Chapter 20
Graphs

Mathcad graphs are both versatile and easy to use. To create a graph, click where you want to insert the graph, choose **Graph⇒X-Y Plot** from the **Insert** menu, and fill in the placeholders. You can modify the format extensively, including reformatting the axes and curves and using a variety of different types of labels.

The following sections describe the use of Mathcad graphs:

Creating a graph

Basic steps in creating and editing a graph. QuickPlots versus graphs where you explicitly specify the range of values over which to plot.

Graphing functions

Procedures for graphing functions.

Graphing a vector

Procedures for graphing vectors.

Graphing more than one expression

Procedures for creating graphs with multiple traces.

Formatting the axes

Procedures for modifying the formats of the *x*- and *y*-axes.

Formatting individual curves

Procedures for modifying the formats of curves or traces in a graph.

Setting default formats

Procedures for using default format settings.

Labeling your graph

Procedures for working with titles, axis labels, and other labels.

Modifying your graph's perspective

Procedures for changing the size of the graph, zooming in on a portion of the graph, and finding coordinates in it.

Gallery of graphs

A set of sample graphs illustrating options for creating graphs.

Creating a graph

You create X-Y graphs in Mathcad using the *X-Y plot operator*. The X-Y plot operator, like other Mathcad operators, has placeholders for you to fill in that specify expressions to be computed and displayed.

You can insert the X-Y plot operator into your worksheet in one of three ways; although these methods are equivalent, only the first is mentioned in the rest of this chapter. Click in your worksheet where you want your graph to appear and either:

- Choose **Graph⇒X-Y Plot** from the **Insert** menu; or
- Press the **@** key; or
- Click on the X-Y Plot button in the Graph Palette.

The X-Y plot operator is very flexible, letting you either:

- Create a *QuickPlot* based only on one or more expressions of a single variable, the dependent variable. Once you have entered the expression(s) in the placeholder on the *y*-axis, Mathcad automatically creates the plot over a range of –10 to 10 for the dependent variable on the *x*-axis.
- Explicitly enter expressions on both the *y*-axis *and* *x*-axis that specify the range of values over which to plot. Usually these expressions depend on range variables you have previously defined in your worksheet. If the range variables aren't previously defined, Mathcad will generate appropriate range variables for the plot.

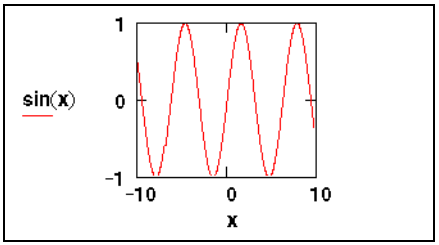
This section outlines the difference between these two uses of the X-Y plot operator. The sections "Graphing functions" on page 468, "Graphing a vector" on page 469, and "Graphing more than one expression" on page 474 describe the kinds of expressions you can plot in greater detail. See "Formatting the axes" on page 476 and "Formatting individual curves" on page 482 for an introduction to Mathcad's plot formatting options.

QuickPlots

You can quickly and easily create X-Y graph from a single Mathcad expression. To do so:

- Enter the expression or function of a single variable you want to plot. Make sure the editing lines remain in the expression.

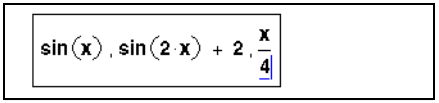
- Choose **Graph⇒X-Y Plot** from the **Insert** menu.
- Press [**Enter**] or click away from the graph.

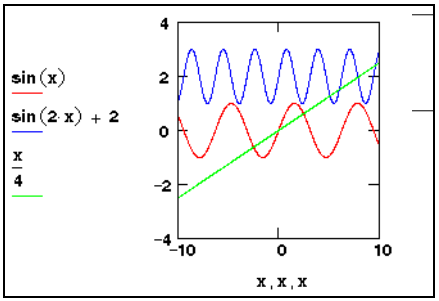


Mathcad automatically produces a plot over a default range of the dependent variable on the *x*-axis: –10 to 10. You can change the axis range by editing the upper and lower limits on the *x*-axis. See "Setting limits for axes" on page 478.

To graph more than one expression using a QuickPlot:

- Enter the expressions or functions of a single variable you want to plot, separated by commas. Make sure the editing lines remain in the expression.
- Choose **Graph⇒X-Y Plot** from the **Insert** menu.
- Press [**Enter**] or click away from the graph.





Mathcad produces a plot of all the expressions or functions, again over a range of –10 to 10. You can change the axis range by editing the upper and lower limits on the *x*-axis as described in "Setting limits for axes" on page 478.

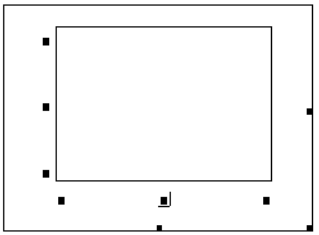
Notice that you can create a QuickPlot in one of two ways. You can either:

- First type the expression(s) and then choose **Graph⇒X-Y Plot** from the **Insert** menu, in which case your expression appears automatically in the *y*-axis placeholder; or
- First choose **Graph⇒X-Y Plot** from the **Insert** menu and then enter the expression(s) in the *y*-axis placeholder.

Explicitly specifying the range on the *x*-axis

When you want to specify the *x*-axis argument or the range variable used, you can create a graph following these steps:

- Click in your worksheet wherever you want the graph to appear.
- Choose **Graph⇒X-Y Plot** from the **Insert** menu. Mathcad creates an empty graph with six placeholders, three on each axis.



To see the graph, fill in the placeholders:

- The placeholder at the middle of the horizontal axis holds the variable or expression to graph against. Enter a range variable, a subscripted variable, or any other expression involving a range variable in this placeholder.
- The placeholder at the middle of the vertical axis holds an expression to graph. Enter a range variable, subscripted variable, or any other expression involving the range variable on the horizontal axis.
- The other four placeholders can be used to override Mathcad's automatic choices of axis limits. For more information about axis limits, see "Setting limits for axes" on page 478.

Mathcad graphs one point for each value of the range variable. If you don't define the range variable in your worksheet, as described above, Mathcad automatically generates an appropriate range for the dependent variable in your plot. Range variables are discussed in Chapter 11, "Range Variables."

Graphs typically have one or more expressions involving range variables on each axis. Be aware that it's usually an error to use two different range variables in the same curve, or *trace*, on a graph. If you use two range variables in the same trace, Mathcad tries to graph one point for each value of each range variable. For example, if i ranges through 20 points and j through 30, and you try to plot y_i against x_j, Mathcad tries to graph a total of 600 points. It is, however, permissible to use different range variables in different traces on the same graph.

Just as with an equation, Mathcad does not process a graph until you click outside the graph region. When Mathcad processes the graph, it draws one point for each value of each range variable in the x or y axis expressions and, unless you specify otherwise, connects them with straight lines.

Figure 20-1 shows some typical graphs with the placeholders filled in. Note the line that appears under the y-axis arguments. This indicates the trace type and color used to display the curve. See the section "Formatting individual curves" on page 482 to learn how to control this.

The graph in the upper left corner of Figure 20-1 is an example of a *parametric* plot: one in which the expressions you are plotting on the x-axis and y-axis are both functions of a single variable. If you do not explicitly define a range variable for the parameter in such a plot, Mathcad uses a default range for this variable to create the graph.

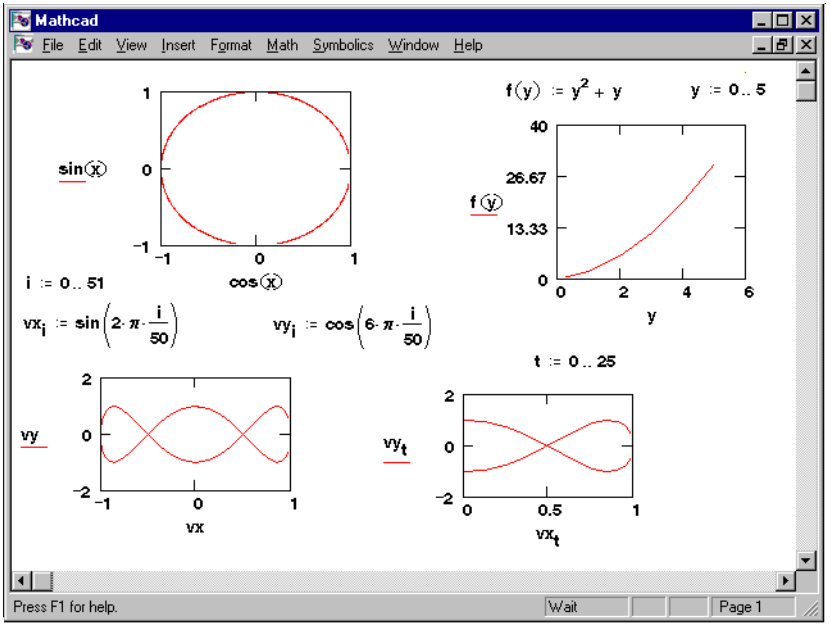


Figure 20-1: X-Y graphs of expressions, functions, and vectors.

If an expression is complex, Mathcad graphs only the real part. The imaginary part is ignored. Note that no error message will be displayed.

Working with graph regions

You can drag, cut, copy, and paste a graph just as you would any other math region. See Chapter 3, “Editing Equations,” for details.

To delete a graph from your worksheet:

- Press and hold down the mouse button just outside the plot.
- With the button still pressed, drag the mouse cursor so as to enclose the graphics region in a selection rectangle.
- Choose **Cut** from the **Edit** menu.

To move a graph, follow the instructions above for deleting it. Then click the mouse wherever you want the graph and choose **Paste** from the **Edit** menu. Alternatively, you can drag a plot as you would an equation.

See “Modifying your graph's perspective” on page 488 for Mathcad’s options for resizing graphs, zooming in on graphs, and reading coordinates from graphs.

Graphing functions

Each trace on a graph depends on a range variable, and Mathcad graphs one point for each value in the range variable. As mentioned in the previous section, however, Mathcad automatically generates a default range for the dependent variable of an expression you type in the *y*-axis and creates the graph over it if you do not explicitly define a range variable.

If you want to specify exactly what range of values the range variable has, you can define a range variable in your worksheet. This method is described in the following sections.

Graphing a function

To graph a function over a range, as shown in Figure 20-2, do the following:

- Define a range variable, such as *x*, that ranges over the values you want to graph. (The range variable need not be called *x*; you can use any valid Mathcad name.) See Chapter 11 for instructions on defining a range variable.
- Type the expression you want to plot in the middle placeholder of the *y*-axis and type *x* in the middle placeholder of the *x*-axis.
- Click anywhere outside the graph region to see the plot.

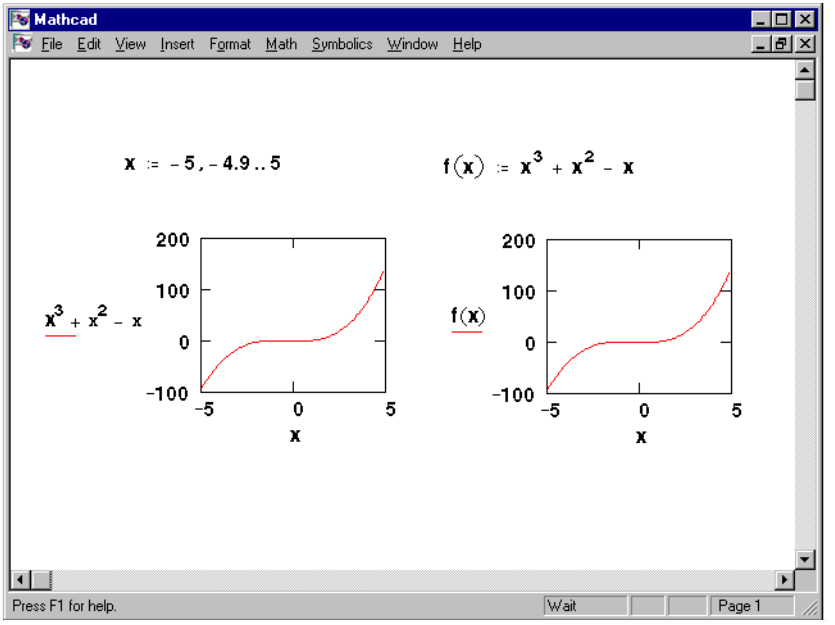


Figure 20-2: Graphing an expression against a range variable.

You can also define a function $f(x)$ and place it in the middle placeholder of the y-axis. This is particularly useful when the expression you want to plot becomes large and unwieldy. The second graph in Figure 20-2, above, shows the same plot as the first graph in the figure, except that it is made with a function definition.

Using functions for polar plots

By creatively using the tools presented in this chapter, you can plot a wide variety of closed curves. The example in Figure 20-3 illustrates how to transform polar into rectangular coordinates. This technique lets you create polar plots, or even paths in the complex plane. In Figure 20-3, the equation for the cardioid in polar coordinates is given by $r(\theta)$. The equations for $x(\theta)$ and $y(\theta)$ are the usual transformation from polar to rectangular coordinates. See Chapter 21, "Polar Plots," for a description of Mathcad's built-in polar plotting capabilities.

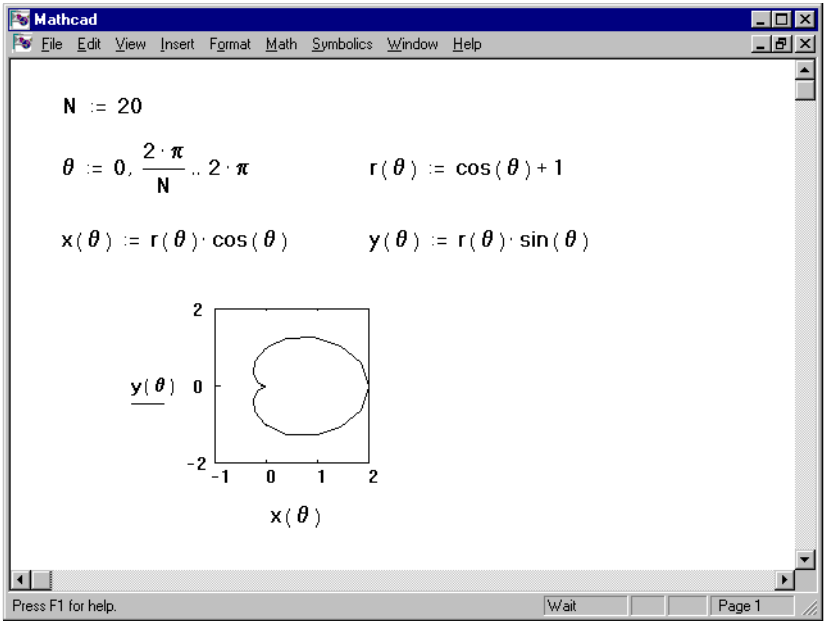


Figure 20-3: Two functions computed independently.

Graphing a vector

To graph the elements of a vector, you need to use the vector subscript operator to specify which elements to plot. A graph of a vector is shown in Figure 20-4. To create this graph, do the following:

- Define a range variable i that references the subscript of each element you want to plot.

- Define a vector y_i. Use the left bracket key, **[**, to create the subscript.
- Press **@** to create an empty plot region.
- Place y_i in the middle placeholder of the vertical axis and *i* in the middle placeholder of the horizontal axis.
- Click anywhere outside the graph region to see the plot.

A graph created using these steps is shown in Figure 20-4.

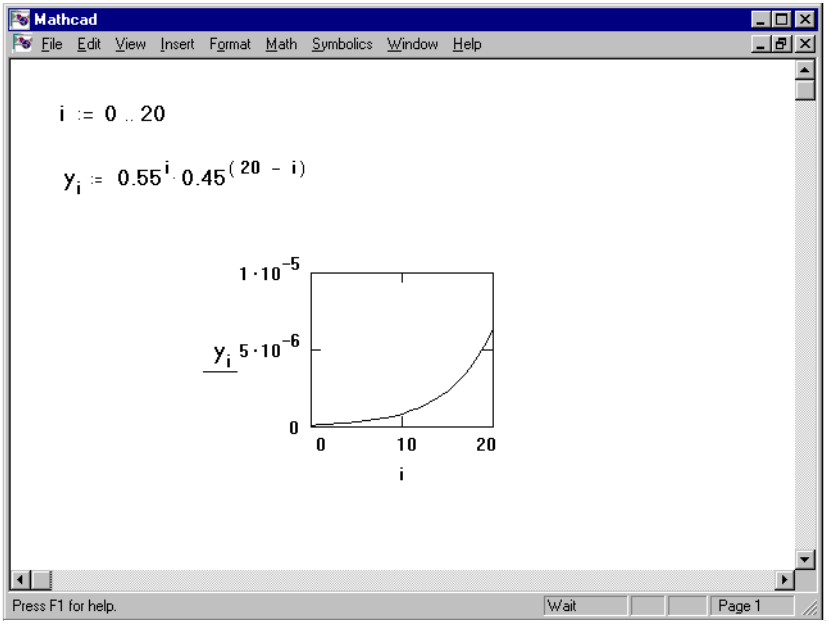


Figure 20-4: Graphing a vector.

Subscripts must be non-negative integers (or integers greater than or equal to ORIGIN, if ORIGIN≠0.) This means that the *x*-axis variable used in a graph like Figure 20-4 can run through whole-number values only. If you want to graph fractional or negative values on the *x*-axis, graph a function as in Figure 20-2, or graph two vectors as described in the next section.

If you have a handful of data points that don't have a convenient functional relationship as in Figure 20-4 but there are too few of them for you to use data files, you might want to use an input table to create a vector. For more information, see “Entering data manually” on page 435.

Graphing one vector against another

To graph all the elements of one vector against all the elements in another, enter the names of the vectors in the *x*- and *y*-axis placeholders on the graph. For example, to create the first graph shown in Figure 20-5:

- Define *x* and *y* as shown in the figure.

- Press @ to create an empty graph region.
- Place y in the middle placeholder of the *y*-axis and x in the middle placeholder of the *x*-axis.
- Click anywhere outside the graph region to see the plot.

Mathcad plots all the elements in the vector *x* against the elements in the vector *y*. If the vectors are not the same length, Mathcad will plot the number of elements in the shorter vector.

In some cases, you may prefer to explicitly tell Mathcad which elements of the vectors to plot. This is useful when you want to only plot some of elements. To plot certain elements as opposed to all of them, you must define a range variable and use it as a subscript on the vectors. The subscript references the elements to graph. A graph produced using this method is shown in Figure 20-1. The vectors do not need to be the same length. The only requirements are:

- The two vector must share the same subscript. For example, you cannot plot x_i against y_j because *i* and *j* are not the same subscript.
- Each value of the subscript must correspond to an element in each vector. For example, if *x* has only two elements and *y* has eight elements, and the range variable goes from 0 through 7, you will get an error.

To create the plot shown in the bottom right of Figure 20-1, do the following:

- Define a range variable *t* that references on the subscript of each element you want to plot.
- Define the arrays vx_t and vy_t. Use the left bracket key, [, to create the subscript.
- Press @ to create an empty graph region.
- Place vy_t in the middle placeholder of the *y*-axis and vx_t in the middle placeholder of the *x*-axis.
- Click anywhere outside the graph region to see the plot.

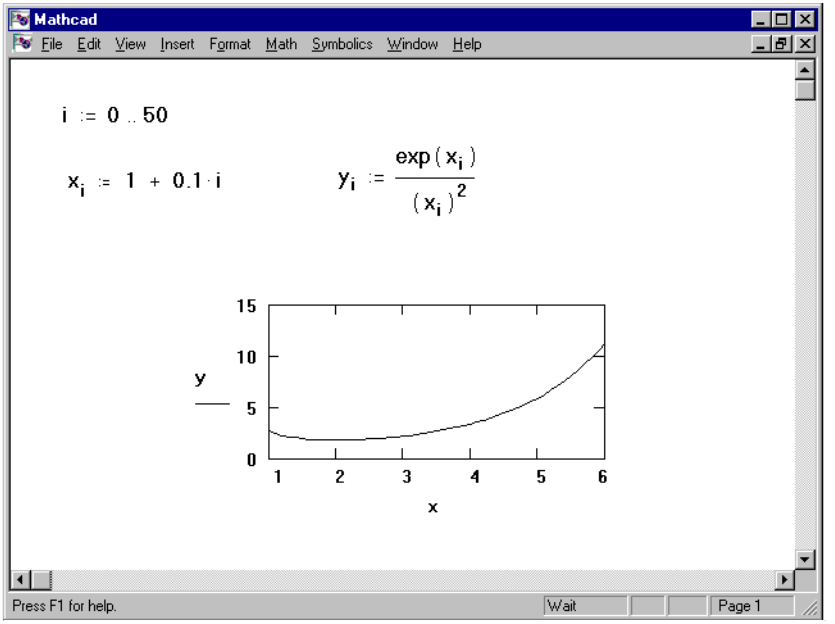


Figure 20-5: Graphing two vectors.

Although the *x* vector in Figure 20-5 is a list of evenly spaced values, this need not be the case. Only the *i* values are required to be evenly spaced integers. No such restriction exists for the x_i. This allows you to plot something besides integers on the *x*-axis while still satisfying the requirement for integers as subscripts.

In Figure 20-5, the y_i came directly from the x_i. Other applications might compute *x* and *y* independently from a third variable. As long as the two vectors use the same range variable, you can graph them on the same graph. Figure 20-6 shows a polar graph in which both *x* and *y* depend on the variables *r* and θ. Figure 20-6 uses vectors to do what was done with functions in Figure 20-3.

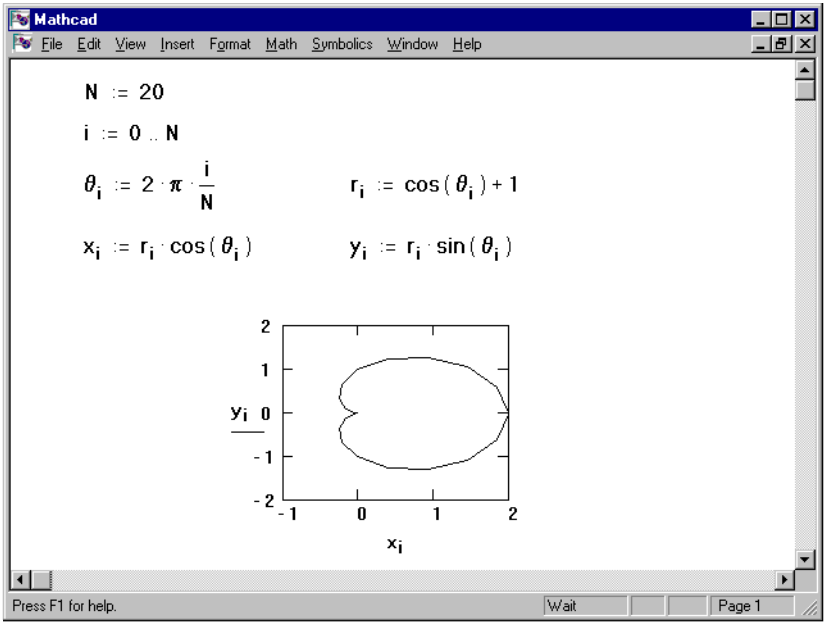


Figure 20-6: Two vectors computed independently.

Note that in Figure 20-6, the range variable *i* must have integer values and must be used to define a vector, namely θ, of equally spaced non-integer values. In Figure 20-3, however, we could define θ directly as a range variable. This is because functions do not require integer arguments the way vectors require integer subscripts.

Graphing data

You don't have to use Mathcad to generate the vectors that you plot, as was done for the example in Figure 20-5. You can create vectors by reading in data from a data file, by pasting in the data from the clipboard, or by typing data directly into an input table. These techniques are described in Chapter 19, “Data Management.” Once you create vectors from data—for example, by extracting columns from a matrix—you can plot the vectors just as you would plot any vectors, as discussed in the previous section. See Figure 20-7 for an example of plotting vectors from data imported from an external file.

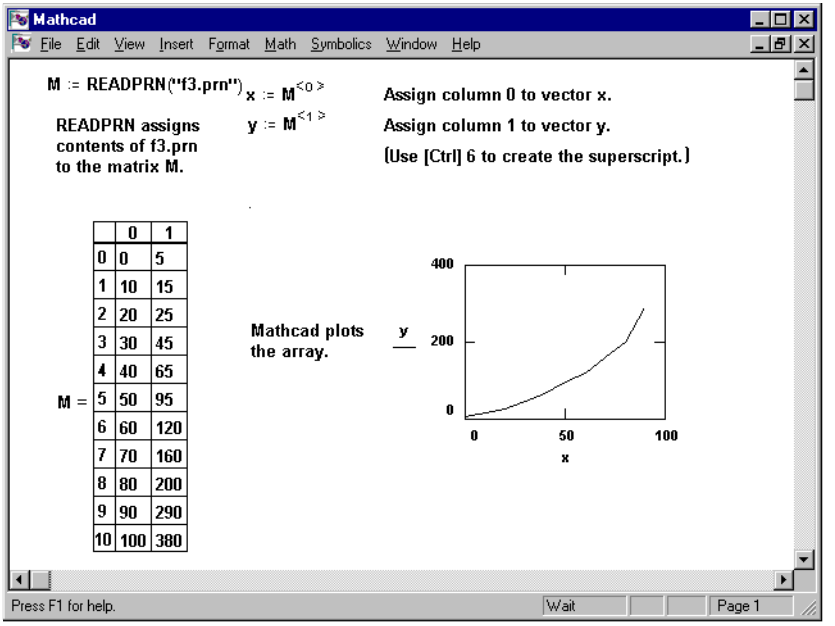


Figure 20-7: Plotting vectors from imported data.

Graphing other expressions

The examples in Figure 20-2 through Figure 20-7 show some of the most common types of graphs. However, graphs are not limited to these examples. You can graph any expression against any other expression, as long as they share the same range variables. For example, see Figure 20-12 for an example of graphing a constant to be used as a marker on the graph of another function.

Graphing more than one expression

You can graph several traces on the same graph. A graph can show several *y*-axis expressions against the same *x*-axis expression, or it can match up several *y*-axis expressions with corresponding *x*-axis expressions. One way to graph several expressions is to create a QuickPlot as described in the first section of this chapter.

Alternatively, you can graph several *y*-axis expressions versus one *x*-axis expression, using a conventional graph. To do so, choose **Graph⇒X-Y Plot** from the **Insert** menu and enter the first *y*-axis expression in the *y*-axis placeholder followed by a comma. You'll see a placeholder immediately below this first expression. Enter the second expression here, followed by another comma to get another empty placeholder. Enter the next expression. All the expressions should use the same range variable, as shown in Figure 20-8.

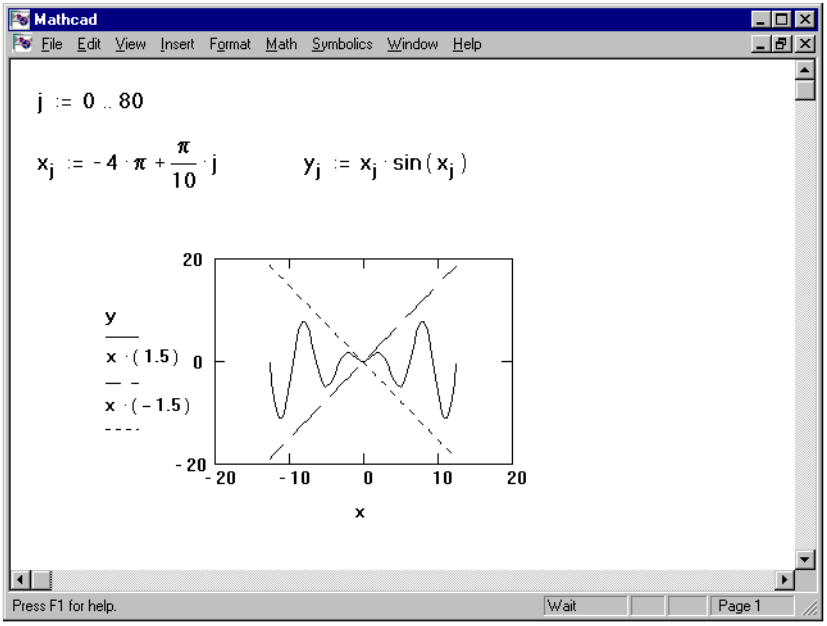


Figure 20-8: Graph with multiple y-axis expressions.

To graph several independent curves on the same set of axes, enter two or more expressions separated by commas on the *x*-axis and the same number of expressions on the *y*-axis. Mathcad matches up the expressions in pairs—first *x*-axis expression with first *y*-axis expression, the second with the second, and so on. It then draws a trace for each pair. Each matching pair of expressions should use the same range variable. The range variable for one pair need not match the range variables for the other pairs.

You can plot up to 16 arguments on the *y*-axis against 1 argument on the *x*-axis.

Figure 20-9 shows an example in which the range variables differ for each pair. Note however, that all traces on a graph share the same axis limits. For each axis, all expressions and limits on that axis must have compatible units.

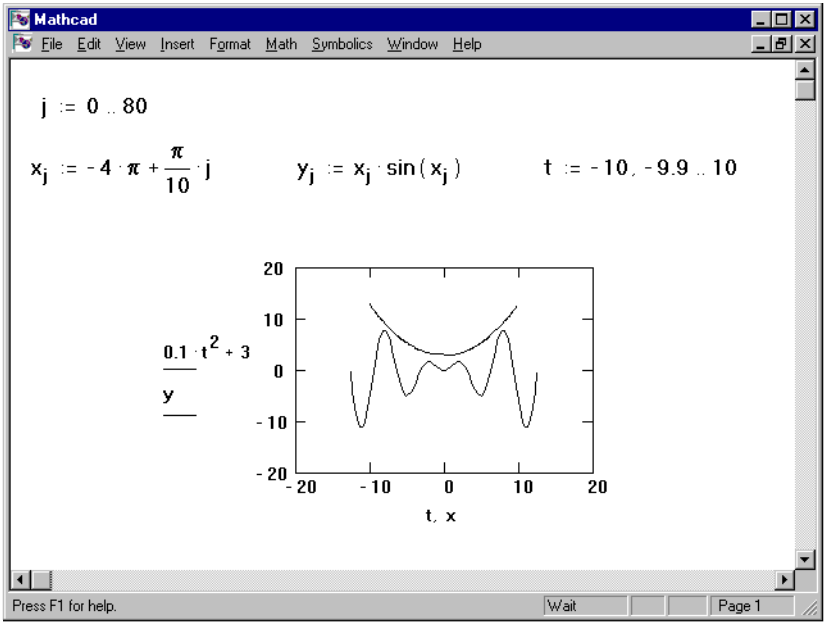


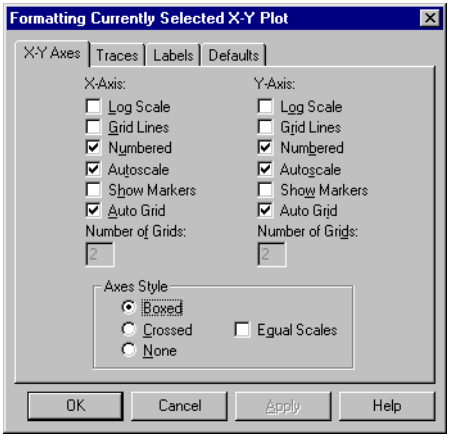
Figure 20-9: Graph with multiple expressions on both axes.

Formatting the axes

You can reformat your graph's axes, using the X-Y Axes page of the Formatting Currently Selected X-Y Plot dialog box.

To change a graph's format:

- Click in the graph to select it.
- Double-click in the graph. Alternatively, choose **Graph⇒X-Y Plot** from the **Format** menu. You'll see the dialog box for formatting X-Y plots.
- If necessary, click the X-Y Axes tab to display the X-Y Axes page, shown below.
- There is a complete group of settings for each axis. Change the appropriate settings.
- Click “OK” to accept your changes and close the dialog box. Mathcad redraws the graph with the new settings in effect. Alternatively, click “Apply” to see the graph redrawn without closing the dialog box. Click “Close” to close the dialog box.



If you initiate this process by double-clicking on an axis, you'll see an equivalent dialog box for that axis alone.

The rest of this section describes the settings on the X-Y Axes page of the dialog box for formatting X-Y Plots. It then provides detailed discussions about options for setting axis limits and for adding horizontal and vertical reference lines to your graph.

Axis settings

Each axis has the following settings associated with it:

Log Scale

When this box is checked, the selected axis is logarithmic and the axis limits must be positive. The bottom-right-hand graph in Figure 20-16 on page 493 illustrates a graph with a logarithmic axis.

Grid Lines

When this box is checked, the tick marks on the selected axis are replaced by grid lines. The top-right-hand graph in Figure 20-16 on page 493 illustrates a graph that uses grid lines rather than tick marks.

Numbered

When this box is checked, the tick marks on the selected axis are numbered.

Autoscale

This controls axis limits that you don't otherwise specify. When this box is checked, Mathcad rounds the axis limit to the next major tick mark. When unchecked, Mathcad sets the axis limit to the data limit. For a discussion of Autoscale and the other ways to set axis limits, see “Setting limits for axes” later in this section.

Show Markers

When this box is checked, you can add reference lines to your graph. For a discussion of Show Markers and another way to create horizontal and vertical reference lines, see “Adding horizontal and vertical lines” later in this section.

Auto Grid

When this box is checked, Mathcad automatically selects the number of grid

intervals created by tick marks or grid lines on the axes. When the box is unchecked, you choose the number of grid intervals by typing in the box labeled "No. of Grids". Enter a number from 2 to 99. You can specify the number of grid intervals only when Log Scale is unchecked. Figure 20-21 on page 495 illustrates the effect of Auto Grid.

In addition to these check boxes, the X-Y Axes page contains the following:

No. of Grids

When available, this text box indicates the number of grid intervals on the associated axis. You can enter a number between 2 and 99, inclusive. This box is only available when Auto Grid and Log Scale are unchecked.

Axes Style

These buttons define the style in which the graph will show the axes. Boxed axes are crossed in the bottom left corner of the graph. Crossed axes are crossed in the center of the graph. If you select None, no axes will be displayed on the graph. Figure 20-22 on page 496 illustrates the use of crossed axes. If you choose Equal Scale, both axes will use the same limits.

See the section "Setting default formats" on page 483 to learn how to:

- Quickly restore the graph to its default format settings.
- Use a particular graph as a model for all future graphs.

Setting limits for axes

Mathcad provides the following ways to set limits for axes:

- Automatically, with Autoscale turned on.
- Automatically, with Autoscale turned off.
- Manually, by entering the limits directly on the graph.

By default, a plot you create in Mathcad is autoscaled. With Autoscale on, Mathcad automatically sets each axis limit to the first major tick mark beyond the end of the data. This will be a reasonably round number large enough to display every point being graphed. With Autoscale off, Mathcad automatically sets the axis limits exactly at the data limits.

Figure 20-10 shows how turning Autoscale on and then off changes the way the graph looks.

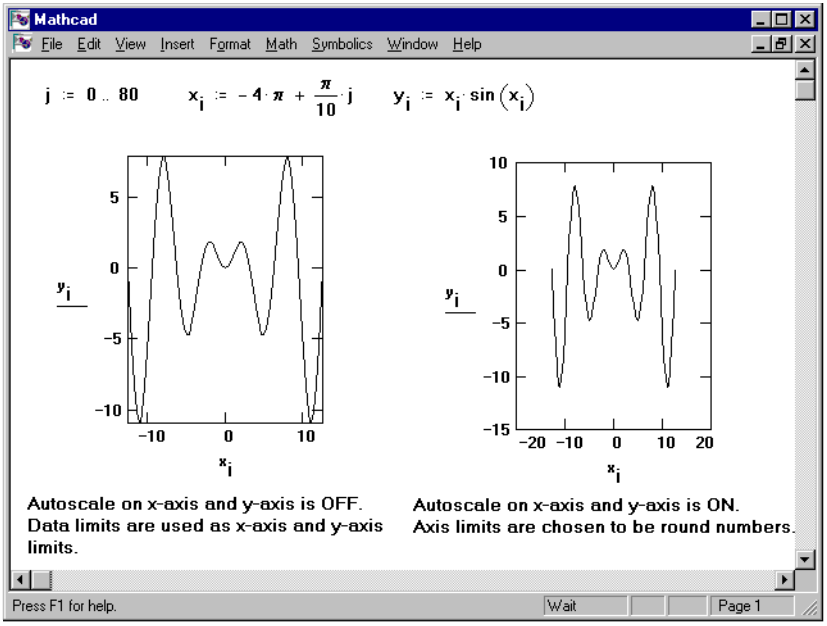


Figure 20-10: The effects of having Autoscale turned on and off.

To turn Autoscale off and have the axis limits automatically coincide with the end of the data:

- Click on the graph to select it and then choose **Graph⇒X-Y Plot** from the **Format** menu. Mathcad displays the dialog box for formatting X-Y graphs, shown on page 476. Click the X-Y Axes tab if the X-Y Axes page is not displayed. (You can also double-click on the axis itself to see a similar dialog box.)
- Click on Autoscale for the appropriate axis to remove the check and to toggle Autoscale off.

You may want to use axis limits other than those set by Mathcad. You can override Mathcad's automatic limits by entering limits directly on the graph. To do so:

- Click the graph to select it. Mathcad displays four additional numbers, one by each axis limit. These numbers are enclosed within corner symbols, as illustrated in the selected plot in Figure 20-11.
- To set the axis limit on the horizontal axis, click on the number underneath the appropriate *x*-axis limit and type the number at which you want the axis to end. To set an axis limit for the vertical axis, do the same thing to the number to the left of the appropriate *y*-axis limit.
- Click outside the graph. Mathcad redraws it using the axis limits you specified. The corner symbols below the limits you changed will disappear. Figure 20-11 shows the effect of manually setting limits on a graph.

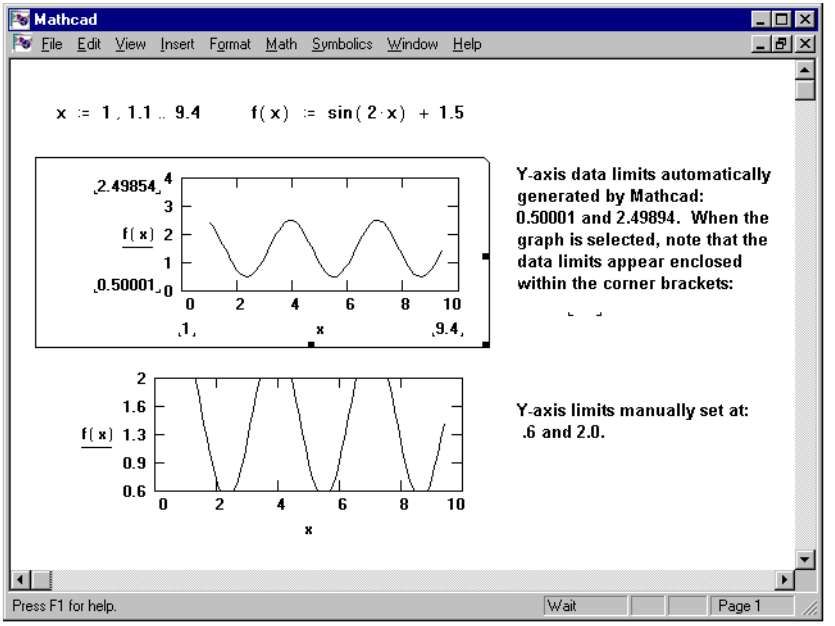


Figure 20-11: Data limits set manually and automatically.

Adding horizontal and vertical lines

Mathcad places linearly or logarithmically spaced tick marks or grid lines on a graph. The spaces between these markings are relatively round numbers that span the range of values on each axis. There may, however, be occasions when you need to place a line somewhere other than where Mathcad would normally place a grid line.

To add a horizontal or vertical line to a plot:

- Click in the plot to select it.
- Choose **Graph⇒X-Y Plot** from the **Format** menu or double-click on the graph to bring up the dialog box for formatting X-Y graphs.
- If necessary, click on the X-Y Axes tab to display the X-Y Axes page, as shown on page 476.
- For a vertical line, click on Show Markers in the X-axis column to add a check; for a horizontal line, click on Show Markers in the Y-axis column to add a check. Click "OK". Mathcad shows two additional placeholders on each axis for which you have Show Markers checked.
- To add a vertical line, click on one of the placeholders under the *x*-axis and type in a value at which you want a line drawn. For a horizontal line, do the same thing in one of the placeholders under the *y*-axis.

When you click outside the graph, Mathcad draws a dashed line at each number you specify. The number you type appears at the end of the line. To move the dashed line,

click on the number in the placeholder and change it. To delete the line, delete this number or click on Show Markers for the appropriate axis to uncheck it.

By using the Show Markers function, you can add to each axis one or two dashed lines stretching across the plot. When you need to place more than two lines or you need more control over the appearance of a line, you can add lines by plotting a constant expression.

- To create a horizontal line, place a range variable on the middle placeholder of the *x*-axis and the constant expression on the *y*-axis. Mathcad will plot a horizontal line across the plot at whatever value the constant value happens to be. The expression you place on the *y*-axis need not depend on the range variable you place on the *x*-axis.
- To create a vertical reference line, reverse the roles of the *x*- and *y*-axes. Place a range variable on the middle placeholder of the *y*-axis and the constant expression on the *x*-axis.

Figure 20-12 compares graphs having reference lines created by plotting constant expressions and by using the Show Markers option.

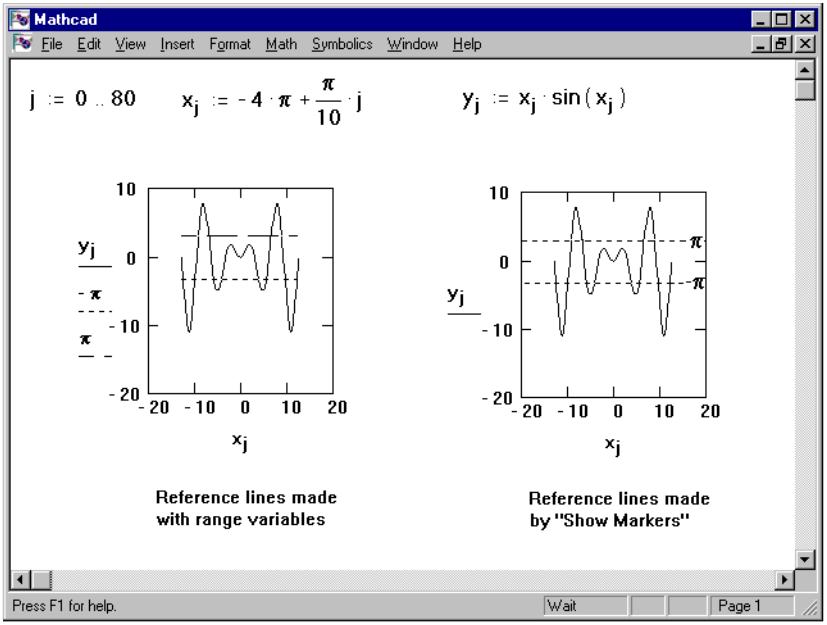


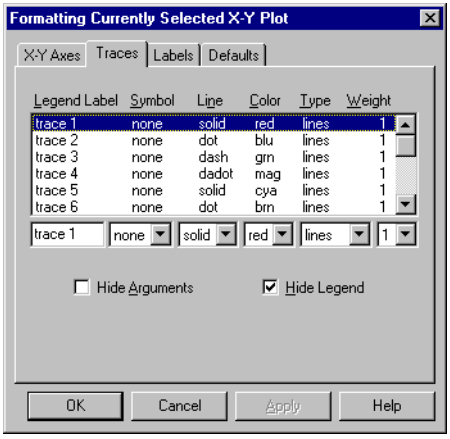
Figure 20-12: Graphs with reference lines.

Formatting individual curves

You can reformat the traces on your graph, using the Traces page of the dialog box for formatting X-Y graphs.

To reformat a graph's traces:

- Click in the graph to select it.
- Double-click in the graph. Alternatively, choose **Graph⇒X-Y Plot** from the **Format** menu. Mathcad displays the dialog box for formatting X-Y graphs.
- If necessary, click the Traces tab to display the Traces page.
- Click on the line in the scrolling list box for that trace. To change the name of the trace, type the new name in the text box under the "Legend Label" column. To change the symbol or marker, line type, color, trace type, or line weight of this trace, click on the arrow beside each text box to see a drop-down list of options, and then click on the option you want. See the next section, "Trace settings," for complete explanations of the various options in these lists.
- Click "OK" to accept your changes and close the dialog box. Mathcad redraws the graph with the new settings in effect. Alternatively, click "Apply" to preview your changes without closing the dialog box.



Trace settings

A graph can have up to sixteen individual traces. Each trace is described by a line in the scrolling list. Mathcad uses these lines as needed, assigning one for each trace in your graph. Each line has six fields:

Legend Label

This is the name of the trace as it would appear in the legend beneath the plot. See the section "Displaying or hiding arguments and legends" on page 488 for more

information about legends.

Symbol

This controls whether each point on the curve is marked with a symbol. You can mark each point with either an "×," a "+," a hollow box, a hollow diamond, a circle, or no symbol at all. If you have a lot of points packed closely together, you should probably select "none." Figure 20-19 on page 494 shows an example in which each data point is marked by with an "×."

Line

This controls whether the line is solid, dotted, dashed, or whether it consists of alternating dashes and dots. This feature provides a useful way to distinguish unmarked curves in black and white printouts.

Color

This controls whether the selected trace is red, blue, green, magenta, cyan (a light blue), brown, black, or white. Mathcad ignores this on monochrome displays.

Type

This controls the type of trace that will be displayed. Mathcad can generate the following types of plots: curves, bar graphs, stepped curves, error bars, stem graphs, and points. Figure 20-17 on page 493 has examples of step graphs and error bars. Figure 20-18 on page 494 has examples of stem graphs and bar graphs.

Weight

This controls the weight or thickness of the trace. Select from 1 to 9 (thinnest to thickest). Select "p" for a trace that is one device pixel wide. Although this may look like weight 1 on your screen, a high resolution printer will print it as a very fine line. This field also controls the size of the symbols marking data points, if you have selected a symbol other than "none". If you have selected trace type points, this field sets the weight of the dot plotted at each data point.

See "Setting default formats" on page 483 to learn how to:

- Quickly restore the graph to its default format settings.
- Use a particular graph as a model for all future graphs.

In addition to the scrolling list and its associated text box and lists, the Trace page has two check boxes: Hide Arguments and Hide Legend. These are explained fully in the "Displaying or hiding arguments and legends" on page 488.

Setting default formats

Mathcad uses default settings to format the axes and traces of new graphs as you create them. You can change these defaults in two ways:

- By saving as defaults the settings of your current graph.

- By using the Setting Default Formats for X-Y Plots dialog box, if you don't want to use an existing graph.

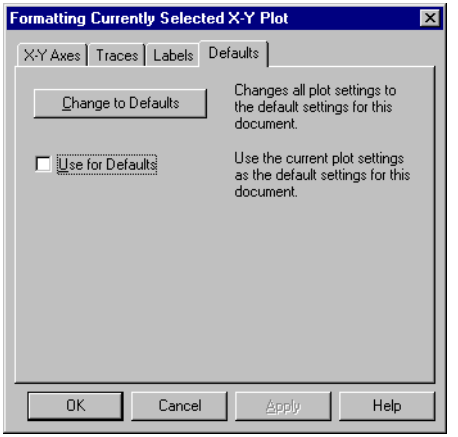
Changing defaults only affects new graphs; previously existing graphs are unaffected.

Copying defaults from an existing graph

One way to create a new set of defaults is to use the format settings of an existing graph. The advantage of this method is that you can actually see how the format settings look as you define them.

To use the format of a particular graph as the default graph format:

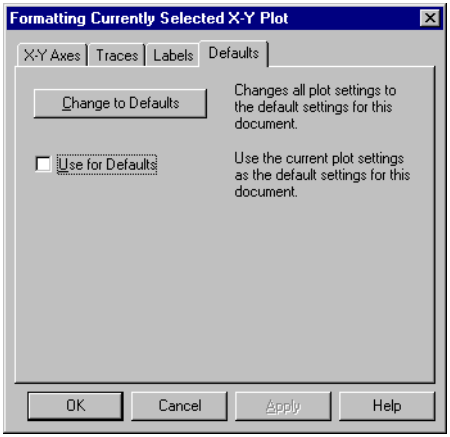
- Click in the graph to select it.
- Choose **Graph⇒X-Y Plot** from the **Format** menu or double-click on the selected graph. Mathcad displays the dialog box for formatting X-Y graphs. If necessary, click on the Defaults tab to see the Defaults page.
- If the Use for Defaults check box doesn't contain a check, click on it to add one. When you close the dialog box, Mathcad saves these settings as your default settings.



Setting defaults without using a graph

You don't have to use an existing graph to create or revise default formats. Instead, you can use the X-Y Axes page on the dialog box for setting X-Y plot defaults. To set defaults this way:

- Make sure that you don't have any graphs selected.
- Choose **Graph⇒X-Y Plot** from the **Format** menu. You'll see the dialog box for setting X-Y graph defaults. The following figure shows an example of this dialog box with the X-Y Axes page displayed.
- Change the appropriate settings on the X-Y Axes and Traces pages.
- Click “OK” to accept your changes and close the dialog box.



Using default graph settings

If you want to reverse the format changes that have been made to a graph since it was created, you can restore its original default settings. To restore the original defaults:

- Click the Defaults tab on the dialog box for formatting X-Y graphs. (See the figure on page 484.)
- Click “Change to Defaults.”
- Click “OK” to close the dialog box.

Mathcad redraws the graph, using the default format settings that were in place when the graph was first created.

Labeling your graph

Mathcad provides several ways to help you to identify what it is that you've plotted. You can choose to display:

- A *title*, either above or below the graph.
- *Axis labels* to describe what's plotted on each axis.
- *Legends* to identify the individual traces.
- *Arguments* showing what you typed into the *x*- and *y*-axis place holders.

Figure 20-13 shows the relative locations of each of these types of labels on a boxed axes graph and on a crossed axes graph.

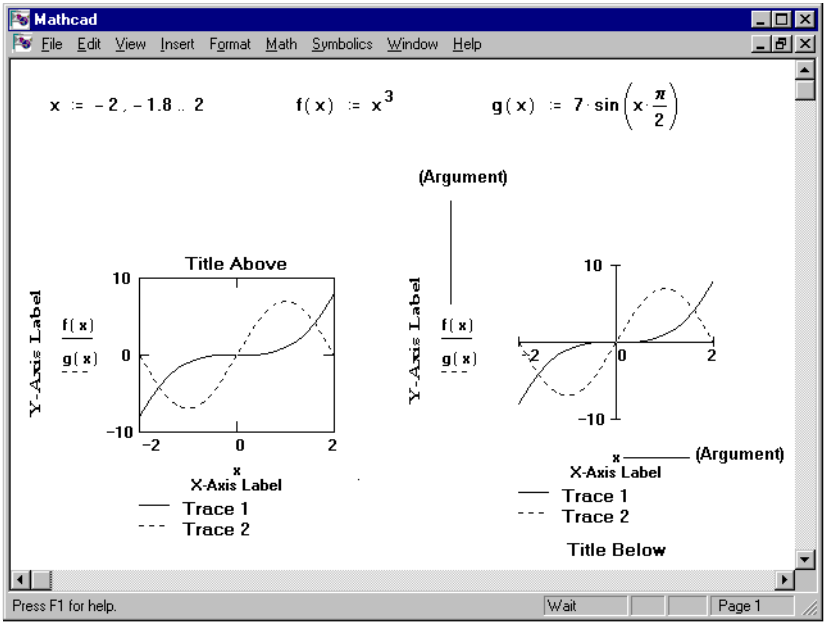


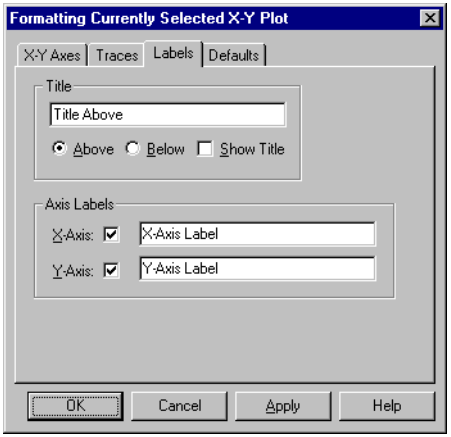
Figure 20-13: Graphs with different labels.

You can use these labels all together or in any combination. By default, Mathcad shows neither title nor axis labels, displays the arguments, and hides legends.

Working with titles

To add a title to a graph, follow these steps:

- Click in the graph to select it.
- Choose **Graph⇒X-Y Plot** from the **Format** menu or double-click on the selected graph. Mathcad displays the dialog box for formatting X-Y graphs. If necessary, click on the Labels tab.
- Type a title for your graph into the Title text box.
- Click on either the Above or Below button, depending upon where you want to put the title. Note, however, that Mathcad doesn't display the title until you click “Apply” or close the dialog box.
- Make sure that the Show Title check box is checked. If it isn't, Mathcad still remembers the title but won't display it.
- Click “OK” to accept your changes. Mathcad redraws the graph with the title in place. Alternatively, click “Apply” to preview your title without closing the dialog box.



To edit a graph's title, follow these steps:

- Click in the graph to select it.
- Choose **Graph⇒X-Y Plot** from the **Format** menu or double-click on the selected graph. Mathcad displays the dialog box for formatting X-Y graphs. If necessary, click the Labels page. (You can also double-click on the title itself to display an equivalent dialog box.)
- Edit the information for the title as appropriate or backspace over the title to delete it.
- Click “OK” to close the dialog box.

Labeling axes on a graph

You can also label one or both axes of a graph in much the same way as you add a title to a graph. The *x*-axis label appears directly below the *x*-axis, and the *y*-axis label appears just to the left of the *y*-axis. To label an axis, follow these steps:

- Click in the graph to select it.
- Choose **Graph⇒X-Y Plot** from the **Format** menu or double-click on the selected graph. Mathcad displays the dialog box for formatting X-Y graphs. If necessary, click on the Labels tab to see that page, as shown in the preceding section.
- Type the axis labels into the appropriate text boxes.
- To save the label name without having it appear on the graph, click X-Axis or Y-Axis to remove the check.
- Click “OK” to accept your changes and close the dialog box. Mathcad redraws the graph with the new settings in effect. Alternatively, click “Apply” to preview your changes without closing the dialog box.

To edit an axis label, follow these steps:

- Click in the graph to select it.
- Choose **Graph⇒X-Y Plot** from the **Format** menu or double-click on the selected graph. Mathcad displays the dialog box for formatting X-Y graphs. If necessary,

click the Labels page. (You can also double-click on the label itself to display an equivalent dialog box.)

- Edit the information for the title as appropriate.
- To remove a label, delete it from the text box.
- Click "OK" to close the dialog box.

Displaying or hiding arguments and legends

Mathcad provides both arguments and legends for identifying specific traces on a graph:

- Arguments are the expressions that you typed into the placeholders of the *x*- and *y*-axes to create the graph. By default, Mathcad displays arguments.
- Legends are labels that appear underneath the graph containing a name and an example of the line and symbols used to draw the trace. By default, legends are hidden.

To display or hide arguments and legends:

- Click on the graph to select it.
- Choose **Graph⇒X-Y Plot** from the **Format** menu or double-click on the graph. Mathcad displays the dialog box for formatting X-Y graphs, as shown below. If necessary, click on the Traces tab.
- To suppress the display of the arguments, click on Hide Arguments to add a check.
- To show the legend, click on Hide Legend to remove the check.

Modifying your graph's perspective

Mathcad provides options for manipulating the presentation of your graph:

- You can resize the graph, making it proportionally larger or smaller or stretching the *x*-axis or *y*-axis for emphasis.
- You can zoom in on a portion of the graph.
- You can get the coordinates for any point that was plotted to construct the graph.
- You can get the coordinates for any location within the graph.

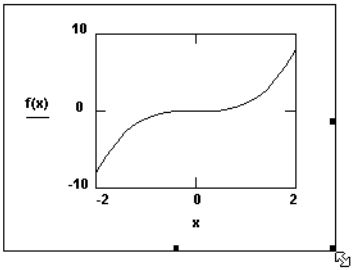
The rest of this section shows how to use these features.

Resizing a graph

Resizing a graph is very much like resizing a window:

- Click in the graph to select it.

- Move the mouse pointer to one of the three handles along the edge of the graph. The pointer will change to a double-headed arrow.



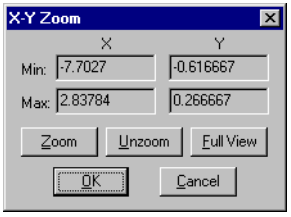
- Press and hold down the mouse button and move the mouse in the direction that you want the graph's dimension to change.
- Once the graph is the right size, let go of the mouse button.
- Click outside the graph to deselect it.

Note that when you change the size of a graph for which the Auto Grid is set, Mathcad may add or delete tick marks or grid lines or change axis limits to maintain the default spacing.

Zooming in on a graph

Mathcad allows you to select a region of a graph and magnify it. To zoom in on a portion of a graph, follow these steps:

- Click in the graph to select it.
- Choose **Graph⇒Zoom** from the **Format** menu, or click on the Zoom button on the Graph Palette. The X-Y Zoom dialog box appears.



- If necessary, reposition the X-Y Zoom dialog box so that you can see the entire region of the graph you want to zoom.
- In the graph region, click the mouse at one corner of the region you want to magnify.
- Press and hold down the mouse button and drag the mouse. A dashed selection rectangle emerges from the anchor point.
- When the selection rectangle just encloses the region you want to magnify, let go of the mouse button. If necessary, you can click on the selection rectangle, hold the mouse button down, and move the rectangle to another part of the graph.

- The coordinates of the selected region are listed in the Min: and Max: text boxes of the X-Y Zoom dialog box. Click the “Zoom” button to redraw the graph. The axis limits are temporarily set to the coordinates specified in the X-Y Zoom dialog box. To make these axis limits permanent, click “Accept.”

Before you make these axis limits permanent, you can select another region to zoom by enclosing another selection rectangle around a new region. Press “Unzoom” to undo the zoom you've just made. If you're working with a graph that has already been zoomed, you may want to view the original graph as it was before any zooming took place. To do so, click on “Full View.”

Figure 20-14 shows the effects of zooming in on a portion of a graph.

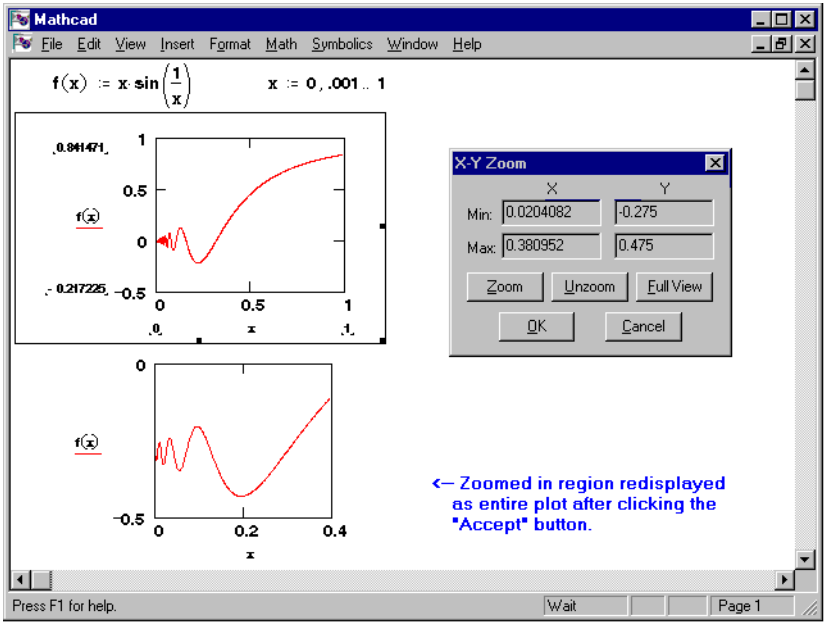
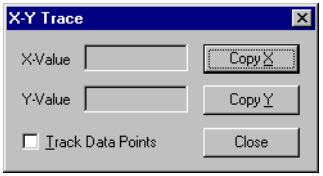


Figure 20-14: A zoomed-in region of a graph.

Getting a readout of graph coordinates

To see a readout of graph coordinates of the specific points that make up a trace, follow these steps:

- Click in the graph to select it.
- Choose **Graph⇒Trace** from the **Format** menu, or click on the Trace button on the Graph Palette, to show the X-Y Trace dialog box.



- If necessary, reposition the X-Y Trace dialog box so that you can see the entire region of the graph. Note that the Track Data Points check box is checked.
- In the graph region, click and drag the mouse along the trace whose coordinates you want to see. A dotted crosshair jumps from one point to the next as you move the pointer along the trace.
- If you release the mouse button, you can now use the left and right arrows to move to the previous and next data points. Use the up and down arrows to move to other traces.
- As the pointer reaches each point on the trace, Mathcad displays the *x* and *y* values of that point in the X-Value and Y-Value boxes.
- The *x* and *y* values of the last point selected are shown in the X-Value and Y-Value boxes. The crosshair remains until you click outside the graph.

To copy a coordinate to the clipboard:

- Click “Copy X” or “Copy Y”. You can then paste that value into a math region or a text region on your Mathcad worksheet, into a spreadsheet, or into any other application that allows pasting from the clipboard.
- Double-click on the control box in the upper-left-hand corner to close the X-Y Trace dialog box. The crosshair will remain on your graph until you click anywhere outside the graph or click the “Close” button.

To see a readout of graph coordinates for any location in a graph:

- Follow the above procedures to call up the X-Y Trace dialog box.
- Click on Track Data Points to uncheck it.
- In the graph region, click and drag the mouse pointer over the points whose coordinates you want to see. A dotted crosshair follows the pointer as you drag it over the graph. Mathcad displays the coordinates of the pointer in the X-Value and Y-Value boxes. The *x* and *y* values change continuously to reflect the current pointer position.
- When you release the mouse button, the X-Value and Y-Value boxes show the *x* and *y* values of the last pixel selected.

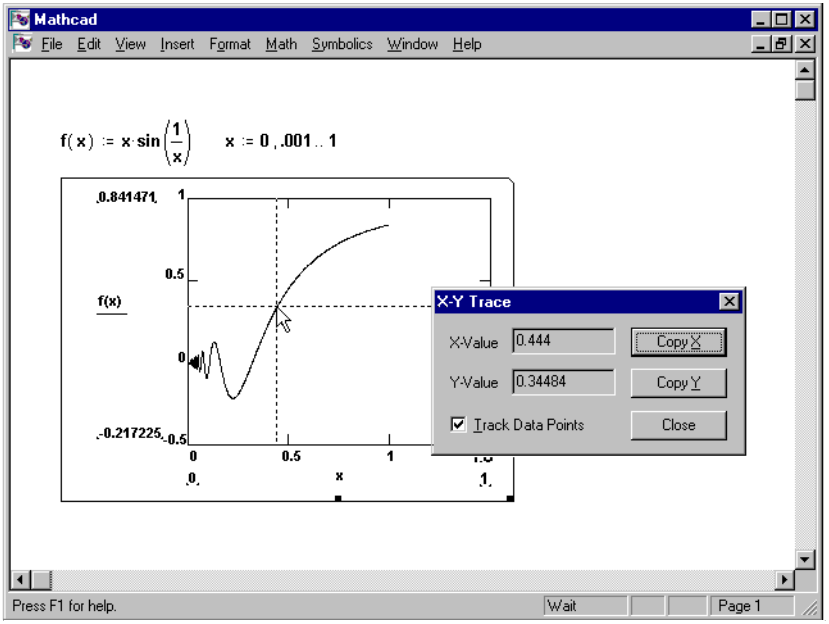


Figure 20-15: Reading coordinates from a graph.

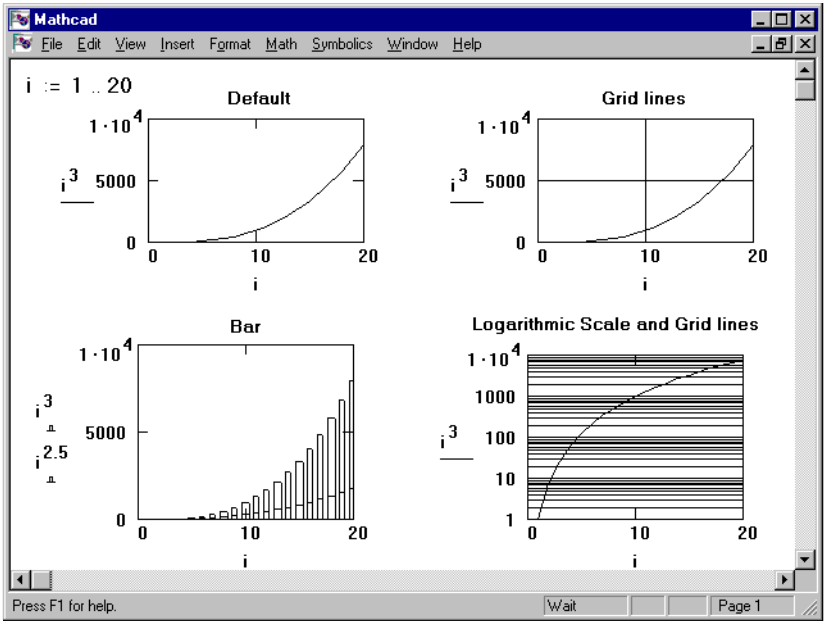


Figure 20-16: Different graph formats on the same graph.

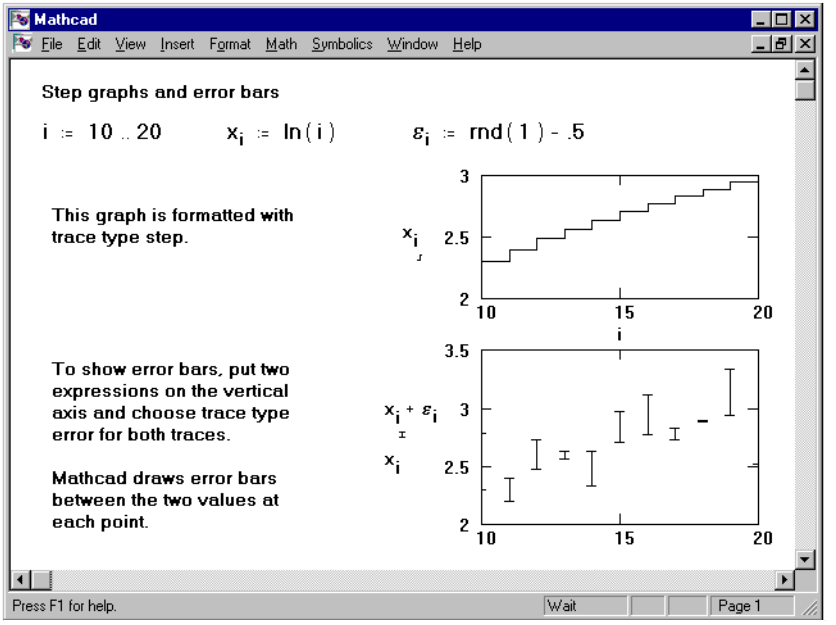


Figure 20-17: Step graphs and error bars from the scrolling list under "Trace type."

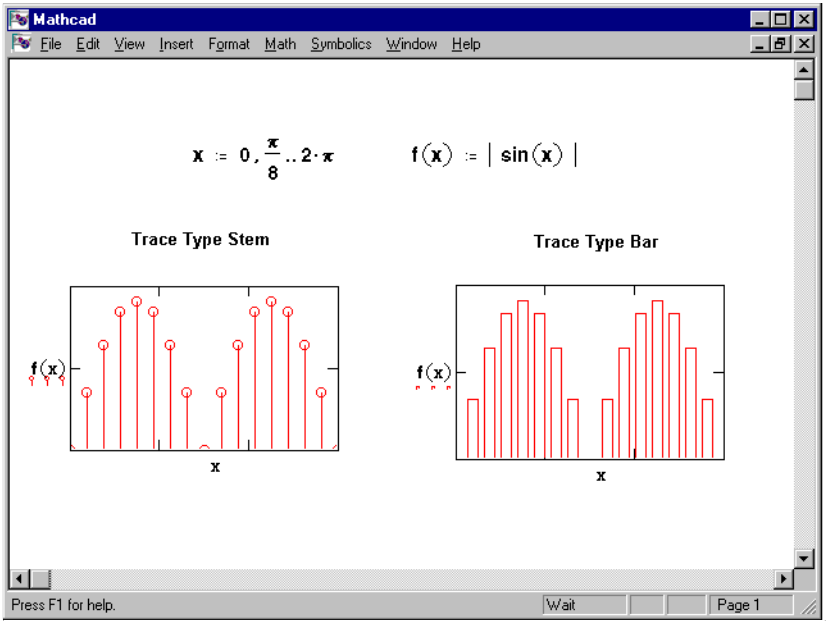


Figure 20-18: Stem graphs and bar graphs from the scrolling list under "Trace type."

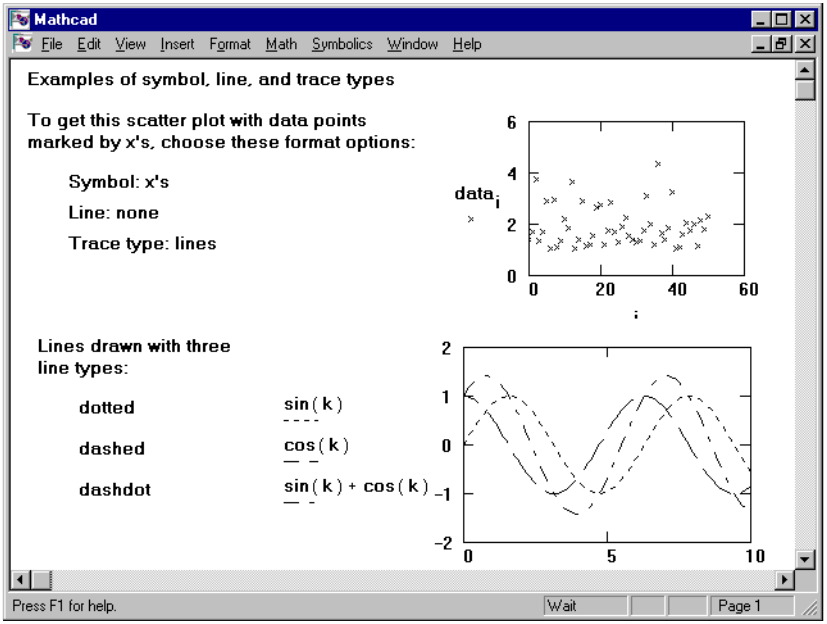


Figure 20-19: Choosing from the scrolling lists under "Line" and "Symbol."

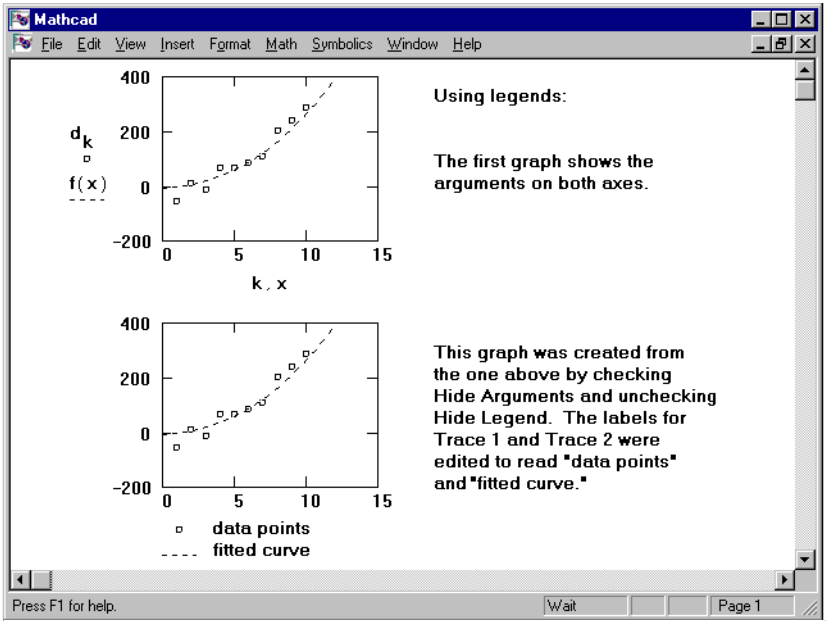


Figure 20-20: Hiding and showing the legend on the same graph.

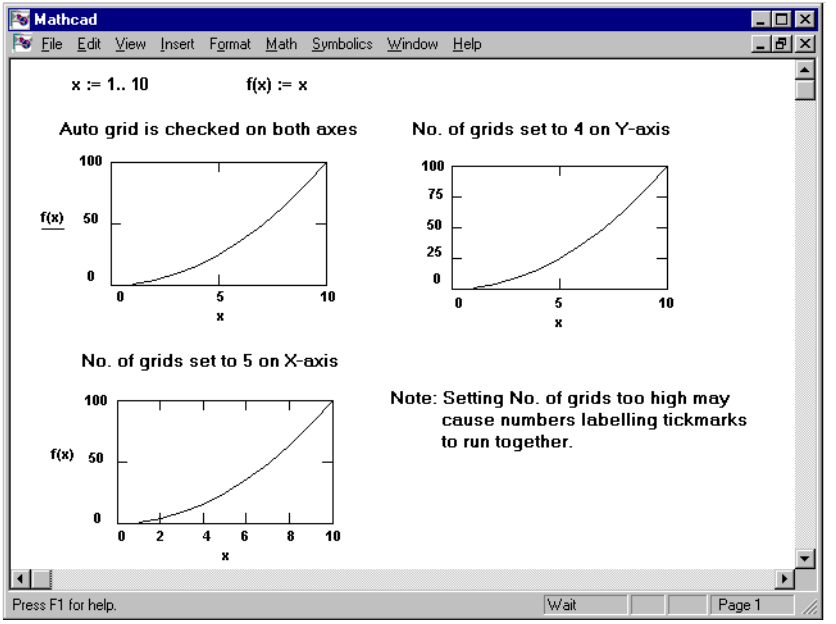


Figure 20-21: Unchecking Auto Grid option to vary the number of tick marks.

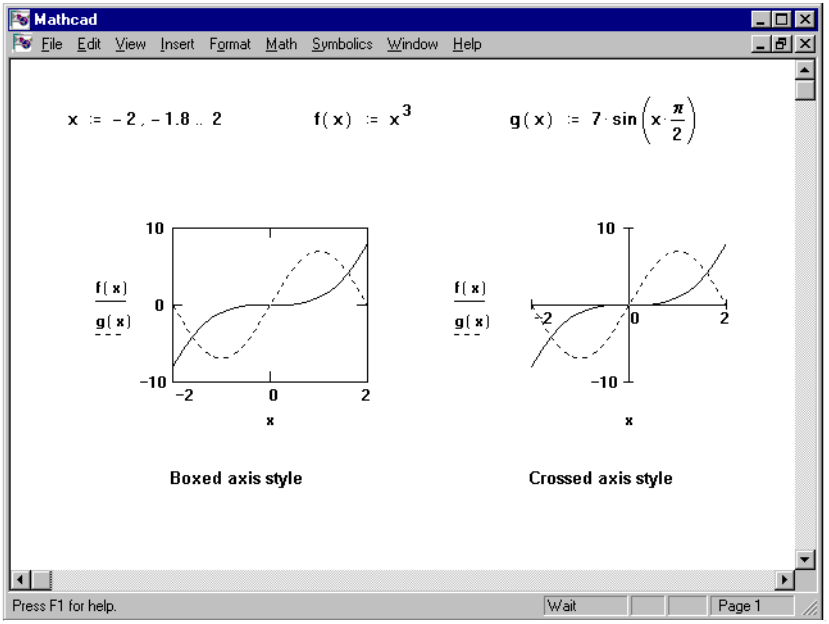


Figure 20-22: Using the "Crossed Axes" option to cross axes in the center of the plot.