Graphmatica for Windows version 1.00

by Keith Hertzer (70711,2071)

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Help by topic

Help by menu item

GRAPHING HELP TOPICS

Graphing Equations: Basic Knowledge
These help topics apply to all types of graphs.
Entering Equations
Operator Table
Specifying a domain for graphs
Drawing Graphs
Error Messages

Different Graphing Techniques
Each topic describes how to draw one type of graph. Overview provides a brief description of each type with a link to the full topic.
Overview
Normal Cartesian coordinate graphing
Polar-coordinate Graphing
Parametric Graphing
Differential Equations

Using AutoRedraw and the Redraw Queue

File Menu

Load List	Saving and Loading Equation Lists
Save	" "
Save Setup Info	Saving Setup Information
Print	Printing Pictures of Your Graphs
Printer Setup	" "
Exit	Quit Graphmatica for Windows

Redraw Menu: Manipulating the Redraw Queue

Last Graph	Redraws the equation at the head of the queue, typically the last one entered.
All Graphs	Redraws all graphs in the queue that are not already on-screen.
Delete Equation	See Deleting an Equation
Clear All	See Clearing the Whole Queue

View menu: Changing the appearance of the screen

Clear Screen	Clearing the Screen
Scale	Changing the scale
Range	Adjusting the Range
Theta Range	Changing the Range of Theta
Fineness	Adjusting the Fineness

Labels Menu: Labelling the grid with text

Legends	Turning Axis Legends on/off
Title	Adding a Title to the Graph
Always On	Labels Always On Option

Options menu: Viewing and setting special options

Settings	Settings Dialog Box
AutoRedraw	Using AutoRedraw
Warnings	Turning Warning Messages on/off
Print Tables	Printing Point Tables
Hog CPU	Hog CPU Option
Monochrome	Monochrome Option
AutoSquare	AutoSquare Feature

The default values of each option are listed in Default Settings of Options

INTRODUCTION to Graphmatica for Windows

Graphmatica is an interactive algebraic equation grapher that can be used as an aide to plotting mathematical curves. While it is designed to be extremely simple to use, its advanced features may not be readily apparent to the first-time user. Please take a moment to acquaint yourself with them:

1. The Redraw Queue. Graphmatica remembers the last 25 equations you typed in or loaded from a file. You can save your work for use in a later session or with any text editor or Graphmatica 3.0 for DOS.
2. **Automatic functions**. Graphmatica will automatically
   + determine the type of graph you are entering,
   + recognize an equation's domain if you include one,
   + alter the sampling rate dynamically while graphing to make sure steep graphs like "y=tan x" are tracked correctly,
   + adjust the x/y ratio when you reset the range or change the size of the graph window so proper aspect ratio is maintained,
   + redraw the most recently-entered equation(s) when you change the size or shape of the grid by any means, and
   + restore the grid and special options settings when you load an equation list that has them.

   You don't have to do anything to use these functions, but the Options menu still gives you complete control over them.
3. **Advanced equation parser** follows mathematical rules--not the computer's. You can use implied multiplication, a complete library of math functions (including trig), and even leave out those annoying parentheses in appropriate places. Forget about isolating variables before graphing! As long as there is only one instance of the dependent variable in the equation, Graphmatica will isolate it for you, and even graph relations. You also get the power of 5 styles of graphing: regular Cartesian, polar, parametric, and slope-field and initial-value approximations for first-order ODE's, detected automatically.
4. **Easy to use controls**, including the convenient Button Bar which provides one-click access to the most frequently-used commands, the status bar, which displays relevant information and help messages, and the Redraw Queue combobox, which lets you select any equation in memory to graph, delete, or edit to form a new equation.
5. Pause and Print tables options let you see the coordinates of points on your graphs... as they are drawn. Print tables shows values at whole-number intervals so you can practice sketching curves yourself.
6. **Lots of output options**. Graphmatica lets you copy equations, point tables, and graphs to the clipboard [See Edit Menu options for details], and you can choose from three levels of print quality for faster or better printouts when you print your graphs. [See Printing Pictures of your Graphs].
7. Every automatic option is also **user-settable** to give you absolute control over your graphs. The Options Settings dialog not only shows you the current settings, but also acts as a master control panel to let you change any customizable option from one dialog box. And the Save Setup Info command lets you save your preferences so they are automatically restored whenever you run Graphmatica.
8. Instructive **help topics** explain the basics of each type of graph...and included **demo files** show you examples of each form of equation. See Demo Files for a list of these files.

DEMONSTRATION FILES

Graphmatica comes equipped with the following demonstration files to show you examples of each kind of graph it can draw. Each file contains a group of related equations, and each equation has a comment attached describing the curve it generates.

Try loading each file up (with the Load List command in the File menu), manipulating the view of the equations, redrawing, and modifying some equations. I suggest clearing the screen (if not the redraw queue as well) before loading a new file so the screen doesn't become too cluttered.

GRAPHMAT.GR	draws Graphmatica's name, mainly to show off the power of parametric equations
XYDEMO.GR	Cartesian-coordinate equations, quadratic equations, relations
TRIG.GR	graphs of trigonometric functions
POLAR.GR	graphs using polar coordinates
DIFEQ.GR	1 slope field and 1 Cauchy-Euler approximation of a first-order differential equation.

ELEMENTS OF THE DISPLAY

Besides the standard Windows display elements like menus, Graphmatica also includes controls that you might expect in a professional-quality application. The bottom of the main window holds the status bar, which displays help messages from the menus, the result of the latest action completed, the status of a selected equation, and during graphing, the equation being graphed, any warning error messages (if desired), and the pause message. So as not to obstruct the graphs, any message that does not require immediate attention or input will be posted in the status bar.

Next, the Button Bar at the top of the window contains controls that allow you to perform the most common commands with one click of the mouse or two keystrokes (Alt+letter). In addition, the zoom buttons zoom in and out using the default scale factor (the last value entered in the Scale dialog) so you don't have to enter a new one, and the range button lets you select the new range with the mouse so you don't even have to type in the new coordinates.

The Redraw Queue combobox serves two functions: first to accept input of new equations (you can type in a new equation at any time as long as you aren't currently graphing one) and second to retrieve old equations from the queue. If you want to enter a new equation, just type it in and press enter or click Graph to graph it. If a previous equation is highlighted on the input line, just start typing to start from scratch or press a direction key to clear the selection and edit it. To retrieve an old equation, use the up and down arrow keys to scroll through the list one equation at a time or click on the icon to the right of the edit field to drop down the list box for mouse selection (if there are more equations in the queue than fit in the box, it will have a scrollbar so you can see them all).

Finally, the Printout window (toggled on or off by the Print Tables menu item) shows the coordinates of selected points from the last graph(s) done with the option on. You may scroll through this list at will. Select however much of the point list you like and then select Copy from the Edit menu to copy the text of the printout to the Clipboard, so you can insert it into a document, print it, etc.

THE BUTTON BAR

Along the top of the screen below the menu bar is the Button Bar. This not only gives you convenient ways to perform tasks that can be done using the menus, but also lets you do a few more things. Following is a list of the buttons and their functions:

Graph Draws an equation you typed in or redraws the currently selected equation. Equivalent to pressing Enter.

Pause Activated only when you are graphing. Clicking this button (or pressing enter or escape) pauses the current graph. When you are pausing, the **Graph** button becomes **ABORT**. Click it to quit graphing or **Pause** again to restart.

Clear Clears the graphing screen. Same as selecting Clear Screen from the View menu.

Zoom in Zooms in on the current grid using the default scale factor. This is the last scale factor you entered using the Scale command. (When you start Graphmatica, the default scale factor is 2.) This allows you to do the same thing as calling up the Scale dialog box and pressing OK with one mouse click.

Zoom out Zooms out on the current grid using the default scale factor. Similar to the **Zoom in** button above.

Range Lets you select a new range to show using the mouse. This is NOT the same as selecting the Range menu option. First select the area you want to see with the mouse by holding down the left button and enlarging the rectangle. Since the computer is better at maintaining a square aspect ratio than you are, you don't have to worry about doing this perfectly. Depending on how you draw the rectangle, either the top or bottom y-coordinate will be AutoScaled. If you start from the bottom and draw up, the bottom coordinate will be fixed and the top one ignored and computed automatically. If you draw downward, the top coordinate will be fixed and the bottom one AutoScaled. When you have selected an area, click on the **Range** button to redraw the grid. Graphmatica will display the exact coordinates of the new range on the status line. If you do not click the **Range** button, the selection will be forgotten as soon as you click the mouse in the graph window, clear the screen, draw another graph, or make a new selection.

Redraw all Same as selecting All Graphs from the Redraw menu. Draws every graph in the queue.

Default grid Sets the grid back to Graphmatica's default of -8 to 8 and AutoScaled y coordinates. This is useful if you have selected a weird range that is really large or small, not centered, or not squared and you want to quickly resize the grid to reasonable, centered proportions.

DRAWING A GRAPH

Once you have successfully entered an equation, Graphmatica will proceed to draw it. If warning messages are on, any non-fatal errors that are encountered will be displayed in the status bar. If you want to pause the graph at any time, just click the Pause button, or press ESC or enter on the keyboard. Graphmatica will display the message

Pause at var1=value1, var2=value2. Press ESC to abort or enter to restart...

which displays the current values of the variables in the equation. Since Graphmatica cannot start a new task while it is in the middle of drawing a graph, while you are pausing you have only two options: turn off Pause and continue graphing by Clicking the Pause button again or pressing enter, or abort the graph by clicking the ABORT button or pressing ESC. You may find that you prefer using the keyboard to clicking the pause button with the mouse, because the response time is somewhat better (i.e. graphing will actually stop sooner) when the computer doesn't have to do the 3-D pushbutton effect.

You may work on other applications while drawing or pausing a graph, but Graphmatica will not respond to anything but pause, restart, and abort requests. (It may look like you can select menu items, but they will not be executed. In fact, drawing will stop while you are in the menu, so don't waste your time trying make Graphmatica do anything else while it is graphing.) You may also move or minimize and restore the Graphmatica window. Do NOT, however, attempt to resize the window while you are graphing. Although Windows will not try to stop you, Graphmatica will ignore any attempts to resize the window as this would likely change the size or shape of the grid and render any points already plotted invalid. This will result in a grid which does not fit the size of the window (if this happens, just minimize and restore the window once graphing is completed and Graphmatica will recalculate the screen size properly).

When the graph for your equation is complete, the status bar will change from "Graphing: xxx" to "ON SCREEN: xxx" to indicate drawing is done. Also, the pause button will be dimmed and the other buttons in the button bar re-enabled. If you'd like to start all over with a completely different equation, just start typing (the last equation is automatically selected in the edit field so the text is automatically cleared once you start typing). If you'd rather modify the last equation, click the mouse or press a direction key to turn off the selection and then go right ahead; it's already stored safe and sound in the redraw queue (for more information see The Redraw Queue). Or you can modify any previously entered equation by using the up and down arrow keys to scroll forwards and backwards in the redraw queue, respectively. (Clicking the mouse on the down arrow icon to the right of the graph prompt drops down a scrolling listbox from which you can view and select equations with the mouse.) You can also use this "scroll back" capability to redraw a graph that is in the queue but not presently on the screen: just select the equation you want and press enter or click the Graph button.

If you want optimum performance and you are not running any timing-sensitive applications (e.g. communications programs doing background file transfers), you can use the Hog CPU option to prevent Graphmatica from yielding the processor to other applications while it is graphing. See Hog CPU option for details.

Since you can draw as many graphs on the same grid as you want, Graphmatica does not provide for having multiple grids on screen at the same time. However, if you would prefer to look at two graphs side-by-side instead of superimposed, just run two copies of Graphmatica next to each other. (You can share data between them by saving and loading equation lists.)

Normal Cartesian equations

Graphmatica's equation parser will automatically isolate the variable "y" wherever it is in the equation. It will graph some relations, like circles ("x^2+y^2=36") and ellipses ("x^2/3 + y^2/4 =20"), as well as hyperbolas, sideways parabolas ("x=y^2") and many other conic sections. (Consult a good Algebra II textbook for help on their formulas, as I'm a little rusty.) The only limitation for functions is that there must be one and only one occurrence of the variable "y". Graphmatica cannot graph an equation without a "y", like "x=4". It also cannot perform the factoring needed to isolate the variable "y" when it occurs more than once (i.e. "x=y^2+3y"). The relation graphing module (for graphs which may have more than one y-value for a given x value) works like this: if in isolating the "y" in an equation Graphmatica finds an even power of it (i.e. "y^2"), it makes two equations for that graph, one with the positive and one with the negative root. This method by no means covers all possible relations, but it is adequate for the most common. In fact, I haven't thought up an equation it can't graph yet.

OPERATORS

Graphmatica uses an operator set almost identical to BASIC's, with several additions to make it more user-friendly. Almost all of the math functions provided in the Microsoft C library have been made available. The supported operators and functions are as follows:

Operator/Function	Meaning
+, -, *, /	Add, subtract, multiply, divide
^	Exponentiation
[( )]	Parentheses: may be nested to any extent, brackets are provided for ease of reading but parser WON'T differentiate between "(" and "["
; (semicolon)	Separate halves of a parametric equation
' (single quote)	Make rest of the equation a comment
{ a, b }	Specify domain, where 'a' is the start of the domain and 'b' is the end. Either end may be left open by omitting 'a' or 'b'.
abs	absolute value
acos, asin, atan	arc cosine, arc sine, and arc tangent
asec, acsc, acot	arc secant, arc cosecant, and arc cotangent
cos, cosh	cosine and hyperbolic cosine
csc	cosecant
exp	Euler's number to the specified power
int	greatest integer ([x] is not supported)
ln, log	natural logarithm, logarithm base 10
sin, sinh	sine, hyperbolic sine
sec	secant
sqr	square root
tan, tanh	tangent, hyperbolic tangent

NOTE that all trig functions work in RADIANS, not degrees.

Besides the variables x, y, r, t, and dx, 2 constants (pi [3.14159...] and e [Euler's number: 2.718...]) are legal identifiers for your convenience.

ENTERING EQUATIONS

There are few restrictions on the form of your equations, and those are probably pretty familiar to you if you have ever worked with BASIC.

Your equation **must** include: *
+ exactly one dependent variable ("y" or "r")
+ exactly one equals sign ("=")
+ some sort of expression on each side of the equals sign

The rest is up to you. You can also include:
+ as many instances of the independent variable ("x" or "t") as you like, or none.
+ constants (decimal numbers and "pi" and "e" are valid)
+ basic math operations (+, -, *, / for division, ^ for exponents). Multiplication can be implied.
+ nested parentheses to any extent
+ trigonometric, exponential, and other functions
+ a domain, which may be open or closed on both sides
+ a comment, so you can make notes to yourself or others

(* Parametric equations, because they are inherently different from most others, have different requirements which are explained in detail in Parametric Graphing.)

For an exact list of these operators, see the Operator Table.

You must separate alphabetic identifiers with a space, paren, or an arithmetic operator. The parser's ability to determine exactly what you want to pass as an argument to a function is somewhat limited, so I suggest you make it a habit to enclose the desired expression in parentheses. "cos x" may work fine but "cos 2x" is interpreted as "(cos 2)*x" and "cos x^2" turns out "(cos x)^2". Typing "cos (2x)" or "cos (x^2)" instead works perfectly.

The order of operations is the standard algebraic left to right of:

Functions
Parentheses
Exponents
Multiplication and division
Addition and subtraction

Graphmatica supports implied multiplication of variables and constants as in "3x" or "5(2x+3)", but not of variables and other alphabetic identifiers such as functions and built-in transcendental numbers like "xx", "xcos(x)", or "xpi", so you must include the times sign in those cases. (Implied multiplication of the two variables x and y [e.g. "xy=1"] **is** supported, however.) The parser may reject some complex expressions for no apparent reason. Keep trying! I suggest liberal use of parentheses: if you are not sure whether something will be interpreted correctly, go back and put parentheses around it. (However, you should not use parentheses gratuitously; the best example of this is that if you enclose the entire expression on either side of the equals sign in parentheses, the parser will NOT be able to find the expression inside.)

For brief or in-depth information about each of the types of graphs Graphmatica supports, read the Overview of Graphing Techniques.

SPECIFYING THE DOMAIN

Graphmatica allows you to specify the domain of each equation independently. This allows you to draw only a particular part of a graph or change the domain without using the Range or Theta range functions to change the default domain. To specify a domain for an equation, type anywhere on the line the expression

{ a, b }

where 'a' is the start of the domain and 'b' is the end. If you want the domain to start at the default start, leave 'a' out. Then, whatever you change the start of the default domain to, that will always be where the equations starts graphing. To leave the end of the domain open, leave out 'b'. So if the range on-screen is (-10,10), specifying a domain of "{ ,5}" will graph from -10 to 5, and one of "{-4, }" will go from -4 to 10.

To graph a parametric equation, you MUST specify a domain that is closed (i.e. one that has neither number left out).

For ease of use for polar graphs or trigonometric functions, you can specify the domain as multiples of pi by typing '###p' and degree measures instead of radians by typing '###d' (see Polar Domains).

ERROR MESSAGES

Fatal Errors occur when either the parser of the evaluator cannot make sense of and expression you have typed in. They are presented in a popup message box and require you to edit your equation.

Warning Messages are errors encountered trying to evaluate specific point(s). By default they are not displayed but you can toggle this with the Warnings Option.

FATAL ERROR MESSAGES

Twelve error messages may be encountered when graphing (apart from messages ingrained in the library functions which I cannot control). Six of them are fatal; the equation cannot be graphed and you must edit it. They will present a popup message box so you know there is a problem. The other six apply only to specific point(s) for which a y-value cannot be generated. They will not appear unless you ask for them using the Warnings option and then they appear silently.

[Please note that all warning messages which refer to the variables 'x' or 'y' will actually be 't' or 'r' when you are dealing with a polar equation.]

"Found bad operation or mismatched parentheses. Press any key to retype..."
You either left out a paren somewhere, left out one or both of the operands for a binary operation or the argument for a function, or typed some other weird thing the parser and evaluator couldn't digest, like putting parentheses around the entire expression. Examine your equation carefully and fix whatever seems to be the problem.

"Found unknown identifier. Press any key to retype equation."
Unfortunately, the evaluator isn't set up to return what caused the error, so you'll have to look for it yourself. Check that your equation contains only valid identifiers (x, y, pi, e, r, t, and the functions listed in the Operator Table) and that you separated each of them with an operator, space, or some other punctuation.

"No equals sign or more than one found. Press any key to edit equation."
To be a valid and graphable, your equation must include exactly one equals sign ['=']. If you get this error, you either left out the '=' or accidentally typed two or more of them. For parametric equations, there must be an '=' on each side of the dividing ';'.

"No 'y' variable or more than one found. Press any key to edit equation."
Although Graphmatica has been enhanced to isolate ONE 'y' variable and graph some relations, it cannot graph an equation without a 'y', like "x=4". It also cannot perform the factoring needed to isolate the variable 'y' when it occurs more than once (i.e. "x=y^2+3y"). If you can adjust the equation so it uses only one 'y', do so; otherwise it can't be graphed. In parametric graphing, this message may also indicate that no 'x' variable was found in the x(t) equation.

"Can't find the inverse of this function of y. Press a key to edit equation."
You tried to graph an equation like "int(y)=x" or "abs(y)=x" for which y cannot be isolated by taking the inverse of the function. The functions which cannot be isolated are "abs", "cosh", "sinh", "tanh", and "int". If you can't adjust the equation so this error does not occur, it is not graphable.

"Parametric equation requires that you specify domain! See Parametric Graphing in help file for details."
You typed in a parametric equation (or accidentally hit the semicolon) and neglected to include a closed domain [like {1,6}]. Because the diversity of parametric equations makes it hard to pick a default domain, you have to include one with each parametric graph. [See Parametric Graphing or Specifying a Domain for more help.]

See also Warning Error Messages

WARNING ERROR MESSAGES

"Overflow at x=#.##."
Some function or operation generated a number too large to fit into a 8-byte floating point variable. The point at x=#.## was not graphed. This error is not fatal, so the graphing process is continued, but if the message is repeated and no image is graphed, you may need to abort graphing and look at your equation again.

"Division by zero at x=#.##."
At x=#.## your equation included division by zero so that point was skipped. Unless you get this error repeatedly, there's no real problem.

"Can't raise a negative number to a fractional power. [x=#.##]"
Due to the possibility of getting an even root of a negative number (like -16^(1/2) which actually equals the square root of -16), the C Library pow() function refuses to process any arguments like these. This is not a fatal error, and the portion of your graph (if any) where the base is not negative or the power is not fractional should be graphed perfectly. This error also occurs when you try to take the square root of a negative number with the "sqr" function.

"Can't find the logarithm of a negative number. [x=#.##]"
The natural logarithm (ln) and base 10 logarithm (log) functions are defined only on x greater than zero.

"Domain error: asin/acos defined only on -1<=x<=1, acsc/asec on x<-1,x>1. [x=#.##]"
The arcsine (asin) and arc cosine (acos) functions are only defined between -1 and 1 (the range of the sin and cos functions). The asec and acsc functions are only defined outside this range.

See also Fatal Error Messages

INTRODUCTION TO POLAR GRAPHS

Polar coordinates are a fundamentally different approach to representing curves in two-dimensional space. The concept is pretty easy to grasp graphically, but if you have never used polar coordinates and want to understand them, you should probably read the section below.

The traditional Cartesian method relies on an x and a y coordinate to mark how far a point is from the axes in two perpendicular directions; polar coordinates plot the location of a point by one coordinate represented by the Greek letter theta which is simplified to "t" in Graphmatica and another called "r". The "t" tells what direction to go in from the origin, and the "r" tells how far to go out in that direction to reach the point. The direction is measured in radians as an angle starting from the positive side of the x-axis and turning around counter-clockwise (like measuring the angle the hand on a clock has traveled starting at the 3 o'clock position and going backwards). There are 2pi radians in a complete circle, corresponding to 360 of the degrees you're familiar with. To put a polar coordinate into Cartesian terms in order to graph it, we use the equations: $x = r \cos t$ and $y = r \sin t$.

To make a graph using polar coordinates, we let theta be the independent variable and calculate a distance to plot out from the origin as we let the angle sweep around in the positive direction. The domain for the graphing is 0 to 2pi (the first complete circle in the positive direction), but you can easily change these values using the Theta Range function in the View menu. Polar graphs can be entered from the "Graph?" prompt just like normal graphs. The only difference in what you type, and the way Graphmatica detects a polar graph, is that you must use the variables "t" and "r" instead of "x" and "y". The restrictions are still the same: you can have one and only one instance of the dependent variable "r," although it can be located almost anywhere in the equation. You can embed the "r" in a term like "r^2" to graph functions that cannot be simplified by normal means and Graphmatica will evaluate both positive and negative roots automatically. You should watch as your graph is drawn, because often the direction it is going is almost as important as the figure it draws. (When you have a "double" equation with "r^2" in it, though, note that the positive roots are drawn first and then the negative roots are drawn: theoretically they should be drawn simultaneously but this is not practically possible.)

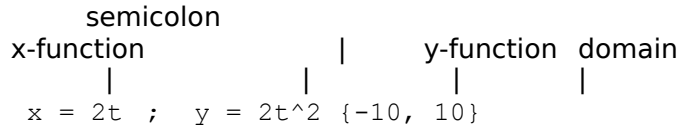
Please note that the x and y coordinate ranges and the range for the variable theta function completely independently; in normal Cartesian graphing, theta's value is irrelevant, and in polar graphing, theta controls the domain of the graph, but the x and y ranges still control the physical screen you see. If you want to change your view of a polar graph, you use the scale or range functions just as you would normally.

See also Specifying Polar Domains for details on how to specify an angular domain.

INTRODUCTION TO PARAMETRIC GRAPHS

Parametric graphing, like polar graphing, uses a different method of calculating points on the plane to come up with curves that may be difficult to compute using normal rectangular coordinates. They are unique in that the Cartesian x and y coordinates are calculated based on a third variable (the "parameter" of x and y) which is traditionally called 't' (not to be confused with the 't' used by Graphmatica to represent theta). T is allowed to increase from the start of the domain you specify to the end. At each value, the functions x(t) and y(t) are calculated to give an (x,y) coordinate which is graphed. Graphmatica then connects these points to form a smooth curve--if something you graph begins to look jagged, you probably need to adjust the fineness. (Parametric graph fineness is linked to the same fineness control as Cartesian and polar graphing, and should be decent at the default fineness value, but if you need to, you can increase or decrease this value. Be aware that this will affect the fineness of non-parametric graphs as well. See Adjusting the Fineness for details.)

To enter a parametric graph, you need to remember four basic parts: the x(t) and y(t) functions, the semicolon between them (this is how Graphmatica knows it's a parametric graph), and the domain for t.



Although as in all other Graphmatica equations you don't need to solve for x and y (i.e. t=5x would be OK), only one x and one y can appear in the whole equation, and "double" equations like "x^2=t" where Graphmatica would normally solve for both the positive and negative roots are NOT supported (you can enter them but only the positive root will be found; each equation in the redraw queue is allowed enough space to hold two computable expressions, and either a double equation or an x/y pair of parametric equations will fit, but not both). You can type the x and y equations in either order, as long as they are separated by a semicolon, and the domain will be recognized anywhere on the line. You MUST specify a domain for each parametric equation! The variety of curves that can be drawn with parametric equations is great and makes choosing an appropriate default domain impossible. Some curves (like those including the circular functions sine and cosine) tend to work best over a {0,2pi} domain, like polar graphs. Others will match up better with the default domain of the normal graphs, the size of the viewing area. Some have a very compact domain, between say 0 and 1, where they will appear on the screen. If you over- or under-estimate the domain, you can always abort the graph and edit your equation.

DIFFERENTIAL EQUATIONS

Graphmatica also has built-in a rudimentary feature for approximating the solutions of first-order differential equations. [I will not provide background material on this function because if you need to use it, you probably know more about differential equations than I do.] To let the parser know you want to graph a differential equation, you must include the differential "dx" as one of your variables.
If you specify an equation as

dx = f(x,t)

where f(x,t) is some combination of the variables x and t (such as "x^3 + t" or "t * x") and do NOT include the domain operator { , }, the program will draw a slope field for dx/dt = f(x,t).

If you do include the domain operator {a, b} , however, it will not be interpreted as a domain but will instead indicate that you want to graph a specific solution to the initial-value problem `x(a)=b` by Cauchy-Euler approximation. This deviation from the normal notation is only valid for differentials.

OVERVIEW OF GRAPHING TECHNIQUES

Graphmatica offers the following methods for graphing equations. Each method is detected automatically by the use of distinctive variables.

Normal Cartesian (rectangular) Graphs Typical graphs like "`y=x^2`" including only the variables **x** and **y**. Also includes relations like "`x^2 + y^2 = 36`".

Polar Graphs Graphs using the polar coordinate system and the variables **r** and **t** (for theta).
Example: "`r=cos t`"

Parametric Graphs Graphs using the rectangular coordinate system but specified by equations of a third variable or "parameter," **t.** These graphs must include a domain.
Example: "`y = sin t ; x = cos t {0, 2p}`" draws a circle.

Differential Equations Graphs used to approximate solutions to first-order differential equations; use variables **dx** (for the differential dx/dt), **x**, and **t**.
Example: "`dx = x^2 + t`" plots a slope field for "dx/dt = x^2 + t."

Graphmatica comes with pre-defined equation lists demonstrating each of these graph types. See Demo Files for details.

While some curves can be drawn by Cartesian relations, polar coordinates, and parametric functions, each technique is better suited for some graphs than for others. For instance, a circle with radius 5 around the origin which can be produced by the equation

x^2 + y^2 = 25

can be drawn faster by the parametric equations

x = 5 cos (t) ; y = 5 sin (t) {0, 2p}

and can be drawn faster and much more simply by the polar graph

r = 5.

USING AutoRedraw

Whenever you change the scale to look at a graph in greater detail or from farther back, or you shift the range of the axes so that the graph you just drew will be centered, the screen must be cleared so that a new coordinate grid can be drawn. So you're left with the viewing angle you wanted for that graph, but the screen is blank. You shouldn't have to solve this problem by retyping the equation...and you don't. You can redraw the equation much more easily by selecting Last Graph in the Redraw menu. But with AutoRedraw ON, you don't even have to do that.

As its name suggests, AutoRedraw will redraw the last equation(s) you typed in automatically when you change the scale or range. If you don't want a graph redrawn, you can abort it by pressing ESC twice. If you want to turn off AutoRedraw completely, just select AutoRedraw under the Options menu.

You can also change the number of equations AutoRedraw draws. Do this in the Options Settings dialog box. This can be anything from 1 to 25, the maximum number of graphs. If this number is greater than the number of equations in memory, all of them will be redrawn. The default is 1.

THE REDRAW QUEUE

Every time you type in an equation, the character string you typed and the program's internal representation of that equation get stored in the redraw queue. From this queue, or list, you can call up any of the last 25 equations you typed to graph again with fewer keystrokes than retyping it. Or you can redraw all of them or the just the last one you typed with even fewer keystrokes. The equations in the queue are stored in an order that puts the most-recently-used at the beginning and the least-recently-used at the end. Hopefully, when the queue fills up, the equations that are bumped off the queue at the end will be the ones you won't miss very much.

The screen clears whenever you execute a Range or Scale command. If you execute either of these functions or clear the screen accidentally with the Clear menu option, you can redraw the last equation (if AutoRedraw hasn't already) by selecting Last Graph from the Redraw menu, or you can redraw all of the equations in the queue using the Redraw All menu option or button. Note that the redraw all function does not care which graphs were on the screen before it was cleared; it just redraws all the graphs in the redraw queue that are not currently on the screen. If you cleared the screen manually, and have not changed the size of the grid before you choose Redraw All, Graphmatica will detect which graphs have already been calculated using that grid and redraw them without recalculating their points (this is much faster than plotting the graph from scratch).

You can scroll through every equation you have entered into the redraw queue using the combo box at the top of the screen. When you select an equation using the arrow keys or mouse, Graphmatica displays its current status (on or off screen) and the text of the equation in the same color the graph was drawn in at the bottom of the screen in the status bar. Press the down arrow key or pull down the listbox with the mouse to scroll back one equation. Press the up arrow key or button to scroll back up the list if you want to. When you have found the equation you want, press enter or click on it and press enter or click the Graph button (do not modify the equation) and the graph will be redrawn. Afterwards, the equation will be displayed for editing, except now it is at the head of the queue.

DELETING AN EQUATION

If you enter an invalid equation that can't be graphed, Graphmatica will automatically prevent the equation from being added to the redraw queue. However, if you want to trim unwanted equations from the redraw queue before saving an equation list or for any other reason want to delete an equation that is already in the queue, just do the following:

1. Using either the down arrow key or the mouse, select the equation you wish to delete from the redraw queue combo-box. DO NOT attempt to select the equation by retyping it in the edit field.
2. Either select Delete Equation from the Redraw menu or click on the "Delete" button on the button bar at the top of the screen.

See also Clearing the Redraw Queue for how to clear the entire redraw queue at once.

CLEARING THE REDRAW QUEUE

To clear the entire redraw queue, simply select Clear All from the Redraw menu. All the equations in the queue will be deleted.

See also Deleting an Equation for how to remove a single equation from the queue.

SAVING SETUP INFORMATION

You can save your preferred grid size and settings of other user options so that whenever you run Graphmatica again they will automatically be restored. You can do this at any time by selecting the Save Setup Info item in the File menu. The options will be saved in the GRAPHMAT.INI file in the **current directory**. If this is not where the program files are stored, Graphmatica will not be able to find it again, so if you change the directory using the load or save list commands, be sure to reset it **before** you save the setup (or be prepared to copy this file into the proper directory).

The setup file is just a special equation list that is loaded automatically when you start Graphmatica. It follows the exact same format as a normal equation list (described in Editing Equation Lists) except that when you save it Graphmatica leaves out the labels and the equations (the important parts of normal equation lists). If you do want to save equations and labels in it, use the normal save command (with the Save setup option checked), and just enter the filename GRAPHMAT.INI.

When Graphmatica saves your options, to simplify things it only records those options that are different from its own internal defaults. (See Default Settings for a list of these.) If your settings are close to the defaults, your setup file will be very short.

SAVING AND LOADING EQUATION LISTS

To save the list of equations you're working on, as well as the title and y-axis labels if you've entered them, simply select Save from the File menu and enter a filename. This file will be saved in the current directory with an extension of ".GR" (for GRaphmatica) unless you specify differently. You can also use the list box to change the directory before saving. If you want to save the current grid and special options along with the file (these are then automatically re-instated when you load the file), mark the "Save setup information too" checkbox.

To reload your list of equations or load up one of the demo files provided with Graphmatica, you have more options. You can automatically load a file when you run Graphmatica by typing its name (with or without a file path or the ".GR" extension) as a command-line argument (or associate ".GR" files with Graphmatica using the File Manager. Then those equations will be loaded up (and graphed) immediately, unless the file contains options specifying AutoRedraw off. You can also load an equation list at any time by selecting Load List in the File menu. Select the file you want from the list box (directories are included at the end of the file list so you can search for files anywhere on the disk).

After you select a file to load, if the redraw queue is not empty, you must decide whether to add the new file's equations to the existing queue or replace its current contents. Check the "Clear old equations from queue" box to do so. Also, you can select whether or not you want to draw all of the equations you have just loaded immediately [the default is to do so] using the "Redraw all after load" checkbox.

The graph title and Y-axis labels (if the file had any) that were loaded will also be displayed if the Labels Always On option is selected.

If the file was saved with the Save setup option on, the grid and special options settings recorded in the file will be loaded and set automatically.

EDITING EQUATION LISTS and graphmat.ini

Graphmatica does not really provide facilities for maintaining equation lists; although you can edit an equation, delete old ones that are no longer needed, and change the order of equations by redrawing selected graphs, determining the precise order of equations in the list is difficult since they are dynamically shuffled each time an equation is entered or redrawn to make Graphmatica more interactive. However, the equation list is just a text file whose structure is virtually identical to the win.ini file, you can create or modify one with virtually any editor. The structure goes like this:

```
[labels]
title = xxxx       any character string
left = xxxx
right = xxxx

[grid]
left = #.##        any decimal number
right = #.##       or "auto" to autoscale
top = #.##
bottom = #.##

[options]
autoredraw = on or off   "on" or "off"
autonum = ##             any integer 0-25
legends = on or off
hogcpu = on or off
mono = on or off
autosquare = on or off
labels = on or off
tables = on or off
warnings = on or off
defscale = #.##          any decimal number
fineness = #.##
tstart = #.##
tstop = #.##

[equations]
up to 25 equations, each up to 80 characters, each on a separate line.
```

The [labels] section specifies the title and y-axis labels. The [grid] section gives the left, right, top and bottom coordinates of the grid. Type "auto" for any one to auto-scale that coordinate based on the other three. Type auto for both the top and bottom to auto-scale the y-axis so the top and bottom coordinates are equal and opposite.

You can omit any item or even a complete section if you don't want to change the default. Type exactly as specified above, including the brackets "[ ]" around the section headings, and replacing the underlined portions with your own values. If you don't know or don't care what the value is for an option, just leave the line out. Don't worry about capitalization, extra spaces, or even extra blank lines. (However, each entry must be on a separate line or some may be ignored.) You can put the options and sections in any order ... the only requirement is that the [equations] section must come last, if there is one. Invalid options are also ignored.

If you want to create a file with no titles or options, simply type the "[equations]" header and then type all of your equations. Each equation must be on a separate line. There is one catch, however: since Graphmatica graphs the most recently entered equation first when it

redraws, when the list is loaded and graphed, the equation listed LAST will be graphed FIRST. (It is certainly possible to correct this situation by graphing the equations as they come in, but then every subsequent "redraw all" command would draw the list backwards anyway.) If you load an equation list and immediately save it without changing anything, the net effect will be that the order of the equations in the file is reversed.

The graphmat.ini file, which is loaded whenever you run Graphmatica without specifying an equation list to load, uses the exact same format... when you choose the Save Setup Info command, Graphmatica simply saves the setup file as it would an equation list, except the [labels] and [equations] sections are omitted, since you probably don't want to have the same graph title and equations load up automatically forever and ever.

To convert equation lists from Graphmatica for DOS version 2.80, load the file in any text editor and make the following changes: [Graphmatica for DOS version 3.0 files are identical to Windows files.]

If there are titles in the file, add a **`[labels]`** header to the top, insert a **`title=`** before the first line, **`left=`** before the second, and **`right=`** before the third.

Insert a new line and type the **`[equations]`** header line before the equations.

That's it. You can now load the file up in Graphmatica and resave it with the save setup option to save a specific grid or other options along with the equations.

CLEARING THE SCREEN

Since Graphmatica allows you to superimpose one graph on top of another indefinitely, after a while the grid may be a huge mess. At this point you might want to select Clear in the View menu to clear the screen. Everything will be erased and the grid will then be redrawn. Remember, every equation you have typed is still stored and can be redrawn later even after you have cleared the screen. In fact, every graph that was on the screen prior to clearing can be recalled instantly and will not even need to be recalculated until the grid size changes.

You can also clear the screen using the "Clear" button on the button bar.

CHANGING THE SCALE

The scale function allows you to change the scale of the graph you have on-screen while keeping the center of the display the same (the origin may move but if (2,2) is at the middle of the screen, it will stay there). The scale is totally relative to the size of the grid that is presently on the screen, so you need not make any comparison with an absolute scale of 1. To rescale the grid, select Scale from the View menu. Then respond to the prompt according to the following guidelines:

Enter a positive number greater than one to specify the amount to zoom (the "scale factor"). Then select the appropriate radio button to zoom in or out and press the OK button. Zooming in by a factor of 2 halves the width and height of the grid. Zooming out by a factor of two makes the grid twice as wide. (In the new Camcorder-age terminology, zooming in acts as a telephoto and zooming out as a wide-angle lens.) Scale factors less than 1 are invalid because they produce meaningless values. Decimals greater than 1 are valid though (e.g. 1.05 changes the dimensions of the screen just slightly).

The scale factor you enter is remembered for future reference and presented as the default the next time you scale the grid. Also, this default value is used when you press the **Zoom in** and **Zoom out** buttons on the button bar so that you do not need to specify a new scale factor. The default value upon startup is 2.

ADJUSTING THE RANGE

The ability to adjust the grid by inputting the beginning and end of the desired range is one of the most powerful and flexible features Graphmatica offers. It can rescale the grid to either be a perfect fit for the function you are graphing so that as much of it is visible as possible or to render the most accurate image possible. Both of these features can be accomplished by selecting Range in the View menu.

To create a grid such as the first, graph an equation on the standard grid, and from that graph determine the top-, bottom-, left-and rightmost extremities of the graph, and enter these values in the appropriate edit fields. The new grid may be somewhat expanded or compressed depending on the aspect ratio, but it will show the same amount of graph in much greater detail.

To create a more accurate representation like the second grid, roughly determine 3 of the 4 coordinates (left, right, top, or bottom of the grid). Enter these 3 numbers, and clear the fourth field entirely by selecting the contents and deleting or just pressing backspace. Now mark the "Autoscale fourth coordinate" checkbox. The coordinate you did not specify will be AutoScaled to the exact y to x ratio needed to make the grid look square.

You can also easily select a new range using the mouse and the **Range** button in the Button Bar. First select the area you want to see with the mouse by holding down the left button and enlarging the selection rectangle. Since the computer is better at maintaining a square aspect ratio than you are, you don't have to worry about doing this perfectly. Depending on how you draw the rectangle, either the top or bottom y-coordinate will be AutoScaled. If you start from the bottom and draw up, the bottom coordinate will be fixed and the top one ignored and computed automatically. If you draw downward, the top coordinate will be fixed and the bottom one AutoScaled. When you have selected an area, click on the **Range** button to redraw the grid. Graphmatica will display the exact coordinates of the new range on the status line. If you do not click the **Range** button, the selection will be forgotten as soon as you click the mouse in the graph window, clear the screen, draw another graph, or make a new selection. **Note**: If you turn the AutoSquare option OFF, your selection will be taken literally, and the grid drawn without AutoScaling any coordinates, regardless of the effect on the aspect ratio.

AXIS LEGENDS

By default, Graphmatica labels the hatch marks across the graph with the number of their coordinate so that you can more easily locate points or find the coordinates of a graphed point. In some cases, though, especially when doing graphs near the axes, the numbers can be confusing and you may want to turn them off. To do this, either select the Legends option in the Labels menu or mark the checkbox in the Settings dialog box under the Options menu. To turn the legends back on, select the Legends option again.

ADDING A TITLE TO YOUR GRAPH

If you want to add a title line to your graph, or add labels to the left or right sides, select Title from the Labels menu. You can type in a new title, edit one you typed in previously, When you print, the title is written across the top of the graphs, and it is automatically centered. When you are graphing, unless you have selected the Always On option in the Labels menu, the labels are not shown.

Graphmatica can add text labels (regular printing going down instead of across) to both sides of your graph. Like the title, these labels are automatically centered (vertically) on the graph.

Click the Clear All button to delete all three fields. If you do this by mistake, just Cancel the dialog box and the labels will not be affected.

Unless the Always Draw Labels option is on, Graphmatica does not draw these labels immediately, since they are intended mainly to enhance hardcopy printing and no space is reserved for them on the screen.

LABELS ALWAYS ON OPTION

Selecting the Always On option from the Labels menu or marking the "Always Draw Labels" checkbox in the Settings dialog box makes Graphmatica always leave space on the screen to display the graph labels (title and left- and right-side), as well as display them if you have entered any. When this option is on, the labels will also be copied to the clipboard along with the grid whenever you perform an Edit Copy Graphs or Copy Graphs Mono command. (By default they are ignored except when you are printing.)

THE DEFAULT SETTINGS

When you first run Graphmatica without a graphmat.ini file, the following settings are in effect. Using the Defaults button in the Range, Theta Range, or Settings dialog boxes resets the options to these "factory" settings.

OPTION		DEFAULT
Grid Range	Start	(-8.0, ___*)
	End	(8.0, ___*)
Fineness		1.0
Legends		ON
Always Draw Labels		OFF
Warnings		OFF
Print tables		OFF
AutoRedraw		ON
# of equations to redraw (AutoNum)		1
Hog CPU		OFF
Monochrome		OFF
AutoSquare		ON
Theta Range		0 to 6.28 (2pi)
Default Scale Factor		2.0

Title, left, and right labels are cleared by default.

* Y ranges vary to provide a square aspect ratio; they are by default equal and opposite.

This provides a basic rectangular grid of decent size with the origin centered, a square aspect ratio (a 1x1 square on the grid really LOOKS square), and a good resolution graph.

VIEWING THE SETTINGS

You can quickly see the settings of the on-off options by seeing if they are checked in the menus. You can also look at almost all of the settings at once by selecting the Settings dialog box from the Options menu.

SETTINGS DIALOG BOX

The Settings dialog box in the Options menu allows you to control just about every option available in Graphmatica. Following is a description of its controls, from top to bottom:

Grid Range displays the current range. The two coordinates are the lower-left and upper-right hand corners. Click the **Change** button to call up the Adjust Range dialog box. Click the **Scale** button to scale the grid.

Theta Range shows the current domain of theta. Click the **Change** button to call up the dialog box to adjust this.

Fineness Factor Displays the current fineness factor; type in a new one if you like.

Checkboxes:

Draw Legends along Axes
: Mark to draw numbers indicating scale along the axes. On by default.

Print warning error messages
: Mark to display warning error messages while graphing. Off by default.

Print point tables
: Mark to show the Printout window and tables of points graphed while graphing. Off by default.

AutoRedraw On--Draw Last ___ equations.
: Mark the checkbox to turn AutoRedraw on. When it is on, you can also type in the number of equations you would like to redraw.

Always Draw Labels
: Mark to keep title and y-axis labels on-screen all the time.

Hog CPU while graphing
: Mark to "hog" the computer while graphing; increases performance at the cost of other programs that are running. Off by default.

Buttons:

OK Accept the current changes.

Cancel Forget the changes made in the Settings dialog box. If you changed the Grid Range or Theta Range, these changes will NOT be undone.

Defaults Set all the options to their default (as specified by Graphmatica, not your graphmat.ini file) settings. See Default settings for details. To reset the Grid Range and Theta Range, however, you MUST call up and use the Defaults buttons in their own dialog boxes.

Help Brings up this help screen.

CHANGING THE RANGE OF THETA

Because the independent variable (theta) in polar coordinates is fundamentally different from the 'x' of Cartesian coordinates, the Cartesian x/y ranges can only be used to determine the size of the screen and not the domain of the equation graphed for polar graphs. Although the default 0 to 2pi range is the typical range of theta used for most graphs that go on forever (like spirals) and some closed graphs (like circles), other graphs cannot be completely drawn in this range of theta. For instance, the figure-8-shaped "r^2=64cos(2t)", because it is undefined where the right half is less than zero, is missing a couple of spots unless theta's range is extended to -2pi to 2pi. To allow the greatest flexibility, Graphmatica allows theta's range to be changed independently of all other options.

To change the range, select Theta range from the View menu and enter the start and end of the range you want. For each end of the range, you can specify whether to use radians or degrees by marking the appropriate radio button. (The default is radians.) You can also specify that a number is given as a multiple of pi by marking the "x pi" box of each coordinate.

You can reset the domain to the default (0.0 to 6.28) by pressing the Defaults button.

The Theta Range dialog box can also be obtained by pressing the Change button next to the Theta Range display in the Settings dialog box.

If you would rather not change the default domain but simply change the domain for a single graph, see Specifying a Domain.

SPECIFYING POLAR DOMAINS

Although Graphmatica works exclusively with radians, you can enter a function of theta's domain in either radians, degrees, or radian multiples of pi. (Decimals are allowed, but no fractions can be entered.) To indicate a value is a degree measure, follow it with a 'd' (any numbers after the 'd' are ignored). To indicate it is a multiple of pi, follow it with a 'p' (again, 'p' must be the last character in your response). A plain number will be understood to be regular radians. You cannot use both the 'p' and 'd' options at once, but it would be ridiculous to measure degrees in multiples of pi anyway. So, to give a function the domain of negative 2 pi to 2pi, you would type "{-2p, 2p}" following your equation at the graph prompt.

ADJUSTING THE FINENESS

The fineness factor determines how high the resolution of the graph will be, and in effect, also the amount of time it takes to complete the graph. The fineness factor of 1 is quite adequate in most circumstances. Although Graphmatica's SmartFineness III automatic fineness adjustment gives consistent quality and speed on just about any equation, making the manual fineness adjustment almost obsolete, you can still manually control the fineness to fill the need for especially sharp graphs or for extra-quick renderings. SmartFineness automatically decreases the fineness when the point being graphed is not on the screen to speed up blank areas, then recovers automatically and backtracks to the spot where the graph comes on-screen again. It also varies the fineness with the slope of the equation being graphed--less when the slope is near-horizontal, greater when the slope tends toward vertical, so steep graphs are tracked more effectively. As the fineness is increased, more of the curve will be smoothed out, but remember that if you increase the fineness factor to 5, the computer will be slowed down to 1/5 its normal graphing speed under the load of all the extra calculations.

Fineness is also linked to the rate at which the angle is allowed to change in polar graphs, and both Cartesian and Polar graphs will be of comparable quality at the same fineness factor. Fineness is also linked to the step rate of parametric graphs; because they vary so much, it is harder to insure that all parametrics will graph well at the default fineness, but those that I have tested look fine.

When graphing differential equations (slope fields), the fineness factor controls the interval at which the hatch marks are drawn. If you use too high of a fineness value on this type of graph, you may not only get an awful mess on the screen, but also exceed the capacity of the data structure that records the points that were graphed for later redrawing. [At this point Graphmatica simply stops recording, so no harm can be done, but the graph will not redraw properly when the screen is repainted but not recalculated.]

To change the fineness factor, select Fineness from the View menu. You can either type a value in directly or use the scroll bar to select a value (the scroll bar is scaled in a logarithmic fashion so any distance to the right corresponds to the same increase in fineness as the same distance to the left of the middle). Any value greater than zero is valid; the default value is 1.0. Theoretically there are no other limits on the fineness, and you can type any value into the edit field you wish, but the scroll bar slider is limited to the reasonable range of about 0.2 to 6. I would recommend not going below 0.25, as the image quality suffers and the graphs begin to look like modern art. Also a factor greater than 5 can bring even a fast computer to a snail's pace.

WARNING MESSAGES

By default, the error messages which do not require the equation to be retyped are suppressed, because they slow down the graphing process, cover up the equation, and are somewhat annoying when you know the graph shouldn't produce any values in some area. (Also, it saves you the effort of specifying the domain for each equation.) If something goes wrong (e.g. the graph doesn't show up on screen when it should and the reason isn't readily apparent), you can turn on the warning messages (using the Warnings function of the Options menu) and redraw it to see what the problem is. You can use the same menu option to turn the messages off later.

See Warning Messages for a complete list of warning error messages.

MONOCHROME OPTION

If you are using a monochrome monitor that does not do gray scales well (i.e. a laptop computer's) and you have trouble finding your equations, you can select Monochrome in the Options menu to make Graphmatica draw only in black on a white background. Also, the messages in the status bar are only printed in black when this mode is on.

The status of the Monochrome option only affects what you see on the screen. It does not control output to the printer or the clipboard. You can copy either a monochrome or color bitmap at any time by selecting the appropriate option in the Edit menu. Color printing is not supported at this time, so all printed output is monochromatic regardless of the state of this option.

Hog CPU OPTION

By default, Graphmatica acts like a good little Windows application and yields the computer's resources to other applications as Windows sees fit at all times, including when it is calculating a graph. This can lead to performance degradation, especially if while graphing you do something equally power-hungry like load up and recalculate a 200k spreadsheet in Excel. Also if another application starts a time-consuming task that cannot be interrupted, Graphmatica cannot continue to draw until that application yields control back. If you want to get lean and mean, check Hog CPU in the Options menu. With Hog CPU on, every time Graphmatica draws or recalculates a graph it will keep the CPU exclusively to itself and not allow Windows to process any messages from other applications until the graph is finished.

WARNING: This option should be used with discretion. While you are drawing a graph with the Hog CPU option on, NO OTHER APPLICATION CAN RUN, even while you are pausing the graph. If you are also running a timing-sensitive application like a communications program doing a background file transfer, that application will likely fail in the time it takes Graphmatica to calculate and draw a new graph (unless you have a very fast processor).

AutoSquare FEATURE

Since working in a window that can be resized means that not only the size but also the shape of the grid can change at any time, the coordinates of the grid must be managed dynamically to prevent unwanted effects on the aspect ratio (simply put, whether a square on the grid looks square or is actually "scrunched" one way or another into a rectangle). Graphmatica has a feature to handle this called AutoSquare.

Whenever you resize the window, turn the print tables option on or off, or turn the graph labels on or off, the dimensions of the grid rectangle change. To keep the grid square when it matches the logical coordinates to the physical screen, Graphmatica keeps the logical width of the grid the same and figures out how much height must be added or subtracted to maintain good aspect ratio. It then divides this height difference by two and adjusts both the top and bottom of the grid by that much. (This way, whatever point on the grid was centered stays centered.)

The state of the AutoSquare option has several important side effects as well. When you save an equation list and include setup information, Graphmatica checks the AutoSquare option. If it is OFF, the dimensions of the grid will be recorded exactly. If it is ON, at least one coordinate will be recorded as "auto" so that no matter what shape the grid is when you load the file again, it will be squared correctly. (If the top and bottom coordinates are equal and opposite, they will both be saved as "auto" so they will be regenerated that way; if they are not, only the bottom coordinate will be saved as "auto". The x-coordinates are always saved exactly.)

When you select a new range using the mouse and the Range button, Graphmatica also refers to AutoSquare. If it is on, the height of your selection will automatically be modified before the new grid is drawn so that square aspect ratio is maintained. If AutoSquare is off, you're on your own.

AutoSquare is ON by default. You can turn it off by selecting it in the Options menu.

When you turn AutoSquare off, the coordinates of the grid will stay the same no matter what size it is. However, this does not prevent the need to recalculate graphs before displaying them again, since to conserve memory graphs are remembered as a list of *physical* points, not *logical* coordinates. Future versions of Graphmatica may support translation of coordinates between different physical grids, making faster redraw possible (at the expense of quality), but not the present one.

The status of the AutoSquare option does not affect automatic coordinate calculation when *loading* an equation list that contains a [grid] section. If AutoSquare was on when the file was saved (or it specifies "auto" for either or both y-coordinates), the grid will be squared. Otherwise it will be drawn with the exact dimensions it had when saved, regardless of x/y ratio.

EDIT MENU OPTIONS

Copy Graphs copies the current graphing screen in color into a bitmap and places it into the clipboard. You can then paste it into virtually any paint program and do whatever you like with the image. (If you have a color printer and a paint program that can print in color, copy the image and print using the paint program if you want color hardcopy.)

Copy Graphs Mono prepares a bitmap of the graphing screen using only black and white, so you can import the image into a document and print it without a color printer.

Hint: for the best possible image quality, let Graphmatica size the bitmap for you instead of scaling it with the paint program or word processor. The copied bitmap will always be the same size as the grid shown on the screen, so if you want a large bitmap, maximize the window, or for a smaller size, make the window smaller.

Copy Tables copies all of the text in the Printout window to the clipboard. If the Print Tables option is not selected, this menu item is disabled.

Copy Equations copies the selected equation (or, if no equation is selected, all of the equations entered in the redraw queue) to the clipboard, from which you can paste the text into any Windows application.

PRINTING PICTURES OF YOUR GRAPHS

Graphmatica prints through Windows' Graphic Device Interface, which means that you automatically get the convenience of both Windows' almost universal printer support and spooled output from Print Manager which allows you to work while the printer is running. (Note however that Graphmatica does not provide specific support for color printers, plotters, or printing over a network, so although you may be able to get satisfactory output using these devices, you might want to export a bitmap using one of the Edit Copy commands to a program that does support them and print it there.)

Except for Super Draft printouts, everything Graphmatica prints is scaled to use as much of the page as possible. When printing in Proof quality, Graphmatica creates a new graph screen in memory that has the same logical size as the one on screen, but whose physical size uses the maximum number of pixels on the display (i.e. 640x480--a routine I wrote to use some printers' higher-resolution abilities failed to print text but will hopefully work by the next release). It then redraws all the graphs listed as being on-screen on that grid and sends it to the printer. When printing in Draft mode, Graphmatica redraws the current graph screen in black-and-white in memory, and then expands that bitmap to fill the width of a page (8 inches). This does not take as much time as Quality mode, since the graphs are not recalculated, but setting up the bitmap can still take 2 minutes or more (the actual printing may take even longer, but this is entirely dependent on your printer). The trade-off in quality is that the smaller your grid on-screen is, the more it will have to be expanded to fill the page and the lower its resolution will be. The fastest way to print is Super Draft mode: Graphmatica does not manipulate the bitmap at all except to adjust the aspect ratio on printers that have fewer dots per inch in one direction than the other. Thus the printout will be faster because it is not expanded, although it will be smaller as well -- Super Draft printouts are dependent on the current size of the graph window. It is not advisable to use this mode on high resolution devices (i.e. over 150 dpi), especially if the graph window is not maximized, unless you literally want just a thumbnail sketch. If your printer has a lower-resolution draft mode, use Printer Setup to select it prior to printing in Super Draft. (NOTE: besides being a silly idea in the first place, printing in Super Draft mode on a laser printer may fail and cause the error message "bitmap didn't print". If this happens, as it did to me inexplicably when I tested the Laserwriter II, just use another print mode.)

The grid in a Proof Quality printout will not necessarily look like the one on the screen. Although it will have the same dimensions, the grid markings and the legends along the axes may be placed at smaller intervals due to the increase in resolution. While you are printing in Proof Quality, Graphmatica gives you progress reports on which equation it is graphing using the status line.

To print, select Print from the File menu, then select the print quality you want (Draft is the default.) If you have trouble distinguishing between graphs and other markings on the grid on the printout, you may want to mark the "Draw graphs with wide lines" checkbox. [This increases the width of the "pen" used to draw graphs from one pixel to two.] Then click the Print button.

You can abort any print operation by pressing Escape or clicking the cancel button in the dialog box. However, the Print Manager may not close itself as it should after you abort the print operation, and repeated aborts may make the link between Graphmatica and the Print Manager unstable and prohibit printing. I am still investigating the cause of this problem, but I will fix it as soon as I can.

Use the Printer Setup menu item to call up the setup dialog box of the current default printer driver if you need to change the settings on your printer. If you do not have a default printer installed, or you want to change printer drivers, you can't use Printer Setup; you must run

Control Panel from the Program Manager.

PRINTING POINT TABLES

This feature allows you to prints a table of coordinates as the program is drawing your graph. When you select the Print Tables option, the rightmost third of the screen is devoted to the Printout window: a listbox displaying the coordinates of graphs as they are drawn. Later you can copy the contents of the Printout window to the clipboard for importing into a document, printing, etc. using the Edit Copy Tables feature. This option is available to aid the drawing of graphs by hand and provide a reference for labeling the axes if you print the graph without the legends on.

By default, the print tables option is OFF; it restricts the space available for the grid and the process does slow graphing a bit.

You can turn it on or off by selecting Print Tables in the Options menu.

Graphmatica's Command Line Arguments...

have been removed for the most part since they are not likely to get much of a workout in Windows where there is no command-line. All of the startup options have been moved to the GRAPHMAT.INI file (See Saving Setup Information for details) except:

filename[.ext]

Specifying the name of a valid equation list file (with or without the ".GR" extension) loads that file upon startup. Unless autoredraw=off is specified in the [options] section of the file, the graphs are drawn as soon as the grid is drawn. You can abort the whole redraw by aborting one of the graphs.

You can provide any number of files for loading; the only restriction is that if they contain a total of more than 25 equations, some of the first equations loaded will not be stored. Also the graph title and options will be set to those found in the last file specified, and any other file's settings may be forgotten.

If you associate the .GR extension with Graphmatica (using the File Manager Associate command or by adding a line to you win.ini file), you can load a file by double-clicking on it in the File Manager.

SHAREWARE

Feel free to distribute copies of Graphmatica to your friends and upload it to bulletin board systems AS LONG AS 1) you charge no fees for its use or distribution and 2) you do not modify the program or documentation files in any way.

You have license to use this program as you see fit but it is to be taken AS IS with no warranties, express or implied. I know of a few minor bugs, but no serious bugs that could cause loss of data (although with Windows a system crash is always a risk). Please tell me about any bugs you may find to be especially bothersome that I should correct for the next release.

If, after using Graphmatica, you find that it is easy, helpful, and convenient to use, please support the release of future versions by filling out the registration form on the next page and sending your contribution (payable to Keith Hertzer) to the address below:

kSoft, Inc.
345 Montecillo Dr.
Walnut Creek, CA 94595-2613

If you send $20 or more, you will be registered to receive a diskette with the next versions of Graphmatica for Windows and DOS when they become available, along with promotional copies of other kSoft programs. For releases after that, you will be informed that a new version is available and where you can download it.

Graphmatica support is now available via CompuServe®. From now on, new releases will be uploaded to the Math and Science forum. (Type "GO SCIENCE".) If you have any questions or feedback, send me e-mail. (My user ID is 70711,2071.)

Even if you cannot send any money, please help me out by filling out the response form found in REGISTER.TXT and (e-)mailing it to me, especially if you have any suggestions about what I should add to the next upgrade.

WHAT'S NEXT? This is the first release of Graphmatica for Windows, written in about 3 months as my first attempt at using the Windows environment. There are several weak points I intend to work on, like color and font support. Doubtless as I become more adept at using the Windows resources, Graphmatica will become easier to use and more visually striking. Graphmatica for DOS will continue to be available, functionally equivalent to the Windows version but still able to run on less powerful platforms. I also plan to begin work on a version for X/Windows in 1992 which will be available on Unix networks.

If you would like a copy of the source code for Graphmatica (compiled under Microsoft QuickC® for Windows version 1.0), please send me $20 and a short note telling why you would like it.