Chapter 2 Overview

CHAPTER CONTENTS

2.1 Welcome to ProModel

ProModel is a powerful, Windows-based simulation tool for simulating and analyzing production systems of all types and sizes. ProModel provides the perfect combination of ease-of-use and complete flexibility and power for modeling nearly any situation, and its realistic animation capabilities makes simulation come to life.

ProModel provides engineers and managers the opportunity to test new ideas for system design or improvement before committing the time and resources necessary to build or alter the actual system. ProModel focuses on issues such as resource utilization, production capacity, productivity, and inventory levels. By modeling the important elements of a production system such as resource utilization, system capacity, and production schedules, you can experiment with different operating strategies and designs to achieve the best results.

As a discrete event simulator, ProModel is intended primarily for modeling discrete part manufacturing systems, although process industries can be modeled by converting bulk material into discrete units such as gallons or barrels. In addition, ProModel is designed to model systems where system events occur mainly at definite points in time. Time resolution is controllable and ranges from .01 hours to .00001 seconds.

Typical applications for using ProModel include:

- **Assembly lines**
- **Transfer lines**
- **Flexible Manufacturing systems**
- **Job Shops**
- **JIT and KANBAN systems**
- **Supply chains & logistics**

Use of ProModel requires only a brief orientation and virtually no programming skills. With ProModel's convenient modeling constructs and graphical user interface, model building is quick and easy. All you do is define how your particular system operates, mostly through part flow and operation logic. Automatic error and consistency checking help ensure that each model is complete prior to simulation. During simulation, an animated representation of the system appears on the screen. After the simulation, performance measures such as resource utilization, productivity and inventory levels are tabulated and may be graphed for evaluation

2.1.1 Where to Go From Here

The first step is to install the software. The Setup and Installation section guides you through the steps necessary to install the software on a stand-alone PC.

In order to use ProModel effectively, you must understand the basics of the Microsoft Windows operating environment. If you are unfamiliar with Windows you should begin by reviewing the help information. To do this, select Help from the Start menu. If you are an accomplished Windows user, you can start immediately. However, you may wish to read through the rest of this chapter (Chapter 1) and Chapter 2 (*Getting Started*).

Although the documentation is self contained, first-time users are *strongly* encouraged to seek formal training at some point before embarking on a complex modeling project. PROMODEL Corporation holds training courses on a regular basis for beginning and advanced users of PROMODEL simulation products. For details on course dates and times, or to register for the course nearest you, call our main office at (801) 223-4600 and ask for the ProModel Product Team.

2.2 What's New in ProModel

This section briefly describes additions and changes made in this release.

New & Modified Features

- Dynamic Plots
- Tank Logic Builder
- Save as Excel
- Import Spreadsheets to Arrays
- Export Arrays to Spreadsheets
- Export Plot & Histogram Data to Excel
- Model Packaging & Data Protection
- SimRunner
- ActiveX Objects

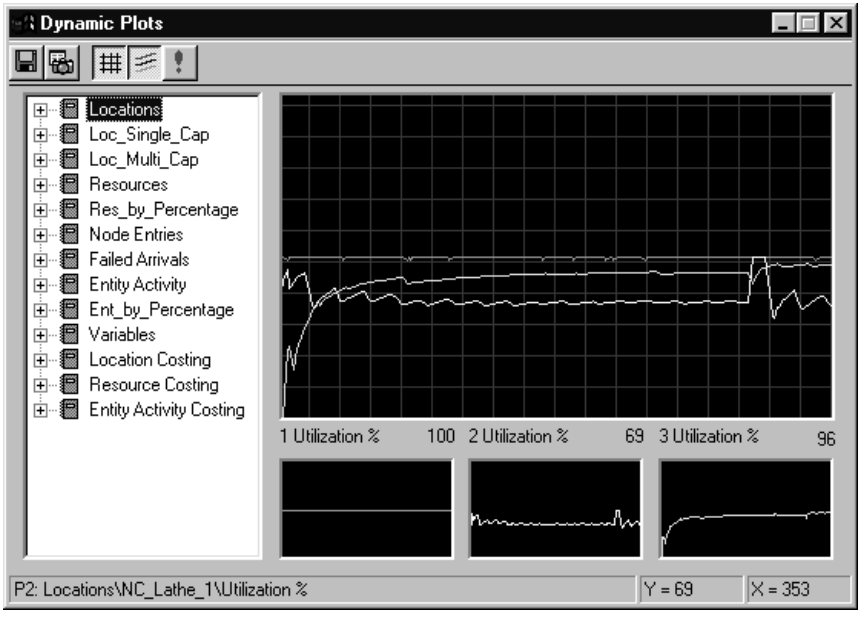
New & Modified Statements and Functions

- Tank_GoDownSched

2.2.1 New & Modified Features

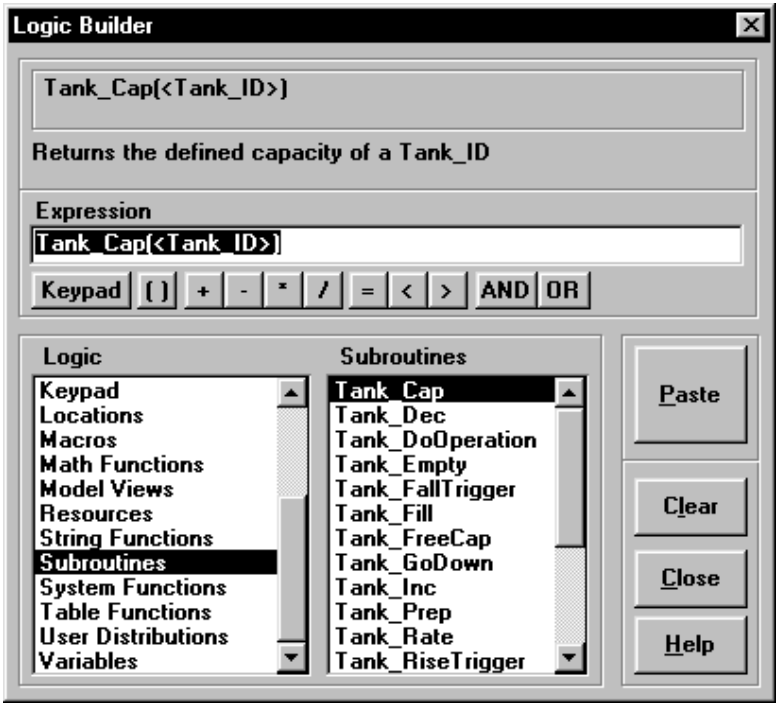
Dynamic Plots

Dynamic plots enable you to graphically observe and record statistical information about the performance of model elements during run time. See *Dynamic Plots* on page 599 for more information.



Tank Logic Builder

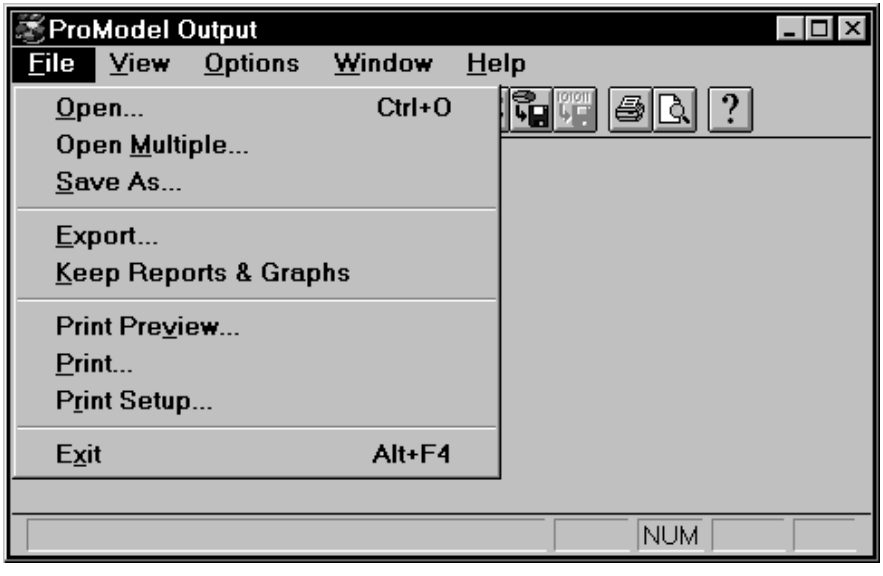
An expanded capability within ProModel, the *tank* logic builder provides you with what you need to model complex tank and fluid system operations. The logic builder contains all available tank subroutines and provides you with a description of the components required to use each subroutine. See *Tanks* on page 357, and *Logic Builder* on page 489 for more information.



Import & Export Data

Save as Excel

After you simulate your model, ProModel prompts you to launch the Output program to allow you to examine the model data. After you view the model data, the newly expanded Save As feature allows you to save a copy of the data to an Excel spreadsheet—ProModel divides the data by category into separate sheets.



Import Spreadsheets to Arrays

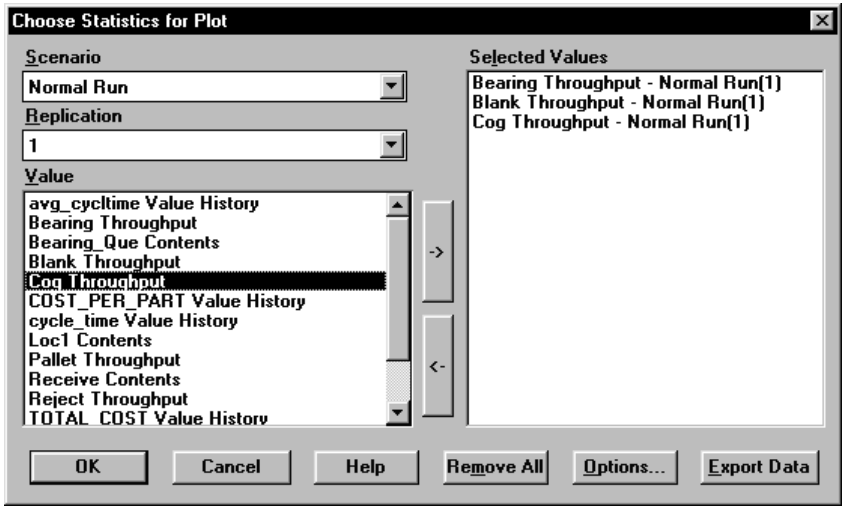
Loads a user-specified portion of an Excel spreadsheet into a two-dimensional array.

Export Arrays to Spreadsheets

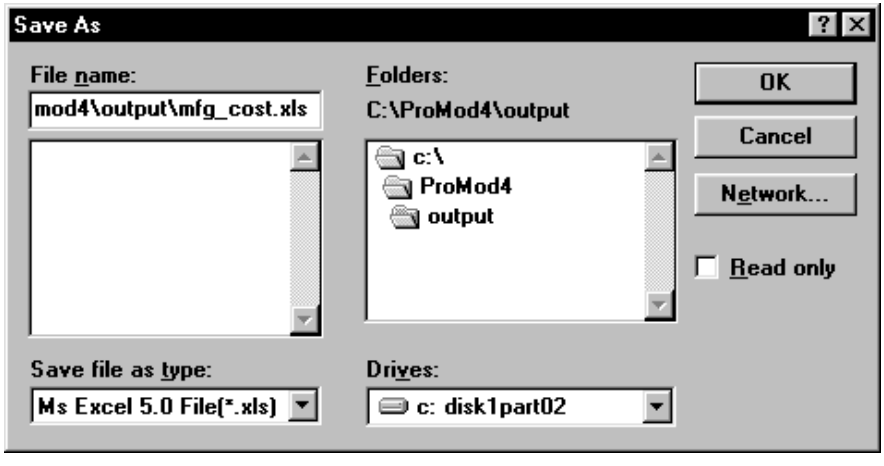
Saves the contents of a two-dimensional array to a user-specified position within an excel spreadsheet.

Export Plot & Histogram Data to Excel

When you select view time series plot or histogram from the output program, ProModel displays the following dialog. From this dialog you may select the model results you wish to graph, then graph them or export the data. (Time Series graphs are available only when you perform a single replication.) See *Time Series Plots & Graphs* on page 649.



When you plot one ore more model elements using a plot or histogram, ProModel allows you to export this 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.



Packaging & Protecting Models

Model Packaging is a powerful tool that allows you to distribute copies of your model for others to examine and review, yet maintain the integrity of the model data. When you create a model package, ProModel builds an archive of several files and allows you to distribute only those files you wish model recipients to access. For further security, you may apply Data Protection to prevent others from viewing or editing data from your model.

When you install and run a model package that uses data protection, you *cannot* view dynamic plots. Additionally, the Build and Edit menus, along with several run-time menu options, are disabled.

Create Model Package Copies the current model and its associated files to a specific directory or disk as <*model name*>.PKG.

Install Model Package Copies the files in a *.PKG file to the destination directory you wish to use.

SimRunner

SimRunner takes your existing ProModel simulation models, evaluates them *for you*, then performs tests to find better ways to achieve the results you desire. Typically, most people use simulation tools to predict and improve a system's performance by modeling the actual location (e.g., a plant floor, a bank lobby, or emergency room) or abstract process (i.e., a logical process). Through testing various "what-if" scenarios, SimRunner can help you determine the most ideal way to conduct operations—we call this *optimization*.

When you conduct an analysis using SimRunner, you build and run *projects*. With each project, SimRunner runs sophisticated optimization algorithms on your model to help you optimize multiple factors simultaneously. For each project, you will need to provide SimRunner with a model to analyze or optimize, identify which input factors to change, and define how to measure system performance using an objective function. SimRunner can conduct two types of tests: Pre-Analysis (Statistical Advantage) and Simulation Optimization.

SimRunner is an add-on capability for PROMODEL simulation software. To activate the full functionality of SimRunner, you must purchase the ProModel *Optimization Suite* and replace the standard ProModel key with a ProModel/SimRunner key. To upgrade to the full ProModel Optimization Suite (ProModel plus SimRunner), please contact:

ProModel Sales and Support Team
Phone (888) PRO-MODEL
Fax (801) 226-6046

Note The version of SimRunner included with ProModel is an evaluation version only. The evaluation version allows *factorial analysis* of two factors or *optimization* of one factor (i.e., a ProModel macro).

SimRunner Benefits

Using SimRunner will help you find *accurate* solutions for your modeling needs. No longer must you sit and experiment with what you think might work, only to find that your solution actually *interferes* with productivity in other parts of the model. SimRunner will help you locate true solutions by monitoring how changes affect each part of the model. In other words, SimRunner will *not* let you improve one area of your model at the expense of another—the results you get are beneficial to the *entire* model.

Starting a New Project

The following describes how to start and prepare a project for analysis. Remember that you must create and validate your model *prior* to analyzing or optimizing it in SimRunner.

How To **Select a model:**

1. Click the **New** button on the button bar or select **New Project** from the **File** menu.
2. From the Open dialog, select the model file you wish to use.
3. Click **OK**.
4. Once you select a model, the model's name will appear in the Project Information dialog.

How To **Define the input factors:**

1. Click on the **Inputs** button.
2. To select input variables, click next to each variable in the **Selected** column. SimRunner will mark the selected items.

Note SimRunner will optimize only single value RTI macros.

How To Define the objective function (output variables):

1. Click the **Outputs** button.
2. In the Objective Function Setup dialog, select the category of the item(s) you wish to minimize or maximize.
3. Highlight an item in the list.
4. Select **Maximize**, **Minimize**, or **Custom** to select the type of optimization you wish to use for the variable.
5. Enter the **Weighting**. This number represents the importance of Maximizing or Minimizing the item. (The higher the number, the higher the importance.)
6. After you set the values for the item, click the right arrow to place the item in the selected list. To remove an item from the selected list, select the item and click the left arrow. (Alternatively, you may double click on an item to add it to or remove it from the list of selected variables.)

Stage one: Pre-Analysis

With the model built, the input factors selected, and an objective function defined, you are ready to conduct a Pre-Analysis. Also known as Statistical Advantage, the Pre-Analysis runs several tests to identify the initial bias (warm-up period), determine appropriate run-length to reach steady-state, find the number of replications necessary to ensure that each event occurs at least once, and locate the model averages.

Stage two: Simulation Optimization

Simulation Optimization is a multi-variable optimization that tries different combinations of input factors to arrive at the combination that provides the best objective function (output) value. Depending on the number of selected input factors and the complexity of the solution space, this process can take a long or short time. Optimizations with many factors and complex solutions take longer to run.

How To Run an optimization:

1. Click on the **Optimize!** button or select **Start Optimization** from the **Project** menu.
2. Click **Play** on the dashboard to begin.

ActiveX Objects

ProModel's ActiveX Automation capability allows you to externally create, view, and edit model elements such as locations, entities, and variables. Using Visual Basic (or any other ActiveX-enabled language), you can add capabilities to ProModel including:

- Customized user interface with table inputs
- Custom-designed parameter screens
- Automatic model creation from external data sources (e.g., Excel spreadsheets, databases, or ASCII text files)
- Software execution from another application

You can also use ProModel's ActiveX capability to access any of the following actions and tables (any table not mentioned in the following list is not currently ActiveX enabled).

Program Operations

- Start program
- Quit program
- Pause simulation model
- Query status of model (e.g., running, paused, etc.)
- Enter Run-time Interface parameters from external data source
- Access any data field provided in output database

Location Table

- Name
- Capacity
- Units
- Stats
- Incoming selection rule
- Incoming rule, max attribute
- Incoming rule, min attribute
- Queuing for Output rule
- Queuing rule, max attribute
- Queuing rule, min attribute
- Multi-unit selection rule
- Notes
- Operation rate (cost)
- Time units (cost)

Clock Downtime Subtable

- Frequency
- First time
- Priority
- Scheduled
- Logic
- Disable

Entry Downtime Subtable

- Frequency
- First time
- Logic
- Disable

Usage Downtime Subtable

- Frequency
- First time
- Priority
- Logic
- Disable

Setup Downtime Subtable

- Entity
- Prior entity
- Logic
- Disable

Entity Table

- Name
- Speed
- Stats
- Notes
- Initial cost

Resource Table

- Name
- Units
- Stats
- Resource search rule
- Entity search rule
- Entity search, min attribute
- Entity search, max attribute
- Speed empty
- Speed full
- Acceleration
- Deceleration
- Pickup time
- Drop-off time
- Return home flag
- Notes
- Network
- Home node
- Shift node
- Break node
- Operation rate (cost)
- Time units (cost)
- Cost per use

Clock Downtime Subtable

- Frequency
- First time
- Priority
- Scheduled
- List
- Node
- Logic
- Disable

Usage Downtime Subtable

- Frequency
- First time
- Priority
- List
- Node
- Logic
- Disable

Processing & Routing Tables

- Entity name
- Preemption process flag
- Location name
- Operation logic
- Routing block number
- Output entity name
- Destination name
- Destination priority
- Begin new block flag
- New entity check box
- Output quantity
- Output rule
- Output probability
- Output user condition
- Move logic

Path Networks Table

- Color
- Visible
- Name
- Type
- Basis (time or speed)

Path Segments Subtable

- From
- To
- Bi-directional
- Time

Interfaces Subtable

- Node
- Location

Mappings Subtable

- From node
- To node
- Destinations

Nodes Subtable

- Coordinates
- Name
- Capacity

Arrivals Table

- Entity name
- Location name
- Quantity of each arrival
- Qty each (cycle table name)
- First time
- Number of occurrences
- Frequency of arrivals
- Arrival logic
- Disable flag

Shift Assignments

- Locations
- Resources
- Units
- Shift files
- Start time
- Priorities
- Logic
- Disable

Scenarios

- Name
- Enabled

Model Parameters

Parameter Subtable

- Value

Attribute Table

- Attribute name
- Type
- Classification (entity or location)
- Notes

Variables Table

- Variable name
- Type
- Initial value
- Stats
- Stats basis
- Notes

Macro Table

- Identification (name)
- Text
- Resource grouping

Subroutine Table

- Subroutine name
- Operation logic

User Distributions

- Distribution name
- Type
- Cumulative
- Percentage
- Value

External Files Table

- Filename
- File type
- Path
- Prompt
- Notes

General Information Dialog

- Model title
- Default time units
- Default distance units
- Graphics library file name
- Initialization logic
- Termination logic
- Model notes

Simulation Options Dialog

- Output path
- Run length type
- Warm-up period flag

Time Only

- Warm-up hours (time only)
- Run hours

Weekly

- Warm-up start (day, hr, min)
- Simulation begin (day, hr, min)
- Simulation end (day, hr, min)

Calendar Date

- Warm-up start (month, day, year, hour, minute)
- Simulation begin (month, day, year, hour, minute)
- Simulation end (month, day, year, hour, minute)
- Output report method
- Output report interval length
- Number of replications
- Clock precision
- Clock units
- Disable time series flag
- Disable animation flag
- Disable costing flag
- Pause at start flag
- Display notes flag

For detailed information regarding ActiveX objects and methods, contact:

ProModel Sales and Support Team
Phone (888) PRO-MODEL
Fax (801) 226-6046

2.2.2 New & Modified Statements and Functions

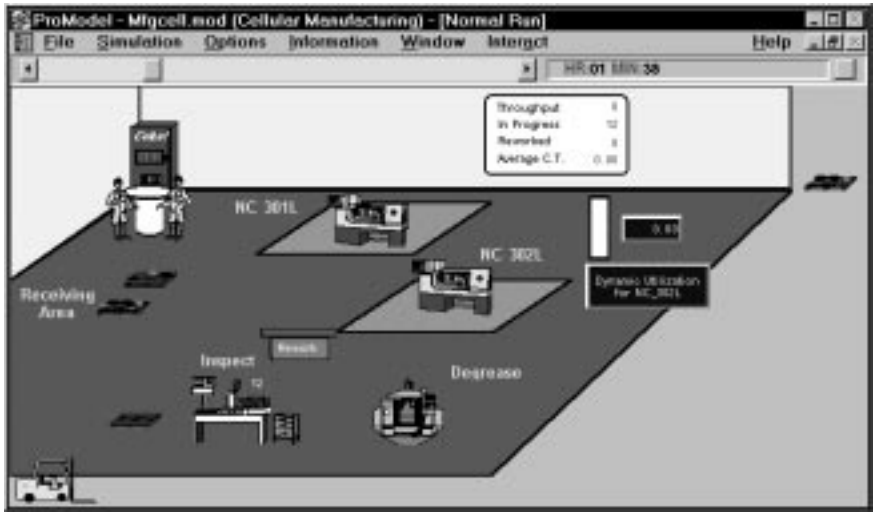
Tank

TANK_GODOWNSCHED Sets the state of the tank to Tank_Down, waits for the specified scheduled downtime, then sets the tank state back to its *previous* setting. Use Tank_GoDownSched to shut down a tank for a scheduled task or event (e.g., interim maintenance or end of scheduled workday). Since the tank uses a *scheduled* downtime, the time lapsed during the event does not record as a downtime.

2.3 Using ProModel

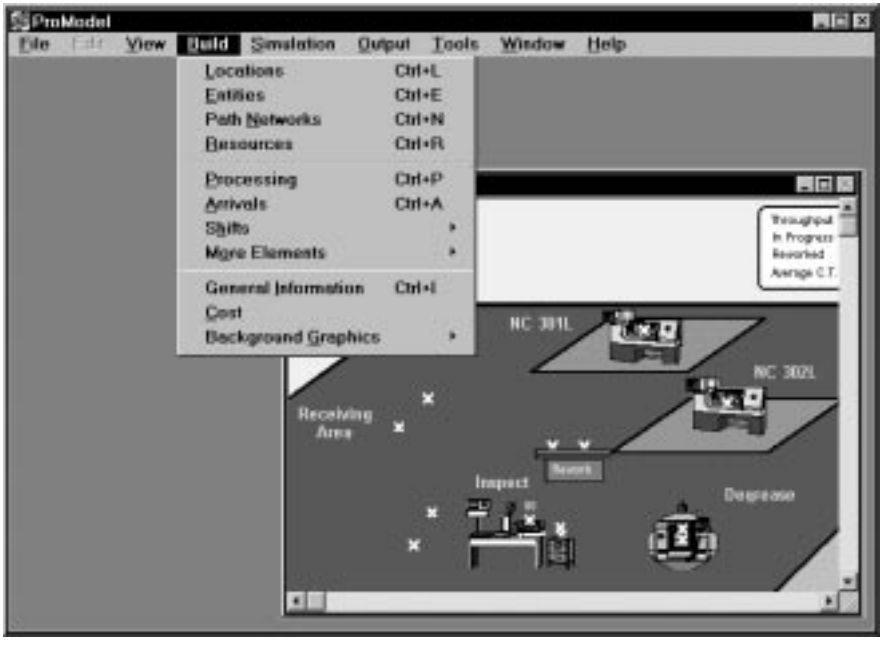
ProModel views a production system as an arrangement of processing locations, such as machines or work stations, through which parts (or entities) are processed according to some processing logic. A system may also include paths, such as aisle-ways for movement, as well as supporting resources, such as operators and material handling equipment used in the processing and movement of parts.

The example below depicts a typical manufacturing workcell with six processing locations (Receiving, NC_301L, NC_302L, Degrease, Inspect, Rework), two entity types (Pallets and Blanks), two operators, and one transporting device (forklift). Models such as this are developed rapidly and easily using ProModel's graphical user interface and point-and-click approach to modeling.



2.3.1 Building Models

Models are created by completing the necessary build modules selected from the Build menu. Each module consists of various edit tables and dialog boxes used to supply model information. A layout window also appears with graphical tools for placing locations, path networks and other modeling elements.

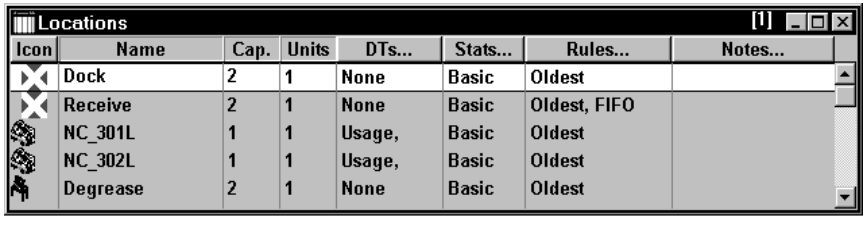


Modules may be completed in any order and with any amount of switching back and forth between modules. However, it is recommended that modules be completed in the general order in which they appear in the menu. For example, it is usually best to lay out the locations and define the parts to be processed before actually defining the processing logic, since processing logic describes the flow of parts from location to location and the operations performed on parts at each location.

Beginning users may wish to use the AutoBuild feature, which automatically opens the build modules in the most logical sequence based on the selected model elements. See *Using the AutoBuild Feature* on page 105 for more information on AutoBuild.

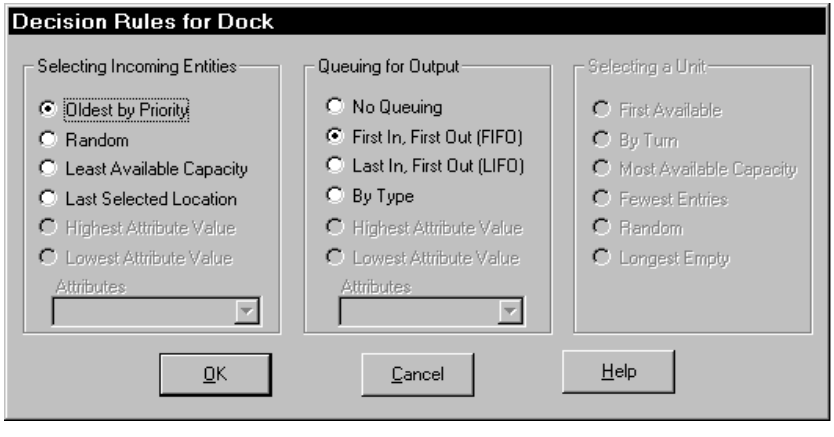
Edit Tables

Edit tables, such as the Locations table shown below, are used extensively throughout ProModel for defining model elements. Edit tables provide direct access to model data, without wading though several levels of dialog boxes. Each table consists of records, which consist of fields describing some aspect of the element. Many of these fields have heading buttons which, when clicked on with the mouse (or by selecting the column and pressing F2), open a dialog box for further definition of the particular element.



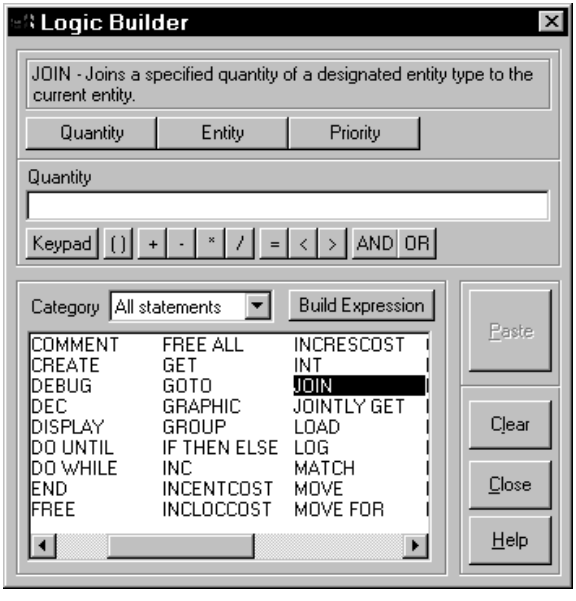
Dialog Boxes

Dialog boxes are used throughout ProModel primarily for selecting options. The Decision Rules dialog shown below contains additional information regarding a location called **Receive**.



Logic Builder

The Logic Builder in ProModel provides a quick and powerful way to create valid statements and expressions in logic windows or fields. It takes you through the process of creating statements or expressions, as well as providing point-and-click access to every element defined in your model. The Logic Builder handles the syntax of every statement and function, allowing you to define logic by simply filling in the blanks.



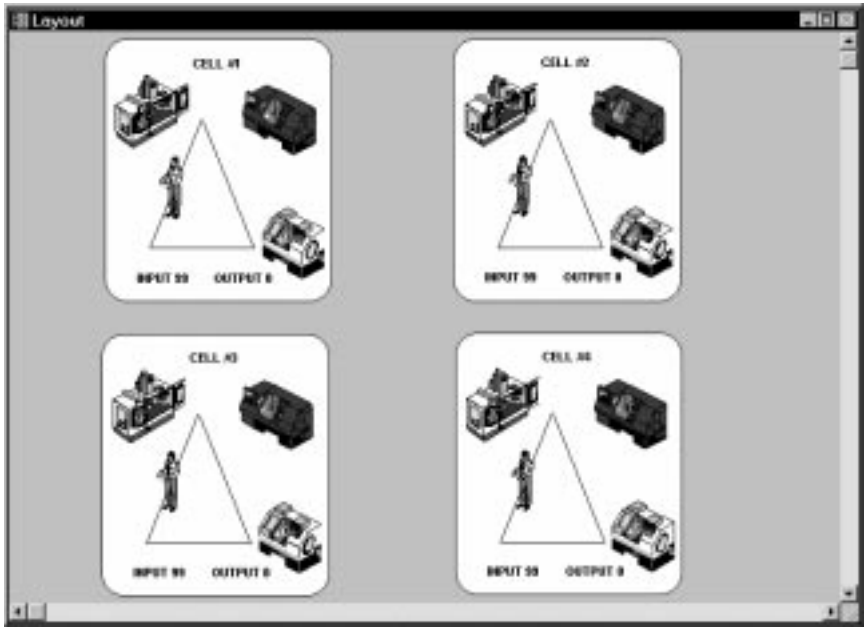
To access the Logic Builder, click the right mouse button in any edit box which accepts an expression or anywhere inside an open logic window. You may also click the *Build* button on the logic window's toolbar.

Model Merging and Use of Submodels

Another extremely useful feature in ProModel is the ability to merge two or more models together into one larger model. This supports the concept of modular model building, where models are created and tested in modules, and then joined together to produce a final model.

The use of submodels further allows you to build common model elements such as workcells and place them repeatedly in a model. The elements of each submodel (i.e., locations, entities, resources, etc.) may all be given a common prefix or suffix to differentiate them from the same elements of another submodel.

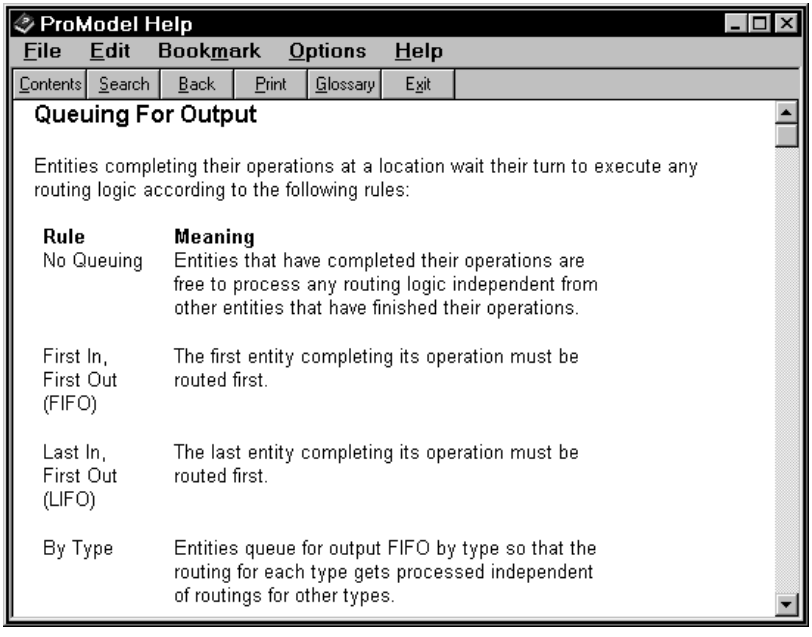
The model below contains four identical workcells. Each cell consists of an input queue, two mills, one degrease machine and an output queue. Instead of defining each of the workcells independently, a submodel was created consisting of the workcell elements. This submodel was then merged into the main model four times.



For more information on merging models, see *Model Merging* on page 149.

On-Line Help

Regardless of where you are in the model building process, ProModel's on-line help system is available to provide context specific definitions and instructions. The help system can even run in the background, allowing instant access to help whenever you need it.

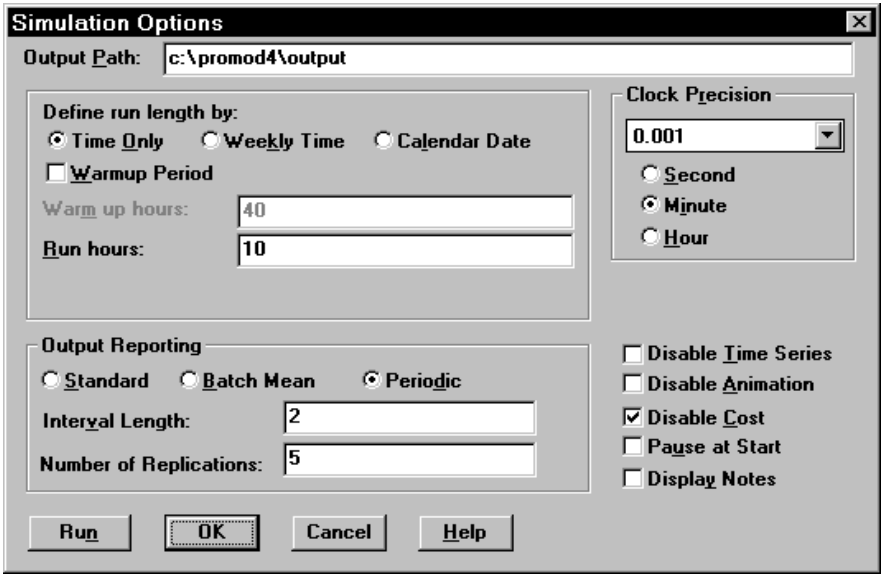


The help screen above was opened by clicking on the Help button from the Decision Rules dialog box in the Locations edit table, and selecting “Queuing For Output.” Like all Windows applications, you can locate the help you need quickly using the standard help tools: Contents, Search, Back, and Glossary. You can also place bookmarks in commonly referenced help screens.

2.3.2 Running Models

Completed models are run using the Simulation menu. Model data is automatically checked for consistency and completeness before each simulation begins.

As shown in the dialog below, ProModel allows you to specify a run length, warm-up period, number of replications, and other special options before running a simulation. In addition, you may run the models with or without animation. For more information on running models, see *Selecting Model Options* on page 177.



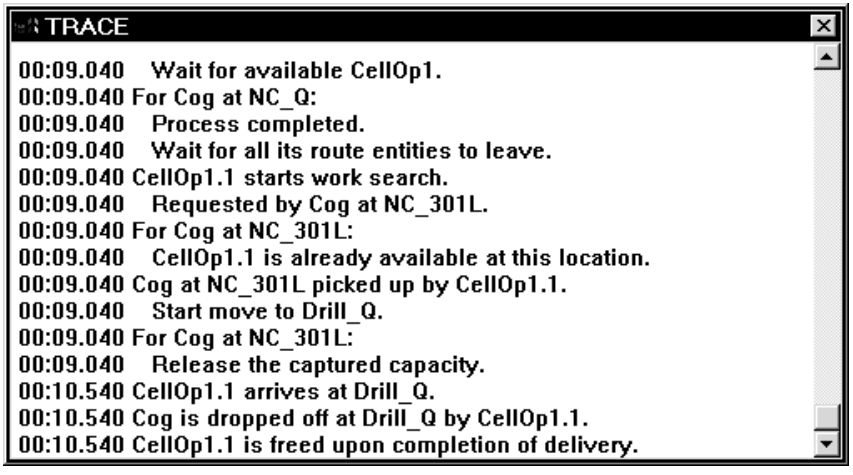
2.3.3 Creating Run-Time Models

One of the most powerful features of ProModel is the ability to create models to be run by others who do not own the full software. PROMODEL allows you to install the software on any machine to run a model. However, without the security key, the user has limited ability to build or make changes to a model.

You may wish to develop run-time models to allow the user to perform “what-if” analyses with the models. PROMODEL encourages you to develop demonstration models, and allows you to distribute them freely. These models can be run by installing ProModel from the CD-Rom onto a computer without a security key.

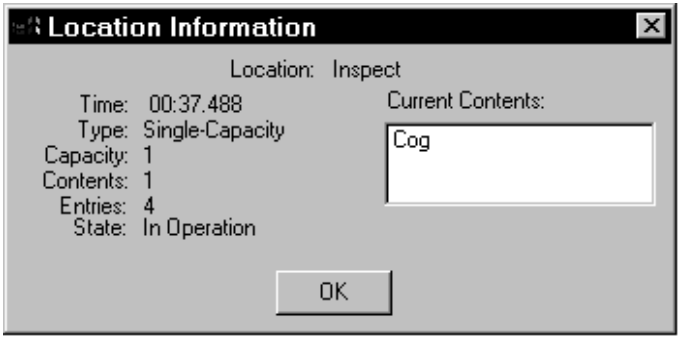
2.3.4 Trace Window

Several tools are available to help you verify and validate your models. During model execution you may trace the activity of the simulation events to see exactly what is happening in the model. The example below shows a brief portion of a trace window.



2.3.5 Location Information Windows

In addition to trace files, you may track the activity at any location through a Location Information window. This feature gives up-to-the-minute information about a selected location, such as current contents, total entries, and operational state (i.e., idle, blocked, in operation, etc.).

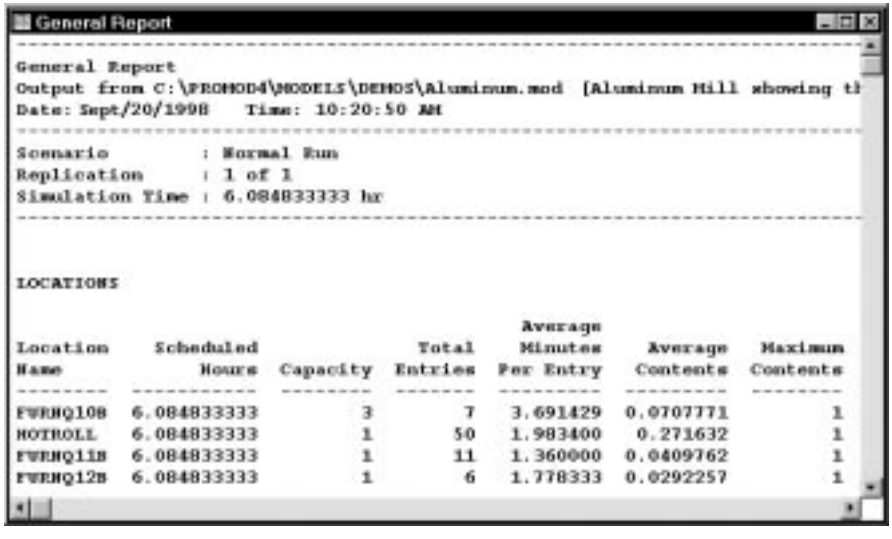


2.3.6 Viewing Output

ProModel's output generator gathers statistics on each location, entity, resource, path network, and variable in the system. You may, however, turn off reporting capability for any element you do not wish to include. The default level of statistics is at the summary level (e.g., average values, % values, final values), although detailed history plots can be gathered on such things as utilization, queue fluctuations and variable values. For more information about viewing the results of a simulation, see *Creating Reports* on page 631.

Simulation results may be presented in either tabular or graphic format, including histograms, pie charts, plots and bar graphs. Multiple output results can even be compared on the same chart.

The example below shows a portion of a general report for a single run of the model.



General Report

General Report
Output from C:\PROMOD4\MODELS\DEMOS\Aluminum.mod [Aluminum Mill showing th
Date: Sept/20/1998 Time: 10:20:50 AM

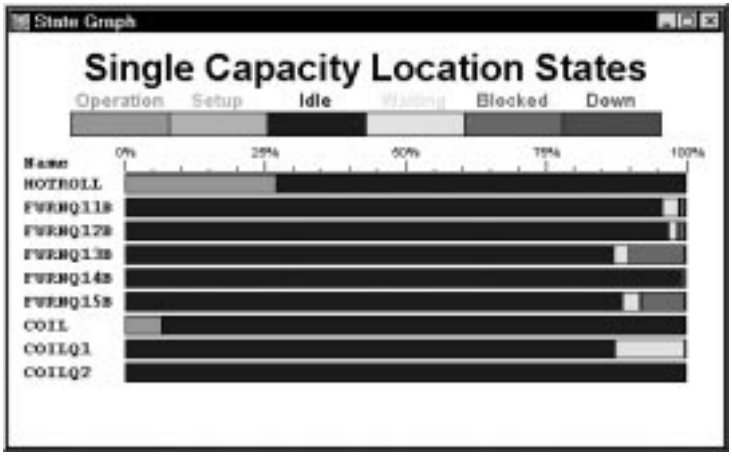
Scenario : Normal Run
Replication : 1 of 1
Simulation Time : 6.084833333 hr

LOCATIONS

Location Name	Scheduled Hours	Capacity	Total Entries	Average Minutes Per Entry	Average Contents	Maximum Contents
FVRHQ10B	6.084833333	3	7	3.691429	0.0707771	1
HOTROLL	6.084833333	1	50	1.983400	0.271632	1
FVRHQ11B	6.084833333	1	11	1.360000	0.0409762	1
FVRHQ12B	6.084833333	1	6	1.778333	0.0292257	1

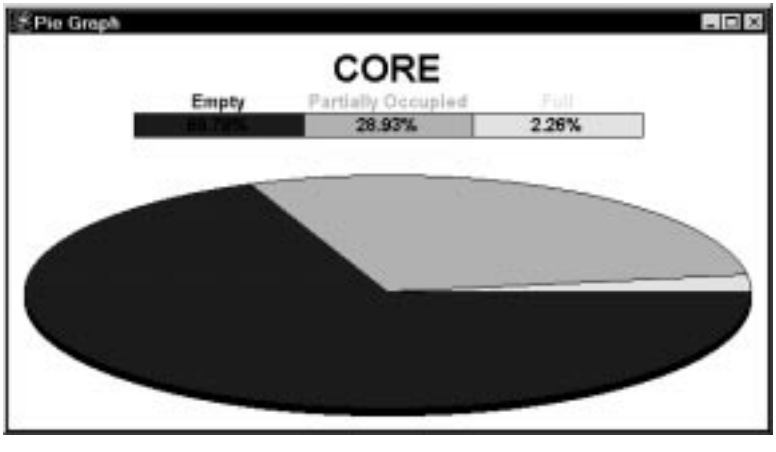
Multiple Replication Analysis

If the simulation runs multiple replications, reports and utilization graphs may be created for one, all, or an average of the replications. The chart below shows the average of all replications for single-capacity location states.



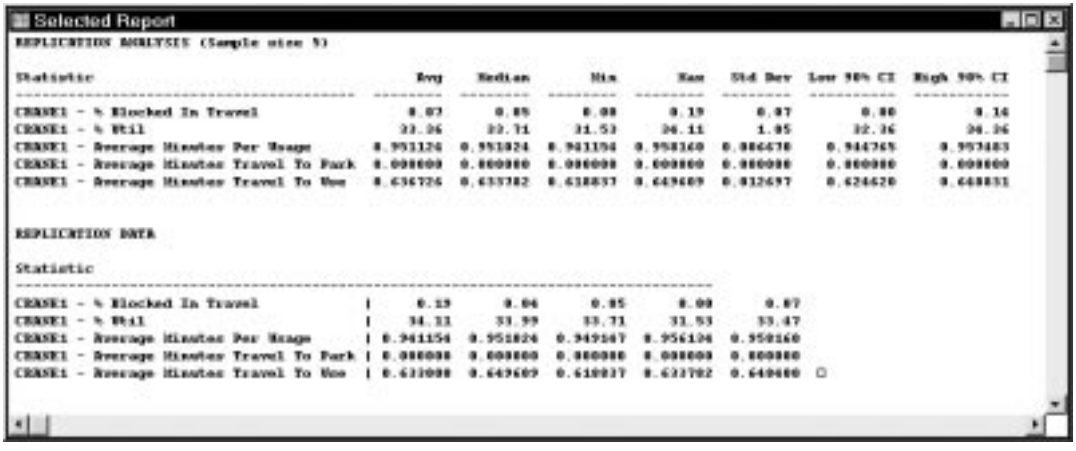
Utilization Graphs

Quickly generate utilization graphs of various types such as the pie chart shown here describing the utilization of the location called **Core**.



Confidence Intervals

In addition to histograms, confidence intervals (CI) can be created when analyzing multiple replication statistics.


Selected Report

REPLICATION ANALYSIS (Sample size 5)

Statistic	Avg	Median	Min	Max	Std Dev	Low 90% CI	High 90% CI
CRANE1 - % Blocked In Travel	0.07	0.05	0.00	0.19	0.07	0.00	0.16
CRANE1 - % Util	33.36	33.71	31.53	34.11	1.05	32.36	34.36
CRANE1 - Average Minutes Per Usage	0.951126	0.951824	0.941154	0.958160	0.006478	0.944765	0.957483
CRANE1 - Average Minutes Travel To Park	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
CRANE1 - Average Minutes Travel To Use	0.636726	0.633782	0.618837	0.649609	0.012697	0.624620	0.648831

REPLICATION DATA

Statistic					
CRANE1 - % Blocked In Travel	0.19	0.04	0.05	0.00	0.07
CRANE1 - % Util	34.11	33.99	33.71	31.53	33.47
CRANE1 - Average Minutes Per Usage	0.941154	0.951824	0.949167	0.956134	0.950160
CRANE1 - Average Minutes Travel To Park	0.000000	0.000000	0.000000	0.000000	0.000000
CRANE1 - Average Minutes Travel To Use	0.631000	0.649609	0.610837	0.631702	0.640480