Figure L5.26 as a pie chart. The different states are move, wait for resource, and operation.

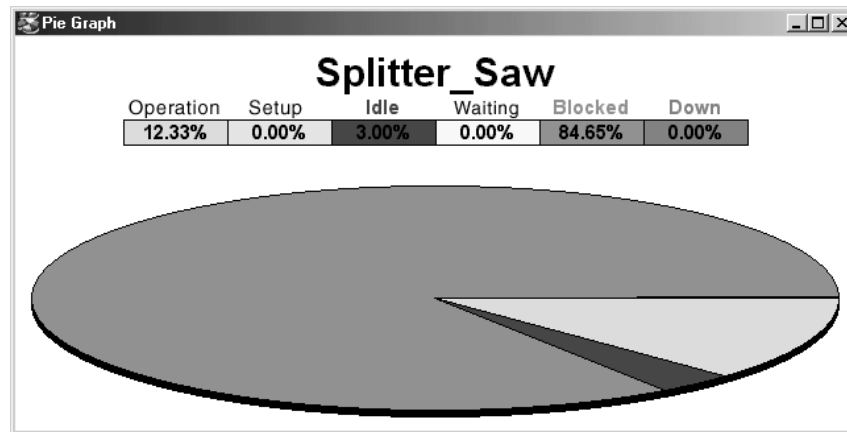
**FIGURE L5.22**

*State graphs for the utilization of single capacity locations.*



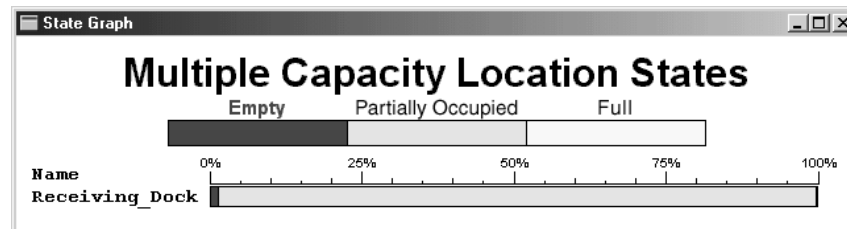
**FIGURE L5.23**

*Pie chart for the utilization of the Splitter Saw.*



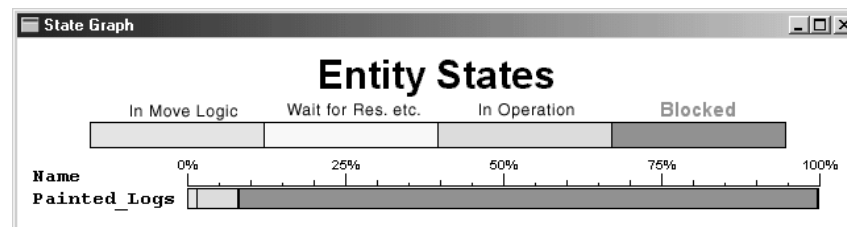
**FIGURE L5.24**

*State graphs for the utilization of multiple capacity locations.*



**FIGURE L5.25**

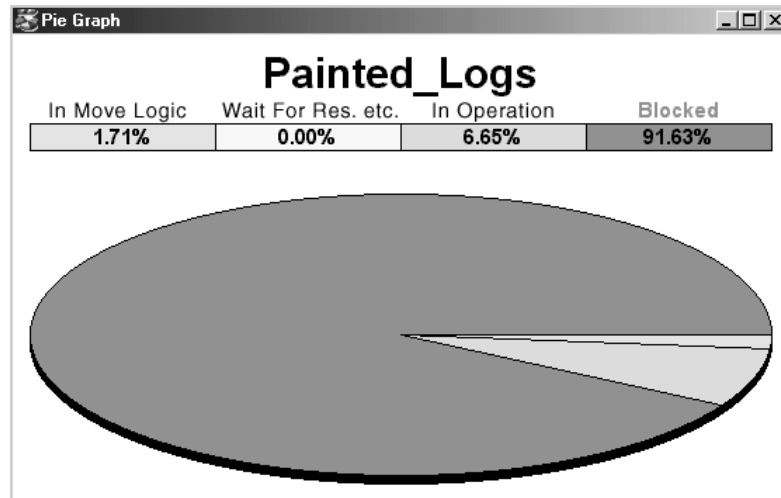
*Graph of the states of the entity Painted\_Logs.*





**FIGURE L5.26**

*Pie graph of the states of the entity Painted\_Logs.*



### L5.3 Exercises

1. Customers arrive at the Lake Gardens post office for buying stamps, mailing letters and packages, and so forth. The interarrival time is exponentially distributed with a mean of 2 minutes. The time to process each customer is normally distributed with a mean of 10 minutes and a standard deviation of 2 minutes.
  - a. Make a time series plot of the number of customers waiting in line at the post office in a typical eight-hour day.
  - b. How many postal clerks are needed at the counter so that there are no more than 15 customers waiting in line at the post office at any time? There is only one line serving all the postal clerks. Change the number of postal clerks until you find the optimum number.
2. The Lake Gardens postmaster in Exercise 1 wants to serve his customers well. She would like to see that the average time spent by a postal customer at the post office is no more than 15 mins. How many postal clerks should she hire?
3. For the Poly Furniture Factory example in Lab 4, Section L4.3,
  - a. Make a state graph and a pie graph for the splitter and the lathe.
  - b. Find the percentage of time the splitter and the lathe are idle.
4. For the Poly Furniture Factory example in Lab 4, Section L4.4,
  - a. Make histograms of the contents of the oven and the paint booth. Make sure the bar width is set equal to one. What information can you gather from these histograms?
  - b. Plot a pie chart for the various states of the entity Painted\_Logs. What percentage of time the Painted\_Logs are in operation?
  - c. Make a time series plot of the oven and the paint booth contents. How would you explain these plots?

5. For the Bank of USA ATM example in Lab 4, Section L4.2,
  - a. Plot a pie chart for the various states of the ATM customer.
  - b. What is the percentage of time the ATM customer is in process (using the ATM)?
6. Run the Tube Distribution Supply Chain example model (logistics.mod from the Demo subdirectory) for 40 hours. What are the various entities modeled in this example? What are the various operations and processes modeled in this example?  
Look at the results and find
  - a. The percentage utilization of the locations Mill and the Process Grades Threads.
  - b. The capacities of Inventory and Inventory 2–6. The maximum contents of Inventory and Inventory 2–6.
  - c. The idle time percent of the location Mill.
  - d. The percent utilization of the resources Transport 1–5 and Fork Lift 1–6.
  - e. What are the various states (in percentages) of the location Process Grades Threads?
7. Run the Warehouse model (deaerco.mod from the Demo subdirectory) for 100 hours. Run only Scenario 1. Go into the Simulation → Options menu and change the Run Hours from 10 to 100.
  - a. What are the average values of inventory of Inventory Aisle 1–12?
  - b. What is the average Time to Fill, Box, and Check?
  - c. What is the Average Time in System?
  - d. What are the cost of customer order, receiving order, and the sum total of cost per order?
  - e. What are the percentage idle times for Checker 1 and Checker 2?
  - f. What are the utilizations of Boxers 1–4 and the average utilization of all the Boxers?
8. Run the Aircraft Fuselage Mating example model (assembly.mod from the Student subdirectory) for 80 hours. Answer the following questions:
  - a. What are the utilizations of the Drill and the Cutter?
  - b. What percentage of time were the Paint, Assembly Jig Q, and Kitting Q fully occupied?
  - c. What is the percentage utilization of the Crane?
  - d. What is the average time a Fuselage spends in the system?