



# Chapter 6

## Working with Graphics and Other Objects

This chapter describes how to insert a variety of graphics and other objects into Mathcad worksheets. You can create a variety of sophisticated two- and three-dimensional graphs to visualize your calculations. You can create pictures in your worksheet by reference to bitmap files, and import graphic images by copying them from another application and pasting them into Mathcad. This chapter also introduces Object Linking and Embedding (OLE) as a way of inserting objects created by other applications into a Mathcad worksheet.

This chapter contains the following sections:

### **Inserting graphs**

Introduction to placing two- and three-dimensional graphs in a worksheet, along with basics of graph resizing and formatting.

### **Inserting pictures**

Using the **Picture** command from the **Insert** menu to create a picture based on a matrix or bitmap file. Pasting in a graphic image from the clipboard. Formatting options for pictures.

### **Inserting objects**

How to insert objects from other applications into a Mathcad worksheet.

## Inserting graphs


Mathcad provides two-dimensional graphs, including X-Y and polar plots, that enable you to visualize a function or expression of one variable, X-Y or angle-dependent data, or a vector. You can also create a variety of three-dimensional graphs, including surface plots for visualizing a matrix of data, contour plots for visualizing level curves, three-dimensional scatter plots for visualizing coordinate data, parametric surface plots, and others. The Graph toolbar provides convenient shortcuts for inserting and manipulating many graphs.

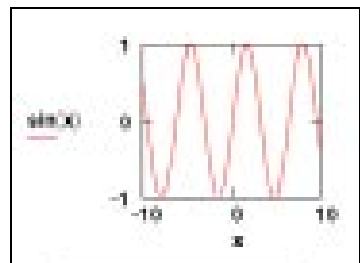
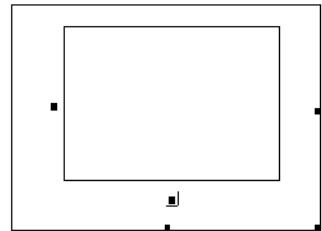


This section provides only a brief introduction to inserting and formatting Mathcad's two- and three-dimensional graphs. See Chapter 12, "2D Plots," and Chapter 13, "3D Plots," for details.

### Inserting a two-dimensional graph

To create an X-Y plot based on an expression of a single variable:

- Click in your worksheet wherever you want the graph to appear. Make sure you see the crosshair.
- Choose **Graph**⇒**X-Y Plot** from the **Insert** menu or click  on the Graph toolbar. Mathcad inserts a blank X-Y plot, a box with one placeholder on the bottom (*x*-axis) and one on the left (*y*-axis).
- Fill in the middle placeholder on the left (*y*-axis) with a function or expression of one variable. For example, type **sin(x)** to see a graph of the *sin* function.
- Press [**Enter**] or click outside the plot.



Mathcad automatically produces a plot using default format settings over a default range of the variable on the *x*-axis:  $-10$  to  $10$ . A plot such as this, where Mathcad chooses the range for the dependent variable, is called a *QuickPlot*.

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**Note** As described in Chapter 12, “2D Plots,” you can explicitly enter expressions on both the  $x$ - and  $y$ -axes that specify the range of values to plot. Usually these expressions depend on range variables you previously defined in your worksheet. But if you have not previously defined the range variables, Mathcad generates the range for the plot implicitly.

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You can plot multiple *traces* on a single two-dimensional graph. For example, an  $X$ - $Y$  plot 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. See Chapter 12, “2D Plots,” for details on how to do this.

## Inserting a three-dimensional graph

As described in detail in Chapter 13, “3D Plots,” you can create sophisticated-looking surface plots, contour plots, and other kinds of three-dimensional plots using a wide range of display options that control the lighting and color and detail that appears. To simplify the creation of a three-dimensional graph into your worksheet, Mathcad includes a *3D Plot Wizard*.

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**Tip** You can also insert specific three-dimensional graphs directly into your worksheet using default format settings by selecting commands from the **Graph** pull-right menu on the **Insert** menu or by clicking appropriate buttons on the Graph toolbar.

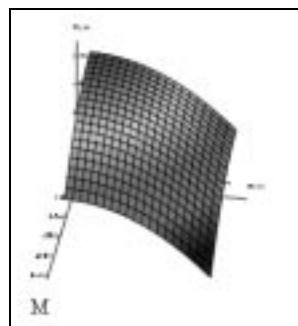
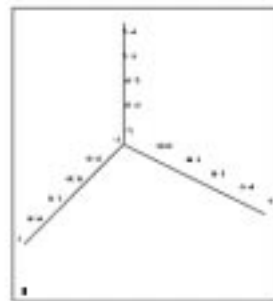
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To use the Wizard:

- Click in your worksheet wherever you want the graph to appear. Make sure you see the crosshair.
- Choose **Graph**⇒**Plot Wizard** from the **Insert** menu. The first page of the 3D Plot Wizard appears.
- Select the type of three-dimensional graph you want to see and click “Next.”



- Make your selections for the appearance and coloring of the plot on subsequent pages of the Wizard. Click “Finish” to insert a plot with appropriate axes and a blank placeholder into your worksheet.
- Enter an expression in the placeholder. For example, to see a surface plot of a matrix  $\mathbf{M}$  you have previously created in your worksheet, enter  $\mathbf{M}$ . Mathcad interprets the number of rows and columns of the matrix as values on the  $x$ - and  $y$ - axes. The matrix elements are plotted as heights above or below the  $x$ - $y$  plane using the display and formatting options you selected.
- Press [Enter] or click outside the plot.



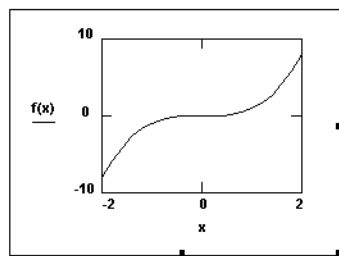
**Note** See “Plot arguments” on page 253 for a description of the expressions you can enter in the placeholder of a three-dimensional plot to produce different plot types such as 3D scatter plots, vector field plots, and parametric surface plots.

You can place multiple plots on a single three-dimensional graph. For example, you can simultaneously plot a surface and a contour plot of the same data. See “Graphing multiple 3D plots” on page 254 for details.

## Resizing a graph

Resizing a two- or three-dimensional graph is very much like resizing a text region:

- Click in the plot to select it.
- Move the mouse pointer to one of the handles along the edges or the corners of the plot. The pointer changes to a double-headed arrow.
- Press and hold down the mouse button and move the mouse in the direction that you want the plot’s dimension to change.
- Once the plot is the right size, let go of the mouse button.



- Click outside the plot to deselect it.

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**Note** See Chapter 12, “2D Plots,” and Chapter 13, “3D Plots,” for information on zooming in or out of a two- or three-dimensional graph.

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## Formatting a graph

When you insert a two- or three-dimensional graph into a worksheet, the graph appears with Mathcad’s default choices for the appearance of various elements in the graph: data points, traces, surfaces, axes, labels, and so on. You can easily modify the appearance of a graph by accessing the formatting dialog box associated with it, as introduced below. See Chapter 12, “2D Plots,” and Chapter 13, “3D Plots,” for details on formatting options for graphs in Mathcad.

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**Tip** Double-clicking a two- or three-dimensional graph is a convenient shortcut for opening the appropriate formatting dialog box.

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### Two-dimensional graphs

To modify the appearance of an X-Y or polar plot:

- Click on the plot and choose **Graph**⇒**X-Y Plot** or **Graph**⇒**Polar Plot** from the **Format** menu. Select the appropriate two-dimensional graph from the pull-right menu. The formatting dialog box appears, as in the example at right.
- Click the tab for the page you want to work with.
- Make the appropriate changes in the dialog box.
- To see the effect of your changes on the graph without closing the dialog box, click “Apply.”
- When you’re finished, close the dialog by clicking “OK.” The plot’s appearance updates to reflect the changes you made.



You can access the following options from the plot formatting dialog box:

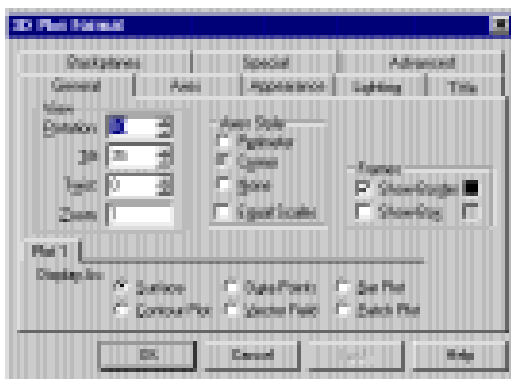
- *Axes settings*, such as whether the axes are logarithmic, whether grid lines appear, and the style of the axes.

- *Trace settings*, such as the weight and color of a trace and whether points on the trace are marked with individual symbols.
- *Labels* on the graph, including the placement of a graph title, axes labels, and legends to identify individual traces.
- The ability to create or apply *default settings* for two-dimensional plots in your worksheet.

### Three-dimensional graphs

To modify the appearance of a surface, contour, 3D bar, 3D scatter, or vector field plot:

- Click on the graph and choose **Graph**⇒**3D Plot** from the **Format** menu. The formatting dialog box appears, as in the example at right.
- Click the tab for the page you want to work with.
- Make the appropriate changes in the dialog box. To see the effect of your changes on the graph without closing the dialog box, click “Apply.”



- Close the dialog box by clicking “OK.” The plot’s appearance updates to reflect the changes you made.

You can access the following options from the Properties dialog box:

- *General settings*, such as the type of surface to create and the angle of view.
- *Axis settings*, such as the appearance of tick marks, grid lines, and axes labels.
- *Appearance* options, governing whether a surface is filled and lines or points are shown.
- *Lighting* settings, governing the location and color of lights for the plot.
- *Backplane* formatting for the planes defined by the intersecting axes.
- *Special* surface options, such as the density of contours in a contour plot.
- *Advanced* color options, such as colormaps for different surfaces.

## Inserting pictures

This section describes techniques for creating and formatting *pictures*—static graphic images—in your Mathcad worksheet.


### Creating a picture

You can create a picture in a Mathcad worksheet in the following ways:

- By using the *picture operator* and supplying either the name of a Mathcad matrix or the name of an external bitmap file, or
- By importing an image from another application via the Clipboard.

#### Creating a picture from a matrix

You can view any matrix in Mathcad as a picture by using the picture operator:

- Click in a blank space in your Mathcad worksheet.
- Choose **Picture** from the **Insert** menu or click  on the Matrix toolbar.
- Type the name of a matrix in the placeholder at the bottom of the operator.

Mathcad creates a 256-shade grayscale representation of the data in the matrix, with each matrix element corresponding to a *pixel* in the picture.

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**Note** Mathcad's picture operator assumes a 256-color model with the value 0 represented as black and 255 as white. Numbers outside the range 0–255 are reduced modulo 256, and any noninteger value is treated as if its decimal part has been removed.

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Since the matrices used in picture rendering are usually quite large, this technique of creating a picture is most useful when you import graphics files into Mathcad as matrices as described in “File access functions” on page 214. For example, you can use the *READBMP* function to read an external graphics file into a matrix, and then use the picture operator to see the picture in Mathcad.

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**Tip** To display an image in color, you must provide the picture operator with the names of three matrices of the same size containing the red, green, and blue color values of the image. Type the three names, separated by commas, in the placeholder of the picture operator. Otherwise, the image appears in grayscale.

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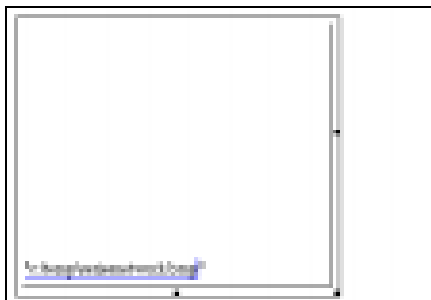
## Creating a picture by reference to a bitmap file

Mathcad can create a picture directly from an external file in Windows bitmap (BMP) format. To do so, click in a blank space in your worksheet and then:

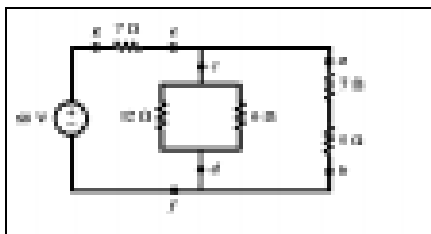
- Choose **Picture** from the **Insert** menu,

or click  on the Matrix toolbar, to insert the picture operator.

- In the placeholder, type a string containing the name of a bitmap file in the current directory, or type a full path to a bitmap file. You create a string in the placeholder by first typing the double-quote (") key.



- Click outside the picture operator. The bitmap appears in your worksheet.



Each time you open the worksheet or calculate the worksheet, the bitmap file is read into the picture operator.

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**Note** If you modify the source bitmap file, you must recalculate your worksheet to see the modified image. If you move the source bitmap file, Mathcad can no longer display the picture.

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## Creating a picture by importing from the Clipboard

You can copy an image from another application to the Clipboard and paste it into Mathcad in one of the formats put on the Clipboard at the time of copying. This section describes using the **Paste Special** command on the **Edit** menu to paste a graphic image into a Mathcad worksheet from the Clipboard in a noneditable format: as a metafile or bitmap. A metafile, which is strictly a Windows graphic format, can be resized in Mathcad without undue loss of resolution, whereas a bitmap is usually viewed best only at its original size. A device-independent bitmap, or DIB, is stored in a bitmap format that is portable to other operating systems.



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**Note** If you use the **Paste** command on Mathcad's **Edit** menu to paste in an image from the Clipboard (or use drag-and-drop from another application), you typically paste a linked *OLE object* into your Mathcad worksheet, as discussed in "Inserting objects" on page 95. When you double-click a linked OLE object, you activate the application that created the object and are able to edit the object in your Mathcad worksheet.

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To paste a graphics image from another application into Mathcad, do the following:

- Open the application and place the graphics image on the Clipboard, usually via a **Copy** command on the **Edit** menu. Many Windows applications have this feature.
- Click the mouse wherever you want the image in your Mathcad worksheet.
- Choose **Paste Special** from the **Edit** menu, and choose "Picture (metafile)" or "Device Independent Bitmap."
- Click "OK." Mathcad creates a picture region and puts into it the image stored on the clipboard.

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**Note** The format choices in the Paste Special dialog box will vary, depending on the application from which you originally copied a selection.

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Mathcad stores the color depth—the number of colors in the image—at the time you paste it into a worksheet. This means that you can safely resave any worksheets that contain color images on systems that have different color displays, either fewer or more colors. The images continue to display at the proper color depth on the systems that created the worksheets.

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**Note** When you import directly from the Clipboard, the picture information is stored as part of the Mathcad worksheet. This makes the file size larger. It also means that when you copy the worksheet, the picture information travels along with it.

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## Formatting a picture

This section describes your options for formatting a picture once you've created it.

### Resizing a picture

To resize a picture region, do the following:

- Click the mouse inside the picture region to select it.
- Move the mouse pointer to one of the handles along the edge of region. The pointer changes to a double-headed arrow.

- Press and hold down the left mouse button. With the button still held, drag the mouse in the direction you want the picture region to be stretched.

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**Tip** When you change the size of the picture region, the picture inside may be distorted. If you resize the picture by dragging diagonally on the handle in the lower right corner, you preserve the aspect ratio—the ratio of height to width—of the original picture. To restore a picture to its original size, click on the picture and choose **Properties** from the **Format** menu. On the display tab of the Properties dialog box, check “Display at Original Size.”

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### Framing a picture

Mathcad allows you to place a border all the way around a picture region. To do so:

- Double-click the picture itself, or choose **Properties** from the **Format** menu. This brings up the Properties dialog box.
- Click “Show Border.”
- Click “OK.” Mathcad draws a border around the picture region.

### Controlling color palettes

If you are using a 256-color display and have color bitmaps in your Mathcad worksheets, Mathcad by default uses a single 256-color palette to display all the bitmaps in your worksheets. This is the same default color palette Mathcad uses for displaying the rest of the Mathcad screen, and is suitable for most pictures.

This default color palette, however, may not be the exact one that any color bitmaps in a worksheet were designed to use. To improve the appearance of bitmaps in your worksheet, you can tell Mathcad to optimize its default color palette so that it chooses the best possible 256 colors to display bitmaps in the worksheet. To do so:

- Choose **Color⇒Optimize Palette** from the **Format** menu. Mathcad surveys the pictures in the worksheet and generates an optimal 256-color palette to use for all of them.
- Make sure that **Color⇒Use Default Palette** in the **Format** menu is checked. Then Mathcad uses the new default palette it generates.

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**Note** If your display driver supports more than 256 colors, the palette-setting options on the **Format** menu are grayed.

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## Inserting objects

This section describes techniques for inserting and editing *objects* created by other applications in your Mathcad worksheets. OLE (Object Linking and Embedding) technology in Microsoft Windows makes it possible not only to insert static pictures of such objects into your applications (or of Mathcad objects into other applications), but to insert the objects in such a way that they can be fully edited in their originating applications.

An object can be either *embedded* in or *linked* to a Mathcad worksheet. An object that is linked must exist in an external saved file. An object that you embed may be created at the time of insertion. When you edit a linked object, any changes you make to the object also update the original file containing the object. When you edit an embedded object, any changes you make to the object affect it only in the context of the Mathcad worksheet. The original object in the source application, if there is one, is unchanged.

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**Tip** For information about using specialized objects called *components* to import and export data, as well as establish dynamic connections between Mathcad and other applications, see Chapter 11, “Vectors, Matrices, and Data Arrays,” and Chapter 16, “Advanced Computational Features.”

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### Inserting an object into a worksheet

You insert an object into Mathcad, which is an OLE 2-compatible application, by using the **Object** command from the **Insert** menu, by copying and pasting, or by drag and drop. The method you choose depends on whether you want to create the object on the fly, whether the object has already been created, or whether you want the object to be an entire file. You can edit objects in a Mathcad worksheet simply by double-clicking them, causing *in-place activation* of the originating application in most cases.

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**Tip** In general, you use the same methods to insert a *Mathcad object* into another application and edit it inside that application as you do to insert objects into a Mathcad worksheet. However, the details depend on the extent to which the application receiving a Mathcad object supports OLE 2. Once you’ve inserted a Mathcad object into a compatible application, you can edit it by double-clicking it. If the application supports in-place activation, as current releases of Microsoft Office applications do, the menus and toolbars will change to Mathcad’s.

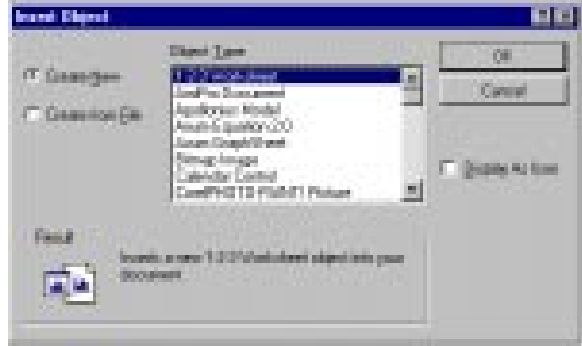
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#### Insert Object command

When you use the **Object** command from the **Insert** menu, you can insert an object that you create at the time you are inserting it, or you can insert an entire file you’ve already created.

To insert an object or a saved file:

- First click in your worksheet where you want to insert the object. Make sure you see the crosshair.
- Choose **Object** from the **Insert** menu to bring up the Insert Object dialog box. By default “Create New” is selected:
- Check “Display As Icon” if you want an icon, rather than the actual object, to appear in your worksheet. The icon is typically the icon of the application that created the object.



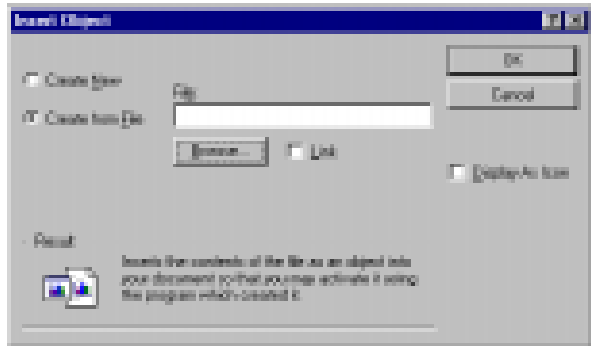
To create a new object:

- Select an application from the “Object Type” list. The available object types depend on the applications you have installed on your system.
- Click “OK.”

The source application opens so that you can create the object. When you are finished working to create the object, exit the source application. The object you created is then embedded in your Mathcad worksheet.

If you want to insert a previously created file:

- Click “Create from File” in the Insert Object dialog box. The dialog box then changes appearance.
- Type the path to the object file or click “Browse” to locate it.
- Check “Link” to insert a linked object. Otherwise, the object is embedded.
- Click “OK.”



### Pasting an object into a worksheet

You can copy an object from a source application to the Clipboard and paste it directly into Mathcad. This method is particularly useful when you’ve already created the object in another application and you don’t want to insert an entire file.

To insert an embedded or linked object into a worksheet via the Clipboard:

- Open the source application containing the object.
- Copy the object from the source application to the Clipboard. You typically do this by choosing **Copy** from the **Edit** menu or by pressing [Ctrl]C.
- Click in the Mathcad worksheet where you'd like to place the object.
- Choose **Paste** or **Paste Special** from Mathcad's **Edit** menu.

If you choose **Paste**, the object is pasted in your Mathcad worksheet in a format that depends on what the source application has placed on the Clipboard. The behavior differs depending on whether you have selected a math placeholder or are pasting into a blank space in the worksheet. Mathcad creates one of the following:

- A *matrix*, if you are pasting numeric data from the clipboard into an empty math placeholder.
- A *text region*, if you are pasting text that does not contain numeric data exclusively.
- A *bitmap* or *picture (metafile)*, if the originating application generates graphics.
- An embedded object, if the originating application supports OLE.

If you choose **Paste Special**, you have the option of pasting the object in one of the available formats placed on the Clipboard. Typically you can choose to paste the object as an embedded or linked OLE object (if the object was stored in a saved file in an OLE-compatible source application), a picture (metafile), or a bitmap. See “Creating a picture by importing from the Clipboard” on page 92 for more information on pasting metafiles and bitmaps.

### **Dragging and dropping an object into a worksheet**

A third way to insert an OLE object into a Mathcad worksheet is to drag it from the source application and drop it into the worksheet. This is very similar to copying and pasting, but does not allow you to create a link to an object. To do so, open both Mathcad and the source application and arrange the two windows side by side on the screen. Then select the object in the source application and drag it with the mouse into your Mathcad worksheet. The object appears when you release the mouse button.

## **Editing an object**

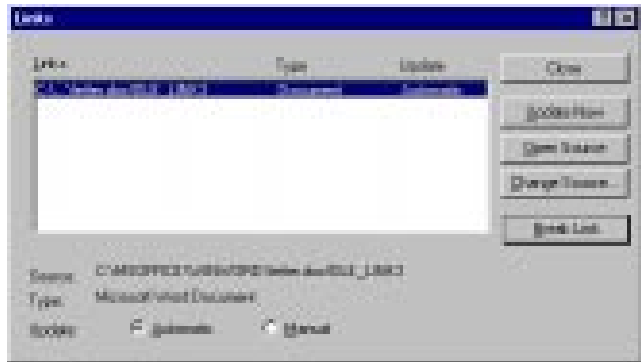
To edit an embedded object in a Mathcad worksheet, double-click the object. Mathcad's menus and toolbars change to those of the source application, and a hatched border surrounds the object so that you can edit it. This OLE editing mechanism is called *in-place activation*. For example, you can use in-place activation to edit objects created by Microsoft Office applications such as Excel and Word inside Mathcad.

If the source application does not support in-place activation inside Mathcad or the object is linked, the behavior is different. In the case of an embedded object, a copy of the object is placed into a window from the other application. If the object is linked, the source application opens the file containing the object.

## Editing a link

If you've inserted a linked object into a Mathcad worksheet, you can update the link, eliminate it, or change the source file to which the object is linked. To do so, choose **Links** from the **Edit** menu.

Choose the link you want to edit from the list of links. Then make changes using the available options:



**Automatic:** Updates links whenever you open the worksheet and any time the source information changes while the worksheet is open.

**Manual:** Updates links only when you press “Update Now.”

**Update Now:** Updates a manual link.

**Open Source:** Opens the application in which the linked object was created.

**Change Source:** Links the object with a different source file. The new source file must have been created in the same application as the original source file.

**Break Link:** Breaks the link between an object's original source and the copy of the object in the worksheet.