Model-It!™
Visual Programming Tool for Dynamic Systems Modeling and Simulation

Norris Software Systems, Inc.
5201 Western Avenue #432
Knoxville, TN 37921
(615) 588-5774
AppleLink: D4135
Compuserve: 76220,515

This file describes the demonstration version of the **Model-It!** software for the Apple® Macintosh™ family of computers. After reading this document, you should have a better idea of what Model-It! software is and what it can do for you. You should also get an idea of how it works and the features it provides. This is not a comprehensive user's manual. Many features cannot be adequately described in this short space. The demonstration version of the Model-It! application file is fully functional with the exception that it will not allow you to save your work. Contact Norris Software Systems for further information or if you have any questions. We appreciate your interest and hope you enjoy this demonstration!

Overview

Model-It! software is a unique visual programming tool that you can use to model and simulate systems, algorithms, and processes. Easily construct block diagrams, supply your models with internally generated or imported data, set up a simulation clock, and watch your models run. Modify data and diagrams and have your changes validated and results updated as you work. Add plots and tables, that you format to your liking, and view your results.

Model-It! software combines ease of construction, flexible tools, and real-time modification and output to form a truly powerful platform for modeling and simulation!

Improve your efficiency. Devote your time to analysis and let Model-It! software do the rest.

Applications

- Simulate dynamic systems.
- Solve differential equations.
- Test algorithms.
- Filter data sets.
- Analyze processes.
- Test and optimize designs.
- Do “What if...” analyses.
- Perform general numeric processing tasks.

Features

- Get results directly from block diagrams without computer language programming!
- Build diagrams with powerful, intuitive drawing tools.
- Organize your diagrams in multiple windows. The number of windows and the size of the diagrams is limited only by available memory.
- Access the extensive set of function blocks which includes arithmetic, transcendental, conditional, Boolean, and dynamic (integrators, unit delays, and accumulators) operators.

- Freely combine discrete and continuous operators.
- Mix text fonts, styles, and sizes to customize the diagrams to suit your needs.
- Select from Euler 1st order, Runge-Kutta 4th order, or error controlling Runge-Kutta 5th and 7th order integration methods.
- Modify data and diagrams, even while a simulation runs, to fully interact with your models. Your changes are validated and the results updated as you work!
- View your results in tables and plots that update automatically.
- Quickly isolate problems with informative error reporting.
- Cut and paste diagrams, tables, and plots.
- Import and export data to and from text files.
- Runs on Macintosh 512KE, Macintosh Plus, Macintosh SE family, and Macintosh II family. System 4.2 or later is required.

What is Model-It! Software?

Spreadsheets have proven to be an almost indispensable tool for modeling financial and other systems. You can use a spreadsheet to construct very elaborate models involving many variables with complex interrelationships. But, what if you have a problem that changes with time? Or, what if you have to do many iterations with different sets of data? What if the quantity that you want to observe is the trend of a variable over time (i.e., several runs of the spreadsheet)? Or, what if you simply do not like to represent your models as rows and columns of numbers with hidden formulas tying the numbers together?

Enter Model-It! software. Model-It! software does calculations like a spreadsheet, but does not use rows and columns. Instead, you use function blocks to graphically construct the formulas that define the quantities of interest. You connect the function blocks with data flow paths that establish the relationships between the quantities. Then you can view your results in several different ways. If you like rows and columns, you can use Model-It! software's output table objects to arrange your results just like your spreadsheet.

But Model-It! software can do much more. Model-It! software lets you analyze models of systems that change with time. You construct a model graphically by combining function blocks that express relationships between quantities with function blocks that express how relationships change from one iteration to the next. You connect the function blocks with data flow pathways. You then enter the data (or import the data files) that drive the simulation, set the clock parameters, and run the simulation. Your results are displayed as single numbers, tables of numbers, or graphical plots.

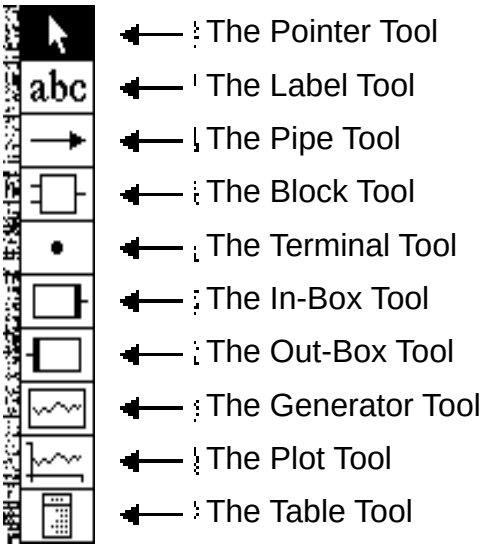
Our approach with Model-It! software has been to implement classical modeling and simulation techniques on the Macintosh. We wanted to create a program to perform much of the mundane work of drawing the model diagram, validating the model, and translating the diagram into a computable form that would normally be done by hand. By performing these steps for the user, Model-It! software extends the user's modeling options. The user is now free to evaluate many more scenarios than have been previously practical.

In designing Model-It! software, we have used the Macintosh's screen to replace the pencil and paper normally used to draw block diagrams. To this we have added intelligence to check your model diagrams for validity, to translate your diagrams into computable form, and to compute results as you draw. We have also provided sophisticated graphical output capabilities in the form of tables and plots. Finally, we have added flexible data import and export capabilities to let you share data with other software packages. The result of all this is that you get a powerful, graphical modeling and simulation tool that integrates smoothly into the Macintosh desktop computing paradigm.

How Do You Use Model-It! Software ?

To use Model-It! software, you begin by using its graphical drawing environment to construct a block diagram model of the system of interest. First, double-click the application icon to launch Model-It! software. Then use the **Create...** item in the **Windows** to create a new **Model Window**. Give the window a title and click OK to create the window.

The Model Window is a standard Macintosh window with a tool palette like the one shown below along the left-hand side of the window. The palette contains all of the tools that you can use to construct a model.



The Model-It! Tool Palette

First, let's consider the **Block** tool. Click this tool's icon and hold down momentarily to bring up the pop-up menu. Continue holding the mouse down and move the cursor into the pop-up menu over the "sin" (for "sine") box. Release the mouse to select this type of Block. Now move the cursor into the model window, press the mouse, drag to draw the Block, and release the mouse to finish. You can use the mouse to grab one of the knobs on the Block to resize it, or you can click-drag the object to reposition it. Notice that the cursor changes to indicate the type of operation that can be performed if the mouse button is pressed.

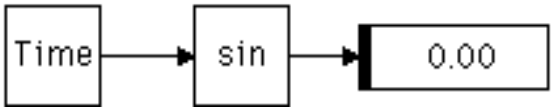
Cursor Pattern	Appears when cursor is over:	Valid actions:
(arrow)	An object's draggable part	Click-drag to move object
(cross)	A sizing knob	Click-drag to re-size objec
(I-beam)	An editable text field	Click-drag to select text or type to insert/delete
(source)	The output side of a source object	Click to anchor a Pipe
(sink)	The input side of a sink object	Click to terminate a Pipe

Model-It! Cursor Patterns

Now, let's create a forcing function for the sine Block. Go back to the Block item in the tool palette and select the "Time" function from the pop-up menu. Use the same procedure as above to draw the Time Block. Position this block to the left of the sin block since it is outputting a value which is the input to the sine block. Notice that Model-It! software uses a left-to-right data flow paradigm. Data always enters a Block on the left and flows out of the block to the right.

Next, let's make an **Out-Box** to display the result of the sine function. Click the Out-Box object in the tool palette and move the cursor to the right of the sine block. Click once to create the Out-Box. Click-drag to move the box to a good place.

Now we're ready to connect the objects with **Pipes**. Select the Pipe object from the tool palette. Move the cursor into the model window over the right (output) side of the Time function block. Notice that the cursor changes to a "waxing half-moon" shape to indicate that it is over a valid source object for a Pipe. Click the mouse to anchor the Pipe to the output of the Time block. Now move the cursor over the left (input) side of the sine block. Notice that the cursor changes to a "waning half-moon" shape to indicate that it is over a valid sink object for this Pipe. Double-click the mouse to terminate the Pipe. Repeat the process to create another Pipe from the sine block to the Out-Box. Notice that the Out-Box now has a value in it, indicating that a valid flow has been made and that the indicated computation has been performed. If you have done all of this correctly, the model window should look something like this:



If all you want to do is to make "graphical spreadsheets," this is all the functionality you need. You can use the extensive set of function blocks to construct formulas and view your results.

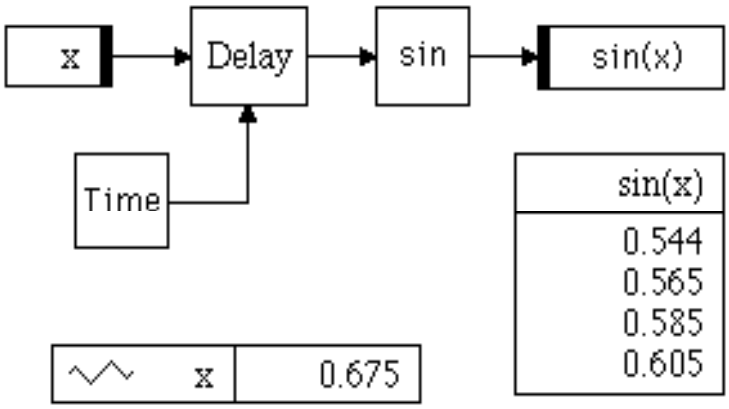
Let's run a quick simulation now. Click in the **Clock Window** (it should have the title "Untitled") to bring it to the front. Enter an end time of 10 and a step size of 0.1. Now go to the **Run** menu and select the **Start** item. Watch the value in the Out-Box changing as its value is recalculated for each time step. Now go back to the Run menu and select the **Reset** item to reset the clock to 0. Use the **Step** function from the Run menu to advance the clock one time step. Notice that the value in the Out-Box is changed, as well as the Current Time field in the clock window.

Since the values in the Out-Box scroll by quickly and then are gone, let's use another tool to store those values so we can view them. Click on the **Table** tool in the palette. Move the cursor into the model window, press the mouse, and drag to draw a box for the Table object. Type a name into the text field of the Table object. You have just created a **Named Variable**. Go back to the Out-Box, click to select it, then click inside the Out-Box to get a text cursor, and type the same name into it as in the Table object. Click on the Table object and click-drag a corner to make the box taller. Go to the Run menu, select Start, and watch the Table fill up. Values in a Table like this are exported to a file by using the **Export...** function in the File menu when the Table is selected.

Let's now consider another type of input object called a **Generator**. Generators allow you to create a set of data to drive a simulation. You can create a set of values interactively using the **Detail...** item in the edit menu or you can import data for the Generator using the **Import...** item in the File menu. To create a Generator go to the tool palette, click on the Generator icon, hold for a moment, and select the bottom item in the pop-up menu. This is an interpolating type of Generator. This means that, for those time steps when the input data list for the Generator has no specified value, the Generator interpolates between the last supplied value and the next supplied value to determine what value to supply. Notice that there are two other types of Generators shown in the pop-up menu. A constant generator simply supplies a constant value for all time steps. A stepping generator supplies the values specified in the input list for the indicated time steps. For other time steps, the stepping generator supplies the same value as the previous step.

Now we want to connect a data flow from the Generator object to some other object. First, let's create another Block. This time, let's use the Delay object. Select the Delay object from the tool palette and create it in the model window as before for the other block objects. Put it between the Time block and the sine block.

We must use a new kind of object called an **In-Box** for the Generator to drive. Select the In-Box icon from the palette, move the cursor into the model window, and click. Type the name of a Named Variable into the In-Box. After selecting the name field of the Generator, type the same name. Connect a Pipe from the In-Box to the input side of the Delay. Move the Pipe into the sine block (i.e., the output of the Time block) to the bottom side of the Delay. Notice that the cursor changes to a half-moon to indicate that you can connect an input to the bottom of a dynamic block, like the Delay. This input is called the **Initial Value** and is used as the block's output for the first time step. Subsequent steps output the result of the function operating on the input value. Connect the output of the Delay block to the input of the sine block. Hopefully, the model window should now look something like this:



To use the Generator, we have to somehow build a list of values. Double-click on the Generator object to open a dialog that you can use to enter values that correspond to particular time steps. Enter some values by text-editing the time and value fields. Click OK when you have some good values entered. You can now Run this model by selecting the Start function from the Run menu.

There is one last function that we need to cover in this demonstration. We need to create a **Plot** object. Select the Plot icon in the tool palette, move the cursor into the model window and click-drag to draw a (big) box for the Plot. In the middle of the vertical axis, just to the left of the axis, click to select the name field for text-editing. Enter the name of the Named Variable used above for the Table object. Similarly, go to the top of the axis and enter a value for the maximum value to plot and go to the bottom of the vertical axis to enter a minimum value. Also enter values for the start time for plotting as the minimum value on the horizontal axis and enter an end time for plotting as the maximum value for plotting.

Now, go to the Run menu and select the Start item again. Watch the values being plotted as the simulation steps through time. With any luck, these should correspond to the sine of the values that you entered with the Generator.

This concludes the structured walk-through. You may want to go back and explore some of the other functions. Create a **Label** object by selecting the Label icon, click-dragging a box, and typing the text. Create some other types of Function Blocks. Use the **Terminal** object to split a data flow so you can route it to multiple sink objects. Create the Terminal object by selecting the Terminal icon then clicking in the model window. Connect one input Pipe into the Terminal and as many output Pipes as desired from the Terminal to other objects.

You don't need to stop a simulation run to edit the model. While the model is running, create an In-Box object by selecting the icon in the palette and clicking somewhere in the model window. Enter a value into the In-Box text field (this could also be a Named Variable) and connect a Pipe from the In-Box to some other object. Close this document and open some of the supplied demonstration documents. See if you can understand what they are illustrating. Try modifying them.

As you can see, there is a lot of functionality built into this product. Obviously, this short document can only discuss some of the more important features. You can try to figure out some of the other features as you wish. If you are intrigued by what you see, order the product. We think you will be even more pleased by the product and its documentation.

Technical Information

Model-It! software runs on all Macintosh computers that are in production at the time this product is released. The Macintosh 128K and Macintosh 512K are supported only if they have been upgraded to run System 4.1 or later. Model-It! software configures itself at run time to take full advantage of your computer's resources (i.e, memory, co-processors, display characteristics, etc.)

Model-It! software runs on Macintoshes with as little as 512K bytes of memory, provided there is at least 256K bytes of memory available to the program. On Macintoshes with limited memory available to programs, Model-It! documents are limited in size.

Model-It! software uses the high quality Standard Apple Numeric Environment (SANE), an implementation of IEEE Standard 754 for Binary Floating-Point Arithmetic, to perform all floating-point calculations. All values are represented internally in the SANE Extended data type, which provides 19 to 20 significant decimal digits. In this format, numbers can range from less than -1.0E-4932 to greater than 1.0E+4932.

The Model-It! program adheres, as closely as possible, to the "User Interface Guidelines" as described in various Apple publications. This ensures maximum functional consistency and data interchange compatibility with other Macintosh applications.

The Model-It! program imposes no limitations on the numbers of windows, objects, variables, etc. The facilities of the computer available to Model-It! software at run time are the limiting factor. For example, a model is allowed to grow to any level of complexity, so long as it fits in available memory.

A Final Plug

We believe that the Model-It! package is a break-through product. Model-It! technology makes it possible to analyze designs by simulation rather than by guesswork. As the world and the systems that comprise our civilization become increasingly more complex, it becomes harder for one person to understand all the aspects of even a small system (industrial, financial, social, etc.) sufficiently to accurately predict its behavior. In the future, modeling tools will be essential to most design and analysis processes. We are proud to offer the Model-It! product as one of the first of these tools of the future. We believe that you will find it a useful and efficient tool for creating graphical models of discrete and continuous dynamic systems and for simulating the behavior of those systems.

We hope that you have enjoyed your demonstration copy of Model-It! software. If you would like to get a production copy with a comprehensive user's manual, please contact Norris Software Systems.