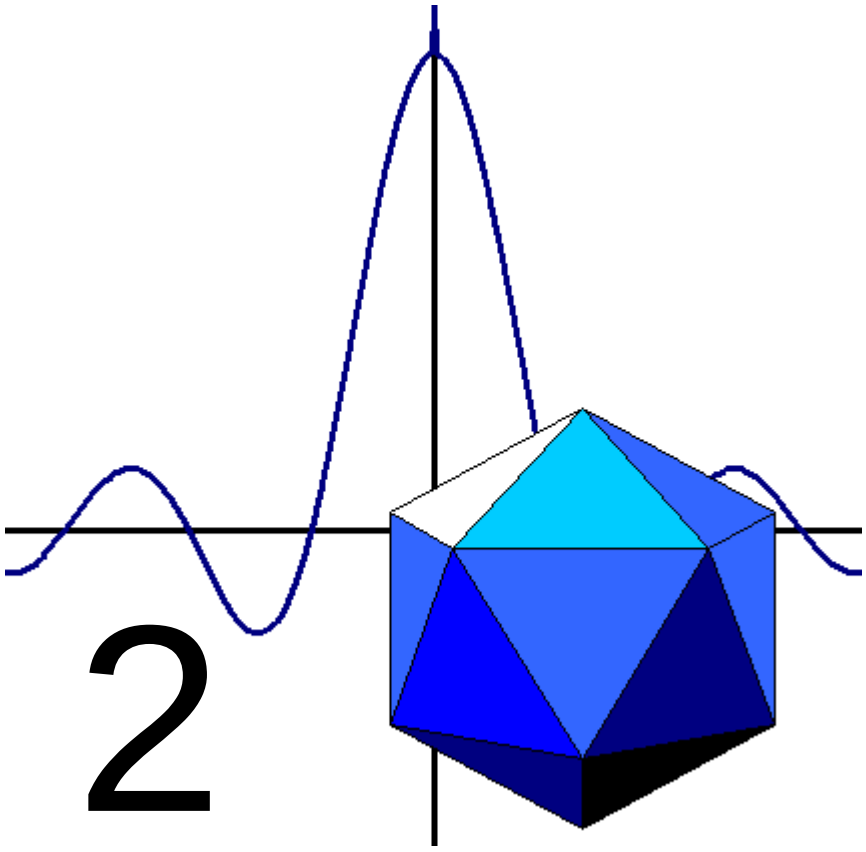

FX Draw 2

The Mathematics Teacher's Drawing Program

FX Draw 2

User's Guide

by Efofex Software

Efofex Software is distributed in the UK and Ireland by Chartwell-Yorke

Always check our website for our current postal, phone and fax details

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FX Draw 2

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1 Features

1.1 Basic Concept

FX Draw is the mathematics teachers' drawing program. The aim is to provide mathematics teachers with a tool that can draw any required mathematical diagram with a minimum amount of input from the teacher. FX Draw provides specialised tools for drawing angles, graphs, normal distribution curves, Venn diagrams and right triangles and also comes supplied with a gallery of over three hundred predrawn diagrams. FX Draw can integrate with your copy of Word to provide a quick and easy solution to your diagramming needs.

1.2 New in Version 2

- Geometrically Aware Drawing!! This is the most exciting aspect of FX Draw 2. Take the time to see how it works and we promise that it will massively improve your productivity.
- Angle tool. You can mark the angle between any two line segments and you can choose to have the actual angle, an arc or a number of other options marked on the angle. The old angle tool has gone because this new one is much more useful.
- Equations. FX Equation's technology is built in – allowing you to get mathematical expressions into your diagrams.
- Rotatable Text. Text boxes can be rotated. The text box is much more advanced and intuitive than the old FX Draw text box. Multi-line text boxes are supported.
- Expanded Gallery System. The new galleries have been opened up. You can create and manage your own galleries and we will maintain a library of galleries on our web site that you will be able to add to and borrow from. The new gallery figures also remember the shape they were originally drawn in – no more squashing into a square.
- Bezier Curves and Smooth Lines. Expanded functions including double and triple lines. They also produce much better results when printed.
- Better Graphing. FX Graph's graphing system is included. This expands the graphs you can draw (shaded integrals, shaded inequations, parametric equations, derivative curves and graphical analysis) while being much easier to use.
- Multi-user Aware. FX Draw will remember YOUR preferences on multi-user machines so you can set it up YOUR way.
- Easier Deployment. Installing FX Draw on a networked system is now much easier with our DEF file technology allowing you to set up systems exactly to your specifications.
- Statistics Capability. FX Stat's statistics engine is included giving you access to one of the best secondary school statistics packages available.
- New Triangle Tool. You can draw ANY triangle by giving FX Draw three unambiguous pieces of information. FX Draw will also fully analyse any triangle giving you side lengths, angles, area, perimeter and altitudes.
- Sectors, Segments and Arcs. The arc tools make it easy to draw sectors and segments as well.

- Grids and Dots. The new grid and dot tool allows you to draw Cartesian dots, isometric dots and polar dots. You can also draw Cartesian grids with or without logarithmic scales, isometric grids, polar grids and hexagonal grids. You can choose the size of the grids and the colour and type of the lines.
- More Point types.
- More Basic Tools. There are four ways to draw circles, three ways to draw ellipses and three ways to draw arcs. You now have exactly the right tool for any situation.
- Exact Sizing. You can now draw graphics that are exactly sized – a 32 mm line will print exactly 32 mm long.
- More Options. There are more options for everything. All options are saved and it is easy to set your defaults.
- Layout Tools. You can change the order figures are drawn in.
- Colour. FX Draw 2 fully supports colour.
- Number Lines. A new number line tool makes drawing number lines easy.
- Easier Registration. Our old registration system was extremely finicky. Our new system is much simpler to use.
- Rotatable Graphics. You can rotate most graphics in 1 degree intervals.
- Undo and Redo are fully supported.
- Improved Polygon Tool. You can add and remove vertices from polygons.
- Reflections. You can reflect figures over y = x and y = -x as well as vertical and horizontal lines.

1.3 Upgrade From Version 1

Version 2 can load FX Draw V1 files and galleries. What it cannot do is take over version 1 links in a document. If you have a large number of version 1 diagrams, you should leave V1 on your computer so that you can edit these images. If you really want to get a version 1 diagram into version 2, save it into a file and load the file in version 2.

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3 Installation

3.1 System Requirements

FX Draw will run on any computer running Windows 95 or later. FX Draw is compatible with Windows 95, 98, Me, NT, 2000 & XP. FX Draw is optimised for use with Microsoft Word V6.0 and later. FX Draw is compatible with most networked situations.

FX Draw is very computationally intensive and responds well to increases in processor speed. FX Draw is USABLE on a 150 MHz processor but requires a 300 MHz processor to really start showing its capabilities.

3.2 Installing FX Draw on Your Computer

To install FX Draw onto your system:

- Put the CD into your computer.
  If the CD does not Autorun, choose Run from the Start menu and type d:\setup where d is your CDRom's drive letter.
- Push the Install FX Draw button

The install program will ask you which directory you would like FX Draw to be placed in and will then make all necessary adjustments to your system.

The CD will install a time-limited version of the product. If you do not enter registration information within 30 days of installation, the product will begin to operate in evaluation mode. You should have received either a Registration Information or a Licence Certificate with your copy of the software that explains the registration process more fully.

FX Draw is designed to be used as an OLE object and this is the preferred way to print a graphic. There is no need to create an icon for FX Draw, it should be accessed as an object through your word processor. Equation Editor and Word Art are other examples of objects in Word for Windows.

3.3 Installation Notes

3.3.1 Administrator Privileges

FX Draw 2 needs to write to the registry to do its job during installation. On some systems you might require administrator privileges to achieve this. Your IT supervisor will be able to do this.

3.3.2 Adding To Word

Adding FX Draw to Word is automatic. You need to know which version of Word you are using and make sure you select the correct option in the setup program.

We recommend that Word is not running when you install FX Draw.

When you restart Word, you may need to move the toolbar to a more convenient location. Simply grab the FX Draw toolbar with the mouse and place it in the desired location.

Older versions of FX Draw placed a button on the standard toolbar. If you have a previous version installed, this button becomes obsolete and should be removed.

To remove the extra button:

- Go to the **Tools** Menu and select **Customize**
- While the Customize dialog box is still on screen, move the extra button (with the mouse) from its current location on the standard toolbar and drop it into the Customize dialog box.
- Close the Customize dialog box.

3.3.3 Registration

If you are evaluating the software and wish to purchase:

- Choose the licence you require. For a full description of the licences available, read the licence information file on this disk.
- Contact Chartwell-Yorke by post, fax or email for the latest prices. Alternatively the latest prices are available from our web site at www.chartwellyorke.com
- Purchase a registration code from Chartwell-Yorke and use the instructions below to register your copy.

If you have purchased the software and have received a CD with attached Registration Information:

You have all the information necessary to register your copy of the software.

To Register your copy:

- From the Help menu of FX Draw, choose Register FX Draw...
- Press the Register Now! button.
- Type in your Registered Name and Registration Code EXACTLY as supplied by Efofex. You MUST enter your registered name using the same capitalisation, the same spaces, the same abbreviations, even the same spelling errors (if we have made any) as the registered name we have supplied.

FX Draw will now operate correctly past the thirty day evaluation period.

3.3.4 Adobe Acrobat

All manuals are provided in Adobe Acrobat PDF format. In order to read and print the manuals you will need to obtain a copy of Acrobat Reader V3.0 or later.

The Acrobat reader is available as a free download from www.adobe.com and is included on our CD.

Before downloading a copy of the reader, try clicking on the supplied PDF files. You are quite likely to already have a copy of Acrobat Reader installed on your system.

3.3.5 FX Draw and Networks (Advanced)

To successfully run, FX Draw requires that MSFLXGRD.OCX is installed and registered on each machine. This is a Microsoft file that installs into the System subdirectory. This is the only file that must be local.

Because FX Draw can operate as an OLE object, it must be located in an always-available location. We recommend, due to speed considerations, that FX Draw is stored locally if possible.

FX Draw is extremely compute intensive and running it on a central server with dumb terminals is generally unsatisfactory.

The default data file directory and the galleries directory can be explicitly set in the Tools/Customize/Directories screen. This allows you to store the galleries and any data files in a central location.

3.3.6 Changes FX Draw Makes (Advanced)

A standard installation of FX Draw makes the following changes to a system.

- FXDraw2.exe, PDF versions of manuals and quick reference cards, an uninstall program and log are all placed in the installation directory (c:\Program Files\Efofex\FXD by default).

- FX Draw's uninstall information is included in the Add/Remove Programs section of Control Panel. This can be disabled by removing the uninstall program and log from the installation subdirectory.

- A Galleries subdirectory is created in the installation directory. This contains all the standard galleries. FX Draw will, BY DEFAULT, look for its galleries in this subdirectory.

- MSFLXGRD.OCX is copied to the Windows system subdirectory and registered (this process is version checked)

- FX Draw registers itself as an OLE object in the registry (HKEY_CLASSES_ROOT).

- Registration information is stored in an ini file saved to the All Users profile. (c:\Documents and Settings\All Users\Application Data\Efofex is a likely location). If FX Draw cannot determine profile information, it will store the ini file in FX Draw's application directory.

- Individual users preferences are stored in the registry (HKEY_CURRENT_USER).

- Word macros and toolbars are stored in FXDraw2.dot. By default, this file is placed in Word's application startup directory (C:\Program Files\Microsoft Office\Office\Startup for example). In networked installations, you may wish to move this file to another startup directory – see below for details. This file has been digitally signed by Efofex Software and must be trusted to install.

It is likely that installation of FX Draw will require Administrator privileges.

3.3.7 Automatic Registration and Configuration (Advanced)

FX Draw has a number of built-in systems that make automatic registration and configuration easy.

Default Configuration & Registration System
Setting up FX Draw 2 on individual machines could be a time consuming task. Each user on each machine needs to enter the registration information. Some important preferences need to be set and FX Draw 2 has hundreds of other options that can be set to preferred values. Many teachers will like to have FX Draw set up in a particular way to standardise their teaching. We have implemented the FXDraw2.DEF file to automate the setting of these preferences.

Using the DEF file is easy:

- Set up one copy of FX Draw 2 exactly as you wish.
- Choose Write DEF file from the Tools/Customise Menu.

The DEF file will be written to the installation directory.

DEF files store EVERY option except toolbar locations.

When FX Draw first starts, it checks to see if there is a DEF file in its directory. If there is, it loads all the options from the file and then attempts to delete it. No error is generated if FX Draw cannot delete the file. This behaviour means that you can use DEF files in one of two ways:

- Ensure that there is a copy of FXDraw2.DEF in FX Draw's directory

and let it customise FX Draw for you. Once it is automatically deleted, the user is free to customise their copy of FX Draw.

- You can make FXDraw2.DEF read only (or make it part of the standard operating environment) so that FX Draw is ALWAYS reset back to your standard configuration when it is run.

Integrate with Word

Configuring Word involves copying FXDraw2.dot into a startup directory that is accessible to the user. Word, by default, loads all templates that are located in a startup directory. There are three startup directories that can be used.

- The application has its own startup directory. This will often be C:\Program Files\Microsoft Office\Office\Startup but this obviously depends on your setup. The FX Chem setup program will automatically copy the FXDraw2.dot into this directory.

- The All Users profile has a Word startup directory. This will often be C:\Documents and Settings\All Users\Application Data\Microsoft\Word\STARTUP.

- Each user has a Word startup directory. This will often be C:\Documents and Settings\%username%\Application Data\Microsoft\Word\STARTUP

You should only have the FXDraw2.dot file in ONE of these locations.

4 Basic FX Draw Concepts

4.1 Accessing FX Draw

There are two main ways of using FX Draw – as a standalone program, or as an object from within a word-processor.

Standalone Mode

If you accept FX Draw's default installation, you can run it as a standalone program by finding FX Draw in the Program Files section of the Start menu. Although this is possible, it is not the best way of using FX Draw. FX Draw is best used from within a word processor.

Document Object Mode

FX Draw is designed to be inserted as an object into a document. You can insert an FX Draw object into a document by either pushing the FX Draw toolbar button (see the section on using FX Draw in Word) or load your favourite Windows word processor and choose Insert / Object from the menus. You will be given a list of available objects and FX Draw V2 Diagram will be on the list. Select it and FX Draw will start. You use it the same way you use FX Draw as a standalone program. The only real difference is how you return to Word.

The green tick will return your image to Word showing all changes you have made. The red cross returns to Word without any changes being updated.

When you have finished your image, just **"Click the Tick"** and your diagram will be inserted into your word document.

4.2 Select & Draw

FX Draw operates in the same way as any drawing package you may have already had experience with. First select the tool you wish to draw with, then actually draw on the canvas. The canvas is the main section of the screen that will initially be shown covered in dots. The dots will not print in your final graphic, they are grid points that make drawing easier.

4.3 Drawing With A Mouse

People have described drawing with a mouse as being something akin to drawing with a brick. This is one of the main problems associated with drawing graphics on a computer. FX Draw's Geometrically Aware Drawing system makes drawing mathematical diagrams easy.

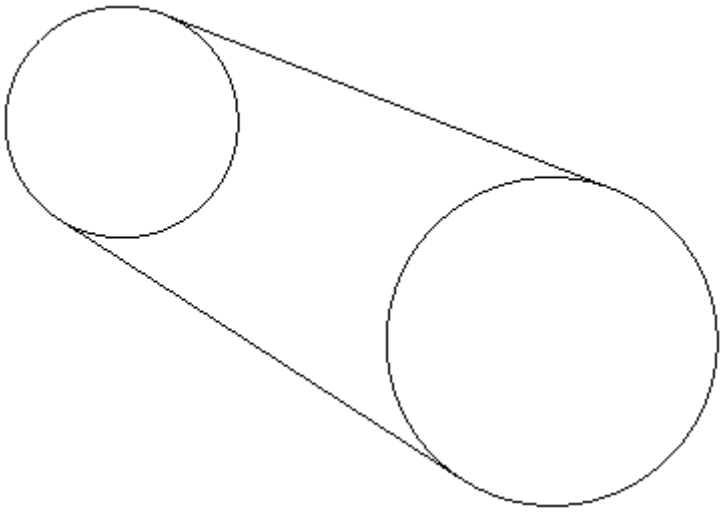
After you have selected the tool you wish to use on the canvas, drawing is accomplished by holding down the left mouse button while moving the mouse. The desired figure will fill the rectangle created by the starting point of the mouse and the current position. For most people this is natural as long as they remember that you must hold down the mouse button to draw.

4.4 Geometrically Aware Drawing (GAD)

FX Draw now implements Geometrically Aware Drawing (GAD) – but what does it mean?

Traditionally, drawing packages had a grid of points that the mouse jumped to while drawing. That allowed you to align figures that were based on lines but made it very difficult to do anything with curves or points of intersection. FX Draw rectifies this problem. While FX Draw still has a grid, it also knows a lot about geometry.

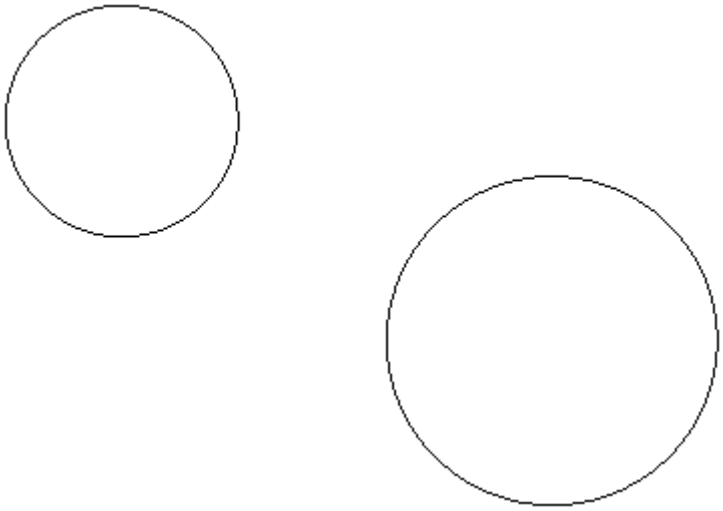
For example.



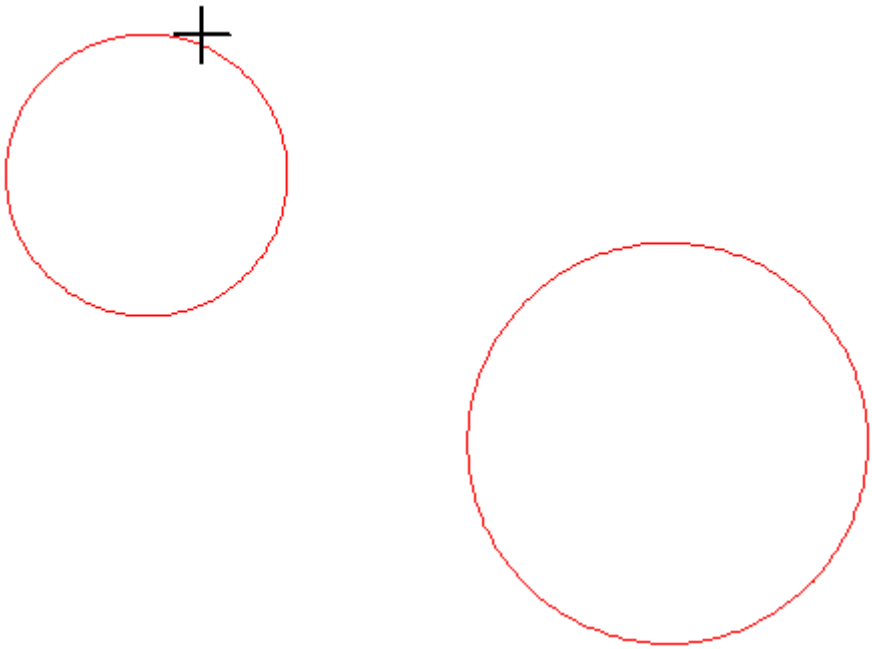
Drawing this diagram in most drawing packages is a difficult proposition. Not only do you need to draw a line that is tangential to a circle, but you also need to draw on the correct point of the first circle so that the line is tangential to both!

Drawing the diagram with FX Draw is almost trivial:

First, draw the two circles.



Second, place the cursor NEAR a point on one circle that would be the end of a line that is tangential to both.

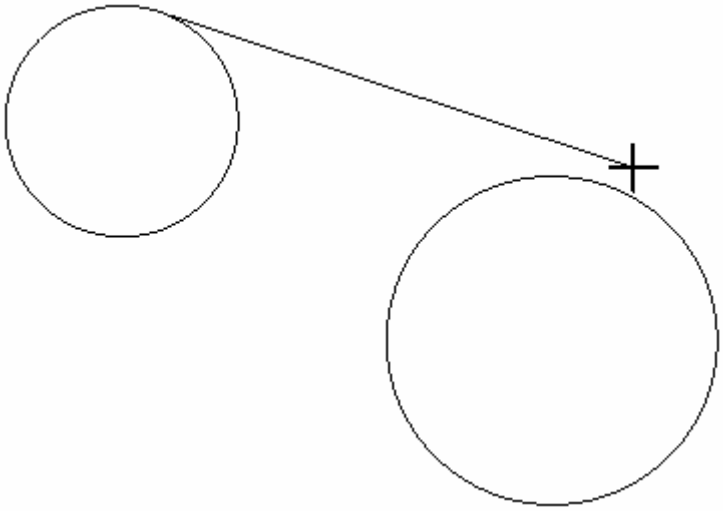


When you are somewhere close, FX Draw will change the colour of both circles and put the following message in the status line (at the bottom of the screen)

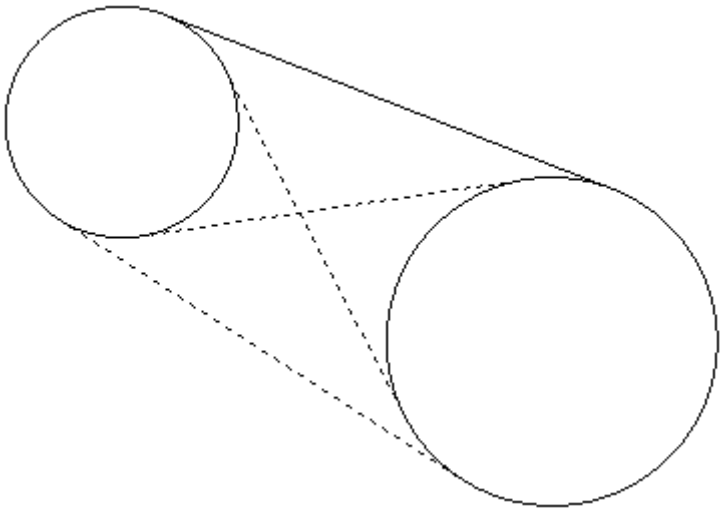
Tangent to both circles – (69.11,36.72)

(the numbers are a grid reference)

If you start to draw the line now, it will automatically begin at the appropriate point.



Finally, move to the other circle, look for the same message and the line is drawn.



We have drawn in the other three possible tangent lines. All are found automatically by FX Draw.

That is the crux of GAD. FX Draw automatically jumps to points which are of geometrical interest. It is "aware" of a wide variety of geometrical points and relationships.

The Grid

Underneath all drawings there is a grid. In the absence of any other significant points FX Draw will automatically jump to the nearest grid point (unless the grid is disabled.)

All Figures

FX Draw will automatically jump to a point on a figure in preference to a grid point. This makes it easy to draw something that starts or finishes ON a circle for example. Points of geometrical interest are more "attractive" than points on a figure.

Lines

FX Draw considers the end points, mid point, third points and quarter points to be important points on a line. FX Draw will also preferentially draw perpendiculars and parallels to existing lines. It will also preferentially make lines the same length or which bisect existing angles.

Circles

The centre point and points on the circumference are attractive points to FX Draw. FX Draw will also draw lines that pass through the centre of the circle and are tangential to the circle. FX Draw can also determine tangents to two circles as shown previously.

Arcs

The end points and centre of arcs as well as the arc's centre of curvature are tracked as geometrically important points.

Points of Intersection

Points of intersection between figures are attractive to FX Draw. FX Draw can find points of intersection for most figures including lines, circles, arcs, ellipses and Bezier curves.

Most figures have geometrically important points. We have not listed all of them

here. Most importantly, the points are found automatically for you and the system tells you exactly what it is finding at all times (see below.)

4.5 Using GAD

This is the easy part. You do not have to do anything to use GAD except keep an eye on the status line at the bottom of the screen and on what figure is changing colour. Everything else is automatic.

4.6 Changing the GAD Level

Geometrically Aware Drawing is a wonderful tool but it does have some problems. Firstly, sometimes you might not want to use it because it does suit your purpose. You might like to use just the grid or you may even wish to turn off GAD entirely. The second problem with GAD is that it is computationally intensive, so intensive that it can eventually bring even the most powerful computer to a standstill if you have enough figures on the screen.

To overcome these problems, FX Draw has four levels of GAD available.

No GAD	FX Draw uses the mouse position for all actions	
Grid Only	FX Draw draws everything to the underlying grid with no geometric analysis.	
Limited GAD (Default)	FX Draw determines geometrically important points and relationships but as the number of figures increases, the range of things determined is reduced. For example, after there are more than 15 figures, FX Draw does not calculate points of intersection. This option allows for extensive use of GAD without the computational limit problems.	
"Infinite" GAD	Sometimes you will want to use GAD regardless of the computational cost. With this option, FX Draw will calculate all geometrically important points and relationships regardless of the number of figures in the diagram	

The GAD level is selected using the GAD toolbar

4.7 Overriding GAD

Sometimes you will want to override the GAD system for just a moment. Perhaps you wish to use a grid point that is too close to an existing figure and the GAD system will not let you use it. You can override the GAD system at any time by using the Shift or Ctrl key while you are moving the mouse.

Shift FX Draw will use a grid point and will ignore any geometrically important points.

Ctrl FX Draw will not use any geometrically important or grid points. It will use the raw mouse position.

4.8 The Toolbars

4.8.1 The Main Draw Toolbar

The toolbar normally exists on the left hand side of the screen. The currently selected tool is shown depressed and this is the tool you will be drawing with. When FX Draw is first loaded, the line drawing tool is selected as shown in the figure. You can select any of the other tools by pressing the appropriate button. The toolbar is the location of most of the power of FX Draw. All of the tools have been designed to be useful to a mathematics teacher.

4.8.2 The Standard Toolbar

The standard toolbar contains standard tools that are common with most other products. Two extra buttons are added, the tick and the cross. These are used to return to a document and are explained fully in the Using FX Draw in Word section of this guide.

4.8.3 The Line Type Toolbar

You can change the type and colour of the line used to draw a figure using the line type toolbar. When you first draw a figure, it will be drawn using the currently selected line type and colour. You can also change the line type of the currently

selected figure using the same toolbar. You have the choice of eleven different line types including dotted, dashed and seven different widths of solid line.

You can select a figure's line colour by pushing the "rainbow" button. You can choose one of forty eight basic colours or define a colour of your own.

4.8.4 The Fill Type Toolbar

You can change the type and colour of the fill used to draw a figure using the fill type toolbar. When you first draw a figure, it will be drawn using the currently selected fill type and colour. You can also change the fill type of the currently selected figure using the same toolbar. You have the choice of solid colour or six types of hatching.

You can select a figure's fill colour by pushing the "rainbow" button. You can choose one of forty-eight basic colours or define a colour of your own.

4.8.5 The GAD Level Toolbar

The GAD Level Toolbar allows you to control the Geometrically Aware Drawing calculations performed by FX Draw ranging from none up to full GAD regardless of the number of figures. Most of the time you will leave it set to the default level (shown).

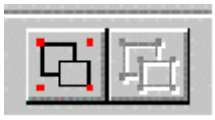
4.8.6 The Layout Toolbar

FX Draw draws the figures in the diagram in the same order you initially created them. If you have overlapping figures this means that one figure will be drawn over the top of the other. The layout toolbar allows you to change the drawing order of the figures so that different figures appear on "top of the pile". Each button represents the currently selected figure in yellow and shows what will happen when the button is pushed.

- Bring the currently selected figure to the front.
- Send the currently selected figure to the back.
- Move the currently selected figure one forward in the drawing order.
- Move the currently selected figure one back in the drawing order.

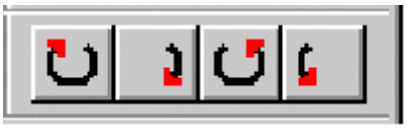
4.8.7 The Grouping Toolbar

Allows you to group the currently selected figures or ungroup the currently selected group. A group is just a collection of figures that is treated as one.



4.8.8 The Rotation Toolbar

Allows you to rotate the currently selected figures. The figure can be rotated clockwise or anticlockwise by 15 degrees or 1 degree. Some of the more complicated figures (eg graphs) cannot be rotated.



4.8.9 The Reflection Toolbar

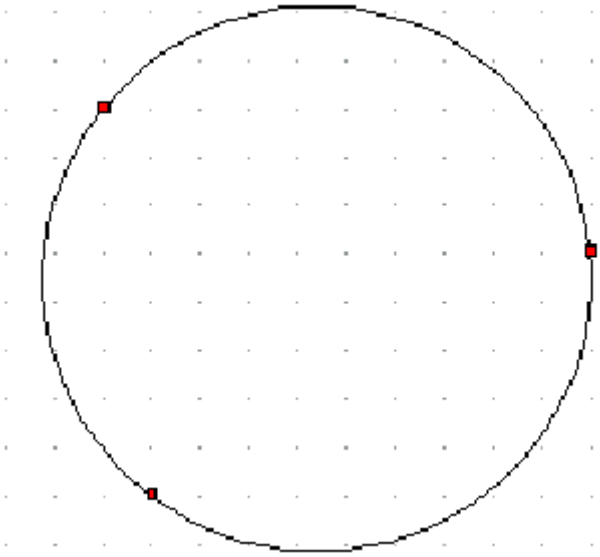
Allows you to reflect the currently selected figures.

4.8.10 The Web Graphics Toolbar

Allows you to create bitmaps (PNG and BMP format) for use in web graphics.

4.9 Control Points

All figures have control points. They are the crucial points that are used to define it. If a figure is selected, its control points will be show as small red squares. Control points allow you to control a figure's shape, size and structure.



For example, the diagram above shows a circle defined by three control points. By moving the points, the circle will be redrawn to pass through the three new points.

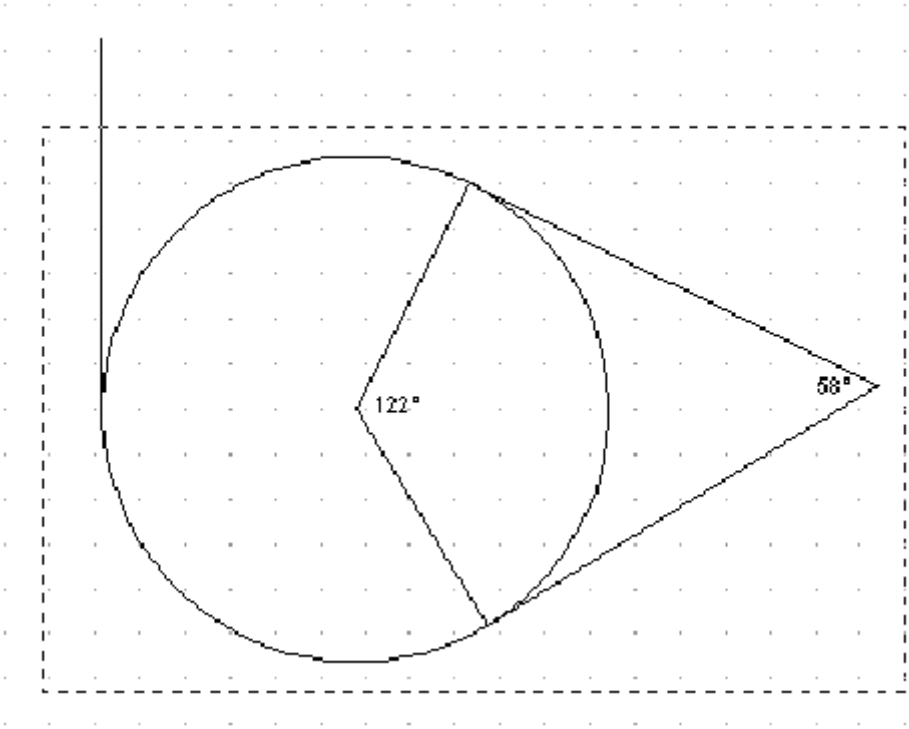
4.10 Manipulating Figures

4.10.1 Selecting Figures

To select figures you must first select the selection tool.

Selecting an individual figure
You can select an individual figure by clicking on it once. With most figures you must click on the LINES that figure is comprised on. FX Draw does not usually allow you to select a figure by clicking on the filled areas.

Selecting a number of figures
A group of figures can be selected by sweeping out a selection rectangle. Any figure whose control points are within the rectangle will be selected.



All of the figures except the tangent on the left will be selected by the (dotted) selection rectangle.

Adding or subtracting a figure from your selection
You can add and subtract figures from an existing selection by holding the Ctrl key whilst clicking on a figure. If the figure is not already selected it will be added to the selection. If the figure is already selected, it will be subtracted from the selection. The use of the Ctrl key whilst clicking the mouse allows you to select exactly the figures you require.

If you wish to move a figure, click and hold anywhere within the select region and you can then move the figure anywhere on the canvas.

It is important that you become proficient in selecting, resizing and moving figures and it is worthwhile practising the skill.

4.10.2 Moving Figures

You must have the selection tool selected to move figures

Moving figures with the mouse
If you click on a figure, it will be selected and will then move with the mouse. If a number of figures are selected and you click on one of them, all of the selected figures will move with the mouse.

Moving figures with the keyboard

Any figures currently selected can be moved with the keyboard. The arrow keys will move the figures in the selected direction.

- Holding down an arrow key will move figures 0.25 mm.
- Holding down Ctrl and an arrow key will move figures 1 mm.
- Holding down Shift and an arrow key will move figures 0.05 mm.

4.10.3 Resizing Figures

If you move a figure's control point, the figure will be redrawn to fit the new control points. The result of moving control points depends on the figure.

4.10.4 Rotating Figures

You can rotate currently selected figures using the keyboard or toolbar.

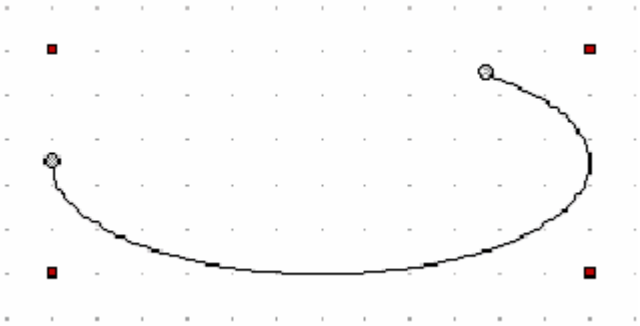
Rotating figures with the keyboard

Ctrl + Pg Up	Rotates 15° anti-clockwise
Ctrl + Pg Dn	Rotates 15° clockwise
Shift + Ctrl + Pg Up	Rotates 1° anti-clockwise
Shift + Ctrl + Pg Dn	Rotates 1° clockwise

Rotating figures with the toolbar buttons

The rotate toolbar can rotate figures in the same increments as the keyboard shortcuts.

4.11 Sliders

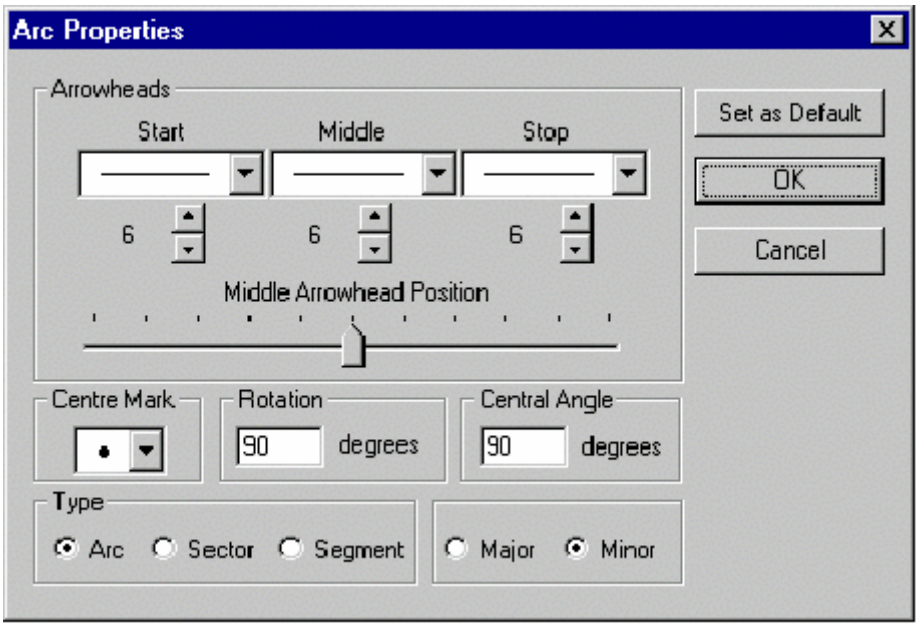


Some of the more complicated figures include "sliders" – little grey dots - which appear when the figure is selected. A slider is a convenient way of manipulating some of the properties of a figure. The diagram shows a four-corner arc figure and its sliders. For an arc figure, the sliders control the end points of the arc. The function of the sliders depend on the figure they are attached to so if you ever see a slider move it (by clicking and holding the mouse button as you move the mouse) and look at the changes. You will find that sliders make many drawing jobs easier.

4.12 Editting Properties

Most of the figures you will be drawing have many properties that can be changed. Properties such as the line type and fill type can be changed using the line and fill toolbars. Some properties may be changed by using the sliders attached to the figure. Mostly, however, you will change a figure's properties by ***right clicking*** on the figure.

Most figures, when right-clicked, will create a dialog box that allows you to adjust the properties of the figure. Below is an example of one of those dialogs.



This shows the available properties for an arc. They will be discussed later in the guide.

4.13 Grid

The grid, shown as the array of dots on the screen, can assist you when drawing figures. FX Draw will preferentially jump to a grid point unless a geometrically important point is nearby. The grid can help you construct accurate figures.

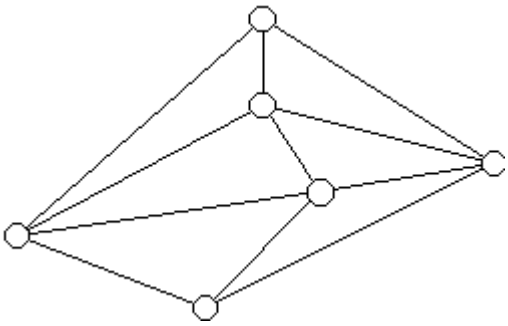
You can override the GAD system by holding down the Shift key whilst drawing. You can override the GAD system and the grid by holding down the Ctrl key whilst drawing.

The Tools / Preferences / Grid menu allows you to adjust the properties of the grid. You can choose to display the grid (the default) or to remove the dots from the canvas. You can set the size of the grid and most importantly you can set to grid to Cartesian or isometric. An isometric grid, although a little harder to work with, makes drawing isometric diagrams easy.

If the GAD toolbar is set to No GAD, the grid is ignored. This is equivalent to holding down the Ctrl key whilst drawing.

4.14 Setting Defaults

Many of the tools come set with defaults. Perhaps the tool that you are most likely to want to set using defaults is the arrow line tool. If you wish to draw this network diagram,



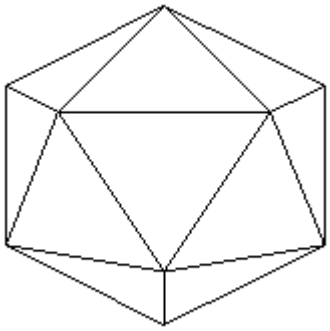
you have to create eleven lines and make the start and end points filled in white circles. Because the arrow line defaults to a line with a triangular arrow head, this means drawing eleven lines, selecting them individually and editing their properties to add the white circles OR set the default for the arrow line.

To set a default, you set a line to the desired type and then press the Set to Default button. Your selected defaults will be saved and used whenever you create another arrow line.

In the example above, the default arrow line was set to

4.15 Grouping and Ungrouping

When you draw a complicated shape, you will often want to group the figures together to form a single figure. For example, if you have drawn an icosahedron, it is useful to move all components of the graphic as a group rather than individually. The easiest way to achieve this is to "group" the components together. To create a group you should:



- Select all figures you wish to group together.
- Choose Group from the Draw Menu OR type Ctrl + G.

Once grouped together, the group figure behaves in much the same way as any other graphics figure, it can be selected, moved or resized. All the gallery figures that you can select are in fact "groups" of lines, arcs, rectangles etc.

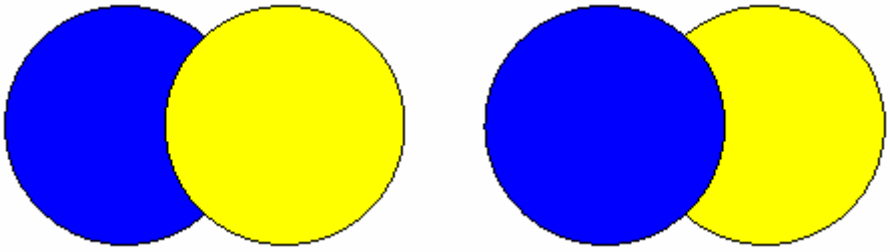
If for some reason you wish to access the individual figures within a group, you can "ungroup" a figure. To do this you should:

- Select the figure to be ungrouped.
- Choose Ungroup from the Draw Menu OR type Ctrl + H.

Because the gallery figures are groups, this gives you the ability to load a gallery figure and modify it to suit your needs. Simply select the figure, ungroup it, and make the modifications you need.

4.16 Changing the Drawing Order

As you create figures, they are added to a list of figures to be drawn. Every time FX Draw redraws your graphic, it draws them in this drawing order. The diagram below shows the result of different drawing orders.



The Layout Toolbar allows you to change the order figures are drawn and get exactly the result you want.

4.17 Printing

FX Draw has in-built print routines but you will usually use some other application to actually print your graphic. All Windows word processors (including Write) have the ability to use and print FX Draw graphics. Although FX Draw is designed to be used in word processor documents, many other packages can use FX Draw graphics (for example, Microsoft Excel and Powerpoint)

4.18 Cut / Copy / Paste

Cut / Copy / Paste works the same way in FX Draw as in any other Windows program. If you wish to cut out a figure and place it on the clipboard or to copy a figure onto the clipboard, all you need to do is to select the figure(s) you wish to operate on, and choose Edit / Cut (Ctrl + X) or Edit / Copy (Ctrl + C). The selected items are then placed on the clipboard. All items placed onto the clipboard in this way can later be Pasted into FX Draw.

To Paste from the clipboard you can choose Edit / Paste (or Ctrl + V) and a copy of the clipboard contents will be pasted onto the canvas. This copy can then be moved to the required location.

If you simply wish to delete the selected figures, without placing them onto the clipboard, press Del.

You can copy an image to the clipboard and then paste it into another application (eg Word) but this IS NOT the best way of using FX Draw. Make sure you read the section on using FX Draw in Word.

4.19 Undo and Redo

All actions except grouping and ungrouping can be undone. You can undo the last action by choosing Undo from the Edit menu or by typing Ctrl + Z. You can redo the last undone action by choosing Redo from the Edit menu or by typing Ctrl + Y.

FX Draw's undo system is limited only by the available memory. For most editing, you will not find the limits of the undo system and should be able to undo actions indefinitely.

4.20 Keyboard Shortcuts

Keyboard shortcuts can make using FX Draw a quicker experience.

Overriding GAD

Shift	Ignores Geometrically Important Points and instead jumps to the grid.
Ctrl	Ignores grid and any Geometrically Important Points.

Editing

Ctrl + X	Cuts selected figures and places them on the clipboard.
Ctrl + C	Copies the selected figures to the clipboard
Ctrl + V	Pastes figures from the clipboard
Ctrl + D	Copies and pastes selected figures
Ctrl + Z	Undo last action
Ctrl + Y	Redo last undone action

Rotating

Ctrl + Pg Up	Rotates selected figures 15° anti-clockwise
Ctrl + Pg Dn	Rotates selected figures 15° clockwise
Shift + Ctrl + Pg Up	Rotates selected figures 1° anti-clockwise
Shift + Ctrl + Pg Dn	Rotates selected figures 1° clockwise

Grouping

Ctrl + G	Collects all selected figures into a group figure
Ctrl + H	Ungroups the selected figure

Drawing Order (Layout)

F6	Brings selection to the front
Shift + F6	Sends selection to the back

Nudging

Up Arrow	Nudges selected figures upward
Down Arrow	Nudges selected figures downward
Left Arrow	Nudges selected figures to the left
Right Arrow	Nudges selected figures to the right

Holding the Shift key decreases the amount the figures are nudged. Holding the Ctrl key increases the amount the figures are nudged.

Resizing Groups

Holding the Shift key whilst resizing a group forces the group to maintain its aspect ratio (ratio of width to height) so that the group is not distorted.

Drawing Gallery Images

Holding the Shift key whilst drawing a gallery image forces the gallery image to maintain the aspect ratio it was created with. This again ensures that the gallery image is not distorted.

Drawing Figures Based on Rectangles

Many of the figures which are based on rectangles (rectangles, rounded rectangles, Venn diagrams, graphs, grids etc) can be forced to a square by holding the Shift key when creating them.

4.21 Creating Web Graphics

FX Draw "thinks" in vectors - lines, circles, rectangles ... Most graphics for web sites are bitmaps - collections of dots. To use FX Draw images on a web page, you need to convert them to bitmaps.

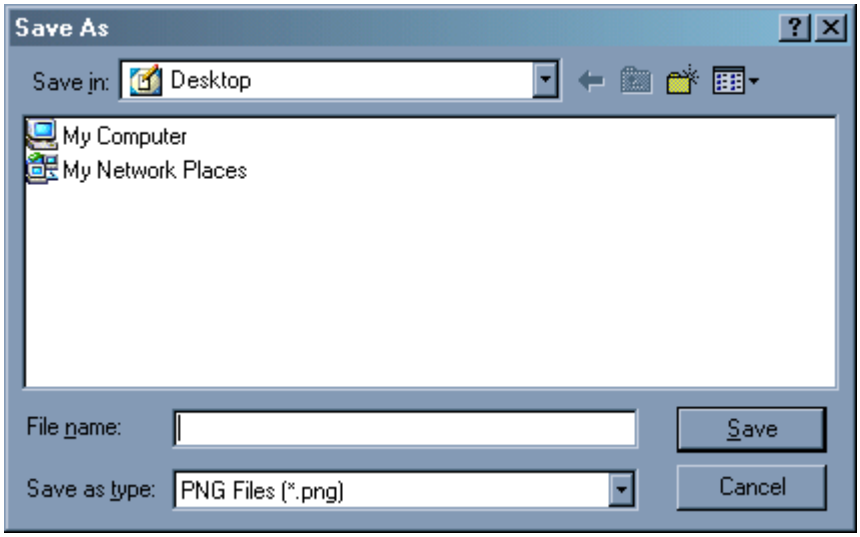
FX Draw includes two tools to produce bitmaps for web pages. The can be

accessed from the tools menu or the web graphic toolbar.

The left hand button will produce a bitmap of the **whole** diagram. The right hand button lets you select a rectangular section of the diagram to save to a bitmap.

To use the tool to save all the graphic:

1. Draw your diagram
2. Push the left hand button
3. Select a filename and a location to save your graphic (see below)
4. Select whether you want your graphic saved as a PNG file or a BMP file (see below)
5. Push OK.



To use the tool to save a rectangular section:

1. Draw your diagram
2. Push the right hand button
3. You will now be returned to the normal FX Draw screen and you can select an area in exactly the same way you would use the select tool.
4. Select a filename and a location to save your graphic (see above)
5. Select whether you want your graphic saved as a PNG file or a BMP file (see below)
6. Push OK.

4.21.1 What Formats are Offered?

FX Draw can create PNG and BMP format bitmaps. You should normally use the PNG format. BMP bitmaps are very large and should only be used if a third party product you need cannot handle PNG style bitmaps.

4.21.2 Why no JPG or GIF?

JPG (also known as JPEG) files are not suitable for the type of graphics FX Draw produces. The JPG format was designed for photographs and, when used on solid colour graphics, such as FX Draw's, produces unsightly extra dots when displayed. While they excel at reproducing photographs, they are simply the wrong tool for the job in this application.

GIF files are ideally suited to the type of diagrams FX Draw produces BUT they rely on a patented algorithm. The owners of the algorithm (Unisys) charge very large licence fees to use the format in software and these fees take little account of the size of the potential market. We would love to provide you with this feature but we simply cannot justify the cost.

The PNG format was developed as a free alternative to GIF files and is widely supported by internet browsers (eg Internet Explorer and Netscape). Support amongst image editors is less ubiquitous but most image editors can load and save PNG files.

5 Using FX Draw in Word

FX Draw is designed to be used in Word to generate publication quality graphics for tests, examinations, worksheets and assignment. The easiest way to insert graphics into Word is to use fxdraw.doc (or fxd695.doc) to add a toolbar button to your Word toolbars (see Adding FX Draw to Word). Alternatively you can use Insert Object from the Insert menu in Word and select FX Draw V2 Diagram.

When you insert an FX Draw object into your document, FX Draw will start and you can use it in the same way you use FX Draw as a standalone program. The only real difference is how you return to Word.

The green tick will return your image to Word showing all changes you have made. The red cross returns to Word without any changes being updated.

Once you have finished drawing your graphic, push the appropriate button to return to Word.

5.1 Editting Graphs

Once you have returned to Word, you can edit a graphic by double-clicking on it. FX Draw will restart and you will be able to edit your graphic.

5.2 Sizing Graphics

There are two ways of sizing graphics for your document; inside FX Draw and inside Word.

When you return to Word, the graphic will be inserted into your word document the same size as you have drawn it in FX Draw. The sizing is very accurate (all points are located to within one hundredth of a millimetre) and a line that is 92.5mm in FX Draw will be 92.5mm when returned to Word and should be 92.5mm long when printed.

Once you have returned to Word, you can resize the graphic inside Word. This can causes problems. Once Word resizes a graphic, there is no way for FX Draw to guarantee lengths of lines or the regularity of circles. For many diagrams this is a not a problem but it can be a problem if you are relying on a particular measurement or if you do not wish your circles to become ellipses. You might also find that fonts become distorted or the spacing of text is incorrect. This is especially the case if you change the aspect ratio of the graphic (the ratio of height to width)

Generally, it is better draw the diagram to size in FX Draw and not resize it in Word. If you must resize in Word, you will get the best results if you maintain the graphic's aspect ratio.

5.3 Copying Data out of FX Draw's Statistics Tool

If you need to copy your data out of FX Draw's Statistics Tool and into a word processor or spreadsheet, you have two options available

Data in Columns

FX Draw's Statistics Tool always works in columns. If your want your data copied into your word processor in columns, you can achieve this easily by selecting your data in FX Draw's Statistics Tool, copying it to the clipboard (using the Edit menu, Ctrl+C or the copy toolbar button) and then pasting it into your word processor.

	A	B
	data	data
1	1	2
2	2	5
3	3	6
4	4	7
5	5	7
6	6	9
7	7	12
8	8	13
9	9	15
10	10	18
11		

Sheet with data selected

1 2
2 5
3 6

4	7
5	7
6	9
7	12
8	13
9	15
10	18

Pasted into the word processor

Data in Rows

If you wish your data to be copied into your word processor in rows, rather than columns, FX Draw has a special function especially for this purpose. Select the same data as shown above but this time select Copy As Rows from the Edit menu. When you paste the data into your word processor, it will be in rows.

1	2	3	4	5	6	7	8	9	10
2	5	6	7	7	9	12	13	15	18

5.4 Copying Statistics out of FX Draw's Statistics Tool

At any stage, pushing the "Copy Statistics to Clipboard" button will copy the statistics to the clipboard in rich text format. This format will retain its formatting when pasted into Word or Excel.

6 Tools

6.1 Select

The select tool allows you to select figures or collections of figures.

If you wish to select a single figure, make sure that the select tool is pushed and click once on the desired figure. It is important to remember that the select region is built around the LINES that make up the figure and not the fill. The selected figure will show its handles so that you can move, resize, cut or copy it.

Sometimes you will want to select a collection of figures so that you can move them as a collection, delete them as a collection or actually group them together (see Grouping / Ungrouping). To select a collection, hold down the mouse button while moving the mouse and a dotted rectangle will appear. Any figure that is totally contained within the dotted rectangle will become part of the collection.

You can add a figure to your selection or subtract a figure from your selection by holding down the Ctrl key while clicking on the figure you wish to add or subtract.

6.2 The Lines

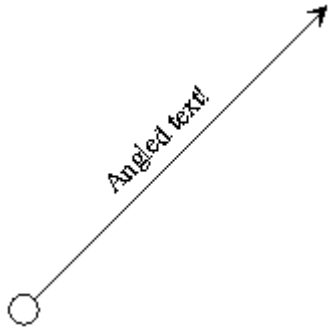
Even though there is really only one type of line, we have included two line buttons – a basic line and an arrow line. The arrow line button is set, by default, to have an arrowhead at one end but you can change the default to any of the combinations available. This allows you to draw many complicated diagrams easily.

Even though the arrow line tool provides you with enormous power, on many occasions you will just want a simple line. This is why we have two buttons – one highly customisable and versatile – the other simple but always available.

The Basic Line

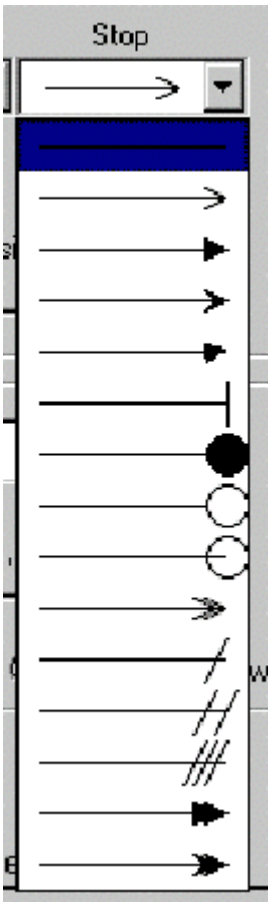
The basic line tool allows you to draw simple lines.

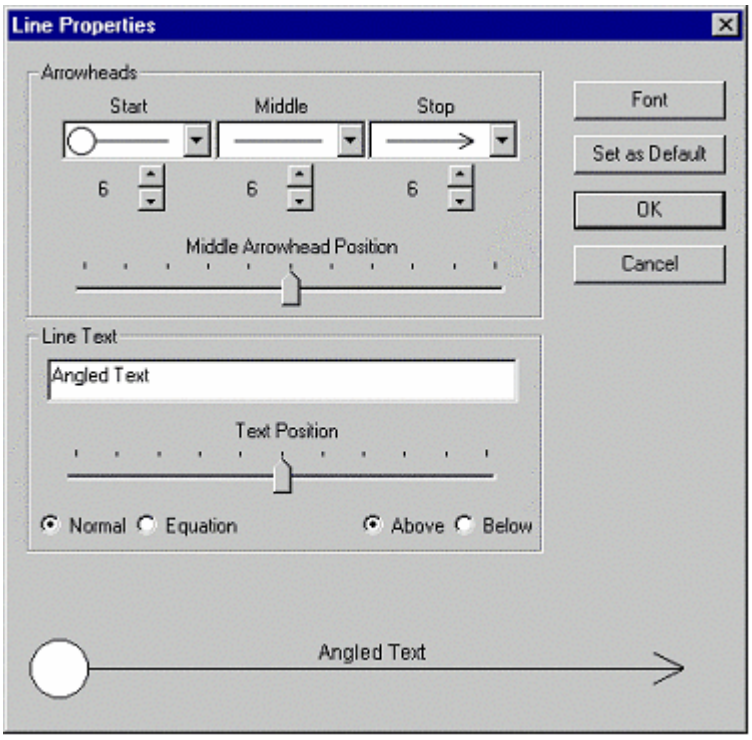
Although the lines you draw with the line tool are simple lines, you can add many features to them by right clicking to edit the properties.



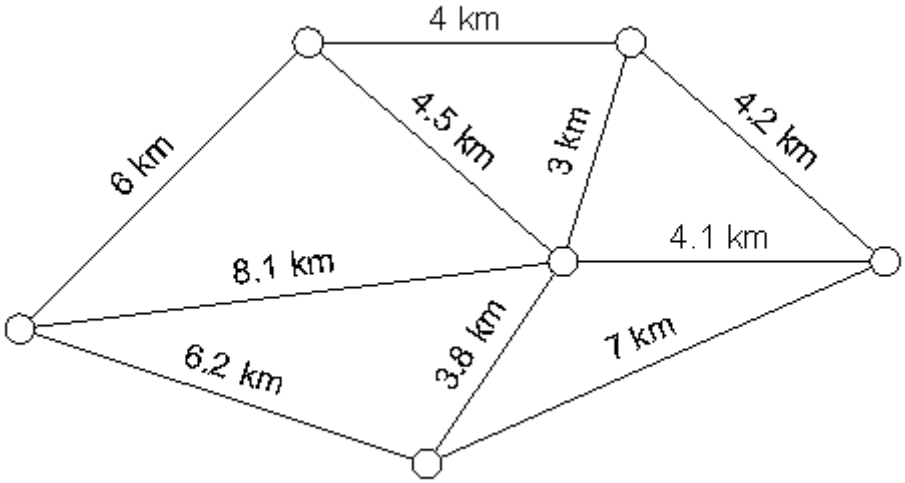
To draw a line, select the line tool; move the mouse to where the line should start; press the left mouse button; move the mouse to the stop position and release the button. It is important to realise that lines have a direction. FX Draw remembers which end you started from.

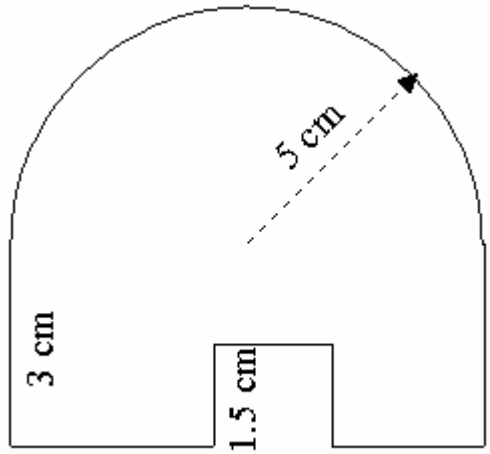
A line can have many different properties as shown in the figure. The options dialog box is quite large because of the number of options.





You have a choice of fourteen arrow types for the start, middle and stop arrow. You can also set the size of the arrows, the position of the middle arrow and text (currently set to halfway along the line) and the attached text. Any text attached to a line is drawn at the same angle as the line. This can be used to good effect when drawing networks or to indicate measurements.





You can also choose to place the text above or below the line depending on your needs.

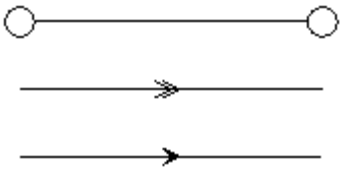
The text can be interpreted as an equation or as normal text. Equations on lines are NOT angled along the line. See the Appendix A on how to enter equations into FX Draw.

Arrow Line

An arrow line is exactly the same figure as a line, the only difference is that its properties can be pre-set to your requirements. When FX Draw is first started, the arrow line is pre-set to a line with a solid arrow at the stop end of the line.

This line, when drawn, can be edited to include any of the properties discussed above.

Sometimes you will wish to set different defaults for the arrow line so that any future arrow lines will be created to suit your purposes.



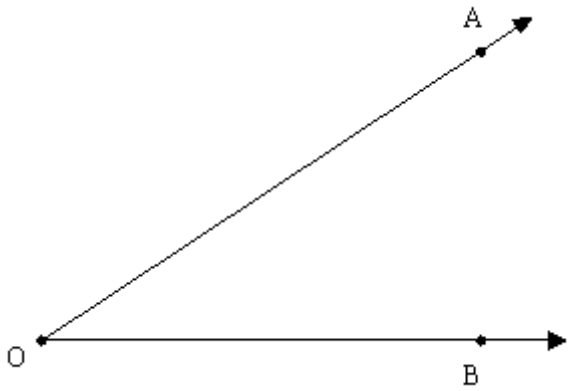
Setting your default line is easy. Draw a line and then change its properties to your desired default. When you are happy, push the Set to Default button. All future arrow lines will be drawn with your defaults.

It is important to remember that arrow lines are exactly the same as lines, just pre-set to your choice.

6.3 Point

The point tool allows you to add points to any diagram.

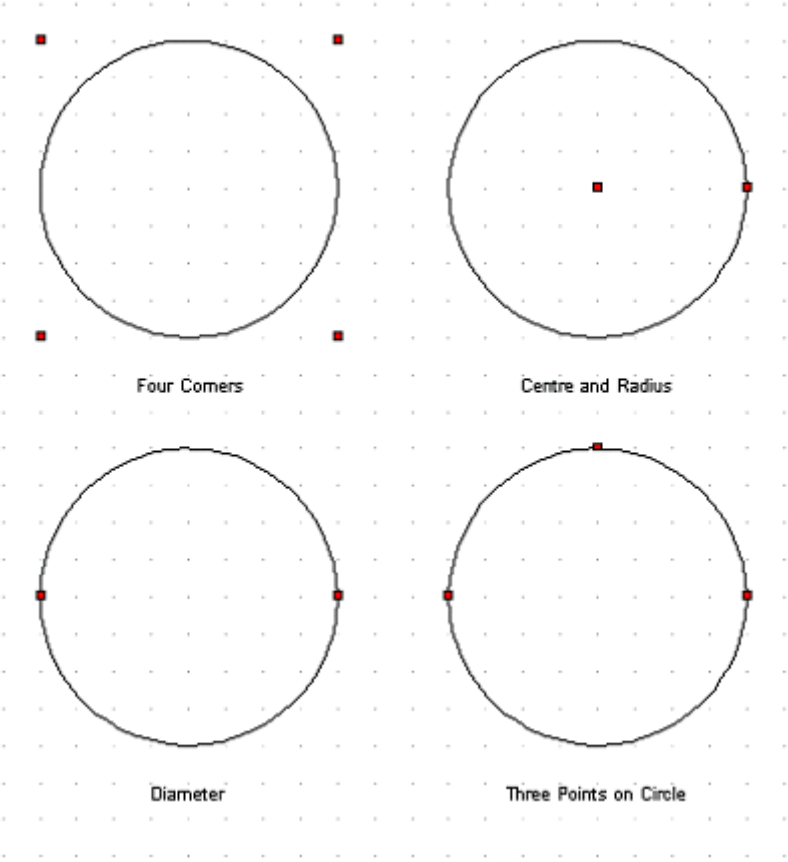
Many mathematical diagrams require the use of a 'point'. The centre of a circle. A point on a line. The point tool allows you to draw these. Marking the centre of a circle can be done automatically for you by the circle tool but any other point must use the point tool.



You have a selection of seven point marks available to you. These are the same as the centre marks for the circle tool discussed next.

6.4 The Circles

Unlike the two line buttons, which produce the same type of figure, there are four DIFFERENT types of circles available in FX Draw. Each of the circle figures has been created to solve a different drawing problem. What makes them different is how the circle's control points are used to define the circle.



When you draw a circle it will be drawn with a default centre mark. You have a choice of seven centre marks and these can be changed by right clicking on the circle. These are the same marks that you can choose as points for the point tool.

Circles can be filled using the fill palette (see Setting Fill Type).

The centre mark for the circle can be set as a default.

When you are drawing diagrams including circles, your choice of circle tool can make a large difference to the ease with which you will draw your diagram.

Four Corners 

The four corner circle will draw a circle inscribed in a square region defined by four control points. This is how FX Draw V1 defined circles and any FX Draw 1 files will load with this type of circle.

To draw a four corner circle, you click and hold the left mouse button – move the mouse to the diagonally opposite corner and release the mouse button.

Centre & Radius 

The centre & radius circle is defined by the centre of the circle and any point on the circumference. This is the circle tool to use if you know the location of the

centre of the circle.

To draw a centre & radius circle, you mark the centre of the circle with your initial click and the point on the circumference when you release the button. Your Centre & Radius circle could extend beyond the bounds of the drawing area. If this occurs, FX Draw will draw as much of the circle as possible.

Diameter 

When you are drawing a diameter circle, the two points you define will form a diameter of the circle

To draw a diameter circle, you click and hold the left mouse button – move the mouse to the other end of the diameter and release the mouse button.

Three Point 

Three-point circles are defined by ANY three points on their circumference. They are ideal for drawing, for example, the circum-circle of a triangle.

Drawing a three-point circle:

- Click AND HOLD the left mouse button – this defines the first of the three points.
- Move the mouse (while holding the button) to the second of the three points. While you are moving the mouse, FX Draw will synthesise a third point and show you a circle. Release the button when you are at the second point.
- Click AND HOLD the left mouse button and move the mouse to the third point. As you move the mouse, FX Draw will draw a circle through your points. Release the button when you are at the third point.

6.5 Rectangle

The rectangle tool draws rectangles that may be filled if desired.

The rectangle tool is the simplest tool FX Draw possesses. There are no special properties apart from the line style and fill style selected from the palettes.

6.6 Smoothed Line

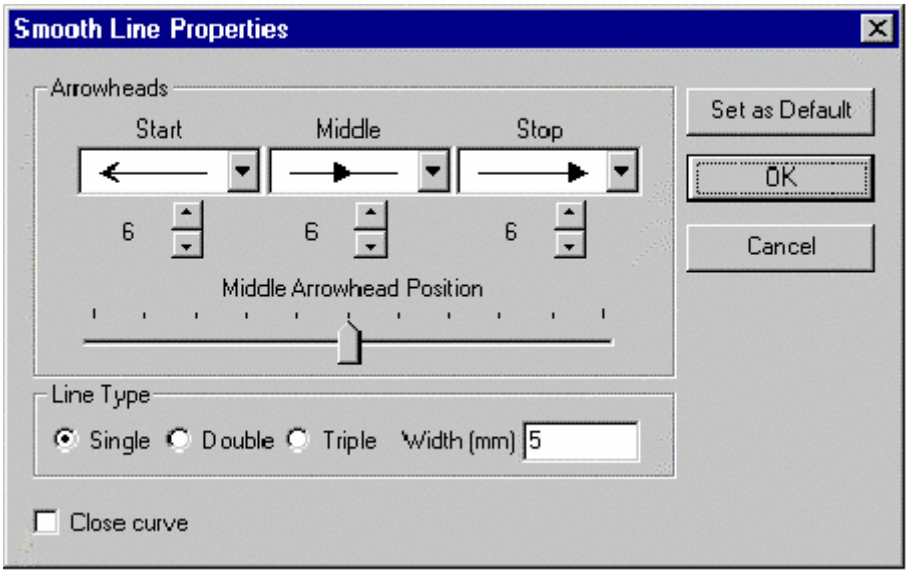
The smoothed line tool will smooth a mouse drawn line for you.

Most people have a great deal of difficulty drawing a smooth line with a mouse.

The smoothed line tool allows you to produce a smooth line without any mouse drawing skills!

Simply select the smoothed line tool and begin drawing. FX Draw will automatically smooth the line for you.

The smoothed line options are shown in the dialog box below.

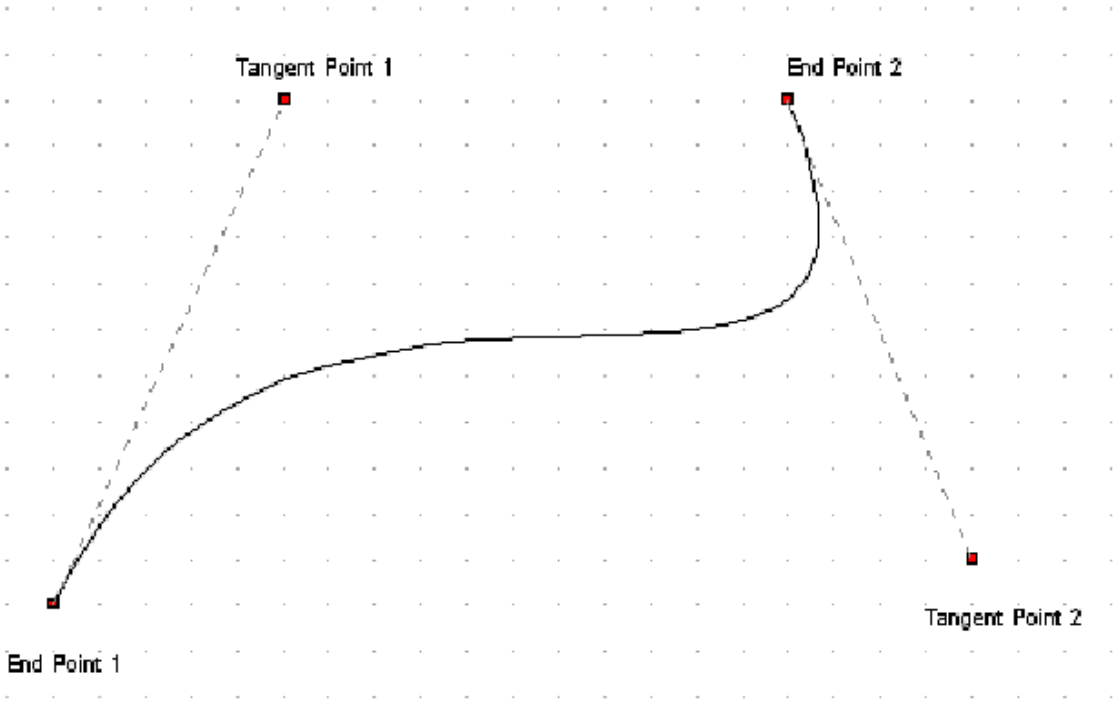


You can add arrows to the start, middle and end of the smooth line. You can leave the line as a single line or make it double (like a road) or triple. You can also close the curve. If the curve is closed, it can be filled.

Please note: Finding the middle of the smoothed line is computationally intensive. Having a large number of smoothed lines with middle arrows can dramatically slow down FX Draw's response.

6.7 Bezier Curve

A Bezier curve is defined by its two end points and two other points which determine the direction the curve approaches its end points. Mathematically speaking, it is a parametric function where both the x and y functions are cubic polynomials.



Drawing Bezier curves:

- Click AND HOLD the left mouse button. This will define End Point 1.
- Move the mouse (while holding the button) to End Point 2.
- Release the button.
- Click AND HOLD the left mouse button. Move the mouse (while holding the button) until you are at Tangent Point 1.
- Release the button.
- Click AND HOLD the left mouse button. Move the mouse (while holding the button) until you are at Tangent Point 2.
- Release the button.

Bezier curves have almost the same properties as a smoothed line. The only difference is that you cannot close the curve.

6.8 Polygon

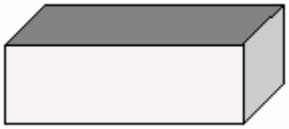
The polygon tool allows you to draw polygons that may be filled if desired.

When drawing a polygon, click the mouse button at the position you want each vertex to fall. You should hold down the mouse button while moving the mouse, so you will be able to see the side of the polygon being drawn. When you have completed the polygon, **right click** to end the polygon drawing process. This is most important, a polygon is **NOT** completed until you **RIGHT CLICK**.

Editing a polygon is different to most other figures. If you right-click on a polygon,

FX Draw will add or delete a vertex. If you right click in the middle of a side of the polygon, FX Draw will add a vertex – increasing the number of sides. If you click on an existing vertex, FX Draw will delete that vertex – reducing the number of sides.

If you wish to draw the side of a box, and wish to colour, or fill, the side, polygons are the tool you will need to use. They allow you to fill odd shapes. This box, for example, has been drawn using filled polygons.



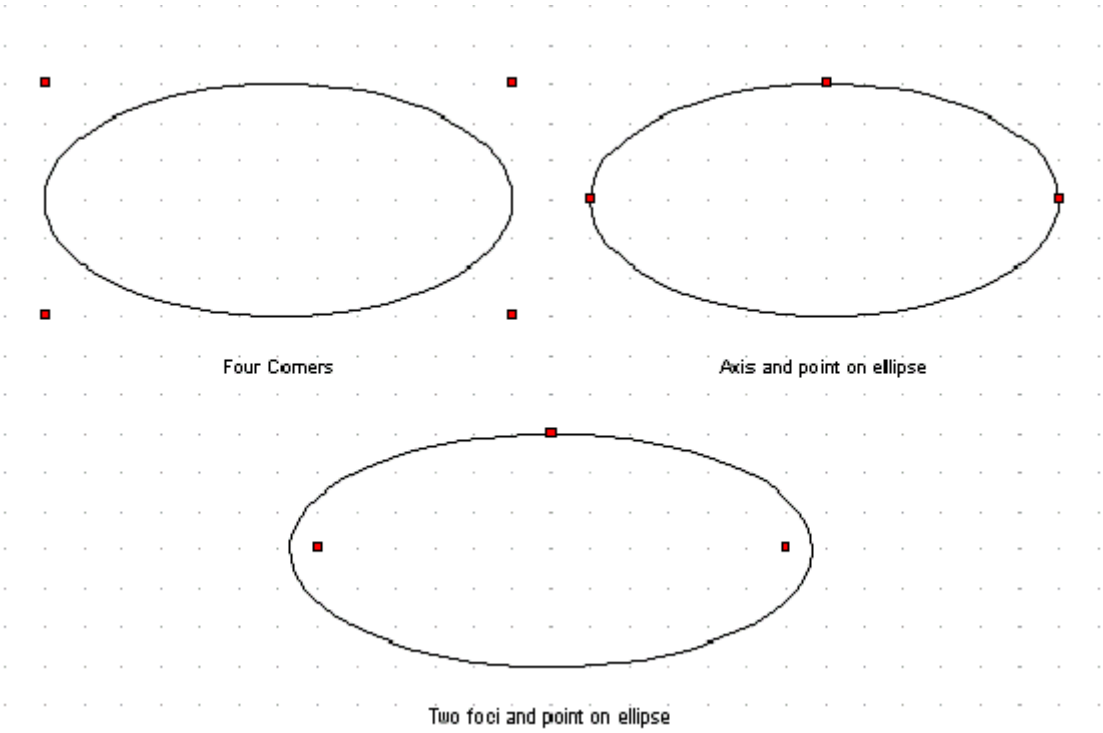
6.9 Rounded Rectangle

The rounded rectangle tool allows you to draw rounded rectangles that may be filled if desired. The radius of the curve may be changed using a slider or by editing the rounded rectangle's properties.

Rounded rectangles are often used to put a frame around text. The only property that can be edited in a rounded rectangle is the radius of the corner curve. When selected, a rounded rectangle has a slider. By moving this slider, the radius of the corner can be changed. The radius can also be entered exactly by right clicking on the rounded rectangle and entering the radius explicitly.

6.10 The Ellipses

FX Draw provides three ellipse tools. As with circles, the tool you choose to draw a particular ellipse depends on what you know about the ellipse you wish to draw. Choosing the correct tool can make your job much easier.



Four Corners

The four corner circle will draw an ellipse inscribed in a rectangular region defined by four control points. This is how FX Draw V1 defined ellipses and any FX Draw 1 files will load with this type of ellipse.

To draw a four corner ellipse, you click and hold the left mouse button – move the mouse to the diagonally opposite corner and release the mouse button.

An Axis and a Point on the Ellipse

This form of ellipse is defined by one of its axes (either major or minor) and one other point on the ellipse.

Drawing the ellipse:

- Click AND HOLD the left mouse button – this defines one end of the axis.
- Move the mouse (while holding the button) to the other end of the axis. While you are moving the mouse, FX Draw will synthesise a third point and show you an ellipse. Release the button when you are at the second point.
- Click AND HOLD the left mouse button and move the mouse to the point on the ellipse. As you move the mouse, FX Draw will draw an ellipse through your points. Release the button when you are at the third point.

Foci and a Point on the Ellipse

This form of ellipse is defined by its foci and one other point on the ellipse.

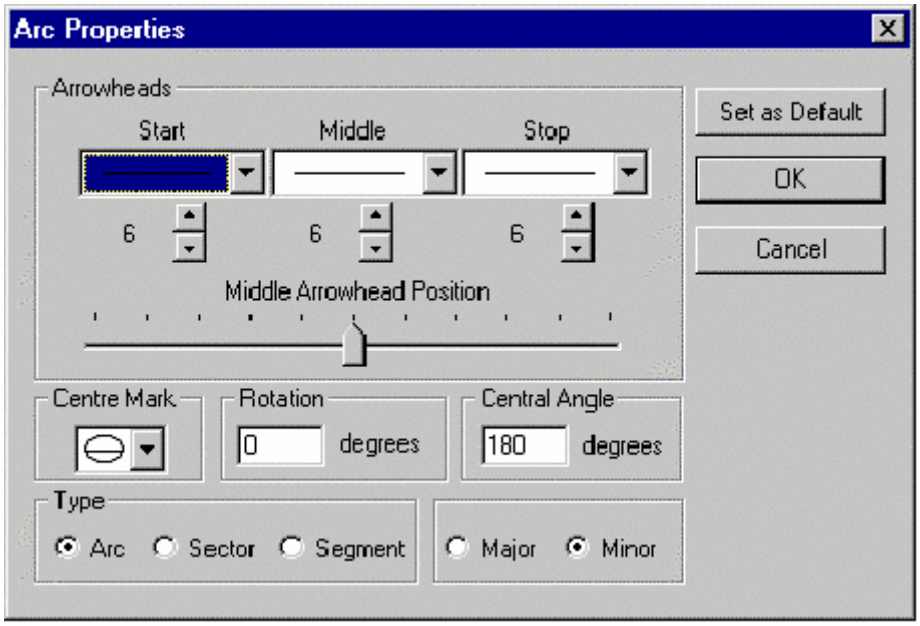
Drawing the ellipse:

- Click AND HOLD the left mouse button – this defines one focus.
- Move the mouse (while holding the button) to the other focus. While you are moving the mouse, FX Draw will synthesise a third point and show you an ellipse. Release the button when you are at the second point.
- Click AND HOLD the left mouse button and move the mouse to the point on the ellipse. As you move the mouse, FX Draw will draw an ellipse through your points. Release the button when you are at the third point.

6.11 The Arcs / Sectors / Segments

The Arcs / Sectors / Segments

Arcs, sectors and segments are all drawn with the same tool. Any arc can be made into a sector or a segment by selecting the options in the properties. As with circles and ellipses, there is more than one way to draw an arc. Once drawn, all arcs share the same properties.

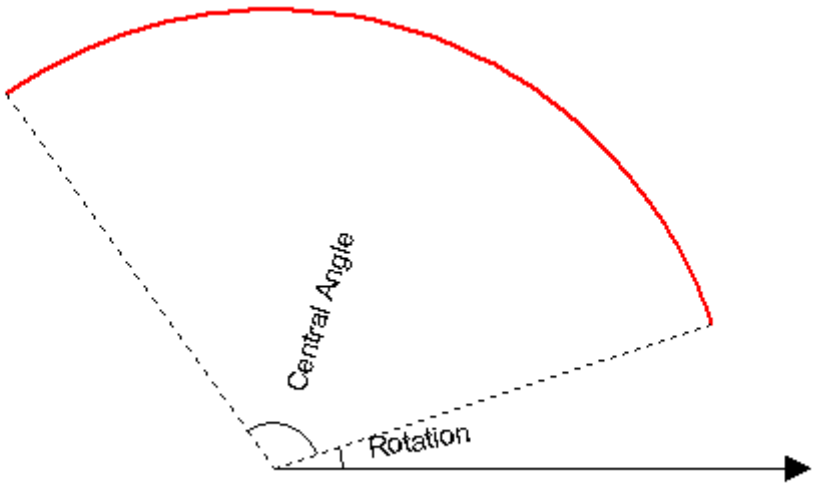


Every arc can have an arrowhead drawn at each end and one in the middle. You can select a mark to show the centre of curvature. On most arcs you can set the rotation and central angle of the arc explicitly. You can choose to draw the arc or its associated sector or segment. Finally, on most arcs you can choose to draw the major or minor arc defined by your control points.

Of the three arc tools, the "End Points and a Point on the Arc" tool is the most

precise. These three points unambiguously determine a circular arc. If you look at the properties for one of these arcs, you will find that you cannot change the Major/Minor setting.

Rotation is measured anti-clockwise from a horizontal line pointing to the right. Negative rotations rotate the arc clockwise. The central angle is the angle between the two arms of the arc.

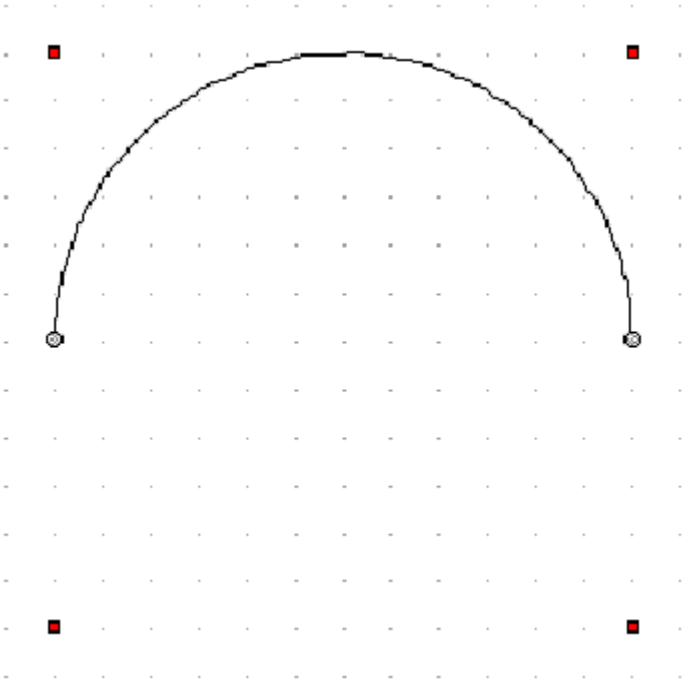


One final major difference between the arc tools is that the four corner tool is the ONLY arc tool that can draw elliptical arcs. The other two tools will always draw circular arcs.

Four Corners

The four corner arc tool is the ONLY way to draw elliptical arcs. When you first draw a four corner arc, you can force the tool to draw a circular arc by holding down the Shift key as you sweep out the rectangle. In common with many FX Draw tools, holding down the Shift key forces the rectangle you sweep to a square.

When you have created the arc it will look like this.



The four control points define the area the arc is drawn into and the two grey sliders mark the start and end point of the arc. You can move the sliders to set the arc or you can right-click and edit the arcs properties so that you have exactly the arc you require.

While you are moving the sliders, the arc will sometimes "flip over". This is due to the major/minor setting. If, for example, it is set to minor, the arc will always draw the minor arc determined by the two end points. As you move the end points, and therefore change the central angle, the part of the arc that is minor will swap and this is what you are seeing.

Centre and Ends of Arc (Circular)

This arc is defined by its centre of curvature and its two end points.

Drawing the arc:

- Click AND HOLD the left mouse button – this defines the centre of curvature.
- Move the mouse (while holding the button) to one end of your arc. While you are moving the mouse, FX Draw will synthesise a third point and show you an arc. Release the button when you are at the second point.
- Click AND HOLD the left mouse button and move the mouse to the other end of your arc. While you are doing this, the arc is likely to "flip". Don't worry about this, you can set the appropriate major/minor setting later. As you move the mouse, FX Draw will draw an arc defined by your points. Release the button when you are at the third point.

End Points and Point on the Arc (Circular)

This arc is defined by its two end points and any other point on the arc. When you use this tool you do not need to set the major/minor property as this definition of an arc is unambiguous.

Drawing the arc:

- Click AND HOLD the left mouse button – this determines one end of the arc.
- Move the mouse (while holding the button) to the other end of your arc. While you are moving the mouse, FX Draw will synthesise a third point and show you an arc. Release the button when you are at the second point.

Click AND HOLD the left mouse button and move the mouse to a third point on your arc. As you move the mouse, FX Draw will draw an arc defined by your points. Release the button when you are at the third point.

6.12 Angle Marks

Angle Marks can be drawn between any two intersecting line segments. You can indicate the angle using points, arcs, the actual angle in degrees, radians or grads, or you can add any text to the angle.

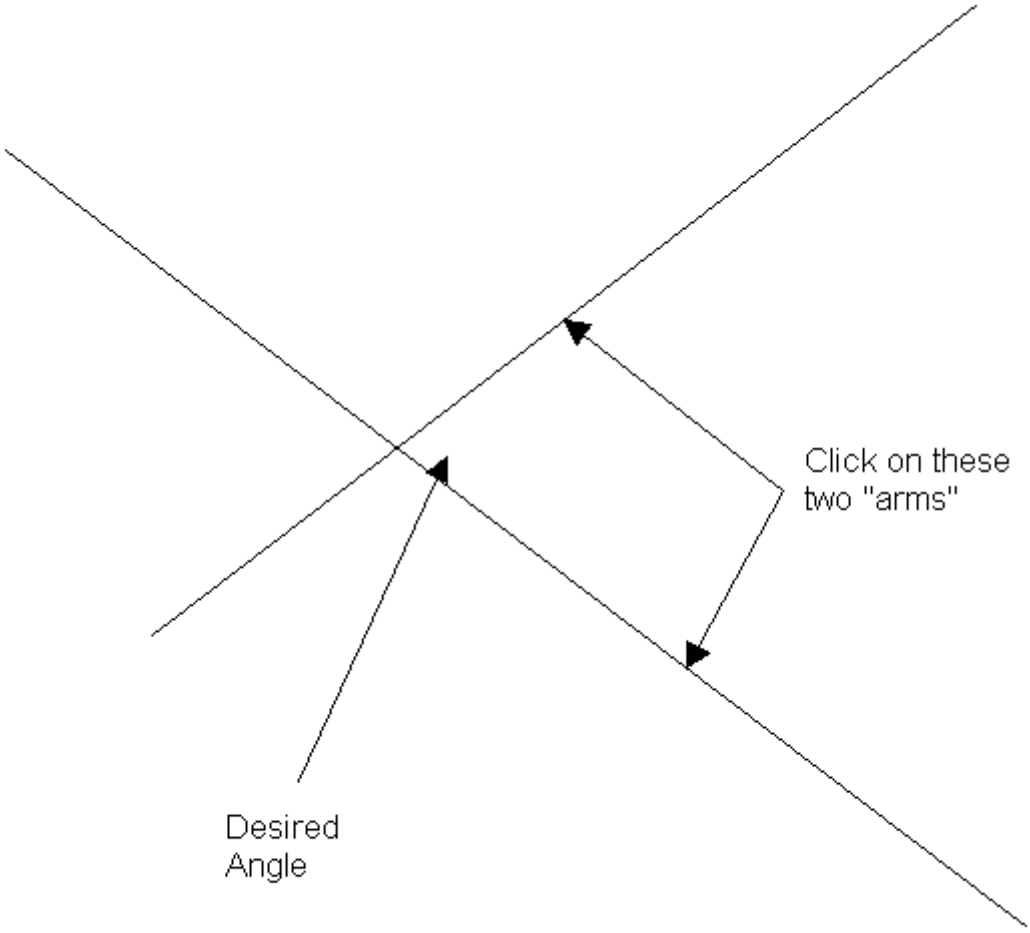
GAD MUST BE TURNED ON TO USE ANGLE MARKS!

FX Draw needs to detect the lines you are using for your angle so you must have GAD on to use this feature.

Drawing an angle mark:

- Select the angle tool.
- Move the mouse to one of the "arms" of your angle. Wait until FX Draw has found the line and flashed it in red.
- Click AND HOLD the mouse button.
- Move the mouse (while holding the button) to the other arm of the angle.
- Release the mouse button when the OTHER arm is detected and flashed red.

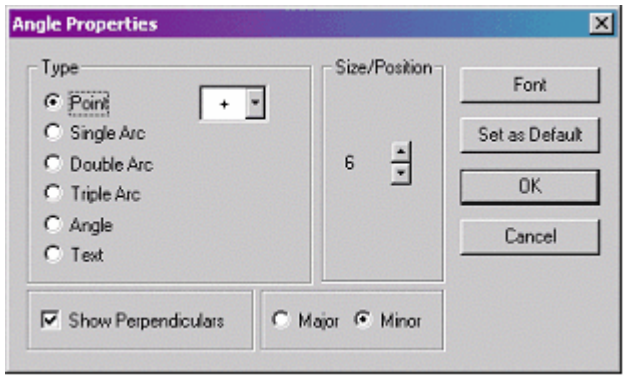
You do not need to be too near to the intersection to draw an angle. Once FX Draw has detected your two lines, it will work back to the intersection automatically.



Depending on your current default setting, FX Draw will mark the angle with either a point, arc(s) or some text. The angles are dynamic – they will adjust themselves as you move the line segments – they will disappear if the line segments no longer cross and reappear if you later move them so that they cross again.

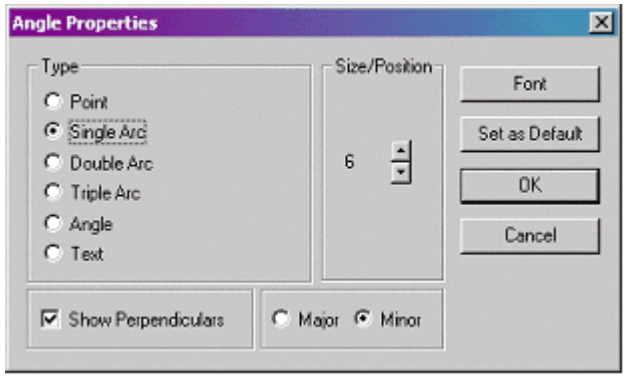
You have a large number of choices for your angle marks. The initial angle will be drawn with the current default. If you wish to change how an angle is marked, right click on it. The dialog box you see will depend on how the angle mark is displayed.

Points



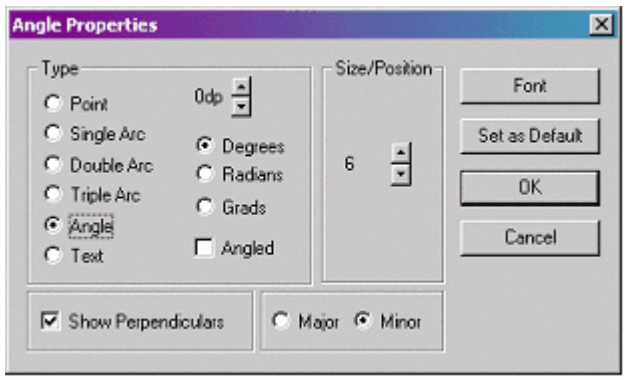
Drawing your angle as a point simply involves setting the type of point you wish to use. In the above example, a "plus" sign will be drawn in the angle.

Arcs

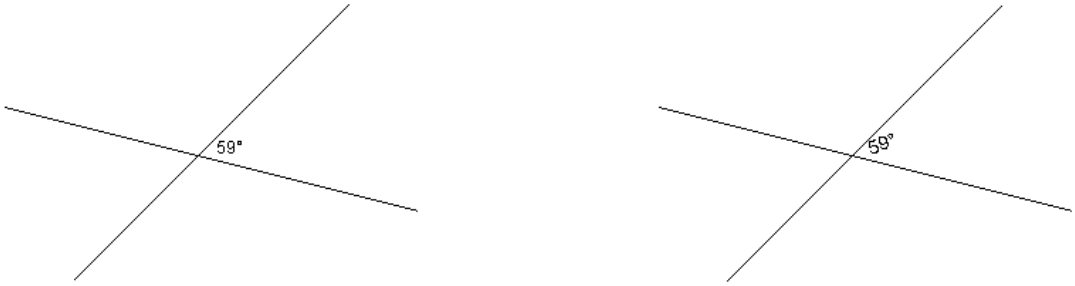


You can have a single, double, or triple arc drawn on your angle. There are no other options to set.

Angle

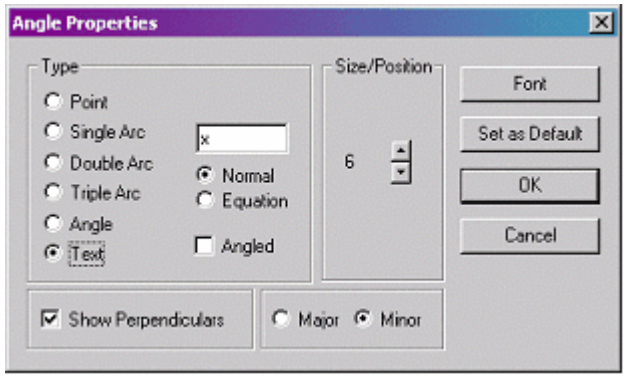


You can have FX Draw mark the angle with its measure in degrees, radians or grads. You can also control the number of decimal places shown on the angle (set to zero in the above dialog box).



The "Angled" setting changes how an angle is written – either horizontally or angled along the bisector of the angle as shown above.

Text



Any text can be placed on the angle. At the moment it is set to "x". The text you enter can be interpreted as normal or as an equation. Normal text can be angled, equations cannot. Perhaps the most common combination, x°, can be entered as an equation entered as x`. Appendix A describes how to use the equation system.

The Size/Position Parameter

All the different angle types can have their size/position set. Usually, FX Draw will draw a suitable angle mark but you may wish to increase or decrease the mark's size or position relative to the intersection. How this parameter is interpreted depends on the type of angle mark.

Points – determines how far from the intersection the mark is placed.
Arcs – determines the radius of the arcs.
Angle / Text – determines how far from the intersection the text is placed.

Showing Perpendiculars

FX Draw can automatically detect perpendiculars for you and mark them appropriately.

Major / Minor Angles

In most cases you will want to mark the minor angle determined by two line segments. On the other occasions, this setting will allow you to mark the major angle.

6.13 Text

The text tool creates a multi-line text box where text can be entered. The text can be left justified, right justified or centred. The entered text can be interpreted as an equation if you wish although there is a dedicated tool for entering equations.

Drawing a text box:

Sweep out a rectangular box the desired size.

Once drawn, you can edit the text.

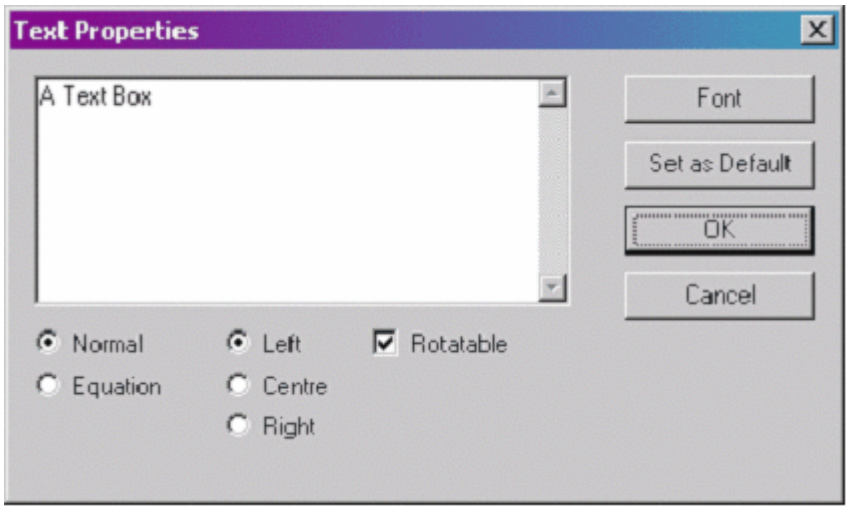
Editing text:

Either

DOUBLE-CLICK on the text box – you will now be able to edit the text in its current location.

OR

Right click on the text box. The following dialog box will appear.



Here you can edit your text, set the justification and font, tell FX Draw to interpret the text as an equation (see Appendix A) or turn off rotation.

Text boxes (but NOT equations) can be rotated like any other figure. Often this is not what you really want to happen. By removing the Rotatable check mark, the text box will NOT rotate with any other selected figures. It will maintain its location relative to other figures but the text will remain horizontal.

6.14 Equations

The Text tool and the Equation tool really produce the same type of figure. You can turn a Text box into an Equation box (by right-clicking) and you can also turn an Equation box into a Text box. Because they are really the same thing, the Text tool description also applies to Equation boxes.

Why have two tools – one for text and one for equations? Because often you will require a quick equation for a diagram and having to go to the above dialog box to tell FX Draw that the box is an equation would soon become tedious. Having an equation tool makes a quick equation easy.

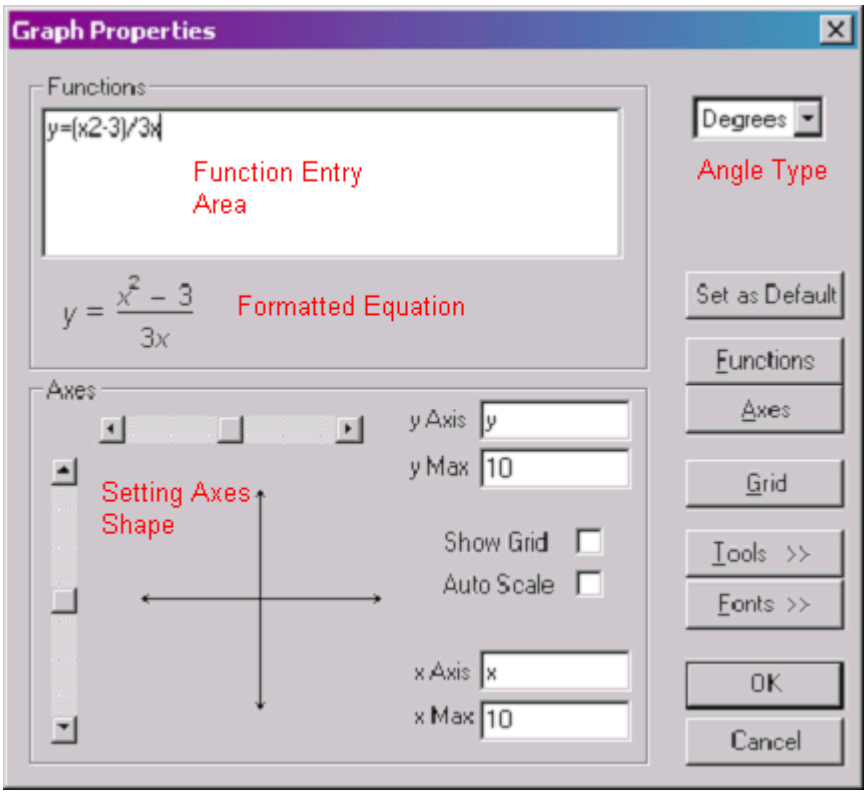
Entering equations into an equation box uses our FX Equation technology. This is fully described in Appendix A.

6.15 Graphs (Functions)

The graph tool allows you to draw graphs of Cartesian, polar, parametric and inverse functions. Up to ten functions may be combined onto one set of axes. If you have used FX Graph, you will find FX Draw's function graphing tool very similar.

6.15.1 The Main Dialog Box

To draw a function graph, select the tool and sweep out a rectangle. The rectangle will be filled with a default set of axes. To start drawing graph, right click on the axes.



The Graph Properties dialog is the hub of the function graphing tool and it is vital that you can use it correctly.

- The Function Entry Area is where you type the equations for the functions and relations you wish to graph. This window can have up to ten lines of text, each line being a separate equation and graph. As you are entering an equation, you will see a formatted version of your equation appear in the grey area immediately under the Function Entry Area. Entering functions is discussed more fully in the next section.

- Setting Axes Shape is one of two components that make setting the axes of your graph incredibly easy. You should set the shape of the axes FIRST. By default, graphs are drawn showing the four quadrants. If you wish to draw a graph entirely in the first quadrant, for example, move the two scroll bars until you see the shape you desire.

- Setting the Maxima for the Axes is the second component that helps you set your axes. Once you have set the shape of your graph, type in the maximum you would like for both the x and y axis (by default they are set to 10). All other settings for the axes are generated automatically. For example, if you set an x maximum of 360, Function graphing tool will recognise this as the number of degrees in a circle and will set a scale with a tick every 45. If you enter "3pi" (literally) as the x maximum, the function graphing tool will interpret this as a multiple of pi and set the scale showing fractional multiples of pi.

- Autoscaling makes the setting of the axes even easier. If this box is checked,

the function graphing tool will automatically detect any points of interest (local maxima and minima, x intercepts and intersections) from -500 to 500 and adjust the axes so that all of the points of interest are visible. Once you have selected Autoscaling, the function graphing tool takes full responsibility for the axes. **Please note that the autoscaling feature slows down the response time of the function graphing tool.**

The Functions, Axes, Grid and Font buttons allow you greater control over your graph.

- The Functions button allows you greater control over how a function is drawn. You can set a domain, change the colour and thickness of the line, turn off arrows or ask the Function graphing tool to draw the derivative of the function.

- The Axes button gives you complete control over the axes by allowing you to explicitly set maximum and minimum values for the x and y axis. You can also set how often the function graphing tool will draw a "tick" on the scale. You can even turn the axes off!

- The Grid button allows you to select the type and colour of the lines that are used for the grid. You can also turn individual components of the grid on or off.

- The Tools button gives you access to more advanced tools for drawing derivatives and integrals.

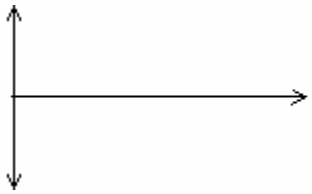
- The Font button sets the font used for the each component the graph. Further details on the use of these buttons can be found in later sections of this manual.

- The Angle Type can be set to degrees, radians or grads.

6.15.2 Setting Axes

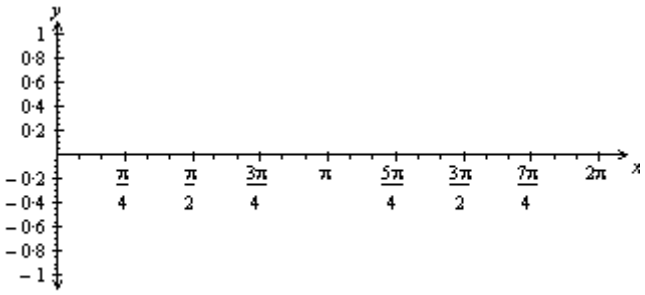
Setting axes is one of the most difficult parts of using most graphing packages. Our Function graphing tool makes setting axes almost trivial.

If, for example, you wish to graph y = sin x from 0 to 2π, you should FIRST move the top scroll bar so that the axes have this SHAPE

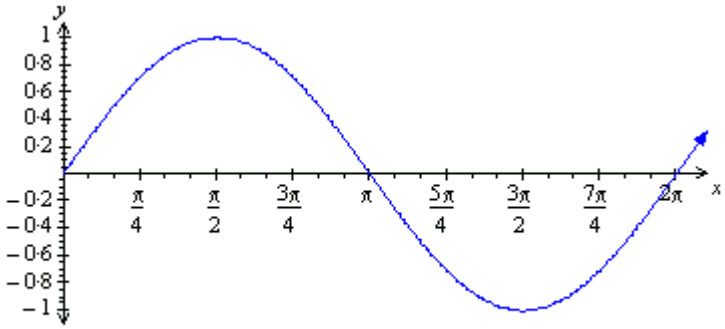


Setting Maxima for the Axes is the SECOND step. Because you wish to graph from 0 to 2π, you need the x axis to have a maximum of 2π. To do this, type "2pi" (literally) into the x Max box. Because you are graphing sin x, the y axis needs to

have a maximum of 1 so type this into the y Max box. EVERYTHING ELSE IS AUTOMATIC and will produce this set of axes.



Now type "y = sin x" into the function entry area and set the angle type to radians to obtain your graph.



6.15.3 Entering Functions

The function graphing tool uses the equation engine from FX Equation so entering functions is extremely easy AND you can see a fully formatted version of your function as you type. Our Equation entry system is fully discussed in Appendix A. This section deals with issues specific to entering functions into the Function graphing tool.

Functions are entered into the function graphing tool by typing what you see WITHOUT any formatting. On most occasions the function graphing tool will automatically format your function for you.
For example. If you want to graph the function $3x^3 + 2x^2 - 7$ simply enter **3x3+2x2-7** into the function entry area. The function graphing tool automatically recognises and formats the powers and displays the formatted function for you to check your entry.
Simple fractions are also entered as you see them. In other words if you want to graph

$$y = \frac{3x^3}{2x^4}$$

you enter **3x3/2x4** and the function graphing tool will automatically build the appropriate fraction. Most simple functions can be entered this way, with NO formatting on your part. More complicated functions will require some limited extra input on your part.

6.15.4 Special Points about Function Entry

Because of the restrictions of a computer interface, there are some special points you will need to understand to enter all functions.

Special Symbols
Because mathematicians use many symbols not normally found on a computer keyboard, the function graphing tool uses a small number of special symbols, codes and abbreviations in order to allow you to enter functions.

	Normal Symbol	Function graphing tool	Notes
Multiplication	×	*	
Exponentiation (Powers)		^ (eg 2^x)	Only needed when the function graphing tool fails to automatically recognise the power.
Division	÷	/ (followed by a space)	The / character is more often used (without the space) to enter fractions.
Pi	π	pi	Can be use

Brackets

Many functions, especially fractions, contain assumed brackets. The function graphing tool will sometimes require you to enter these brackets even though you cannot see them. For example, if you enter y = 3/x+3 does this mean

$$y = \frac{3}{x} + 3$$

or

$$y = \frac{3}{x + 3}$$

To graph the second function you need to add logical brackets to your function and type y = 3/(x+3). These brackets will not be displayed but will influence how your function is interpreted.

As a general rule, if the function is not shown formatted correctly by the function graphing tool, add some brackets to make your meaning clear.

A very important use of brackets is to logically identify the numerator and denominator in complicated fractions. For example: (x+2)/(x-3) needs the brackets to be interpreted as

$$\frac{x + 2}{x - 3}$$

rather than

$$x + \frac{2}{x} - 3$$

Brackets are also used to logically identify powers and ensure that the function graphing tool interprets your function correctly.

All three bracket types {, [and (may be used interchangeably in the function graphing tool and the function graphing tool makes no distinction between them. The function graphing tool does not even check to see if brackets are paired. You are responsible for this. If there is a fraction inside a bracket, the bracket is automatically resized.

Example:

$$3\left[(x-2)^2+\frac{1}{2}\right]$$ is entered as **3[(x-2)2+1/2]**

Powers
Most powers will be automatically recognized by the function graphing tool. The function graphing tool will not automatically recognize powers if

- you require a variable as a power
- you require a function as a power
- you require a power of a number
- you require a complicated power.

In these cases you need to explicitly indicate the power using the ^ symbol. As with fractions, complicated powers need to be surrounded with brackets. These brackets will not be displayed.

Examples:

$e^{\sin\theta}$ is entered as **e^sinth**

x^{2y+3} is entered as **x^(2y+3)**

Spaces
Spaces change the way a particular equation is formatted and therefore interpreted. This can best be illustrated using these examples.

$\sin^2\theta$ is entered as **sin2 th**

$\sin 2\theta$ is entered as **sin 2th**

The only difference between the two equations is the **location of a space**.

Restrictions
The function graphing tool will correctly graph any equation you enter. Unfortunately, restrictions in the FX Equation technology prohibit the function graphing tool from DISPLAYING some equations with the correct formatting. The three classes of equations that will not be formatted correctly are:

Multilevel fractions $\dfrac{1}{1+\dfrac{1}{x}}$

Square roots of square roots $\sqrt{\sqrt{x}}$

Powers of powers of powers $y^{x^{2n}}$

Please note: The graph will be drawn correctly, it is only the equation that cannot be displayed correctly.

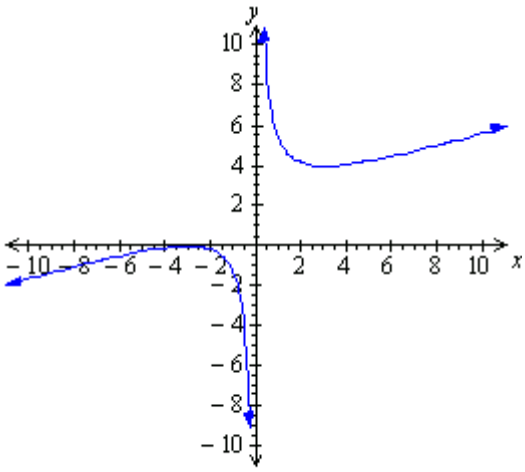
6.15.5 Cartesian, Polar, Inverse or Parametric?

The function graphing tool is capable of drawing many different classes of functions. So how does it tell them apart? How does it know if you want to graph a Cartesian, polar, inverse or parametric function?

The answer lies in how you enter the equation, in particular the variables you use. For example, polar functions are always entered in terms of θ (typed as "th") and are always prefixed with "r =". To successfully use the function graphing tool you will need to understand how each class of function must be entered.

6.15.6 Cartesian Functions

Prefix: NOT REQUIRED but y = OR f(x) = are acceptable.
Variable: x
Example: ((x+3)2)/3x

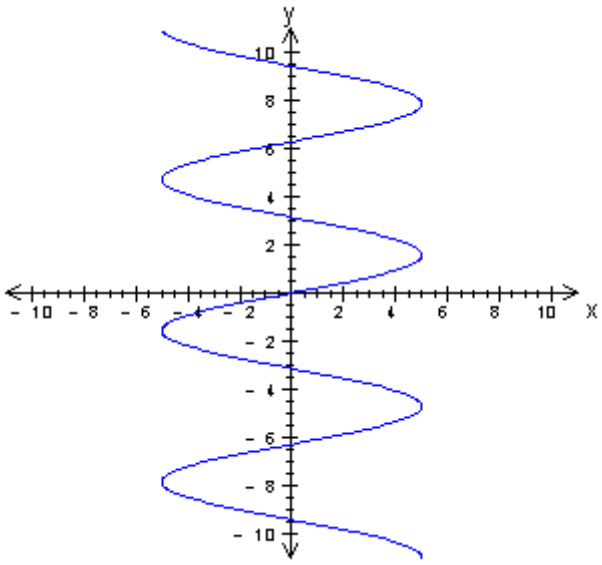


Notes:

- Cartesian functions are the most commonly graphed and the function graphing tool is optimised to handle them.
- Cartesian functions are assumed in the function graphing tool. That is why you are not required to enter "y =" to define the equation.
- Cartesian functions are the ONLY type of function that does not require an equals sign.
- Some functions (integration and differentiation) are only available for Cartesian functions.

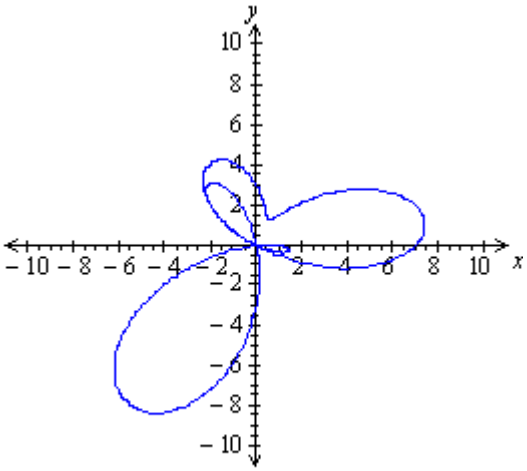
6.15.7 Inverse Functions

Prefix: x = OR f(y) =
Variable: y
Example: x = 5sin y



6.15.8 Polar Functions

Prefix: r =
Variable: θ (typed as "th")
Example: r = 3sin 2th + 4 cos 3th + 3

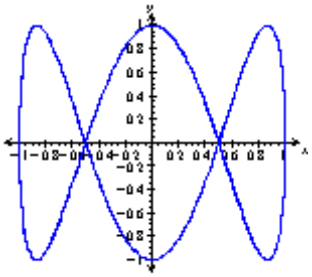


Notes:

- Currently the function graphing tool cannot find points of interest for polar graphs.

6.15.9 Parametric Functions

Prefix: x= AND y= separated by a semicolon
Variable: t
Example: x = sin t; y = cos 3t



Notes:

- Currently the function graphing tool cannot find points of interest for parametric graphs.

6.15.10 Function Reference

These constants and functions can be used in equations.

Command	Description
e	constant e = 2.18281828…
pi	constant π = 3.141592654…
sin	sine of an angle
cos	cosine of an angle
tan	tangent of an angle
asin or sin-1	arcsine or inverse sine
acos or cos-1	arccosine or inverse cosine
atan or tan-1	arctangent or inverse tangent
sec	secant of an angle
cosec	cosecant of an angle
cot	cotangent of an angle
cosh	hyperbolic cosine
sinh	hyperbolic sine
tanh	hyperbolic tangent
ln	natural logarithm

6.15.11 Points of Interest

Points of interest include

- Local Maxima
- Local Minima
- x Intercepts
- y Intercepts
- Points of Intersection

The function graphing tool detects these points in interest automatically. To display them, simply CLICK the mouse button ON them. The function graphing tool will detect which point of interest you are clicking on and display it at the base of the graph.

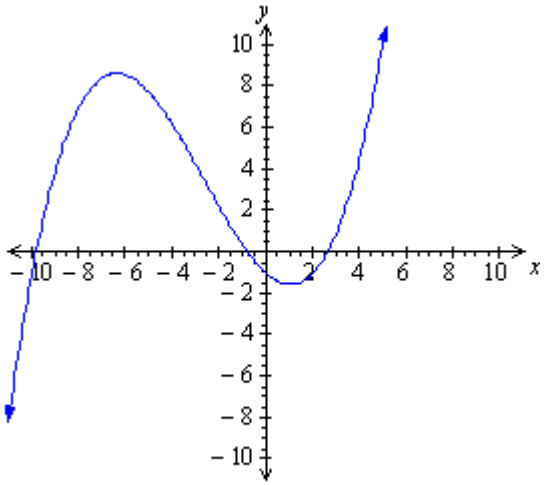
Some points of interest are interesting for more than one reason. For example, the function x^2+2 has a point, (0, 2), that is both a local minimum and a y intercept. In this case, click the mouse button again WITHOUT MOVING THE MOUSE and the function graphing tool will cycle through all points of interest in the immediate vicinity.

6.15.12 Analytical Tools

The function graphing tool provides a number of analytical tools that allow you to find derivatives and definite integrals. These tools operate numerically so small errors will sometimes occur.

6.15.13 Derivatives

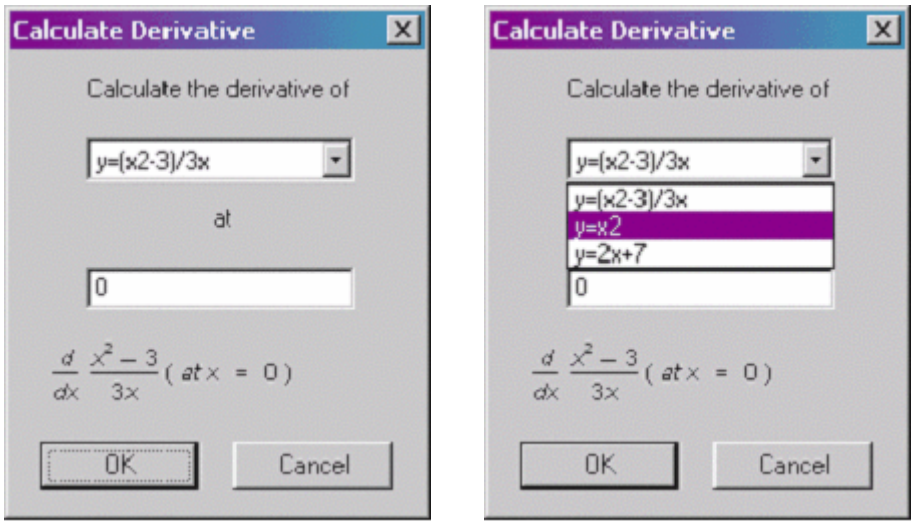
The function graphing tool will graph the derivative curve for a function using a dotted line. This feature may be turned on for individual functions using the Function Dialog Box or can be shown for all functions by choosing Show All Derivatives from the function graphing tool's Tools button.



The function graphing tool will only graph derivative curves for Cartesian functions.

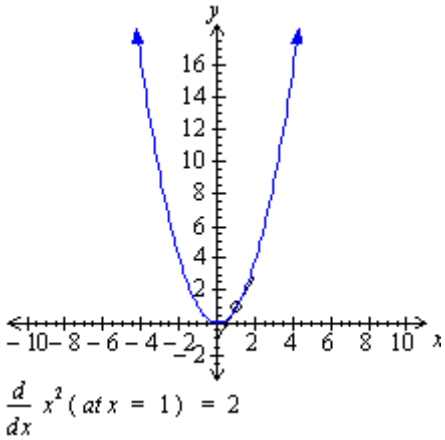
6.15.14 Derivative at a Point

To calculate the value of a derivative at a point, choose Calculate Derivatives from the Tools button.



The screen allows you to pick a function from those available (the right hand diagram shows a different function being chosen) and the point at which you wish to calculate the derivative.

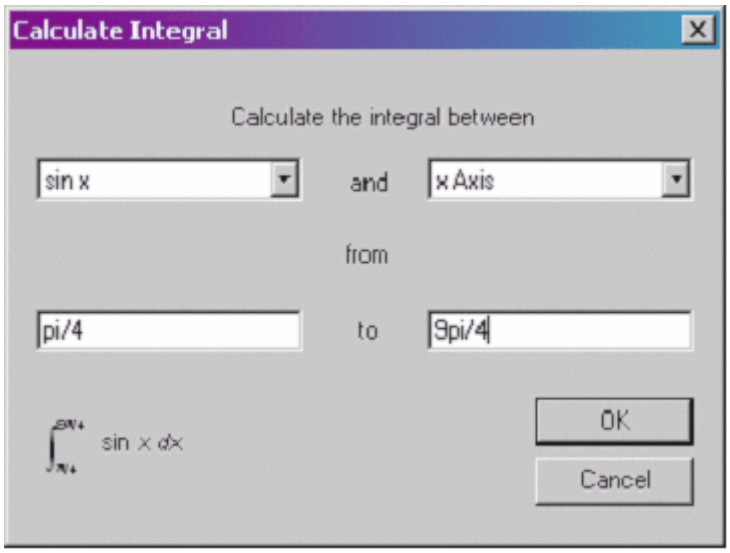
Once you have constructed your request, the function graphing tool will display the result and show the result on the graph.



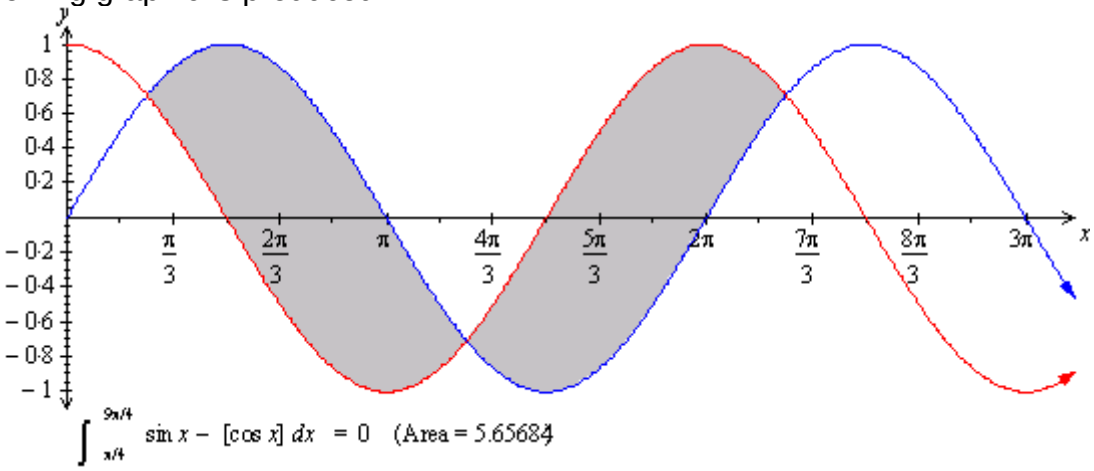
The function graphing tool will only calculate derivatives at a point for Cartesian functions.

6.15.15 Definite Integrals

To find a definite integral, choose Integrals from the Tools button.



This screen allows you to find the integral between any function you have previously entered and the x axis or between any two functions. Notice that the bounds can be expressed in terms of pi. If the x Axis is changed to cos x the following graphic is produced.

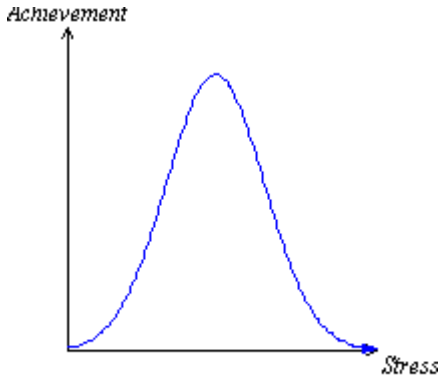


The function graphing tool will show you a shaded graph and gives you both the value of the definite integral and the area found.

The function graphing tool will only find definite integrals for Cartesian functions.

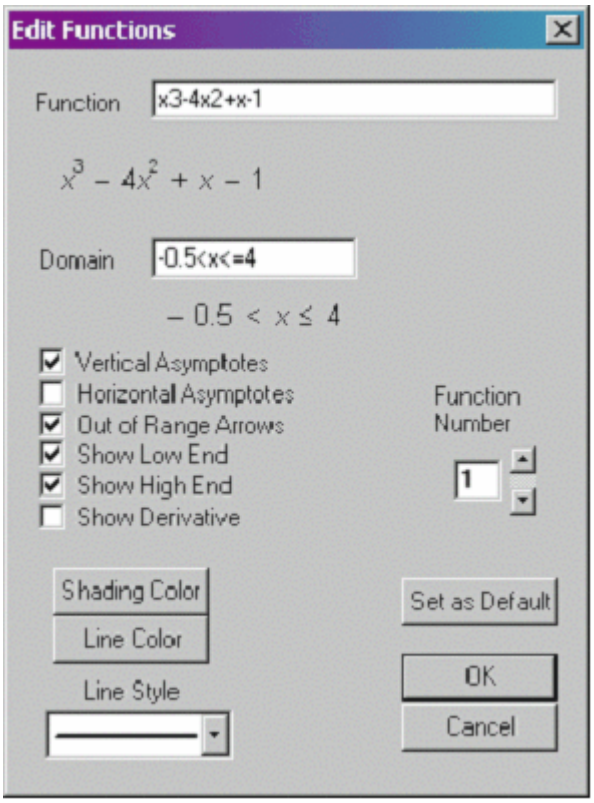
6.15.16 Annotating the Axes

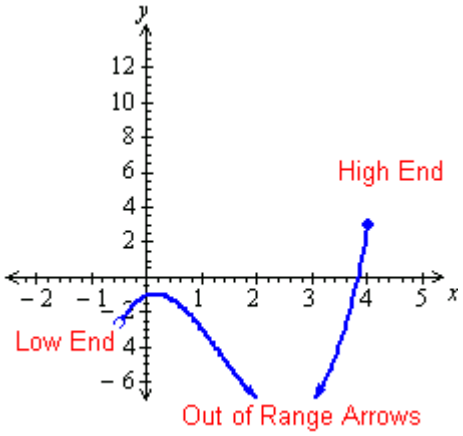
By default, the axes on a graph are annotated with x and y. These can be changed to any desired messages. The x Axis and y Axis boxes in the Quick Function Entry screen allow you to call the axes anything you desire.



6.15.17 The Function Dialog Box

The Function Dialog box allows you much greater control over how individual functions are drawn.



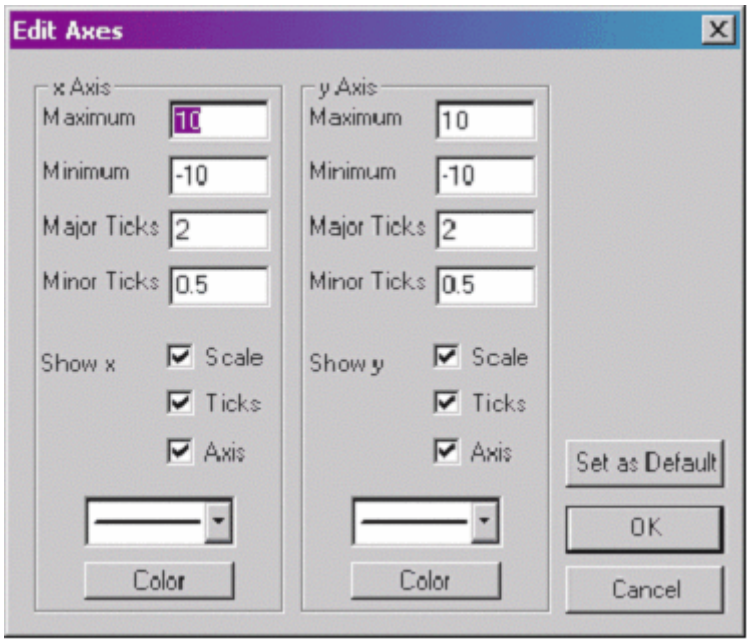


The figure above shows an example Function Dialog box and its graph.

Function	The function area is the same as the function entry area on the Quick Function Entry screen but only allows the editing of one function.
Domain	The domain of the function is entered in this area. The domain is entered in standard mathematical notation (see example on previous page). Function graphing tool will draw open circles for domains constrained by greater than or less than expressions and closed circles for domains constrained by greater than or equal to and less than or equal to expressions. Domains do not need to have both ends specified. Examples: -2 < x <= 4 th > 4 t <= 2
Function Number	Function graphing tool can graph up to ten functions. These can be input one per line on the Quick Function Entry screen but in the Function Dialog box you examine one function at a time. The screen above shows that function 1 is being edited at the moment. As you change this number, you change the function you are editing.
Vertical Asymptotes	By default, Function graphing tool will attempt to detect vertical asymptotes and will draw in any detected. Sometimes Function graphing tool may detect an asymptote that is not actually there. This allows you to disable this feature.
Horizontal Asymptotes	By default, Function graphing tool will NOT attempt to detect horizontal asymptotes. You can turn on the detection feature here but please note that Function graphing tool can be fooled into finding horizontal asymptotes that are not actually there.
Out of Range Arrows	Out of range arrows are drawn whenever the value of a function cannot be shown on the given axes in the MIDDLE of drawing the graph. Arrows at the ends of the graph are handled differently. If you do not require the arrows, they can be turned off here.
Show Low End / High End	The low end and high end of a graph can be open circles or closed circles (if you have set a domain) or they can be arrowheads. If you do not wish to show the ends you can turn them off.
Show Derivative	Function graphing tool will show a derivative curve for a function using a dotted line. This feature is turned on here.
Shading Colour	Function graphing tool automatically selects a shading colour for each graph but you can set your own here. Please note that we have selected our colours very carefully and it is difficult to choose colours that combine well.
Line Colour	Function graphing tool automatically selects a line colour for each graph but you can set your own here.
Style	Allows you to choose thicker lines, dotted lines and dashed lines. The function graphing tool will automatically select a dotted line if graphing an equality.

6.15.18 The Axes Dialog Box

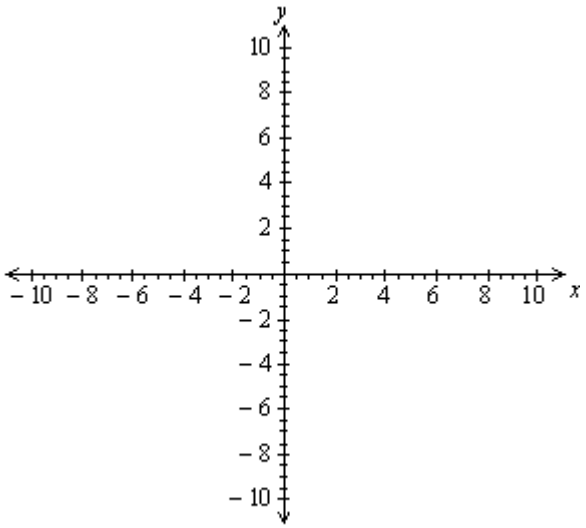
The function graphing tool automates the setting of axes but if you want complete control over the format of the axes, you need to use the Axes Dialog box.



The x Axis and y Axis maximum and minimum explicitly set the maximum and minimum for a set of axes. The maxima and minima can be entered in terms of pi (2pi for example).

Major ticks are marks on the scale that are numbered. Minor ticks are marks on the scale that are not numbered. Both major ticks and minor ticks can be entered in terms of pi.

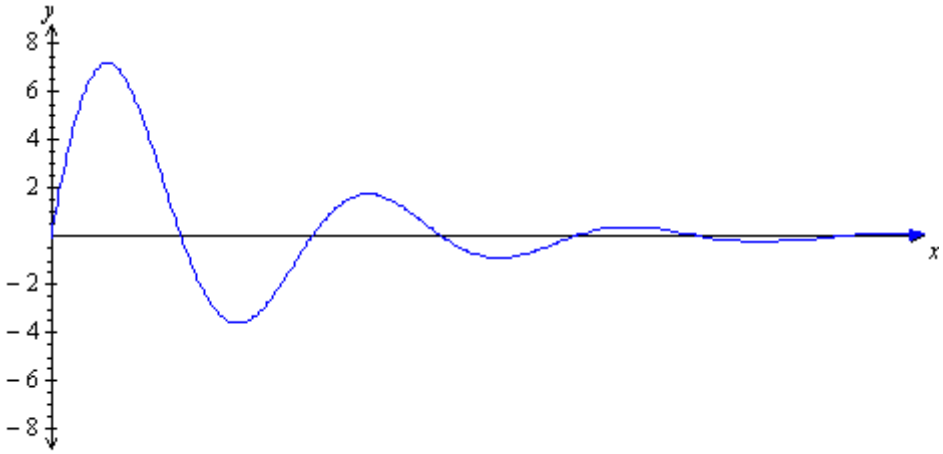
The Axes Dialog box shown produces the default set of axes.



Note that each axis has a scale that is numbered every 2 and has a smaller tick each 0.5.

By modifying these four numbers for each axis you can produce any desired set of axes.

The three check boxes for each axis allow you to turn off the scale, ticks and even the axis line! By turning off the x scale and ticks, we have produced this graph.



You can also set the style and colour of the axes.

6.15.19 The Font Button

The font used on the axis annotations, the scale and the reports are able to be independently set. They can be accessed via the Font button.

6.15.20 Graphing Inequations

Inequations can be graphed using the function graphing tool by replacing the equals sign in an equation with either

Type	Symbol	Function graphing tool	Example
Less than	<	<	y < 3x - 2
Greater than	>	>	x > 2
Less than or equal to	≤	<=	y <= 4
Greater than or equal to	≥	>=	x >= 3y - 2

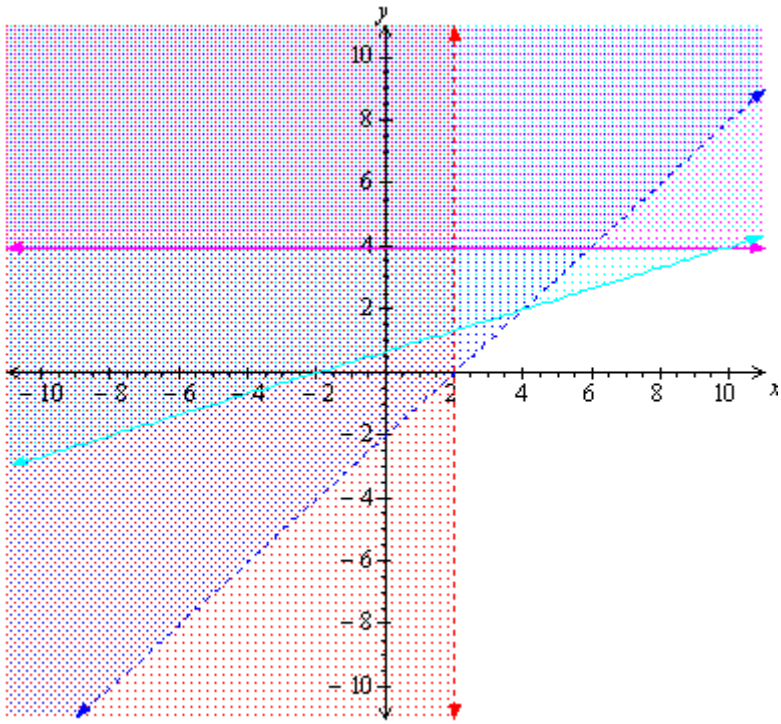
The function graphing tool will shade either

The area that complies with the inequation or

The area that does NOT comply with the inequation.

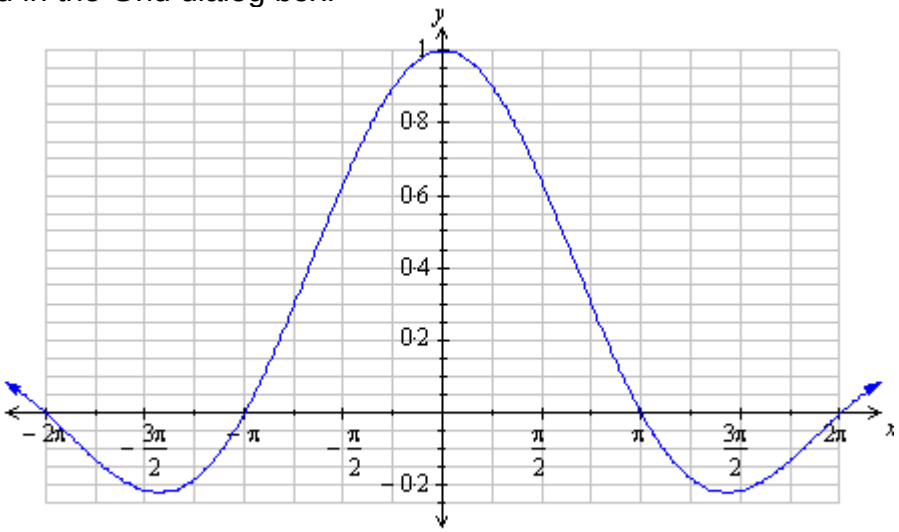
depending on the setting in Tools/Customise.

The graph below shows the four inequations mentioned above shading the areas which do NOT comply with the inequation.



6.15.21 Showing a Grid

If the show grid checkbox is checked, the function graphing tool draws grid lines as defined in the Grid dialog box.



6.15.22 Default Domains

If you have not explicitly set a domain, the function graphing tool will choose one for you.

Cartesian and inverse graphs have a domain implied by the size of the axes and the function graphing tool will automatically draw a graph for this implied domain.

Polar and parametric graphs have no implied domain so the function graphing tool uses:

Polar graphs $0 \leq \theta \leq$ **360 (degrees mode)**
$0 \leq \theta \leq 2\pi$ **(radian mode)**
$0 \leq \theta \leq$ **400 (grad mode)**

Parametric graphs $0 \leq$ **t** $\leq$ **20**

If your polar or parametric graph is incomplete, you may need to set your own domain.

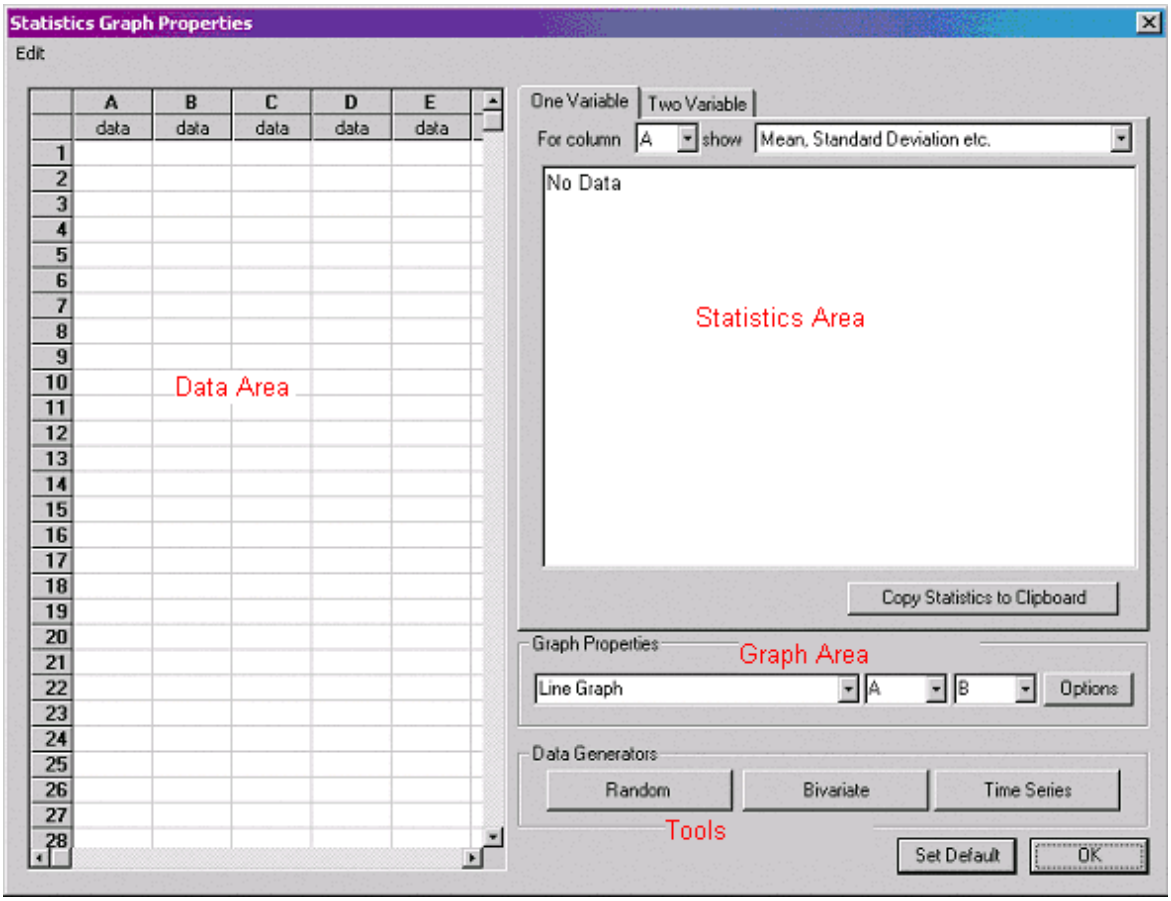
6.16 Graphs (Statistical)

FX Draw provides a comprehensive statistical graphing tool. If you are familiar with FX Stat you will find this tool to be very similar.

To draw a statistical graph, sweep a rectangular region with your mouse. A set of axes will fill the rectangle. Right click on the axes to start graphing.

6.16.1 The Main Data Entry Screen

The statistical graphing tool allows you to look at your data in numerous ways. You enter your data in the data area and watch as the statistics area dynamically summarises your new information. The graph area allows you to set options for the resulting graphs. This emphasises the different ways of looking at data.



The Data Area

The data area is a small, modified spreadsheet that allows for the entry and manipulation of data. Many of the skills you have developed for spreadsheet use are applicable in the data area apart from one major difference … the data area operates exclusively in **columns** rather than individual cells. If you keep this in mind, the rest is easy.

You can enter data straight into the data area or you can use formulas to create or manipulate your data. For example, if you placed your cursor somewhere in column B and typed

= A + 10

the statistical graphing tool would take every value in column A, add ten, and place the result in column B.

A full list of available functions is provided in Appendix B of this manual.

The Statistics Area

The statistics area calculates summary statistics for the selected data. Click on the tab for one or two variable statistics. Select the column(s) you are interested in and select the type of statistics you want to see. You can copy the statistics to the clipboard to place them into a word-processing document. The statistics area automatically calculates summary statistics for frequency tables and grouped data.

The Graph Area

The graph area allows you to control the graph output of the tool. Select your data columns and your graph type. The graph area has a large number of options that are available using the options button.

The Tools Menu

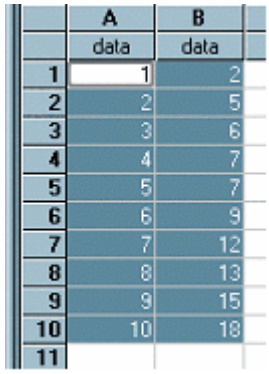
The tools menu gives you easy access to some of the more powerful features of the statistics tool. The tools include a random number generator that produces random numbers that satisfy all sorts of probability density functions and a bivariate data generator that makes producing bivariate data sets easy. You also have the access to a powerful time series data generator.

6.16.2 Copying Data Out of the Statistical Graphing Tool

f you need to copy your data out of FX Draw's Statistics Tool and into a word processor or spreadsheet, you have two options available

Data in Columns

FX Draw's Statistics Tool always works in columns. If your want your data copied into your word processor in columns, you can achieve this easily by selecting your data in FX Draw's Statistics Tool, copying it to the clipboard (using the Edit menu, Ctrl+C or the copy toolbar button) and then pasting it into your word processor.



	A	B
	data	data
1	1	2
2	2	5
3	3	6
4	4	7
5	5	7
6	6	9
7	7	12
8	8	13
9	9	15
10	10	18
11		

Sheet with data selected

1	2
2	5
3	6
4	7
5	7
6	9
7	12
8	13
9	15
10	18

Pasted into the word processor

Data in Rows

If you wish your data to be copied into your word processor in rows, rather than columns, FX Draw has a special function especially for this purpose. Select the same data as shown above but this time select Copy As Rows from the Edit menu. When you paste the data into your word processor, it will be in rows.

1	2	3	4	5	6	7	8	9	10
2	5	6	7	7	9	12	13	15	18

6.16.3 Copying Statistics Out of the Statistical Graphing Tool

At any stage, pushing the "Copy Statistics to Clipboard" button will copy the statistics to the clipboard in rich text format. This format will retain its formatting when pasted into Word or Excel.

6.16.4 The Data Area

The data view is the main area in the statistical graphing tool and it contains most of the less obvious features. A good look at this section will pay large dividends in the use of the tool.

6.16.5 Think in Columns!

We cannot over-emphasise the main difference between the statistical graphing tool and a spreadsheet. The tool "thinks" in columns. Statistics are calculated on whole columns. Graphs show the information in whole columns and formulas operate on the whole column at once. It is perhaps the last point that is most different to a spreadsheet. For example, moving into column B and typing

= Rank(A)

will place the rank of each datum in column A into column B. It works on the whole column at once. In a traditional spreadsheet you would need to copy this formula into each cell in the column.

The second major difference is that formulas in the tool only work once. Move into a column, type your formula and that column is updated. Your column will NOT continue to be updated automatically as new data is entered. If you want your column to automatically update, you need to use a formula column.

6.16.6 Column Types

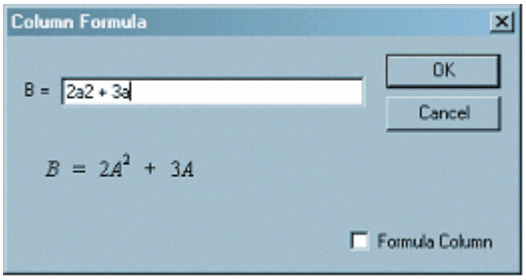
The tool supports five different types of columns:

Data Columns	**Used to enter your data sets**
Frequency Columns	**Used to hold frequencies for information in a data column or a group column**
Label Columns	**Used to hold labels for some of the graph types**
Group Columns	**Used to hold the bounds for grouped data**
Formula Columns	**Used when the column's data needs to be automatically updated.**

These column types are discussed later in this section.

6.16.7 Entering Formulas

To enter a formula for a column, move your cursor to somewhere in the column and type =. A formula entry box will pop up and allow you to enter your formula.

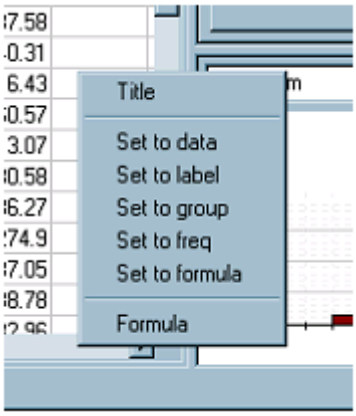


The tool has FX Equation technology built in so you can see your formulas formatted as you type. FX Equation's technology is fully described in Appendix A

Click on OK and your column's data will be updated. The Formula Column check box allows you to convert the column into a formula column that automatically updates its data when you modify its source data.

6.16.8 Column Titles

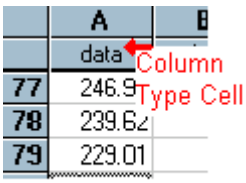
Column titles are used in some graphs and statistics. By default, the first column title is A, the second B and so on. If you wish to enter a new title for the column, right click on the column. The right-click menu will pop up. Select the title option and enter your new title.



If you right-click ON the title cell (the A at the top of the column) you will not see this right-click menu, you will just jump straight to the column title box.

Even if you have given a column a title, you must still use the column's letter in any formulas.

6.16.9 Changing Column Types



Column types (data, label, group, frequency and formula) can be set using the same right-click menu as the column title. Alternatively, you can click on the column type cell. As you click on this cell, it will cycle through all the available column types.

The frequency column type (freq) will only be available if the column is to the right of a data or group column. The frequency must belong to a set of data or a group. For this reason it is impossible to set column A to be a frequency column.

6.16.10 Data Columns

Data columns contain most data in the statistics tool. They have no special features associated with them. If a data column has a frequency column to the immediate right of it, the frequency column contains the frequencies for each data item in the data column.

6.16.11 Using Frequency Columns

Frequency columns are used to indicate frequency information for both data and group columns. They allow you to enter frequency tables and grouped data.

	A	B
	data	freq
1	21	1
2	22	4
3	23	6
4	24	7
5	25	9
6	26	10
7	27	5
8	28	4
9	29	3
10	30	1

Frequency Table

	A	B
	group	freq
1	20-30	5
2	30-40	14
3	40-50	31
4	50-60	54
5	60-70	42
6	70-80	35
7	80-90	14
8	90-100	4
9	100-110	1
10		

Grouped Data

The tool correctly identifies the first set of data as having 50 elements and the second set 200. Statistics and graphs are generated utilising the frequency information.

You can enter your data directly into frequency tables or grouped data tables.

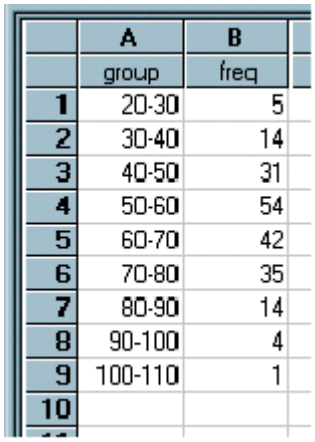
Alternatively, frequency columns can be automatically generated from raw data when you use the FreqTable, CumFreqTable, Group, GroupW and GroupE functions in the data view.

6.16.12 Label Columns

Label columns can contain alphanumeric data that will be used as labels for bar and column graphs, pie graphs and (optionally) line graphs.

Normally you would only have one label column in a data set and, once a column is set to the label type, the label column is automatically used by the graph view. If you have more than one label column, you will need to indicate which column is to be used for a graph in the General section of the Graph View Options.

6.16.13 Entering Grouped Data



	A	B
	group	freq
1	20-30	5
2	30-40	14
3	40-50	31
4	50-60	54
5	60-70	42
6	70-80	35
7	80-90	14
8	90-100	4
9	100-110	1
10		

Grouped data is entered into a grouped data frequency table. The Group column contains the bounds of the groups and the attached frequency column contains the number of data points in each group.

The bounds of the groups are entered as two numbers separated by a hyphen; lower bound – higher bound. For example:

20 – 30	for data points where	$20 \leq x < 30$
30 – 40	for data points where	$30 \leq x < 40$

and so on.

It is important to note that a value of 30 will go into the second group.

If you are manually creating the groups it is possible to create groups that overlap, have gaps, do not have a constant width or do not accommodate all of the data points. When you try to calculate statistics on a grouped data column that contains such errors, the statistics view will warn you of any problems. Any groups created automatically by the tool will be consistent.

The tool gives you the power to automatically group data using the Group, GroupE

and GroupW functions.

Group(A,6) Groups the data in column A into six groups
GroupE(A) Groups the data in column A into the groups that already exist in the column you enter the formula into.
GroupW(A,5) Groups the data in column A into groups five wide (eg 20-25, 25-30)

6.16.14 Formula Columns

Formula columns contain any formula. The main difference is that the contents of the column are constantly updated as data in other columns changes. They behave more like a traditional spreadsheet.

It is important to note that formula columns slow down the tool.

6.16.15 Statistics Specific Functions

The tool contains many statistics specific functions that can be used in your data analysis and creation tasks. Full details on the meaning, use and syntax of these commands are available in the function reference section (Appendix B)

Normal Distribution
Normal( ) – NormP( )
NormQ( )
NormPDF( )
ZScore( )
Standardise( )

Random Number Generation
Rand( )
RandBernoulli( )
RandBetween( )
RandBinomial( )
RandGeometric( )
RandHyperGeometric( )
RandNegBinomial( )
RandNormal( )

Regression and Time Series Data
MPA( )
Predict( ) – PredictY( )
PredictX( )
Residual( ) – ResidualY( )
ResidualX( )
Seasonalise( )

Sorting
Sort( ) – SortA( )

SortD( )
SortCol( ) – SortColA( )
SortColD( )

Ranking
Rank( ) – RankD( )
RankA( )

Frequency Tables
FreqTable( )
CumFreqTable( )

Grouping Data
Group( ) – GroupN( )
GroupE( )
GroupW( )

Deciles / Stanines and Percentiles
Decile( )
Stanine( )
Percentile( )

6.16.16 The Statistics Area

The statistics area shows summary statistics for the selected columns. It is updated dynamically as your data changes.

6.16.17 Selecting Your Statistics

To select the statistics to be viewed:

1. Select the one variable or two variable tab.
2. Choose the column(s) that you wish to view the statistics for.
3. Choose the statistics you wish to view.

The desired statistics will appear in the window.

6.16.18 One Variable Statistics

The tool provides access to a large number of one-variable statistics. These are divided into groups of statistics that can be easily accessed using the statistics selection box.

- Mean, Standard Deviation etc. (Default)

- ALL Data
- Median, Inter-quartile Range etc
- Deciles
- Percentiles
- Stanines
- Measures of Central Tendency
- Measures of Dispersion
- Measures of Central Tendency & Dispersion

Many of these groups overlap in the statistics they present.

All of the reports report n, the number of scores. Other reported statistics are:

Measures of Central Tendency

- Mean — Arithmetic mean
- Mode — Identifies bi-modal and no mode situations
- Median — Central score in a sorted list
- Harmonic Mean — Geometric mean.

Measures of Dispersion

- Range — Maximum score – minimum score.
- Sample Standard Deviation
- Population Standard Deviation
- Variance
- Inter-quartile Range — Result depends on settings in Tools/Preferences.
- Upper & Lower Quartile — Results depend on settings in Tools/ Preferences.
- Mean Absolute Deviation
- Min
- Max

Other Measures

- Deciles
- Percentiles
- Stanine Cutoffs

All of these measures depend in some way on Percentiles. Percentile calculation is dependent on settings in Tools/Preferences.

6.16.19 Two Variable Statistics

The tool calculates two variable statistics for seven regression models. To access the regression calculations, select the two variable tab, the two columns you wish to examine and the regression model you wish to use. The calculated statistics are displayed in the statistics window. When calculating two variable statistics, the tool treats the first column as the independent variable (x) and the second column as the dependent variable (y).

Two Variable Statistics

All regression models provide you with some basic information regarding the regression.

- Correlation Coefficient r Measures the strength of the fit of the model to the data
- Covariance
- Sum of Products

Regression Models

- Linear Regression $y = a + bx$
- Quadratic Regression $y = a + bx + cx^2$
- Exponential Regression $y = a.e^{bx}$
- Logarithmic Regression $y = a + b.\ln(x)$
- Power Regression $y = a.x^b$
- Reciprocal Regression $y = a + b/x$
- Median Line $y = a + bx$

Copying Statistics to the Clipboard

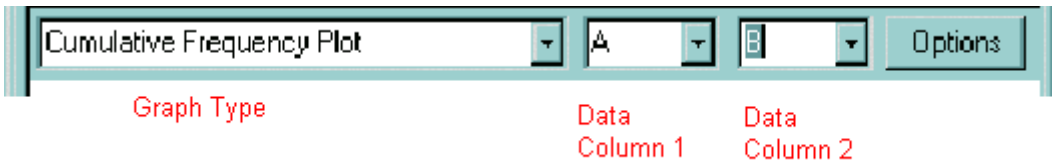
At any stage, pushing the "Copy Statistics to Clipboard" button will copy the statistics to the clipboard in rich text format. This format will retain its formatting when pasted into Word or Excel.

Swapping Columns

When calculating two variable statistics, a second button appears at the base of the Statistics Area. This button will swap the columns identified. This swapping also affects the first two columns of the Graph Area.

6.16.20 Basic Graphing

Basic graphing relies on few steps.

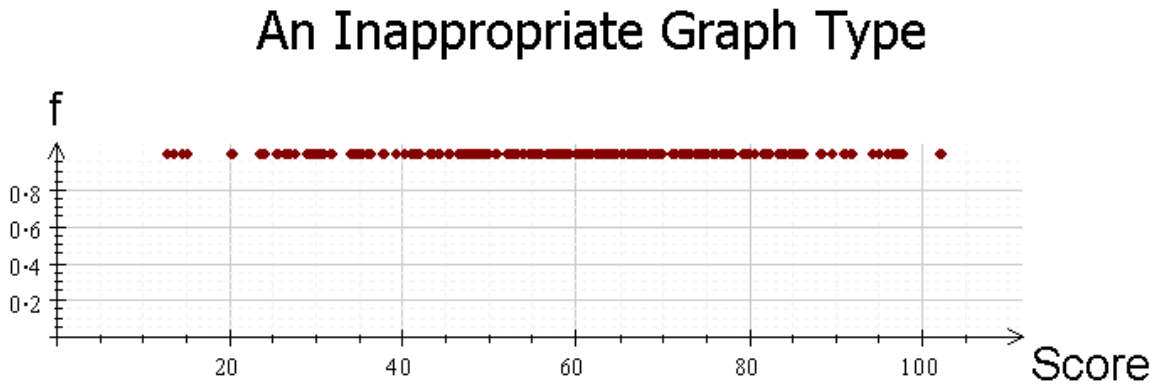


Select a Graph Type

The tool can produce graphs of the following types:

- Bar Graph
- Column Graph
- Histogram
- Dot Plot
- Box & Whisker Plot
- Line Graph
- Scatter Graph
- Frequency Polygon
- Cumulative Frequency Graph
- Residuals Graph
- Pictograms
- Stem & Leaf Plot

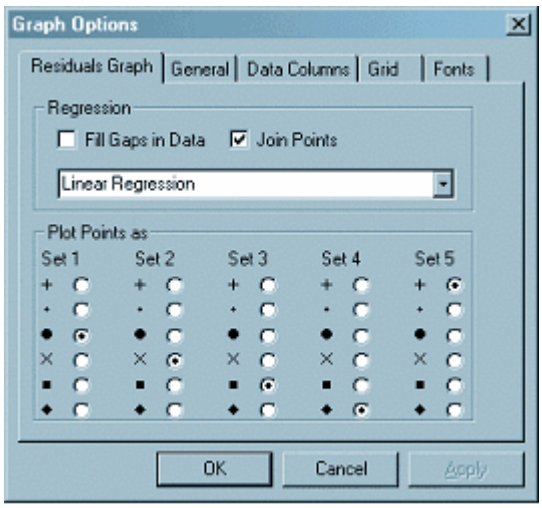
The tool makes no attempt at explaining which graph is most suitable to graph a particular data set but the graphs produced by each option often clearly demonstrate the advantages and disadvantages of each graph type. For example, if you have a set of data such as 50.25, 32.49, 38.19 … and use a Dot Plot you get this sort of result.



Select a Column (Columns)
Column 1 and Column 2 offer you the opportunity of selecting the first two columns to graph. The two columns will be combined onto one graph. Most graph types can have up to ten columns of data included. To graph extra columns of data, look at the Data Columns page of the graphing options.

6.16.21 Graph Options

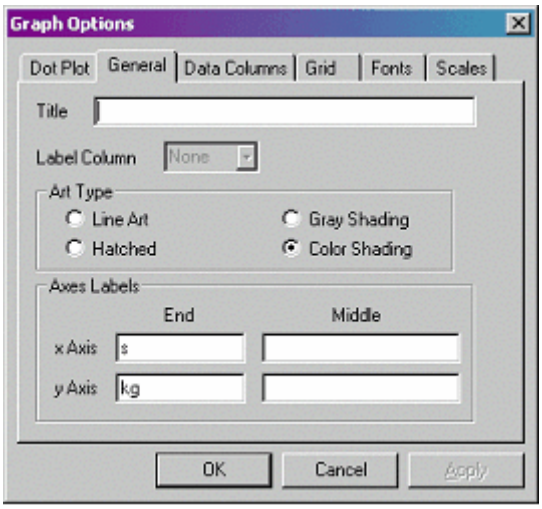
Press this button to make changes to the format of the graph. There are a large number of options available for graphing. When you press this button, an options dialog box similar to this will appear, depending on the current graph type.



The first tab, in this case Residuals Graph, allows access to options specific to the current graph type. The other four tabs allow you to adjust options that affect all graph types.

6.16.21.1 General

The general tab gives you access to some of the more basic graphing options.

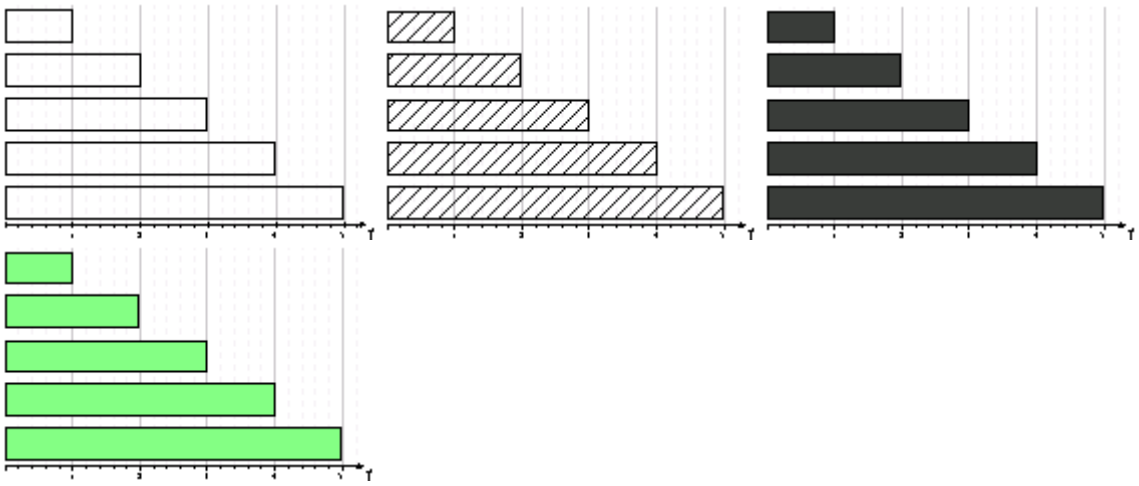


Title
The graph title is included at the top of any created graph. In the example earlier in this section, the title was "An Inappropriate Graph Type".

Axis Labels
Labels can be added to the end and middle of both axes. Any string can be entered here.

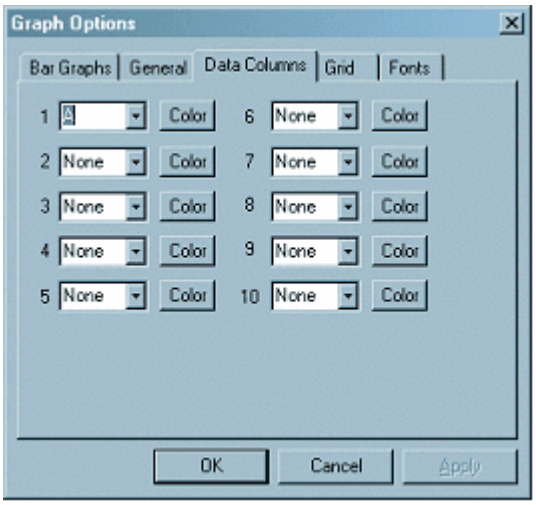
Label Column
The label column is rarely used. In the example above, there is no label column in the data set so the option is disabled. If a column had been identified as a label column, it would automatically be selected in this area and automatically used for any graph types which require it. The only times that this option is likely to be used is if you have two or more label columns and wish to choose which one to use OR if you have a label column and choose not to use it.

Art Type
Depending on the display you are using, the Art Type option allows you to produce the most acceptable graphics.



6.16.21.2 Data Columns

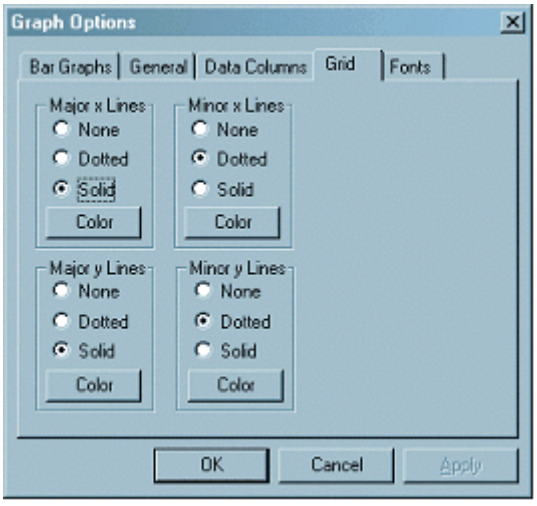
The data columns tab allows you to specify up to ten columns of data that are to be graphed. Most graph types can graph ten sets of data (or five pairs of data columns).



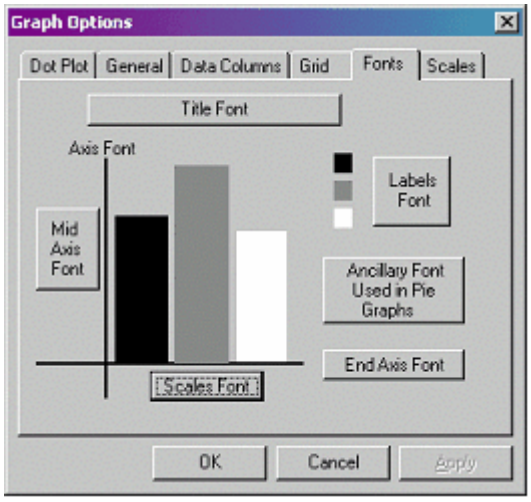
The ten columns are selected using the selection boxes. Each column can also have its own colour selected. Press the button next to the selection box.

6.16.21.3 Grid

The grid options allow you to select the line type and colour for both major and minor gridlines on both axes. You may need to spend some time choosing colours that best suit your display device.

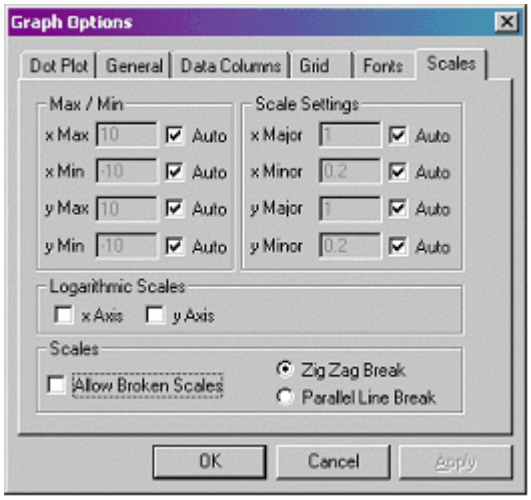


6.16.21.4 Fonts



Every font in an statistics graph can be changed in this tab. The face, size and colour can all be adjusted. The ancillary font is only used for sector labels in pie graphs.

6.16.21.5 Scales



Min / Max
By default, the statistics tool automatically calculates the maximum and minimum values for both axes. If you wish to set your own maximum and minimum values, this can be done here. Please note that if a data point lies beyond the maxima and minima you enter, the statistics tool will automatically override your values.

Scale Settings
The statistics tool will automatically select an appropriate scale to display the data you have entered. If you wish to enter your own scales this can be done here. The "major" entries determine axis ticks that are annotated. The "minor" entries determine axis ticks that do not have a number attached.

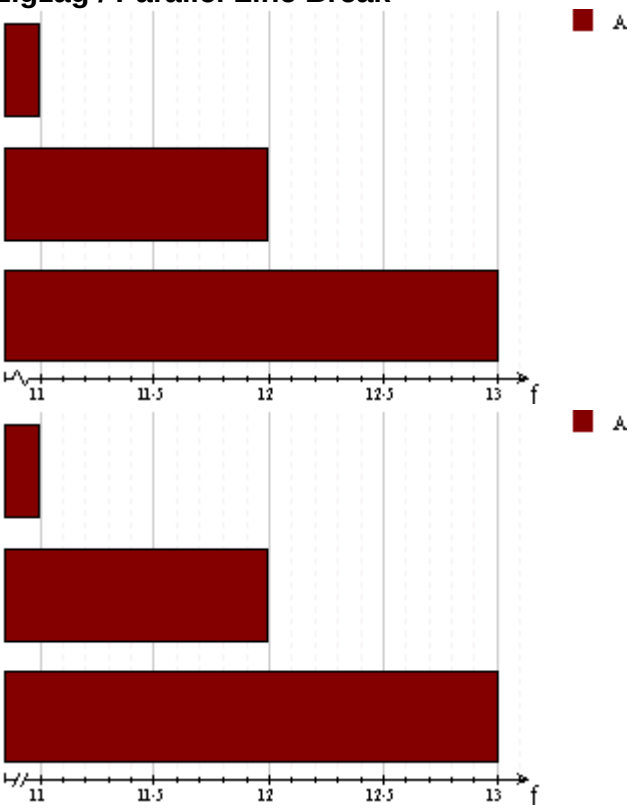
Logarithmic Scales

Both the x-axis and the y-axis can be logarithmic. It is important to note that logarithmic axes will not make too much sense unless they are showing data at least two orders of magnitude apart (eg 1 and 100).

Allow Broken Scales

Many data sets produce better graphs if the scale is broken. The statistics tool can automatically break scales if you wish. The style of break is determined by the next option.

Zigzag / Parallel Line Break

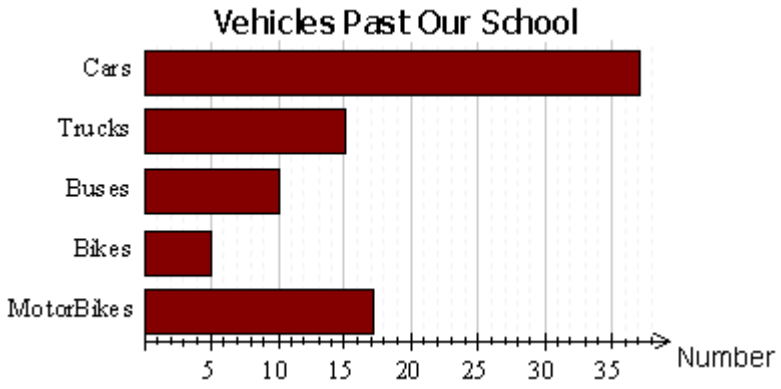


6.16.22 Specific Graph Options

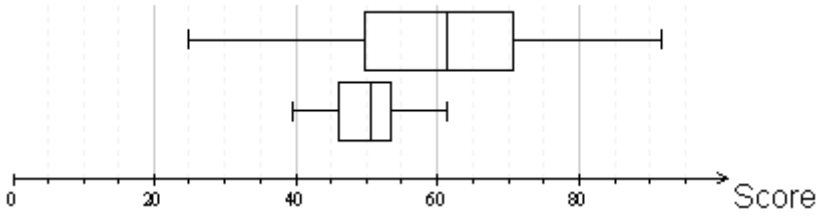
6.16.22.1 Bar Graph

The only option available for bar graphs is to select whether a legend is shown or not.

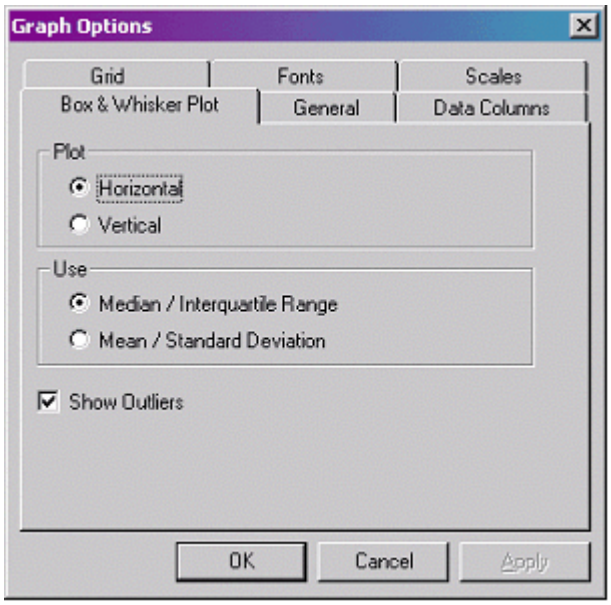
The labels for the bars have been entered into a label column.



6.16.22.2 Box & Whisker Plot



Box and whisker plots have two main options. Box Plots can be drawn horizontally (as shown) or vertically. They can also be drawn using the range, median and interquartile range (as shown) or alternatively using the range, mean and standard deviation.

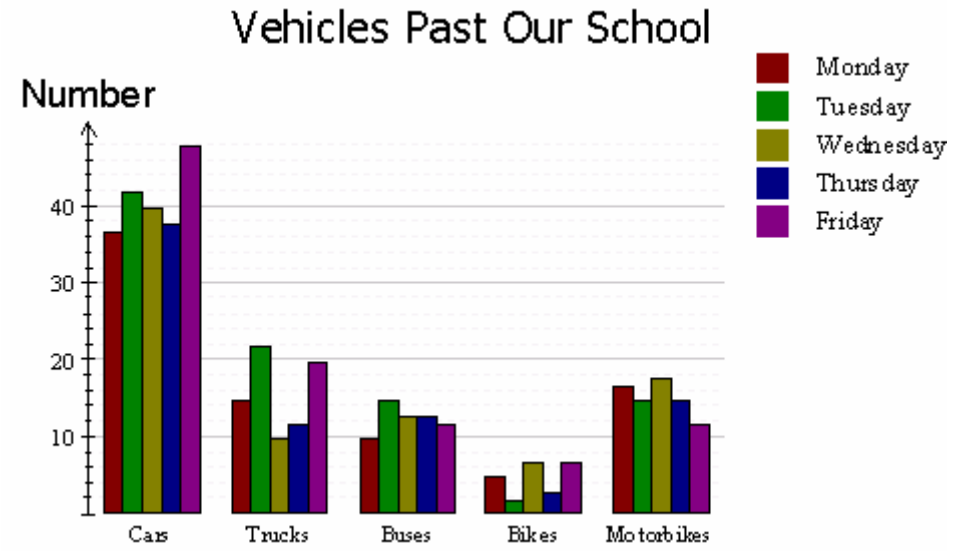


The show outliers option changes the graph so that any points more or less than 1.5 IQR's from the median are shown as outliers (dots) on the graph.

6.16.22.3 Column Graph

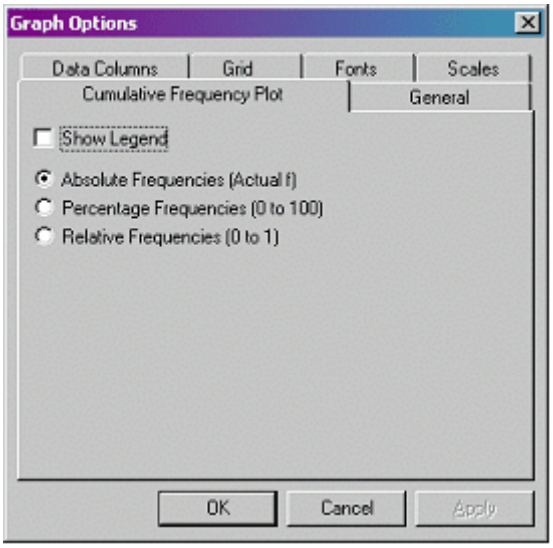
Column graphs, like bar graphs have only one option available, whether to include a legend.

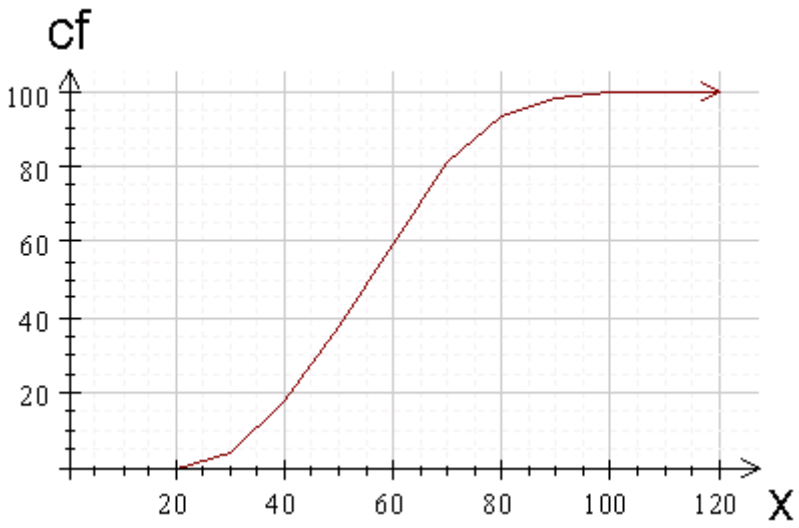
The example graph shows a column graph with legends shown. The labels for the columns have been entered into a label column. The legend information has been entered as titles for the five columns. The five data columns were entered in the data column section of the graph options.



6.16.22.4 Cumulative Frequency Graph

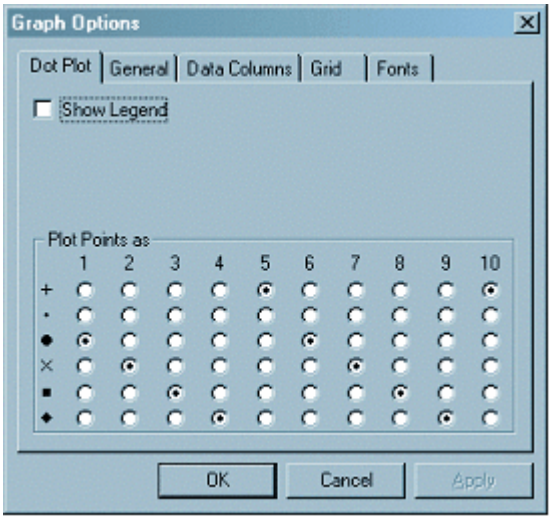
Cumulative frequency graphs can have legends turned on or off. You also have the option of showing the cumulative frequencies as percentages or relative frequencies. These later options are particularly useful if you are comparing the cumulative frequency graphs of two or more data sets.



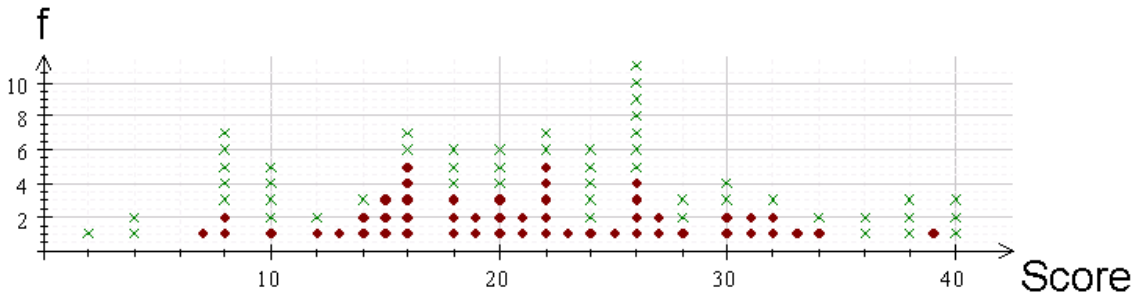


6.16.22.5 Dot Plot

Dot Plots have two main types of options. The legend can be turned on or off and you can change the way points are plotted for each of the ten data columns

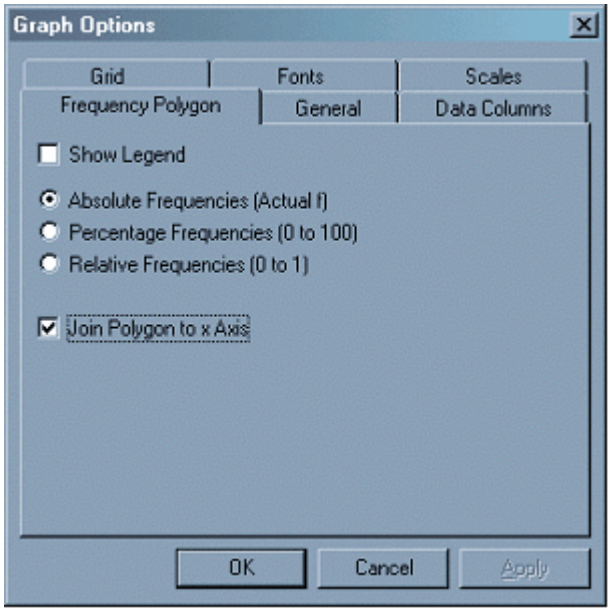


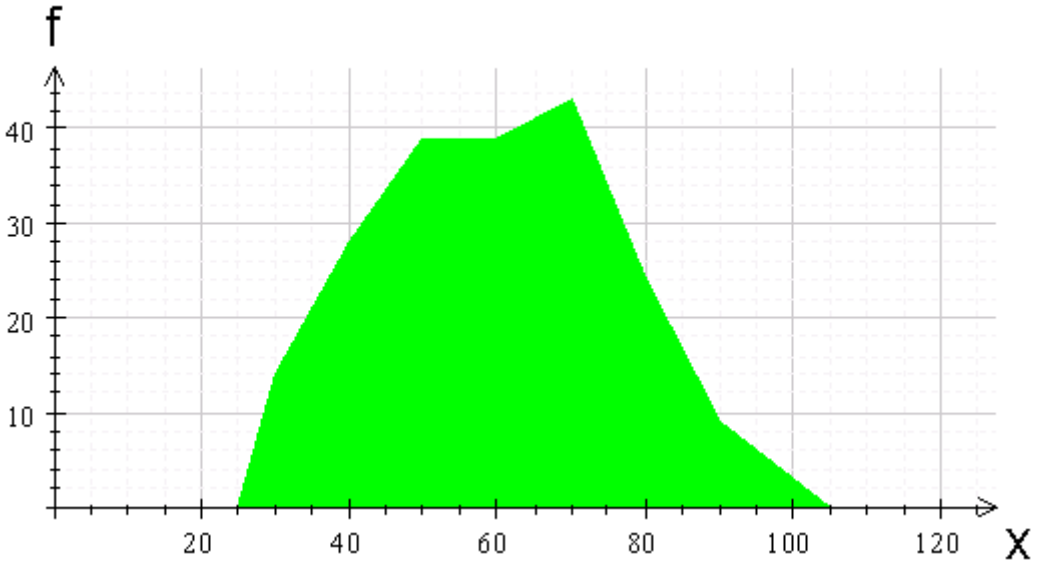
The example graph shows a dot plot graphing two data columns.



6.16.22.6 Frequency Polygon

Frequency polygons can have legends turned on or off. You also have the option of showing the frequencies as percentages or relative frequencies. These later options are particularly useful if you are comparing the frequency polygons of two or more data sets.

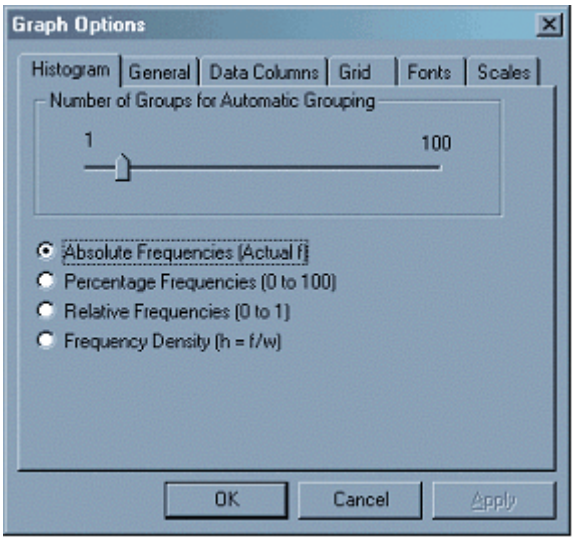




You can also stop the polygon from joining up to the x axis – as is required in some locations.

6.16.22.7 Histogram

Histograms can be drawn for two types of data. If you select a column of ungrouped data, the histogram graph type will automatically group the data for you. The number of groups is determined by the Histogram option screen.

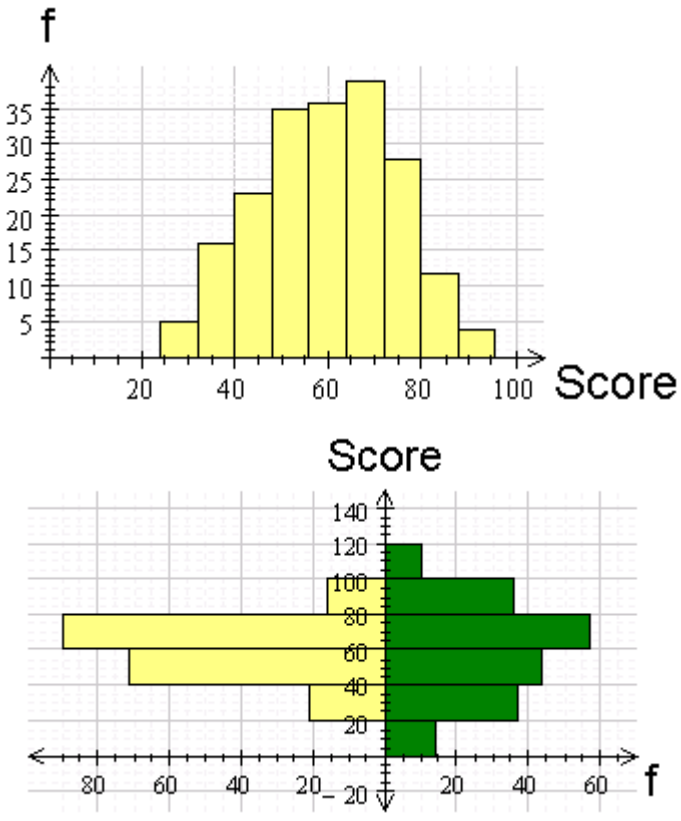


By adjusting the slider, you can force the histogram graph to group into more or less groups.

Alternatively, the histogram graph can graph data that has already been grouped. In this case, the number of bars is determined by the existing groups.

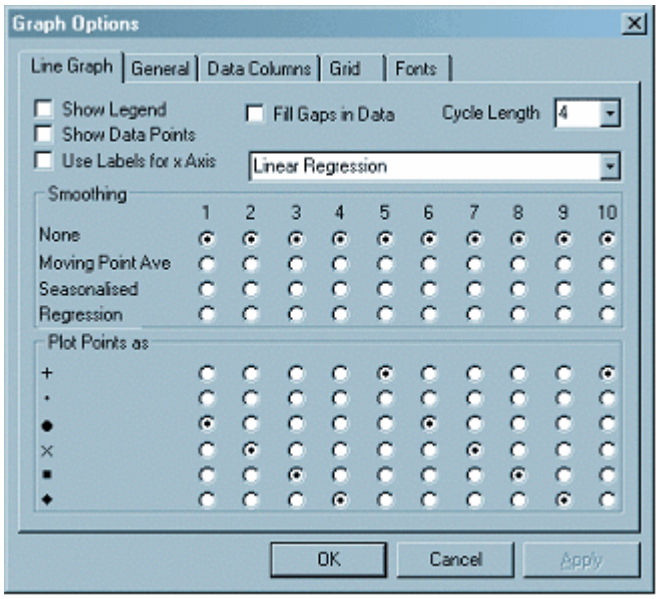
Frequencies can be shown as absolute, relative, percentage or frequency densities.

The histogram graph type is only capable of graphing, at most, two data sets.



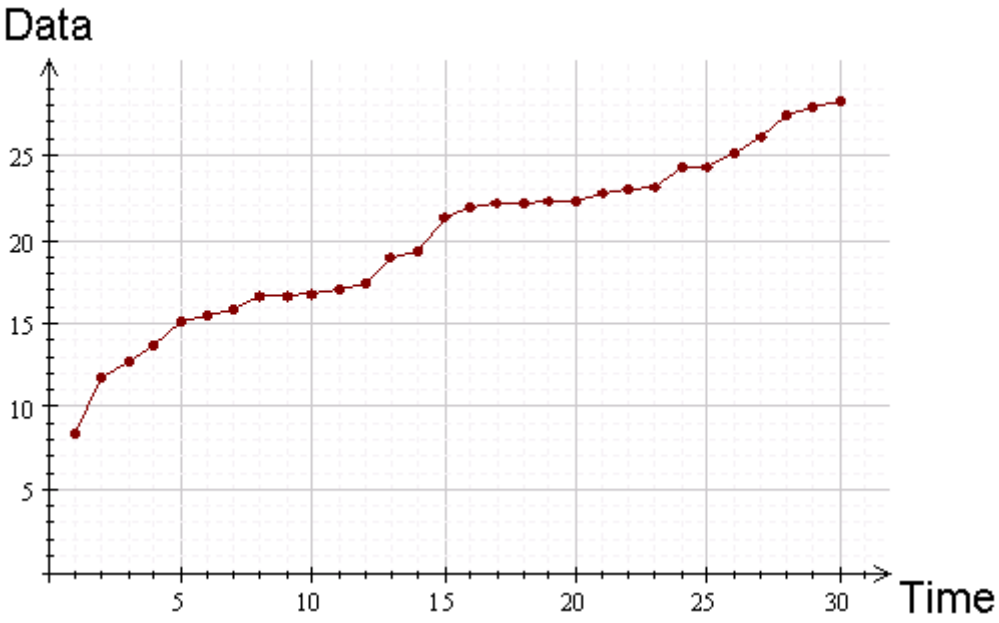
6.16.22.8 Line Graph

Line graphs have by far the largest number of options available to the user.



Show Legend
A legend can be shown. This is particularly useful if a large number of data sets are to be shown on one set of axes.

Show Data Points
A mark can be placed at every data point. These data points are then joined by lines. The first graph example shows data points. If data points are not shown, a line graph will show only a line.

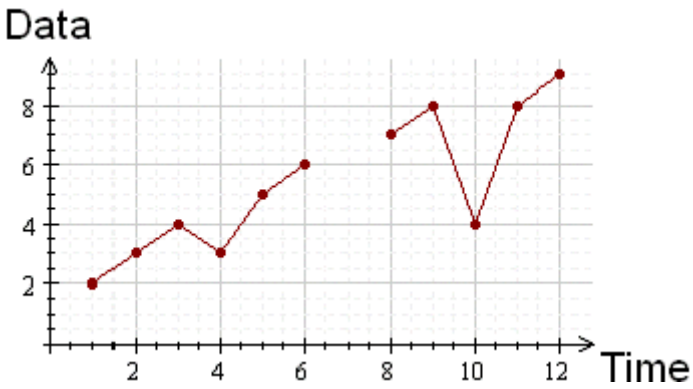


Use Labels for x Axis.
Although the x axis of a line graph normally shows a scale, the user has the option of using labels for the x axis. This allows the user to construct a graph with labels such as the months of the year on the x axis.

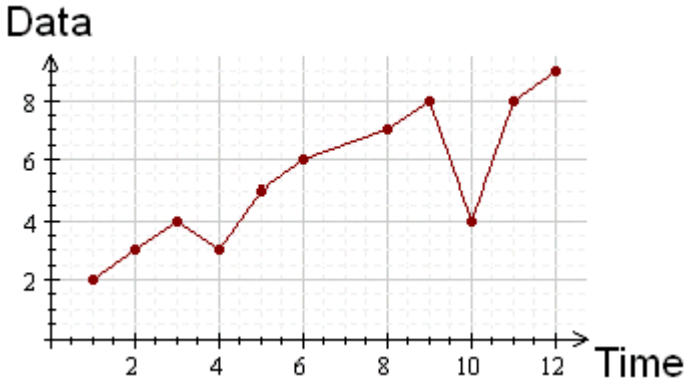
Fill Gaps in Data
If there is an unfilled row in your data set, this option determines how the tool will graph the information. For example, if your data is entered as:

	A
	data
1	2
2	3
3	4
4	3
5	5
6	6
7	
8	7
9	8
10	4
11	8
12	9
13	

Data with a gap



Fill gaps off



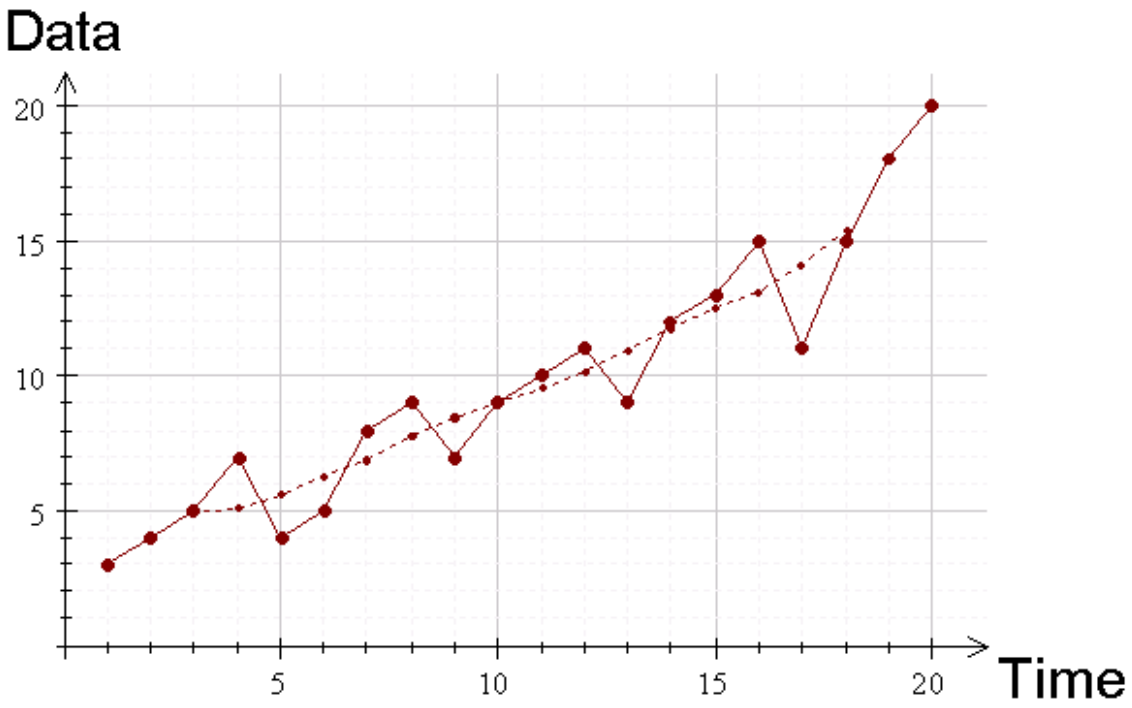
Fill gaps on

Cycle Length
This cycle length is used for moving average and seasonalised smoothing.

Regression Model
The regression model to be used for regression smoothing.

Smoothing.
Data can be smoothed in one of three ways and this is selectable for each data set.

- **Moving Average** calculates the moving point average or centred moving point average of cycle length and displays the information as a dotted line.
- **Seasonalised** calculates the seasonalised information and displays it as a dotted line.
- **Regression** calculates the regression line (curve) and displays it as a dotted line.

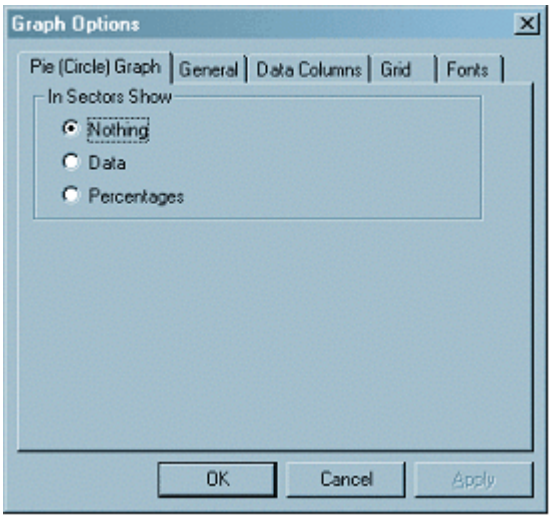


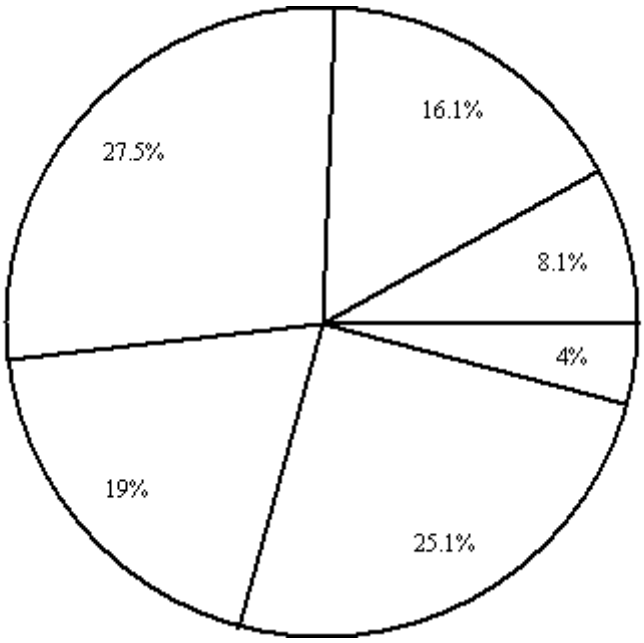
Line graph showing moving point averages

Plot Points As
The type of point to be plotted can be entered for each data set.

6.16.22.9 Pie Graph

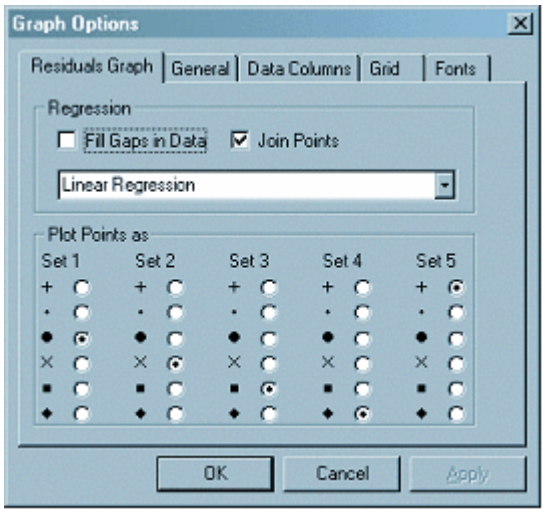
Pie graphs can only be used to graph two data sets at one time. Users have the option of adding the data or the percentage to the sectors. This in-sector information is the only use of the ancillary font.

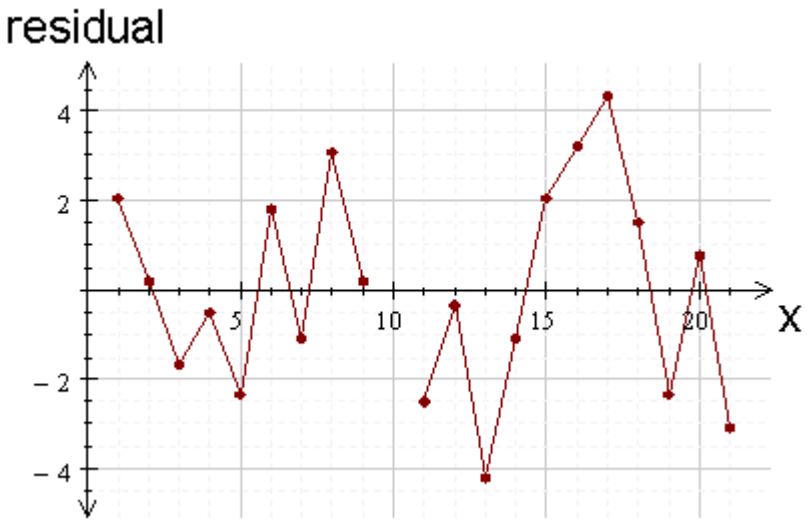




6.16.22.1 Residuals Graph

The residuals graph can graph up to five PAIRS of data columns. Residual graphs can be drawn for each regression model. You can join the points with lines if this is appropriate. Residuals graphs have the capability of filling gaps in data in much the same way as line graphs.

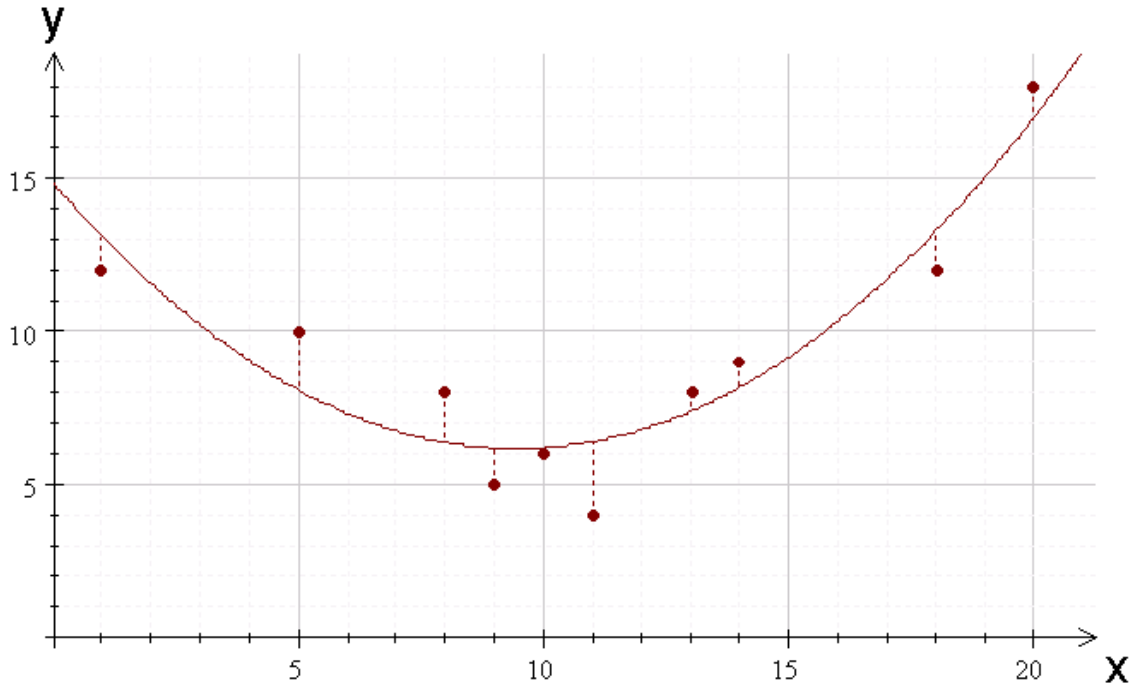




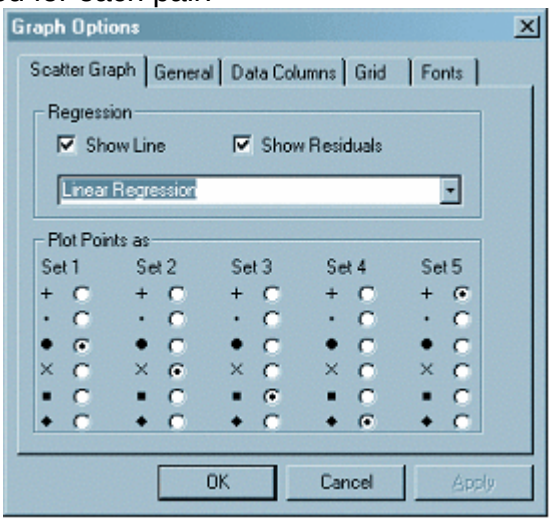
The example shows a residuals graph with Join Points on and Fill Gaps off.

6.16.22.1 Scattergraph

The scatter graph can graph up to five PAIRS of data columns. The example graph shows one pair of data columns with a quadratic regression curve and residuals shown.

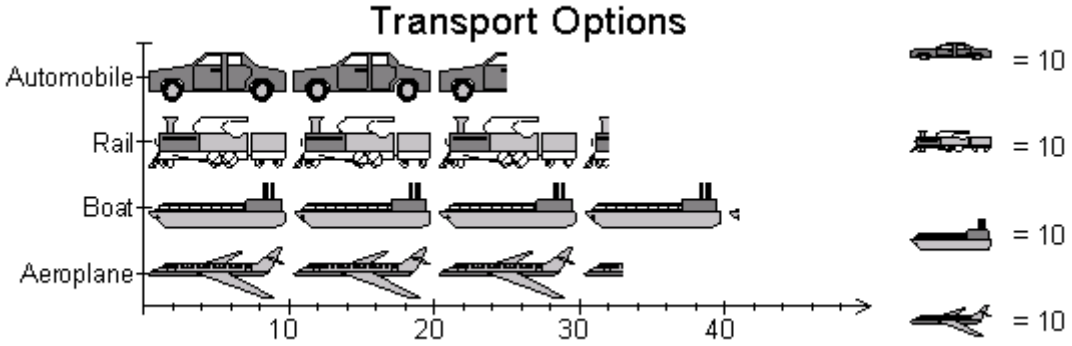


The scatter graph options page allows you to turn the regression line on or off, the residuals (dotted lines) on or off, select the regression model and determine the type of points that are plotted for each pair.



6.16.22.1 Pictogram

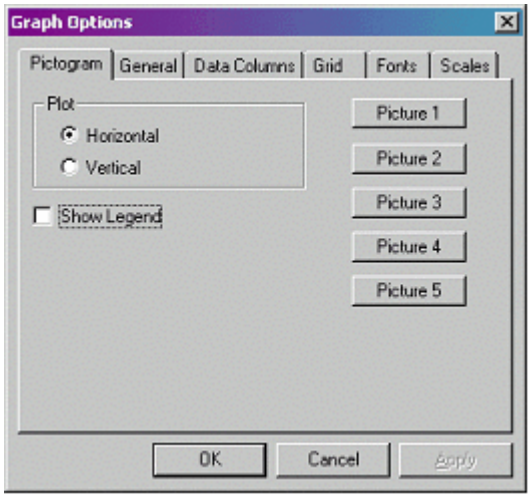
The pictogram can graph using up to different pictures. If the pictogram shows more than five data points, it will start recycling the pictures.



The pictogram options page allows you to set the graph to horizontal or vertical (the example is horizontal) and turn the legend off.

The Picture buttons allow you to set the pictures for the data. The pictures are selected from the galleries.

Scales will not be broken and grid lines will not be shown on a pictogram regardless of the Grid and Scales settings.



6.16.22.1 Stem & Leaf Plot

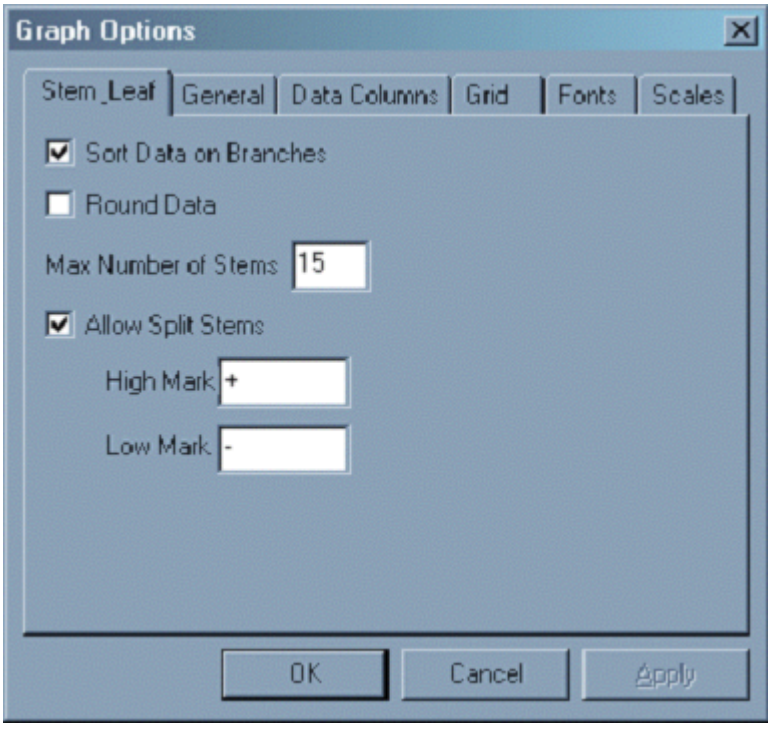
The Stem & Leaf plotting tool can graph up to two sets of data. There are some differences in the way the Stem & Leaf tool plots when compared to the other tools:

1. The tool does NOT resize the plot to suit the display rectangle. All other tools automatically fit the graph into the rectangle. Because the Stem & Leaf plot's size is determined by the font used, this is not possible.
2. The Stem & Leaf tool can only plot information whose range is less than (about) 300. This means that some data sets will not be plotted in any reasonable manner. This is an inherent limitation of Stem & Leaf plots rather than our tool.

	10	0
	9	69
	8	12255
4	7	011333449
54422100	6	05788889
98866554444432200	5	001345579
8777666443333100	4	2577899
877753	3	23799
87	2	28
	1	48

7-	4
6+	5
6-	2041240
5+	5668859
5-	4342444200
4+	7866677
4-	431330304
3+	57787
3-	3
2+	78

14	70
13	30,50
12	
11	80
10	60,90
9	40,90
8	30,90
7	30,50
6	10
5	80,80
4	00,20,20,30,40,40,80
3	00,80
2	00,10,10,10,20
1	00,10,20,20,30,50,60,70,70
0	10,10,30,40,40,50,70,70,80,80



These three graphs show some of the stem & leaf plots available. The first graph shows a two-sided stem & leaf graph where the data points range from 14 to 100. The second graph shows a stem & leaf plot where FX Stat has been allowed to "split" the stems into a low half and a high half. The final graph shows values between 10 and 1470 where FX Stat has put two digits into the leaves.

Stem & Leaf options include

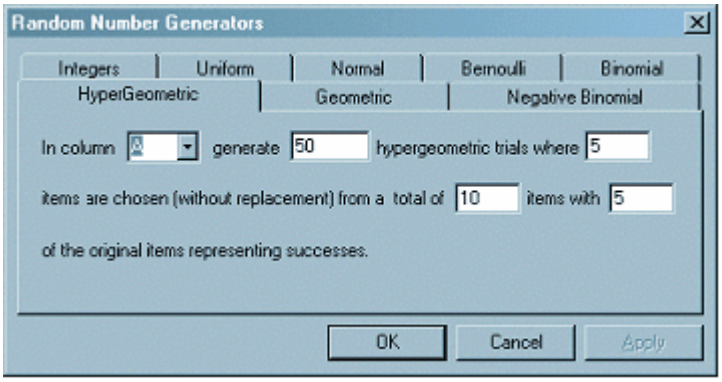
1. The ability to sort the data on the branches. The second graph above has NOT had the branches sorted. Not sorting the branches produces the sort of graph you are likely to produce if you graph the data by hand.
2. Decide whether you round the data or not. This determines whether a number like 76.8 is shown with a leaf of 6 or 7 on your plot.
3. Maximum number of stems. You can allow FX Stat to have more stems in your plot if it suits your purpose.
4. Allow split stems. Whether you allow graphs such as the second one. You can also set what mark you wish to use for the high and low half of the stems.

Finally, FX Draw uses the SCALES font when graphing a stem & leaf plot.

6.16.23 The Tools

6.16.23.1 Random Number Generator

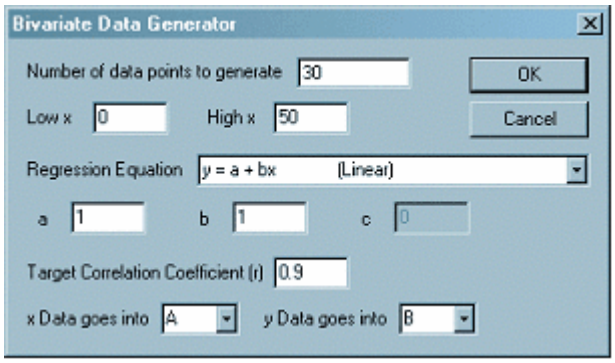
The random number generator allows easy access to the random number generation functions discussed in the function reference (Appendix B). Some of these functions have up to four parameters which must be entered in the correct order. The Random Number Generator tool allows you to generate random numbers without remembering all of the parameters.



Full details of the random number generators is available in the function reference (Appendix B). The Integers tab above allows access to the RandBetween function and the Uniform tab allows access to the Rand function.

6.16.23.2 Bivariate Data Generator

The bivariate data generator allows you to quickly and easily generate bivariate data that satisfies a set of given parameters.



The bivariate data generator opens the above dialog box. To generate your data:

- Enter the number of data points to generate. This determines the number of "dots" on the scatter graph.
- Enter the low and high values for x. The tool will generate random x values between these two values.
- Choose the regression equation
- Enter the parameters for the equation (a, b and c). The c parameter is only used for quadratic regression equations.
- Enter the target correlation coefficient. The tool cannot calculate correlation coefficients for quadratic regression equations but it will still take the target correlation coefficient into account while generating data.
- Enter the columns that the x and y data will be put into.

The generator will now do its job.

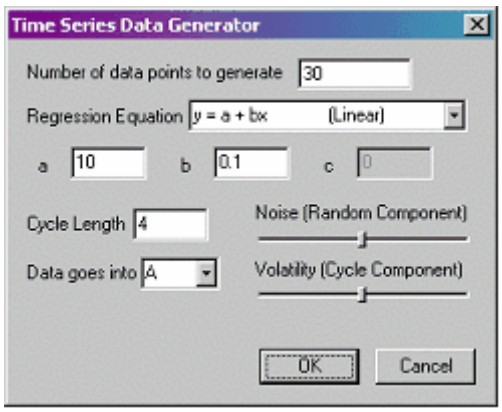
Please note:

- The generator will not produce data to exactly match your parameters but the match will be close. If the match is not good enough, you can always try again.

The "a" parameter is the least likely to be matched in all regression models.

6.16.23.3 Time Series Data Generator

The Time Series Data Generator allows you to quickly and easily generate time series data for use in questions and examples.



The time series data generator opens the above dialog box. To generate your data:

- Enter the number of data points to generate.
- Choose the regression equation
- Enter the parameters for the equation (a, b and c). The c parameter is only used for quadratic regression equations.
- Enter the cycle length required.
- Set the noise (random) component slider. If the slider is fully to the left, there will be no random component to the data. Fully to the right and the pattern may not be recognisable.
- Set the volatility (cyclic) component slider. This determines how "dramatic" the cycle is.
- Enter the column that the data will be put into.

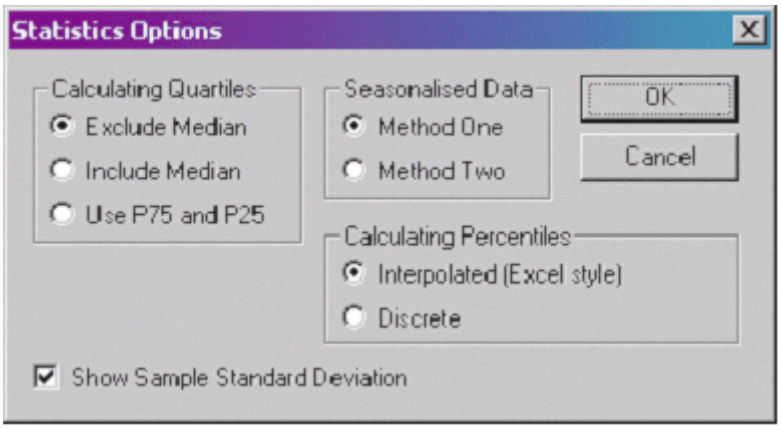
The generator will now do its job.

6.16.24 Customising The Statistics Tool

Statistics, particularly secondary school statistics, is INCREDIBLY localised. The "right" way of doing something in one location is often very different to the "right" way of doing it in another location. The system options allow you to customise your version of the statistics tool to suit your local conditions. The options can be accessed through the Tools/Preferences menu.

With all the system options it is vital that you TRY each setting and pick the one that suits your situation. Unfortunately there are no standard names for different methods of calculation.

Please note that Efofex expects this area of the statistics tool to be very fluid. The system options you see may differ from the screen presented below.



Calculating Quartiles

Efofex has found three common methods of calculating quartiles.

1, 3, 3, 4, 5, 6, 6, 8, 9, 10, 10, 11, 13, 14, 16, 18, 20

In the above example, 9 is the median. The lower quartile is the median of the bottom half of the scores BUT does the lower half include the 9 or exclude it? Depending on your answer, the lower quartile would be 4.5 or 5.

This gives us two of the three options for calculating quartiles. The third is to use the 75th and 25th percentiles. The results of this option depends on how you calculate percentiles.

Seasonalised Data
Method One is to calculate the average residual between a point in the cycle and the **moving point average** at that point. This average residual is then removed from the data to obtain the seasonalised figure.

Method Two is to calculate the average deviation between a point in the cycle and the **mean of the data set**. This average deviation is then removed from the data to obtain the seasonalised figure.

Calculating Percentiles
The interpolated method of calculating percentiles (as found in Excel) produces this result.
If the data point 13 indicates the 20th percentile and 14 is the 30th percentile, the 21st percentile is 13.1, the 22nd is 13.2, the 23rd 13.3 and so on.

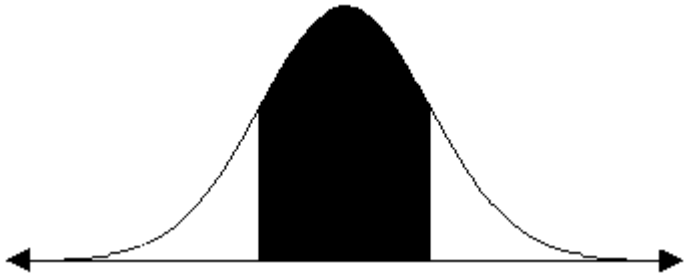
The discrete method of calculating percentiles would produce 13 as the value of the percentile for the 20th up to the 29th percentile.

Show Sample Standard Deviation
Some school systems make no distinction between sample and population standard deviation. This can be accommodated by turning this option off.

6.17 Normal Distribution Curve

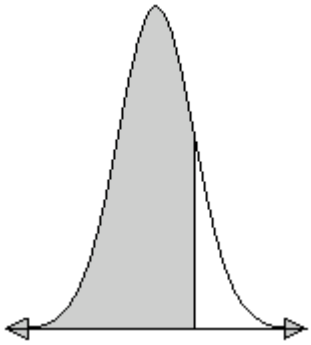
The Normal Distribution Curve tool allows you to draw shaded or unshaded normal distribution curves.

If you select the Normal Distribution Curve tool and draw the curve, this will be displayed.



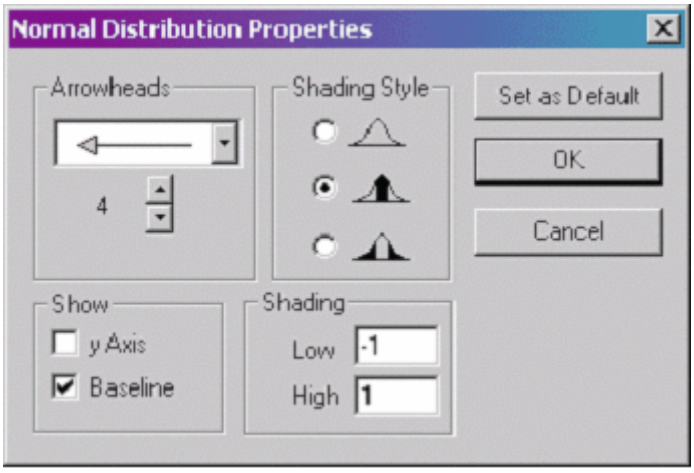
This is a normal distribution curve that has been shaded between z = -1 and z = 1.

When selected, the normal distribution curve will have two sliders. The top slider controls the lower bound of the shading and the bottom slider controls the upper bound.



If you wish to produce a diagram where one tail is shaded, merely decrease the lower bound (or increase the upper bound) as far as possible. This will produce the desired result. You will also notice that the shading has changed. This can be achieved using the fill palette.

To achieve other shading effects or to set the upper and lower bounds exactly, you will need to right click to edit the properties.

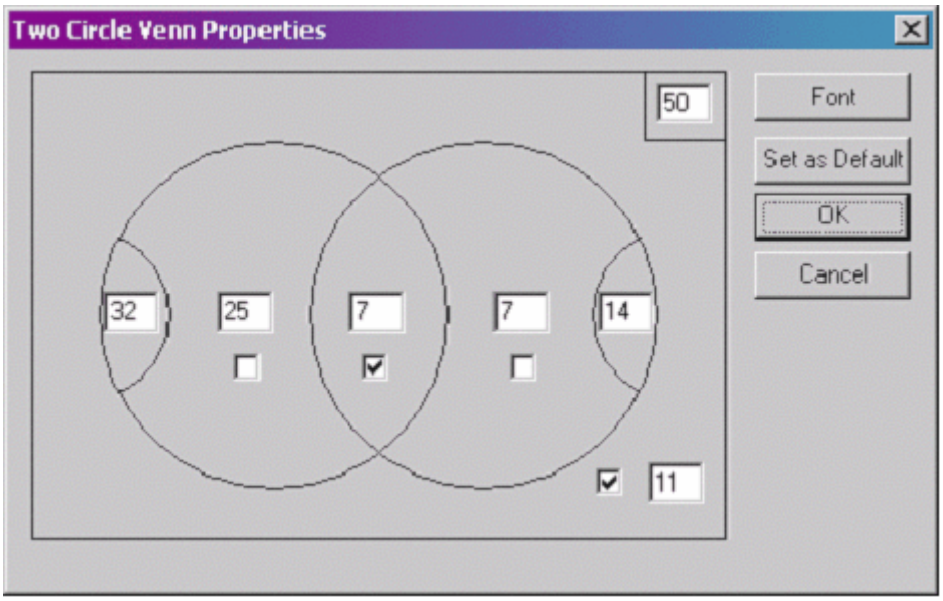


Here you can edit the arrow types, the type of shading (which allows two tailed shading), whether to draw in the baseline or y axis and finally, you can set exactly the low and high bounds of the shading. You should enter then number of standard deviations from the mean you require.

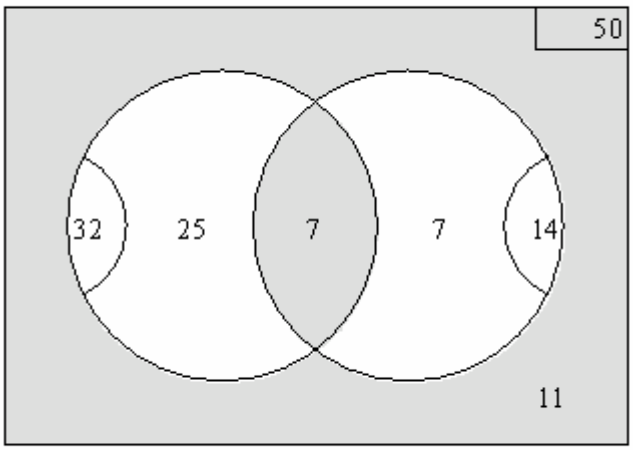
6.18 Two Circle Venn

The Two Circle Venn Diagram tool allows you to draw shaded and annotated two circle Venn diagrams.

After you have drawn the initial diagram, the properties of a two circle Venn diagram may be accessed by right clicking.



In this dialog box, you can choose to add totals to different areas on the Venn diagram. Any total left blank will not be shown (see 3 circle Venn diagrams). You can also shade any of the four regions in a 2 circle Venn diagram. Finally you have access to the font used to annotate the diagram. The diagram below is the result of using the properties shown.

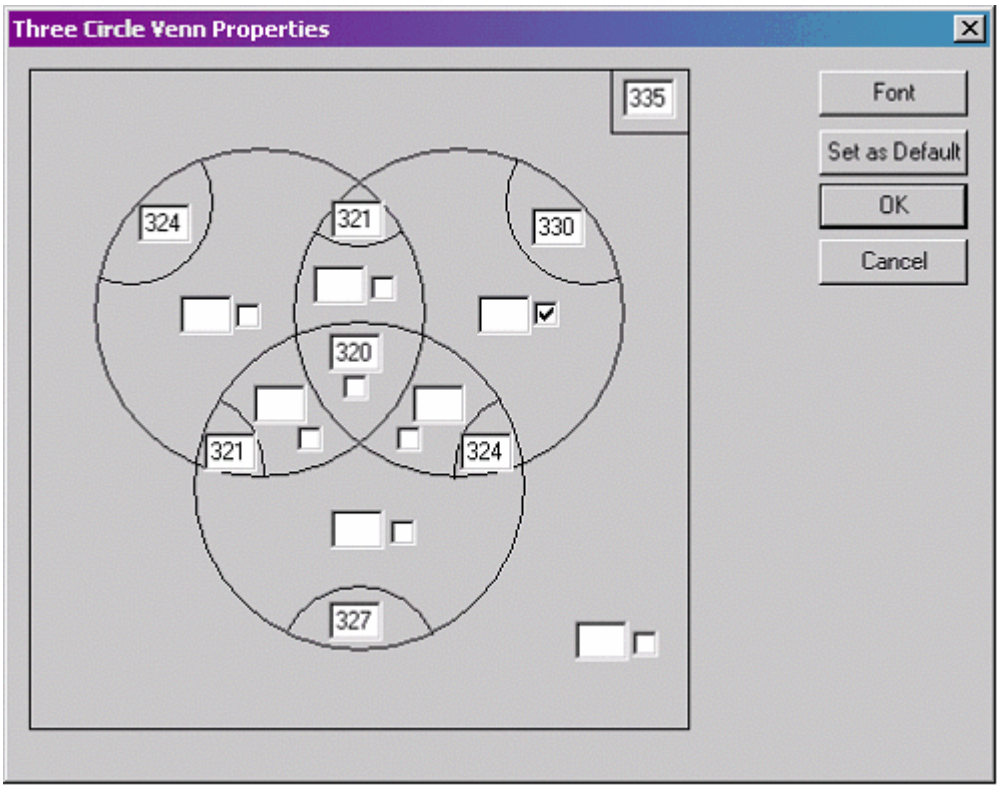


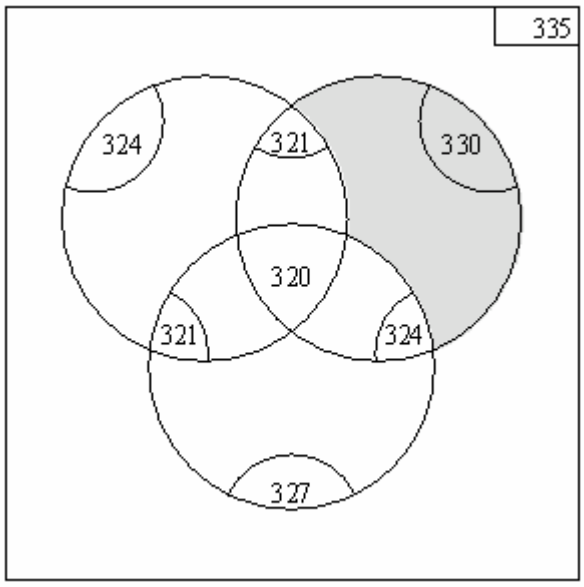
The shading is controlled using the fill palette.

6.19 Three Circle Venn

The Three Circle Venn Diagram tool allows you to draw shaded and annotated three circle Venn diagrams.

The operation of the three circle Venn diagrams is exactly the same as two circle diagrams. The only difference is that there are more properties to edit.





Notice that only those totals entered as properties are included in the diagram.

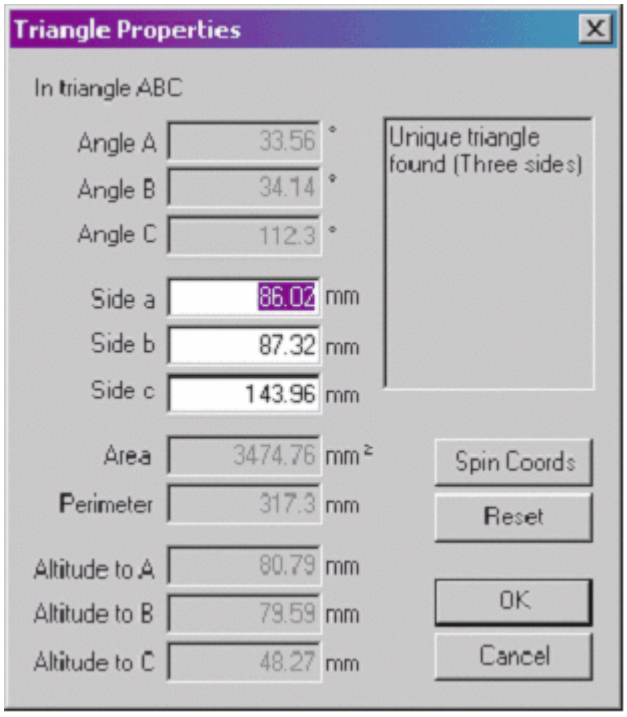
6.20 Triangles

The triangles tool allows you to analyse ANY triangle – calculating its sides, angles, area, perimeter and altitudes. It also allows you to CREATE any triangle by giving FX Draw three unambiguous pieces of information.

Drawing a triangle:

- Click AND HOLD the left mouse button – this defines one vertex.
- Move the mouse (while holding the button) to another vertex. Release the button when you are at the second point.
- Click AND HOLD the left mouse button and move the mouse to the final vertex. As you move the mouse, FX Draw will draw an triangle through your points. Release the button when you are at the third point.

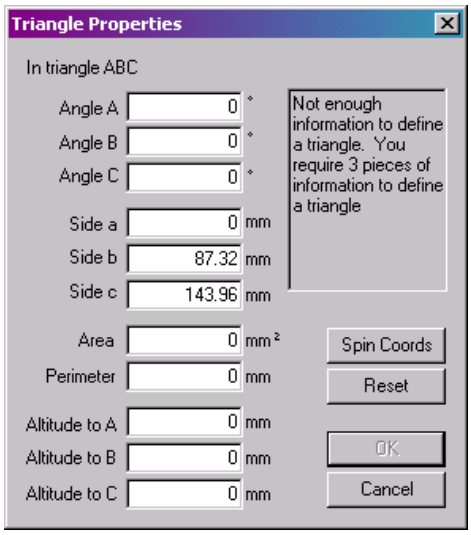
If you select the triangle, FX Draw will give you a small report (sides and angles) in the status line at the bottom of the screen. To fully analyse a triangle, right-click on it.



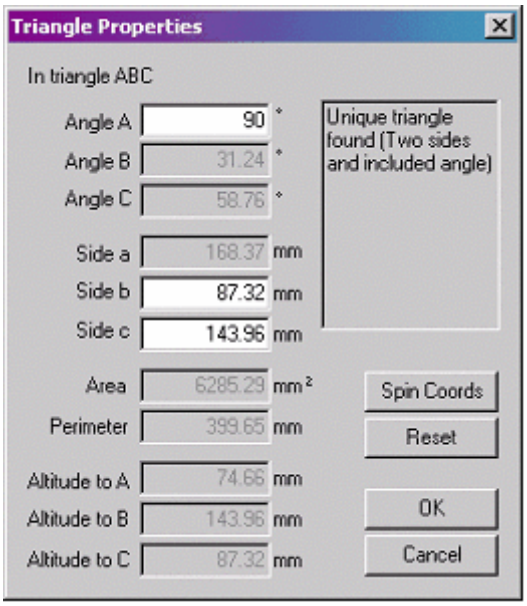
This dialog box shows you all crucial measures of your triangle. You can use it to provide you with solutions to most trigonometry problems. The dialog box is dynamic. If you change the currently selected figure from 86.02 to 90, all the other figures will be updated.

Also notice the report area. Currently it is telling you that you have a unique triangle defined by its three sides. This report area will keep you informed about the type of triangle you are drawing.

If I delete the value in side a, leaving only two pieces of information, the dialog box changes character.



All the calculated measure have gone and you can enter data into them. As you enter data, FX Draw will determine if it can identify a unique triangle from your data. As soon as it can, it disables the other measures and shows you calculated values.



By setting Angle A to 90° we have again defined a unique triangle and analysed it.

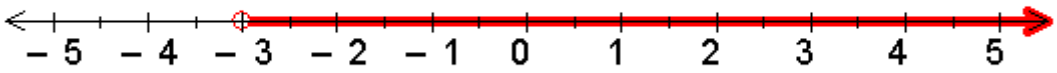
The Spin Coords button will move the data attached to the three sides/angles and altitudes. This can help you get the triangle you are after.

The Reset button sets all values to zero and allows you to define a triangle with exactly your measurements.

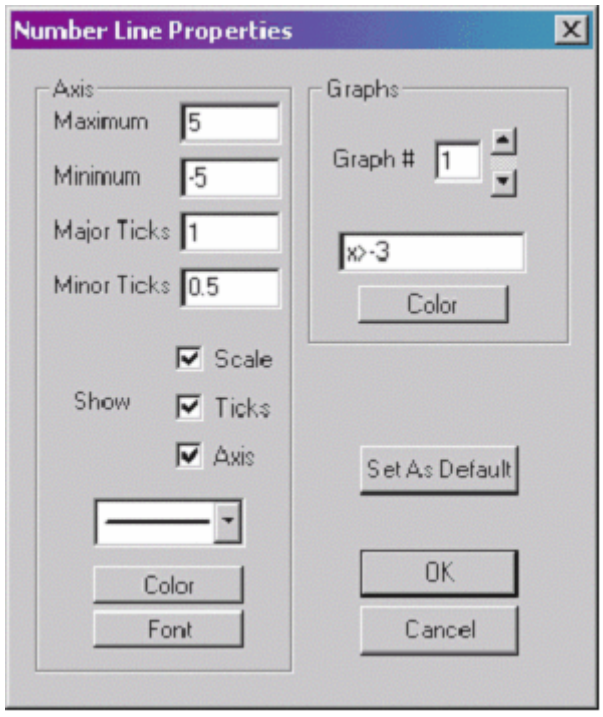
The triangles tool detects ambiguous cases and situations where the data you have entered does not define a triangle. It constantly keeps you informed of what it has found.

There are 165 different ways you can enter three pieces of information into the eleven available places. We have not yet implemented solutions for all of these combinations. FX Draw may tell you that it cannot solve the triangle given the information you have provided. We intend solving all 165 combinations as soon as possible.

6.21 Number Line



To draw a number line, you sweep out a rectangle. It is advisable to sweep out a short, wide rectangle but FX Draw will fit the number line to whatever rectangle you create. When you have created the rectangle, FX Draw will create a blank number line. To add a graph, right click on the number line.



This dialog box allows you to set up the axis in exactly the same way as the function graphing tool. You can also add up to ten graphs onto your number line (although this can easily get confusing). You enter the graphs in terms of x and you can enter the following combinations (using –3 as the number – you obviously can use any number).

x > -3 x greater than negative three
x >= -3 x greater than or equal to negative three
x < -3 x less than negative three

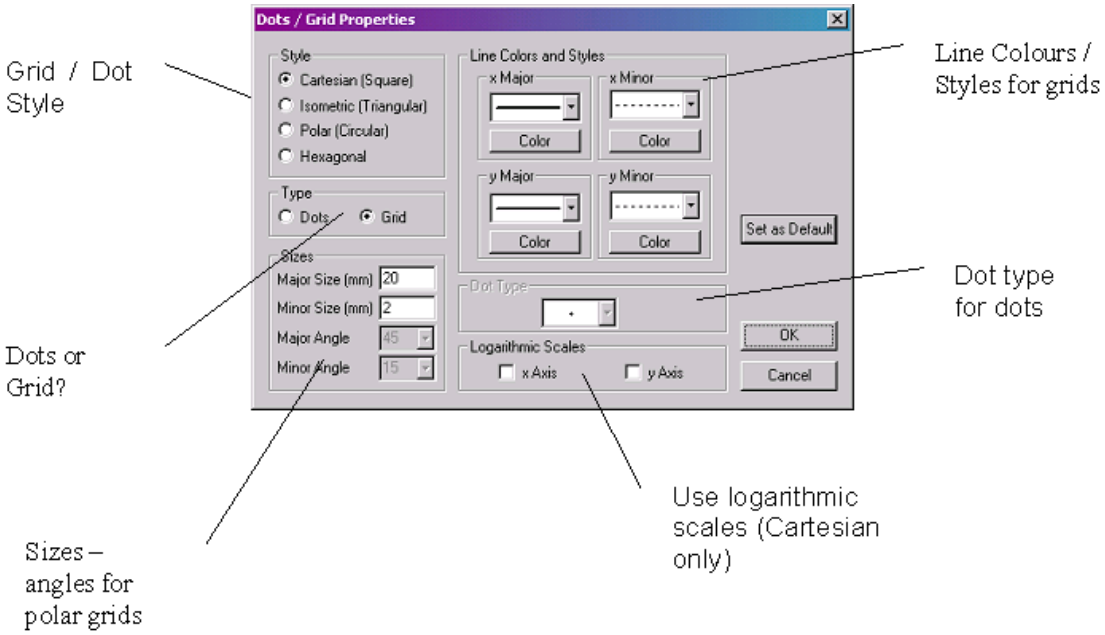
x <= -3 x less than or equal to negative three
x = -3 x equals negative three
x <> -3 x is not equal to negative three.

You can also place x in a range.

-3 < x <= 2 x is greater than negative three and less than or equal to two.

6.22 Grids / Dots

The grids & dots tool gives you access to nine different types of grids & dots. Start by sweeping out a rectangular area. FX Draw will fill the area with the current default grid type. Right click to access this tools options.



Select the options you are after and push OK. The grid you produce is "Geometrically Active". FX Draw will preferentially jump to points on the grids/dots you have defined. This makes drawing most grid based diagrams easy.

6.23 The Galleries

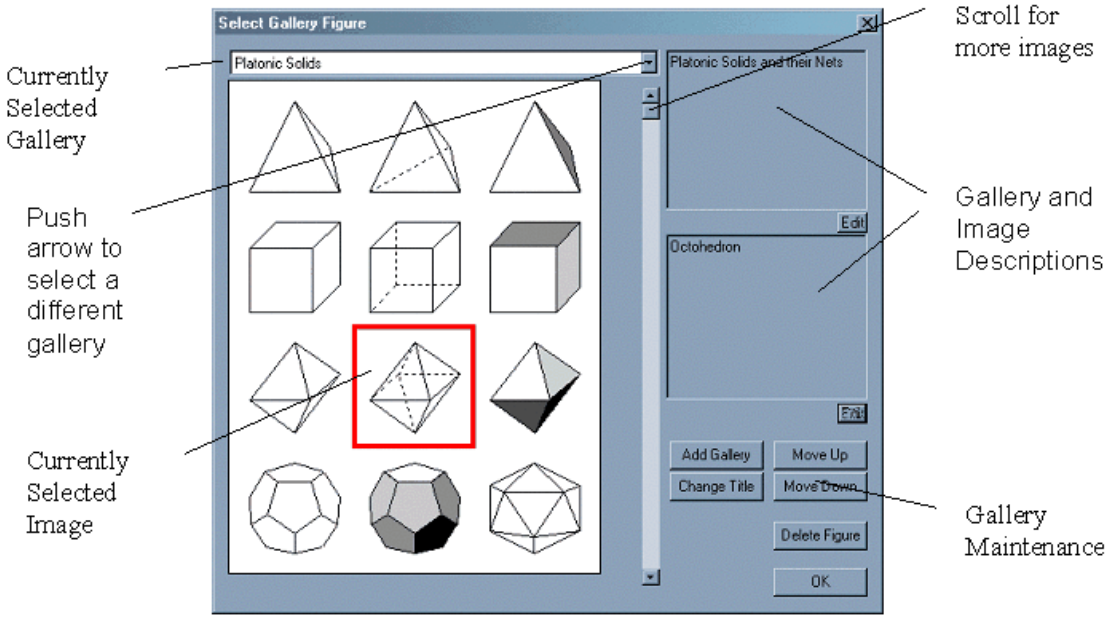
The gallery tool gives you access to the hundreds of pre-drawn images available in FX Draw. The left button lets you draw the currently selected gallery image, the right button lets you select an image. When you first start FX Draw the left

hand button will be grayed out because no image is currently selected.

In order to use the gallery tool you must first select the image you wish it to draw. To do this you need to push the right gallery button.

6.23.1 Selecting a Gallery Image

When you push the right button to select an image, you will see something like this screen.



All you do is select the image you wish to draw and the gallery tool will draw that image every time you select it.

The galleries you have on your computer will depend on which galleries you have installed and any others you have created. Efofex will create a library of galleries on our web site that you can use to expand your collection. We will be asking for contributors to the library.

The gallery maintenance buttons allow you to create new galleries and maintain existing ones. You can change the title of a gallery, move figures up and down in the gallery (changing the order) and delete figures. This allows you to construct your own galleries.

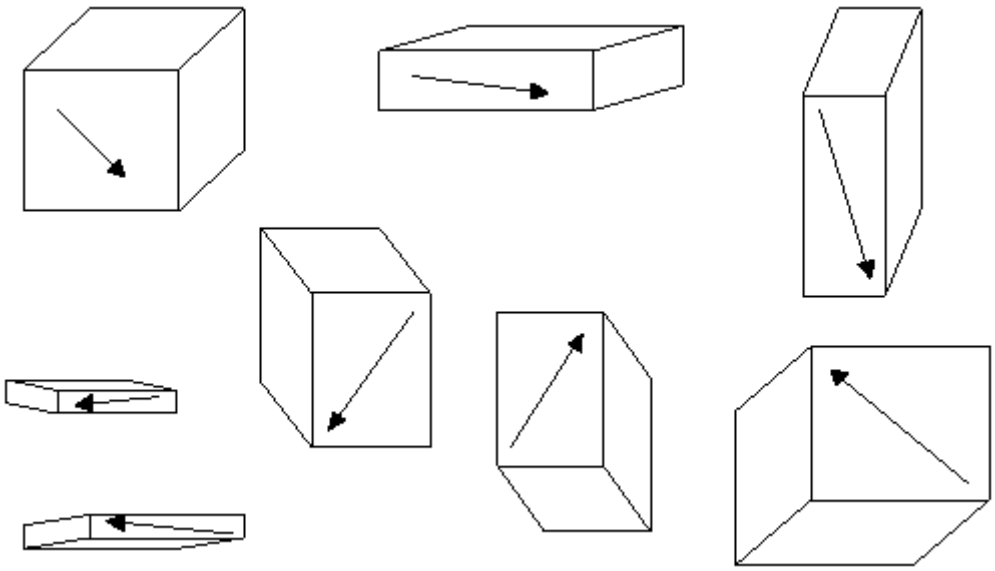
The gallery and image descriptions provide you with more information about the gallery images. The top pane shows a general description of the whole gallery of images. The bottom pane displays a description of the currently selected image. You can edit the descriptions by pushing the Edit buttons under each pane.

While the author of the gallery will have added any descriptions that they feel would assist you, you can add your own notes to any image or gallery.

6.23.2 Drawing a Gallery Image

Once you have selected an image, the left button allows you to draw it. The left button will draw your selected image UNTIL you select a new image or restart FX Draw.

When drawing using a gallery figure, the drawing is stretched to fit the rectangle you have drawn. This allows you to obtain differently proportioned shapes. The gallery figures also depend on the direction you drawn them in. All the diagrams below have been drawn with the one gallery figure. The direction that they have been drawn has been indicated on each shape.



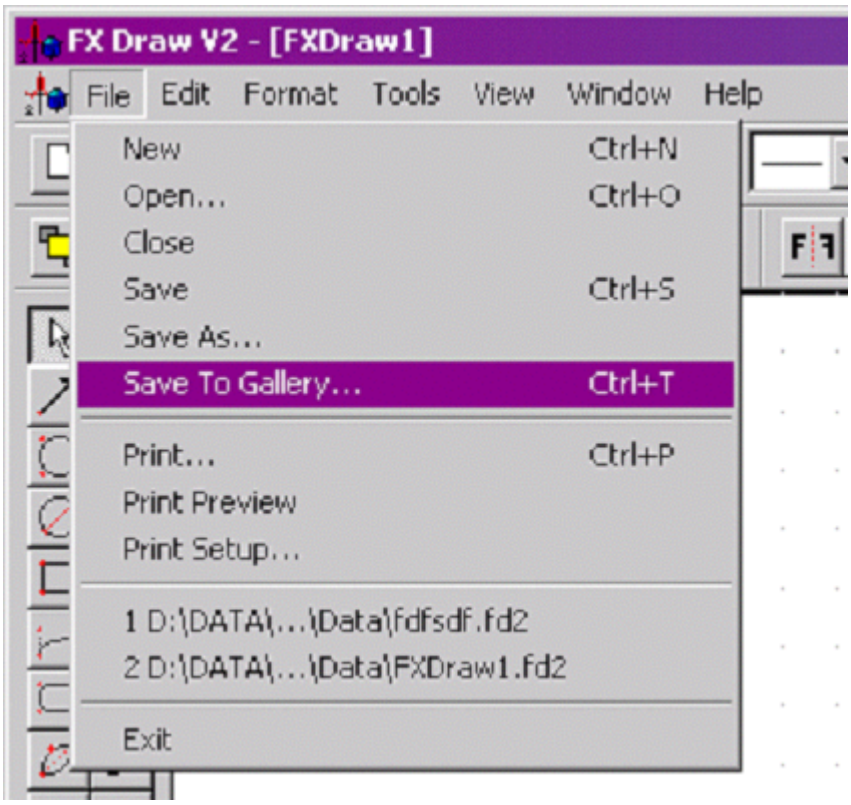
This ability to be resized makes each gallery figure extremely powerful.

Gallery images remember the aspect ratio (ratio of height to width) that they were originally drawn in. In many situations you will need the image to stay fixed to that aspect ratio ESPECIALLY if the image contains circles.

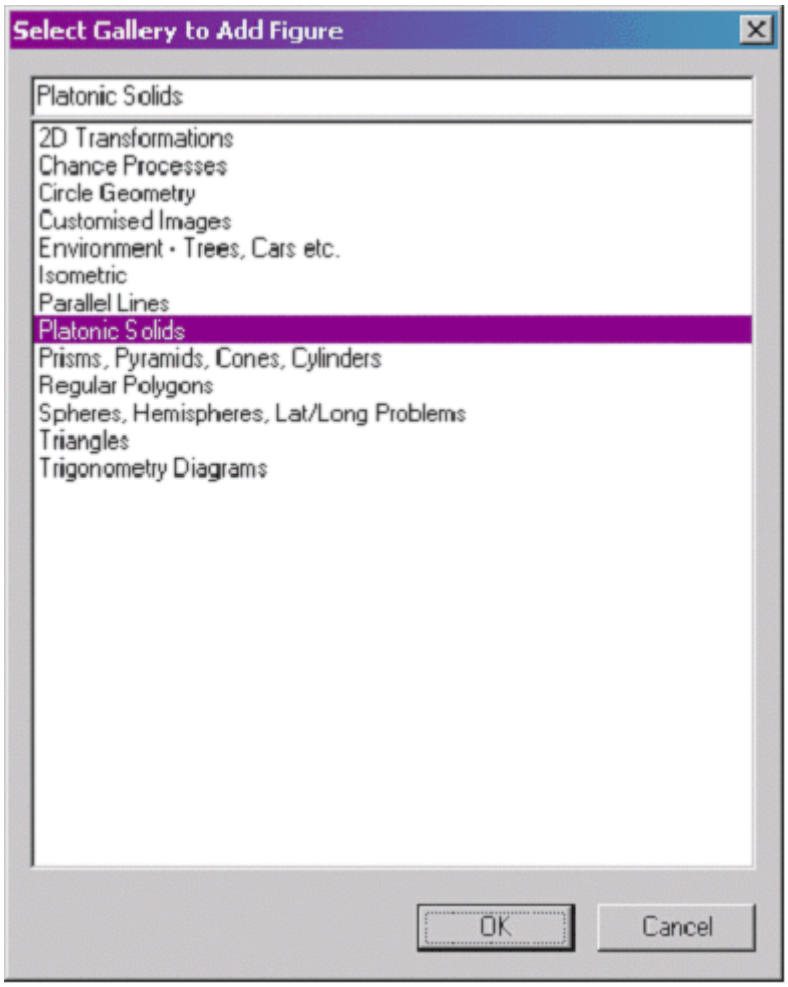
By holding down the SHIFT key while initially creating the image, the image will be forced to maintain this aspect ratio.

6.23.3 Saving to Galleries

If you have created an image that you believe should be part of a gallery, select the image and choose Save To Gallery from the File menu (or push Ctrl + T).



The selected objects will be placed into the gallery you select from the list of available galleries.



6.23.4 Other Gallery Issues

FX Draw always searches for galleries in a Galleries subdirectory of its own directory and this is where gallery images are placed by default when you first install FX Draw.

If you wish to have your galleries stored in a different location, you need to tell FX Draw the new location. Go to the Tools / Customise / Directories menu option and enter the new location.

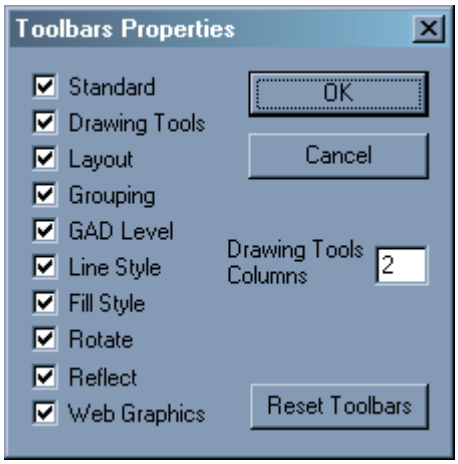
The Gallery file location is saved as part of the DEF file. See the installation notes for more information about using the DEF file to configure your software.

7 Customising FX Draw

7.1 Moving the Toolbars

You can move toolbars to whatever location you wish. They can be attached to any side of the drawing canvas or can be left floating. Your toolbar configuration is saved by FX Draw so that your screen will appear the same when you next start FX Draw.

You can turn toolbars on and off by going to Tools / Customise / Toolbars in the menus.

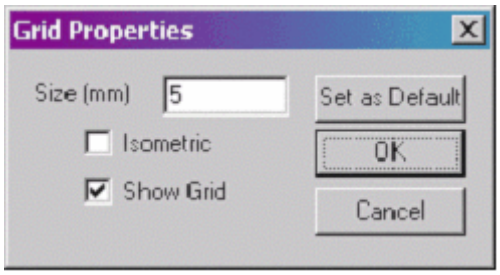


You can also set how many columns the drawing tools are drawn in. Finally, if your toolbars have become too messy, the Reset Toolbars button will restore your toolbars to their default settings.

7.2 Setting the Preferences and Customisations

FX Draw allows you to set many different customisations to make it exactly fit your location. We will never tell you that your way of doing things is "wrong". We will make FX Draw do things your way. All of the settings can be accessed from the Tools menu.

Tools / Preferences / Grid

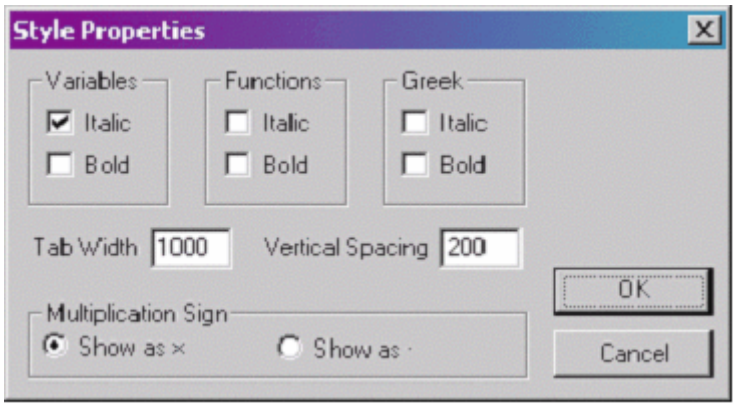


The grid plays a relatively minor role in FX Draw 2. While your initial figures will sit on the grid, later figures will become more influenced by the GAD system.

Nevertheless, you can change the background grid using this dialog box. The main two settings are the size of the grid (measured in millimetres) and whether it is isometric or not. You can also choose whether to have the grid shown or not.

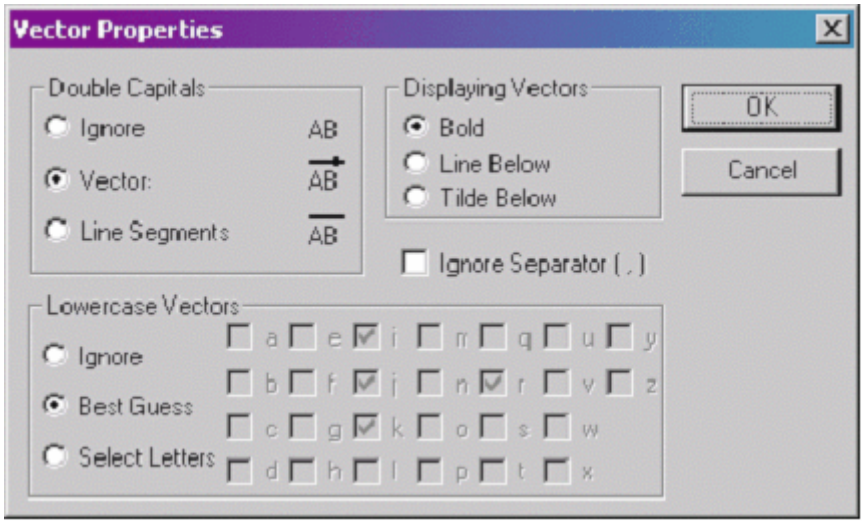
Because the new Grid / Dot tool produces a geometrically active grid, this is often a better way of obtaining the result you are after.

Tools / Preferences / Equations / Style



This dialog box determines how Equations are produced. You can set the style for variables, functions and Greek letters. You can also set the tab width and vertical spacing of equations. Finally you can choose to show the multiplication sign as a cross or as a dot.

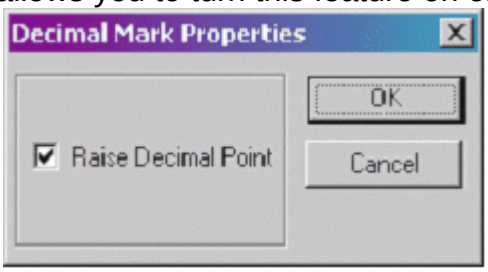
Tools / Preferences / Equations / Vectors



Our equation technology automatically detects vectors. Because the symbols used to create vectors are ambiguous, this dialog box allows you to specify what the equation system treats as a vector and how it displays it.

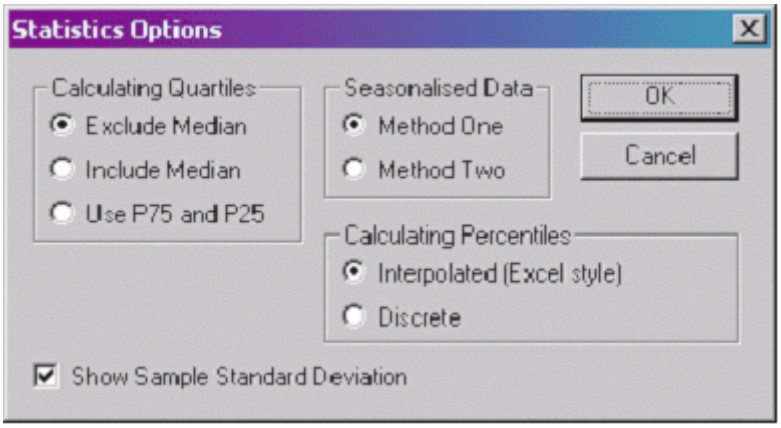
Tools / Preferences / Equations / Decimal Point

Some locations require that a decimal point is raised to be midway up the numerals. This setting allows you to turn this feature on or off.



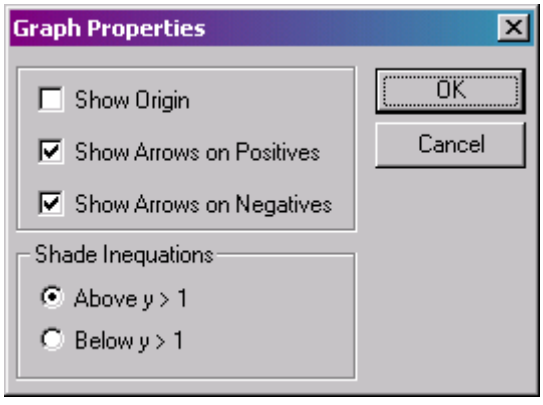
Tools / Preferences / Statistics

Many locations have their own unique ways of calculating and determining statistics. This dialog box allows you to set your preferences. The meaning of each of these options is fully discussed in the Statistics tool section of the manual.

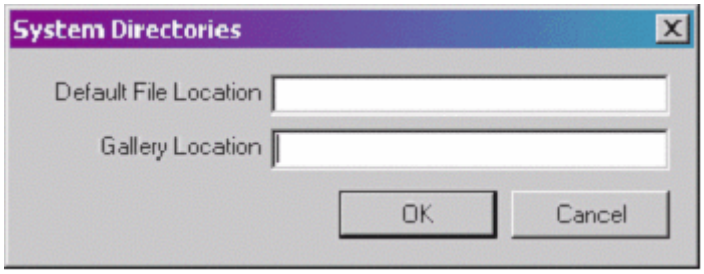


Tools / Preferences / Graph

Some locations require that a small circle is drawn at the origin of a set of axes to indicate the origin. Another requested option is that arrowheads are NOT shown on the positive and/or negative ends of axis lines. Finally you can choose which side of an inequation you want to shade.



Tools / Customise / Directories



In some networked environments, your system administrator will require that files

and galleries be stored in specific locations. This dialog box allows you to specify locations for files and galleries.

7.3 DEF Files - Tools / Customise / Write DEFinition File

ALL FX Draw settings and options (apart from toolbar locations) can be written to a definition file. This file can be placed in FX Draw's directory and FX Draw will use it to set up the copy of FX Draw on another machine. The installation section of this manual describes DEF files and their usage more fully.

8 Hints & Tips

8.1 How Do I Select Figures?

You can select figures in one of two ways. If you want to select an individual figure, click on it. You need to be reasonably accurate to ensure that you select the desired figure.

If you wish to select a few figures at one time, sweep out a rectangular area while holding down the left mouse button. Any figure totally contained within the rectangle will be selected. You can then move, copy or delete the selected figures.

8.2 How Do I Change a Figure's Properties?

Right click on it. For example, if you have drawn a line and want to add a new end point, right click on the line. A large dialog box will appear allowing you to change many of the line's properties. Most figures have properties that can be changed.

8.3 What Are Sliders?

Some figures (rounded rectangles, arcs, normal distribution curves) have sliders. These little grey circles on the top or side of a figure allow you to adjust a property of the figure by sliding the circle up and down or left and right. For example, the rounded rectangle's slider adjusts the radius of the rounded corner.

All properties that can be visually adjusted using sliders can be explicitly adjusted using the figures property dialog box that is accessed by right clicking on the figure.
If you see a slider, move it and see what happens!

8.4 What Is The Most Under-utilized FX Draw Feature?

Changing a figure's default properties. This can make using FX Draw much easier.

8.5 How Do I Change a Figure's Default Properties?

Most figures have a Set To Default button on their properties dialog box. Simply set up a figure so that it is exactly what you are after and press the button. Every figure you create from then on will fit this default.

8.6 Why Is There an Arrow Line Tool?

There are two line drawing tools, the line and the arrow line. The line tool will always draw a line regardless of any other settings. The arrow line tool can have its default changed. This allows you to turn it into, for example, a "line with an open circle at each end" tool that makes drawing network diagrams easy.

8.7 Why Is There an Equation Tool?

The text tool and equation tool are basically the same so why have an equation tool? The equation tool is simply there to make getting an equation easy. We did not want to hide FX Draw's equation capability so we made a separate button for it.

8.8 How Do I Draw Network Diagrams Easily?

Change the arrow line's default to be a line with an open circle at each end. If you want to draw a directed network, select an arrowhead for the centre of the line. The arrow line tool will now allow you to easily draw a network diagram. If you right click on each arc of the network diagram, you can enter any text you require and it will be angled to suit the line.

8.9 Why Do I End Up With a Small Mess When I Use The Graph Tool?

You are not moving the mouse enough when creating the graph. Your graph will fill the rectangle you sweep out with the mouse while holding down the mouse button. If you do not sweep out a large enough area, all components of the graph are drawn in a tiny area.

8.10 How Do I Draw More Than One Function On A Graph?

The main function graphing tool properties dialog box has a large area for entering functions. Each function takes one line in the box. If you want more than one function, enter more than one line.
Alternatively you can press the function button in the graph dialog box. This allows you finer control over the first function and allows you to enter up to nine more functions.

8.11 How Do I Draw Polar Graphs?

Polar functions must be typed in so that they are prefixed with "r =" and are in terms of t (used as a substitute for theta). An example of a polar function is "r = 2sin(4t)".

8.12 How Do I Draw Inverse Graphs?

Inverse functions are typed in so that they are prefixed with "x=" or "f(y)=" and are in terms of y. An example of an inverse function is "x=2sin(y)".

8.13 How Do I Enter Domains?

Each function can have its own domain. These are entered by pressing the f(x) button (the first function's domain can be entered on the graph screen). Domains are entered the way you would normally write them (in terms of x or t).
For example
x > 2 t <= 4 -3 < x <=7

8.14 Can FX Draw Draw Piecewise Defined Functions?

Not directly. You can draw up to ten functions on one graph and give each of the functions their own domain. FX Draw will graph these correctly but will NOT add the dotted vertical lines often used for piecewise defined functions. These can be added later using the line tool.

8.15 How Do I Draw A Graph Without Any Axes?

When you are entering a function, you will notice an "Axes" button. This allows you to have fine control over how the scales on your axes are divided up. Each axis has three options that allow you to turn off the scale (the numbers), the ticks (the little dashes) and the axes. This allows you to construct images with no axes if you wish.

8.16 What is the Difference Between Out Of Range Arrows and High/Low End?

When you graph a function you graph it with either an explicit domain, that you have typed in, or an implied domain determined by the x-axis you have selected. How the graph is represented at the high and low end of this domain is determined by the settings of the Show High End and Show Low End Options for that function. FX Draw will determine if an open circle, closed circle or arrowhead should be shown and you choose if it will be shown.

Many functions will have values that lie outside the range of the axes within the domain selected, tan for example. At these values, FX Draw will add arrowheads to show that the graph continues beyond the range of the axes. These arrowheads are called out of range arrows.

8.17 What is a Group?

A group is a collection of figures that have been grouped together and are treated as one figure by FX Draw. This new grouped figure can be cut, copied, pasted and resized as easily as a simple figure such as a circle.

8.18 How Do I Group Figures?

Select all the figures that you wish to include in your group and either choose group from the edit menu or type Ctrl+G.

8.19 How Do I Ungroup Figures?

If you need to ungroup some figures in order to modify them individually, select the group and choose ungroup from the edit menu or type Ctrl+H.

8.20 What Can Groups Be Used For?

If you have created an image that you wish to repeat on the same drawing, it is advisable to group the image together so that you do not lose any component as you copy and move the image. Gallery images are stored as groups for this very reason.

8.21 What Is A Gallery?

A gallery is a collection of pre-drawn mathematical diagrams that you can use in your documents. Most gallery images are extremely versatile as they appear differently depending on the aspect ratio they are drawn into and the direction in which they were drawn.

8.22 How Do I Use the Galleries?

Push the Gallery Select button. The first gallery will appear and you can choose any of the galleries you have loaded. Once you have selected the gallery image you require, push OK. The gallery tool will now draw that image whenever the tool is selected. It is important to realize that you must move the mouse while holding down the left button to draw a gallery image. If you simply click the mouse without moving it, you will get no image.

8.23 How Does the Direction of Drawing Affect the Gallery Images?

Most gallery images will draw differently depending on which direction you draw them in. Try selecting the gallery image of a cuboid. Draw the image by holding down the mouse button while you move the mouse:

- Top left to bottom right
- Top right to bottom left
- Bottom left to top right
- Bottom right to top left

The combination of drawing direction and aspect ratio makes each gallery image worth much more than just clipart.

8.24 How Do I Save My Own Graphics To a Gallery?

Draw the image in FX Draw and select the figures you want saved. From the File menu, choose Save To Gallery. Pick the gallery you want to save to and press OK.

8.25 Can I Edit Gallery Images?

Yes. Gallery images are saved as grouped figures. When you have drawn a gallery image, you can:

- Select it
- Ungroup it
- Modify the individual figures.

8.26 What Is The Grid?

The grid is the array of points you see on the screen when you start FX Draw. Any figure will be drawn so that it fits the grid UNLESS GAD is on and another point is more attractive.

8.27 How Do I Draw Isometric Diagrams?

Change the grid settings (see Tools / Grid) to be an isometric grid with a distance of 10 to 20 mm and draw your image using the line tool. You lines will be forced to comply with the isometric grid points making it easy to draw the diagrams. It is best to turn GAD off when drawing isometric diagrams.

8.28 How Can I Remember The Greek Letter Codes?

All the Greek Letter codes are made from the first two letters of the Greek letter's name:

al	α
be	β
ch	χ
de	δ
ph	ϕ
ga	γ
la	λ
mu	μ
pi	π
th	θ
rh	ρ
si	σ
SI	Σ

Greek letters not in this list are not supported.

8.29 Does The Equation Tool Balance Brackets?

No. The tool makes no attempt to examine the logical consistency of your brackets. It even treats the three types of brackets, ({ [as being equivalent. It is up to you to ensure that what you type is logical.

8.30 Why Are Spaces So Important?

The tool attempts to automatically format most equations. Unfortunately many expressions are ambiguous, sin2x for example. We wanted to automatically recognize $\sin^2 x$ while still allowing you to get sin 2x if you wish. The solution was where you put a space. If you leave a space between sin and 2x, you will get sin 2x. Without the space you get $\sin^2 x$. This is much easier to use than describe. In general, if the tool does not format your equation the way you expect, try entering a space between things.

8.31 How Do I Enter An Ordered Pair?

It is amazing how often we are asked this question. People quickly realize that typing an ordered pair into the equation tool produces a vector and they want to know what to do if they REALLY want an ordered pair. The answer is obviously to not use the equation tool and just type your ordered pair into a text box OR use quotes to prevent the equation tool from formatting your equation.

8.32 How Do I Stop the Equation Tool From Formatting Something?

This question most often occurs when someone is trying to type a word such as "and" or "there" and the tool insists on formatting it into an intersection symbol or θere. By enclosing a section of your equation in quotes ("and" and "there") you prevent the tool from formatting that part of the equation.

8.33 How Do I Enter A Matrix?

Matrices are entered column by column. It is advisable to add a few spaces between the columns.

[1,2,3 4,5,6 7,8,9 :,:,: a,b,c]

$$\begin{bmatrix} 1 & 4 & 7 & : & a \\ 2 & 5 & 8 & : & b \\ 3 & 6 & 9 & : & c \end{bmatrix}$$

You are limited to three rows per column

8.34 How Do I Enter a Degrees Sign?

Degrees signs are entered with the ` key. This is normally the key NEXT to the 1 key and it normally produces a ~ when pressed whilst holding down the Shift key.

The ` key is a backwards single quote. It is not the normal ' key (next to semicolon).

9 Appendices

9.1 A - The Equation Tool

9.1.1 Entering Equations

Equations are entered into the equation tool by typing what you see WITHOUT formatting. On most occasions the equation tool will automatically format your equation for you.
For example. If you want the equation

$$3x^3 + 2x^2 - 7$$

simply load the equation tool and enter **3x3+2x2-7**. The equation tool automatically formats the powers and italicises the variables.

Simple fractions are also entered as you see them. In other words if you want

$$\frac{3x^3}{2x^4}$$

you enter it as **3x3/2x4** and The equation tool will automatically build the appropriate fraction. Most simple equations can be entered this way, with NO formatting on your part. More complicated equations will require some extra input on your part.

9.1.2 Symbols

Mathematicians use a large number of specialised symbols and FX Equation attempts to make accessing these symbols as easy as possible. Any symbol that is not on the keyboard is entered using one of two methods.

Either

A key is designated to be automatically replaced. The two symbols that use this approach are

- ° *uses the ` key (usually next to the 1 on the keyboard)*
- × *uses the * key. The * symbol is often used to represent multiplication on computers.*

or

A code is used and this code is automatically replaced with the appropriate symbol. The code chosen has been chosen to be easily remembered and is usually a logical combination of characters. For example

- ≤ *is built from < and = so the code is <=*
- ≈ *is built from two wavy lines so the code is ~ ~*

Some codes are built from the word describing the symbol.

- ∞ *(infinity) the code is inf*

Code	Symbol
< =	≤
> =	≥
< >	≠
= /	≠
= ~	≅
~ =	≅
- =	≡
~ ~	≈
+ -	±
*	× or ·
/ (followed by a space)	÷
`	°
- >	→
= >	⇒
inf	∞
tri	Δ
ang	∠
perp	⊥
and	∩
or	∪

element	∈
prop	∝
subset	⊂
tf	∴

Note: Some symbols have two codes.

$0^\circ \leq x \leq 360^\circ$ is entered as **0` <= x <= 360`**

$x \rightarrow \infty$ is entered as **x -> inf**

9.1.3 Absolute Value

Absolute values are entered with the | key. On most keyboards it is above the Enter key and shares the key with \. To enter | you hold Shift when entering.

On some keyboards, especially languages other than English, this key is show as two vertical dashes - one above the other.
eg.

|
|

9.1.4 Degrees

Degrees signs are entered with the ` key. This is normally the key NEXT to the 1 key and it normally produces a ~ when pressed whilst holding down the Shift key.

The ` key is a backwards single quote. It is not the normal ' key (next to semicolon).

9.1.5 Greek Letters

The commonly used Greek letters are supported. They are all entered using a two character code. The two character code is always the first two letters of the letter's name.

Code	Greek Letter
al	α
be	β
ch	χ
de	δ
ph	ϕ
ga	γ
la	λ
mu	μ
pi	π
th	θ
rh	ρ
si	σ
SI	Σ
om	ω
OM	Ω

$\frac{\pi}{4}$ is entered as **pi/4**

$\sin^2\theta$ is entered as **sin2 th**

9.1.6 Square Roots

sqrt or sr may be used to indicate square roots. Complicated square roots will need to be surrounded with brackets. Square roots may be included as part of more complicated equations.

Examples:

$\sqrt{4}$ is entered as **sr 4** or **sqrt 4**

$\sqrt{x^2 + y^2}$ is entered as **sr(x2+y2)** or **sqrt(x2+y2)**

$\frac{\sqrt{3}}{2}$ is entered as **sr3/2**

9.1.7 nth Roots

Any root of a function can be shown using the root keyword.

Examples:

$\sqrt[3]{x}$ is entered as **3root x**

$\sqrt[x]{2x^2}$ is entered as **xroot 2x2**

9.1.8 Fractions

We have already seen how to enter some simple fractions. Fractions with complicated numerators or denominators must have the numerator and/or denominator surrounded by brackets. These brackets will not be displayed, they are used as logical brackets so that you clearly indicate the elements that comprise the numerator and denominator.

Examples:

$\frac{3x + 2}{4}$ is entered as **(3x+2)/4**

$\frac{(x + 1)^2(x + 2)}{x + 1}$ is entered as **((x+1)2(x+2))/(x+1)**

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$ is entered as **x=(-b +- sr(b2-4ac))/2a**

9.1.9 Using Brackets

We have already seen the use of brackets to logically identify the numerator and denominator in complicated fractions. This is a very important use of brackets. Brackets are also used to logically identify powers and subscripts.

All three bracket types {, [and (may be used interchangeably in the equation tool and the equation tool makes no distinction between them. The equation tool does not even check to see if brackets are paired. You are responsible for this. If there is a fraction inside a bracket, the bracket is automatically resized.

Example:

$$3\left[(x-2)^2 + \frac{1}{2}\right]$$ is entered as **3[(x-2)2+1/2]**

9.1.10 Powers

Most powers will be automatically recognised by the equation tool. The equation tool will not automatically recognise powers if

- you require a variable as a power
- you require a function as a power
- you require a power of a number
- you require a complicated power.

In these cases you need to explicitly indicate the power using the ^ symbol. As with fractions, complicated powers need to be surrounded with brackets. These brackets will not be displayed.

Examples:

a^m is entered as **a^m**

$e^{\sin\theta}$ is entered as **e^sinth**

3^2 is entered as **3^2**

x^{2y+3} is entered as **x^(2y+3)**

Limited support is provided for multilevel powers and fractional powers. An equation can include either a two-level power or a fractional power.

Examples

e^{x^2} is entered as **e^x2** (Note the use of the ^ symbol)

$x^{\frac{1}{2}}$ is entered as **x^(1/2)**

9.1.11 Subscripts

The \ (backslash) symbol is used to indicate the next character or group of characters is a subscript. Complicated subscripts must be surrounded with brackets which will not be displayed. Please Note: On some keyboards (eg Swedish) the \ key is not accessible in Word. The § key can be used instead.

Examples:

T_n is entered as **T\n** **(or T§n)**

T_{n+1} is entered as **T\(n+1)** **(or T§(n+1))**

9.1.12 Integrals

Integrals can be entered using the **int** command.

Example:

$\int x\,dx$ is entered as **int x dx**

For definite integrals, the upper and lower bounds are placed in brackets and separated by a comma (see Decimals).

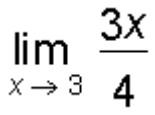
$\int_{-1}^{1} x^2 + 1\,dx$ is entered as **int(-1,1)x2+1 dx**

$\int_{\pi/4}^{\pi/2} e^{\sin x} .\cos x\,dx$ is entered as **int(pi/4,pi/2)e^sinx .cos x dx**

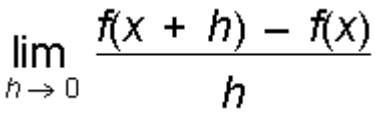
9.1.13 Limits

Limits are entered using the lim command. The value the limit approaches is placed in brackets. Limits are the main use of the -> code which produces an arrow.

Examples:



is entered as **lim(x->3) 3x/4**

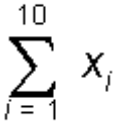


is entered as **lim(h->0) (f(x+h)-f(x))/h**

9.1.14 Sigma Notation

Sigma notation is entered using the sigma command. The parameters are placed in brackets and are separated with a comma.

Example:

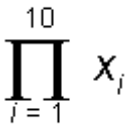


is entered as **sigma(i=1,10) x\i**

9.1.15 Product Notation

Product notation is entered using the product command. The parameters are placed in brackets and are separated with a comma.

Example:



is entered as **product(i=1,10) x\i**

9.1.16 Double Capitals

Double capital letters are used to represent line segments, rays and vectors. The equation tool can automatically place an annotation over double capitals. You would use this feature if you were, for example, entering a lot of position vectors in an exam. The annotation used by the equation tool can be set using the Options/Vectors menu.

Examples:

$\overrightarrow{AB} = \overrightarrow{OB} - \overrightarrow{OA}$ is entered as **AB = OB - OA**

$|\overrightarrow{OA}| = \sqrt{9 + 16}$ is entered as **|OA|=sr(9+16)**

$\cos\theta = \frac{\overrightarrow{AB}.\overrightarrow{BC}}{|\overrightarrow{AB}|\,|\overrightarrow{BC}|}$ is entered as **cos th = (AB.BC)/(|AB | |BC|)**

9.1.17 Vectors

Because vectors are shown in so many different ways, the equation tool has many different ways of handling them.

If you are using vectors of the form

$\mathbf{r} = 3\mathbf{i} + 2\mathbf{j}$

The equation tool can automatically recognise that you are typing a vector and make the r, i and j bold. The equation tool can also be set to indicate vectors using a line or tilde underneath, depending on your preference.

This automatic recognition of vectors can save you hours of time, but the equation tool may sometimes get the automatic recognition incorrect. By default, the equation tool will take its "best guess", you can also turn this feature off or alternatively, explicitly tell the equation tool which variables to recognise as vectors.

It is important to remember that you do not need to tell the equation tool that you are working with a vector, the equation tool will automatically identify this.

Example:

$\mathbf{r} = (3\mathbf{i} + 2\mathbf{j} + \mathbf{k}) + \lambda(\mathbf{i} - \mathbf{j} + 3\mathbf{k})$ is entered as **r=(3i+2j+k)+la(i-j+3k)**

If you wish to enter vectors in the vertical format, they are simply entered as (3,2) using a comma as a separator (see Decimals). Three-dimensional vectors are entered in the same way.

Examples:

$\begin{pmatrix} 3 \\ 2x \end{pmatrix}$ is entered as **(3,2x)**

$\begin{pmatrix} 3 \\ 2 \\ 5 \end{pmatrix}$ is entered as **(3,2,5)**

$r = \begin{pmatrix} 2 \\ 7 \end{pmatrix} + \lambda \begin{pmatrix} 1 \\ -4 \end{pmatrix}$ is entered as **r=(2,7)+la(1,-4)**

9.1.18 Matrices

Although the equation tool does not explicitly support matrices, it is a simple matter to build matrices using two or more vectors surrounded by square brackets. Matrices built in this way can have up to 3 rows and an unlimited number of columns.

Examples:

$$\begin{bmatrix} 2 & 4 \\ 3 & 6 \end{bmatrix}$$

is entered as **[2,3 4,6]**

$$\begin{bmatrix} 1 & 4 & 7 \\ 2 & 5 & 8 \\ 3 & 6 & 9 \end{bmatrix}$$

is entered as **[1,2,3 4,5,6 7,8,9]**

9.1.19 Complex Numbers

The equation tool correctly formats complex numbers without any extra input on your part and recognises cis, arg and mod.

9.1.20 Means and Complements

A character can have a line added above it by typing an underscore _ directly after the character. **Only one character can be modified in this way**. This can be used to show means and complements.

Example:

$\overline{x}$ is entered as **x**_

9.1.21 Predictions

Statistical predictions ("y hat") are entered using a DOUBLE power symbol.

Example:

$\hat{y}$ is entered as y^^

9.1.22 Preventing Formatting

On occasions you will want to prevent the equation tool from formatting a section of an equation. Usually this will be if you want some text in an equation. Surrounding the text in quotes will prevent it being formatted.

Example:

$x = 3 \text{ and } y = 4$ is entered as x = 3 "and" y = 4

9.1.23 Spaces

Spaces change the way a particular equation is interpreted and therefore formatted. This can best be illustrated using these examples.

$\sin^2\theta$ is entered as **sin2 th**

$\sin 2\theta$ is entered as **sin 2th**

The only difference between the two equations is the **location of a space**. Spaces can be used to add space between characters but they can also be used to indicate a change of mode

9.1.24 Decimals

The equation tool asks Windows what symbol you are using for decimal points (usually a full stop or a comma). It then uses the OTHER symbol for its vector separator. For example, Australia uses a dot as a decimal point so the equation tool uses a comma for the entering of vectors and matrices so

$\begin{pmatrix} 3 \\ 2 \end{pmatrix}$ is entered as (3,2).

9.1.25 Restrictions

The equation tool will be able to correctly interpret many of your equations. Some classes of equations that it cannot correctly handle include:

Multilevel fractions $\dfrac{3}{1+\dfrac{1}{x}}$

Square roots of square roots $\sqrt{\sqrt{3}x}$

9.1.26 The Tools / Preferences / Equations Menu

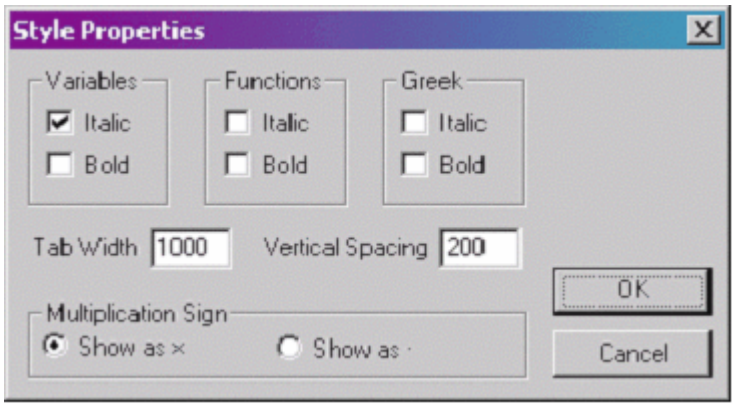
This menu gives you control over how the equation tool interprets some of the equations you enter.

Vector Options
The vector options allow you to modify

- The way the equation tool interprets double capitals. By default the equation tool shows double capitals with an arrow above. This can be changed to a line or nothing if you wish.
- The way the equation tool shows vectors. By default the equation tool shows vectors by bolding them. This can be changed to a line below or a tilde below.
- How the equation tool interprets vectors. By default the equation tool takes its best guess as to when an equation is a vector. This feature can be disabled or you can explicitly tell the equation tool, which letters to show as vectors.
- Whether the equation tool uses the separator (usually ,) to identify vertical vectors. If you do not need to use vertical vectors or matrices, selecting "Ignore Separator" allows you to use the comma in an equation.

Style Options

Many people like to italicise variables or maybe make functions bold. The Style Options allows you to set the styles for your equations.



You can set the styles of variables, functions and Greek letters. You can also set the width of tabs and the vertical spacing between multi-line equations. The final option allows you to choose how the * key is interpreted, as an × or as an ·.

9.1.27 Multi-Line Equations

Up to twenty lines of equations can be entered at one time. Simply push the down arrow or Enter Key to access the next line when using the main input screen.

9.1.28 Tabs

Equations can include tabs. The size of the tab is adjusted in the Options/Style menu.

9.1.29 My Equation is Not Formatted Correctly!

The equation tool makes its best attempt to interpret what the user has typed in a logical way. We have aimed to produce an equation editor that **automatically** formats over 98% of the equations a typical secondary mathematics teacher would need to produce. If your equation happens to be in the group of equations that the equation tool cannot handle, you may have to use one of the other tools available. We have not tried to replace these complex and highly versatile tools. We have simply tried to automate the most common equations.

If your equation is not listed as one of the restrictions, tell us about your equation and we may be able to upgrade the equation tool to allow it.

9.2 B - Statistics Function Reference

9.2.1 The Statistics Functions

9.2.1.1 CumFreqTable(column)

Calculates a cumulative frequency table for *column* and puts it into the two columns indicated by the location of the cursor or mouse when the formula is entered.

A cumulative frequency table shows the number of scores that are equal or less than each value in the table.

Score	cf
10	2
11	5
12	12
13	20

This cumulative frequency table would be generated from this data:

10, 10, 11, 11, 11, 12, 12, 12, 12, 12, 12, 12, 13, 13, 13, 13, 13, 13, 13, 13

Example: CumFreqTable(A)

9.2.1.2 Decile(column)

Calculates the decile rank of each score in *column*. The decile rank is calculated using the percentile figures so any changes in the system options that affect the calculation of percentile scores will affect the calculation of the decile scores.

Example: Decile(A)

9.2.1.3 Deviation(column)

Calculates the deviation from the mean for each score in *column*, using the calculated mean of the column.

Example: Deviation(A)

9.2.1.4 Fibonacci(first, second number)

Generates *number* scores in a Fibonacci sequence starting with *first* and *second* numbers.

Example: Fibonacci(1,1,50)

Note: If you type decimals using a comma (eg 3,2) you should enter this formula as Fibonacci(1;1;50) - using the ; as a separator

9.2.1.5 FreqTable(column)

Calculates a frequency table for *column* and puts it into the two columns indicated by the location of the cursor or mouse when the formula is entered.

A frequency table shows the number of each score in the data set. They are used to efficiently display large numbers of scores that fall into a small number of possible values.

Score	f
10	2
11	3
12	7
13	8

This frequency table would be generated from this data:

10, 10, 11, 11, 11, 12, 12, 12, 12, 12, 12, 12, 13, 13, 13, 13, 13, 13, 13, 13

Example: FreqTable(A)

9.2.1.6 Group(column, number) / GroupN(column, number)

These two functions are equivalent.

The Group function groups data in *column* into *number* groups. The statistics tool will select appropriate group widths and in some situations it will not be able to divide the data into exactly *number* groups.

0-20	4
20-40	20
40-60	78

60-80	63	This is the result of Group(A,7)
80-100	32	
100-120	1	
120-140	1	

The number parameter is optional. If it is omitted, the statistics tool will attempt to divide the data into 10 groups.

The group function is used to generate data for histograms.

Examples: Group(A,10) Group(B) GroupN(c,4)

Note: If you type decimals using a comma (eg 3,2) you should enter these formulae as Group(A;10) - using the ; as a separator

9.2.1.7 GroupE(column)

C	D
group	freq
0-20	14
20-40	38
40-45	9
45-50	14
60-70	23
Other	102

The GroupE function allocates data in *column* into existing groups. To use this command you first need to decide your own groups and place them into the target column. Secondly you need to set the target column to be a group column and the next column to be a frequency column.

Any data that cannot be allocated to an existing group will be allocated to an "other" group appended to your existing groups.

As shown in the example, the groups do not necessarily need to be a constant width and gaps are allowable.

Example: GroupE(A)

9.2.1.8 GroupW(column,width)

Allocates data in *column* into groups *width* wide. This function is useful where you wish to force the statistics tool to group data into predetermined divisions.

0 - 14.5	1	
14.5 - 29	3	
29 - 43.5	26	
43.5 - 58	58	
58 - 72.5	71	Generated by GroupW(A,14.5)
72.5 - 87	35	
87 - 101.5	5	
101.5 - 116	1	

Note: If you type decimals using a comma (eg 3,2) you should enter this formula as GroupW(A; 14,5) - using the ; as a separator

9.2.1.9 Inc(start,increment,number)

Inc is a data generation function. Inc generates *number* data points that begin with *start* and go up in *increment.*

2
2.2
2.4
2.6 Generated by Inc(2, 0.2, 8)
2.8
3
3.2
3.4

Note: If you type decimals using a comma (eg 3,2) you should enter this formula as Inc(2; 0,2; 8) - using the ; as a separator

9.2.1.10 MPA(column,cyclelen)

Calculates the moving point average, or centred moving point average, for the data in *column* with a cycle length of *cyclelen*.

The MPA function automatically centres the moving point average if *cyclelen* is even.

The data in column B of the example has been generated using MPA(A,4)

	A	B
	data	data
1	3	
2	4	
3	5	4.375
4	5	4.75
5	4	5.25
6	6	5.875
7	7	6.375
8	8	6.5
9	5	6.375
10	6	6.25
11	6	
12	8	
13		

Note: If you type decimals using a comma (eg 3,2) you should enter this formula as MPA(A ; 4) - using the ; as a separator

9.2.1.11 Normal(column) / NormP(column)

These two functions are equivalent.

The data in *column* is interpreted as z-scores (standard deviations) and the Normal function calculates the probability that a score will be less than or equal to the z-score

in *column*. This function is equivalent to the P function on many scientific calculators or the normal distribution data in a tables book.

The data in column B of the example has been generated using Normal(A)

	A	B
	data	data
1	-3	0.0013
2	-2.5	0.0062
3	-2	0.0228
4	-1.5	0.0668
5	-1	0.1587
6	-0.5	0.3085
7	0	0.5
8	0.5	0.6915
9	1	0.8413
10	1.5	0.9332
11	2	0.9772
12	2.5	0.9938
13	3	0.9987
14		

9.2.1.12 NormPDF(column)

Calculates the value of the probability density function for each of the data points in *column* (interpreted as z-scores).

Example: NormPDF(A)

9.2.1.13 NormQ(column)

The data in *column* is interpreted as z-scores (standard deviations) and the NormQ function calculates the probability that a score will be greater than the z-score in *column*. This function is equivalent to the Q function on many scientific calculators and for any input value = 1-NormP.

Example: NormQ(A)

9.2.1.14 Percentile(column)

Calculates the percentile (or percent rank) of each data point in *column*. The percentile represents the percentage of scores in the data set that are less than or equal to the data point.

Column B in the example contains the percent ranks of scores in column A.

	A	B
	data	data
1	43.74	17
2	69.27	84
3	68.24	75
4	82.88	100
5	34.25	0
6	51.69	25
7	67.07	67
8	41.9	9
9	52.45	34
10	62.33	50
11	64.53	59
12	54.92	42
13	78.99	92

9.2.1.15 Predict(column1, column2, regtype) / PredictY()

These two functions are equivalent.

column1 contains the independent variable's data (usually x values)
column2 contains the dependent variable's data (usually y values)
regtype is the regression model

1 linear regression
2 quadratic regression
3 power regression
4 exponential regression
5 logarithmic regression
6 median line
7 reciprocal regression

Please note that it is not necessary to remember or use these codes.

Predict calculates the predicted value of y for the x in *column1* using the *regtype* regression model.

All three parameters are optional. If they are not included, the current column one, column two and regression type as shown in the Statistics View are used. On most occasions you would simply type Predict( )

In the first example, column C has been generated using Predict( ). We did not use any parameters because the Statistics View was showing Linear Regression Calculations for A and B. We could have typed Predict(A,B,1) and got the same result regardless of the Statistics View. Column C fits the equation $y = 23.39 – 1.29x$.

	A	B	C
	data	data	data
1	1	27	22
2	2.5	18	20.06
3	4	16.2	18.12
4	5.5	18.2	16.18
5	7	12	14.24
6	8.5	11.1	12.3
7	10	10.2	10.35
8	11.5	5.4	8.41
9	13	6.3	6.47
10	14.5	5	4.53
11	16	4.5	2.59
12	17.5	2	0.65

Predict can be used to predict y values for x values that are not in the data set. Simply add extra x values with no corresponding y values. Predict will correctly calculate a predicted y value. If you include a y value that corresponds with an x value, the pair will automatically be included in the data set. The second example shows predicted y scores for the x values of 7, 8 and 9.

	A	B	C
	data	data	formula
1	1	2	1.9375
2	2	3	3.0625
3	3	4	4.1875
4	4	7	5.3125
5	5	5	6.4375
6	6	9	7.5625
7			
8	7		8.6875
9	8		9.8125
10	9		10.9375

Note: If you type decimals using a comma (eg 3,2) you should enter this formula as Predict(A; B; 1) - using the ; as a separator

9.2.1.16 PredictX(column1, column2, regtype)

column1 contains the independent variable's data (usually x values)
column2 contains the dependent variable's data (usually y values)
regtype is the regression model

PredictX calculates the predicted value of x for the y in *column2* using the *regtype* regression model.

PredictX operates in exactly the same manner as Predict and all three parameters are optional. In the example, column C has been generated using PredictX using the same data as shown for PredictY. PredictX can predict x values for y values not in the data set in the same way that Predict can predict y values for x values not in the data set.

	A	B	C
	data	data	data
1	1	27	-2.86
2	2.5	18	4.09
3	4	16.2	5.48
4	5.5	18.2	3.94
5	7	12	8.73
6	8.5	11.1	9.42
7	10	10.2	10.12
8	11.5	5.4	13.83
9	13	6.3	13.13
10	14.5	5	14.14
11	16	4.5	14.52
12	17.5	2	16.46

Note: If you type decimals using a comma (eg 3,2) you should enter this formula as PredictX(A; B; 1) - using the ; as a separator

9.2.1.17 Rand(number)

Calculates *number* uniformly distributed random numbers between 0 and 1.

Use Rand(100), for example, to create 100 random numbers.

The Rand function can be used to simulate other random variables.

9.2.1.18 RandBernoulli(probability,number)

Simulates *number* Bernoulli trials where the probability of success in each trial is *probability*.

Probabilities are expressed as decimal values between 0 and 1.

Bernoulli trials can result in either success or failure, represented by 1 and 0 respectively. The RandBernoulli function simulates Bernoulli trials.

RandBernoulli(0.3,30) might generate
0, 0, 1, 0, 1, 0, 0, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 0, 0, 0, 1, 0, 1, 1, 0, 1

Note: If you type decimals using a comma (eg 3,2) you should enter this formula as RandBernoulli(0,3; 30) - using the ; as a separator

9.2.1.19 RandBetween(low,high,number)

Generates *number* random integers between *high* and *low* inclusive. The random integers are uniformly distributed.

RandBetween(5,10,30) might generate
9, 7, 7, 9, 9, 7, 10, 10, 8, 9, 8, 5, 7, 5, 8, 10, 7, 6, 9, 9, 8, 8, 5, 6, 7, 5, 6, 7, 5, 8

Note: If you type decimals using a comma (eg 3,2) you should enter this formula as RandBetween(5; 10; 30) - using the ; as a separator

9.2.1.20 RandBinomial(attempts,probability,number)

Generates *number* random binomial trials. RandBinomial returns the number of successful attempts in *attempts* attempts where the probability of success on each attempt is *probability.*

For example, when rolling a die, the probability of rolling a six is one sixth. If you roll a die 10 times, how many sixes will you roll?

You can simulate this problem thirty times using RandBinomial(10,1/6,30) and you might generate the following data.

2, 2, 1, 1, 1, 0, 1, 3, 0, 1, 2, 1, 4, 5, 2, 1, 1, 1, 0, 3, 1, 1, 1, 1, 2, 2, 2, 1, 4, 1

Note: If you type decimals using a comma (eg 3,2) you should enter this formula as RandBinomial(10; 1/6; 30) - using the ; as a separator

9.2.1.21 RandGeometric(probability,number)

Generates *number* random geometric trials. RandGeometric returns the number of attempts before a success where the probability of success on each attempt is *probability*.

For example, how many rolls of a die does it take to roll a 6?

You can simulate this problem thirty times using RandGeometric(1/6,30) and you might generate the following data.

16, 3, 6, 9, 7, 10, 10, 3, 5, 11, 1, 9, 2, 6, 5, 7, 20, 21, 4, 2, 5, 5, 2, 10, 6, 2, 13, 1, 1, 10

Note: If you type decimals using a comma (eg 3,2) you should enter this formula as RandGeometric(1/6; 30) - using the ; as a separator

9.2.1.22 RandHyperGeometric(select,total,success,number)

Generates *number* random hypergeometric trials. RandHyperGeometric returns the number of successes when *select* selections are made, without replacement, from a *total* where *success* successes are present.

For example, five marbles are drawn, without replacement, from a bag of 10 marbles, six red and four green. How many red marbles will be drawn?

You can simulate this problem thirty times using RandHyperGeometric(5,10,6,30) and you might generate the following data.

3, 2, 3, 4, 1, 4, 2, 3, 3, 3, 3, 3, 3, 5, 4, 4, 3, 3, 3, 3, 2, 3, 3, 3, 2, 3, 4, 2, 3, 3

Note: If you type decimals using a comma (eg 3,2) you should enter this formula as RandHyperGeometric(5; 10; 6; 30) - using the ; as a separator

9.2.1.23 RandNegBinomial(successes, probability, number)

Generates *number* random negative binomial trials. RandNegBinomial returns the number of attempts before a *successes* successes where the probability of success on each attempt is *probability*.

For example, how many rolls of a die does it take to roll a total of four 6's?

You can simulate this problem thirty times using RandNegBinomial(4,1/6,30) and you might generate the following data.

19, 18, 23, 18, 14, 25, 52, 69, 17, 24, 21, 29, 12, 36, 52, 36, 17, 22, 8, 30, 8, 26, 11, 41, 18, 13, 41, 18, 30, 25

Note: If you type decimals using a comma (eg 3,2) you should enter this formula as RandNegBinomial(4; 1/6; 30) - using the ; as a separator

9.2.1.24 RandNormal(mean, sd, number)

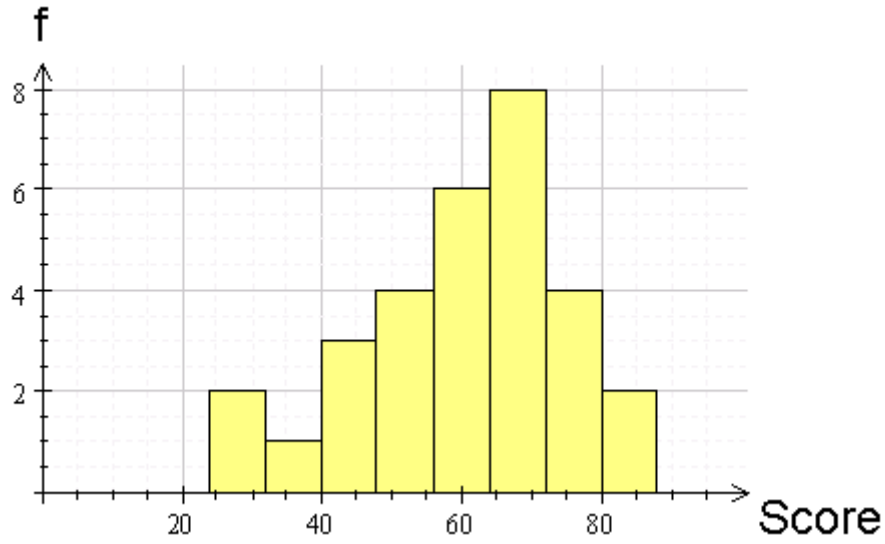
Generates number normally distributed scores with a mean of mean and a sample deviation of sd.

The RandNormal function can quickly produce normally distributed data sets and can produce data sets with almost exactly the given mean and standard deviation.

For example, RandNormal(60,15,30) might return

71.14, 64.14, 53.42, 60.18, 85.18, 33.88, 77.8, 64.43, 54.79, 40.79, 42.7, 72.37, 69.64, 27.99, 61.92, 49.87, 64.42, 61.74, 71.67, 83.69, 70.52, 54.36, 63, 24.77, 57.12, 77.01, 57.06, 72.68, 66.49, 45.23

This set of thirty numbers has a mean of exactly 60, a standard deviation of 14.9995591 and has a distribution that looks like this:



Note: If you type decimals using a comma (eg 3,2) you should enter this formula as RandNormal(60; 15; 30) - using the ; as a separator

9.2.1.25 Rank(column) / RankD(column)

Generates the rank of each data point in column. Higher values ranked first.

The example shows column B containing the rank of column A. This column was generated using Rank(A). Because there are two 18's in the data set, they are both given a rank of 3 and 17.2, the next value, is given a rank of 5.

	A	B
	data	data
1	15.1	7
2	18	3
3	10.5	11
4	10.1	12
5	11.1	9
6	17.2	5
7	12.5	8
8	20	1
9	10.7	10
10	15.2	6
11	19.3	2
12	18	3

9.2.1.26 RankA(column)

Generates the rank of each data point in column. Lower values ranked first.

The example shows column B containing the rank of column A. This column was generated using RankA(A).

	A	B
	data	data
1	15.1	6
2	18	9
3	10.5	2
4	10.1	1
5	11.1	4
6	17.2	8
7	12.5	5
8	20	12
9	10.7	3
10	15.2	7
11	19.3	11
12	18	9
13		

9.2.1.27 Residual(column1, column2, regtype) / ResidualY( )

These two functions are equivalent.

column1 contains the independent variable's data (usually x values)
column2 contains the dependent variable's data (usually y values)
regtype is the regression model

1	linear regression
2	quadratic regression
3	power regression
4	exponential regression
5	logarithmic regression
6	median line
7	reciprocal regression

Please note that it is not necessary to remember or use these codes.

Calculates the residual value of y for the x in *column1* using the *regtype* regression model. The residual value is the difference between the actual value and the predicted value.

All three parameters are optional. If they are not included, the current column one, column two and regression type as shown in the Statistics View are used. On most occasions you would simply type Residual( )

	A	B	C
	data	data	data
1	1	27	-5
2	2.5	18	2.06
3	4	16.2	1.92
4	5.5	18.2	-2.02
5	7	12	2.24
6	8.5	11.1	1.2
7	10	10.2	0.15
8	11.5	5.4	3.01
9	13	6.3	0.17
10	14.5	5	-0.47
11	16	4.5	-1.91
12	17.5	2	-1.35

In the example, column C has been generated using Residual( ). We did not use any parameters because the Statistics View was showing Linear Regression Calculations for A and B. We could have typed Residual(A,B,1) and got the same result regardless of the Statistics View. Column C fits the equation $y = 23.39 – 1.29x$.

Note: If you type decimals using a comma (eg 3,2) you should enter this formula as Residual(A; B; 1) - using the ; as a separator

9.2.1.28 ResidualX(column1, column2, regtype)

column1 contains the independent variable's data (usually x values)
column2 contains the dependent variable's data (usually y values)
regtype is the regression model

ResidualX calculates the residual value of x for the y in *column2* using the *regtype* regression model.

ResidualX operates in exactly the same manner as Residual and all three parameters are optional. In the example, column C has been generated using ResidualX using the same data as shown for Residual.

	A	B	C
	data	data	data
1	1	27	-3.86
2	2.5	18	1.59
3	4	16.2	1.48
4	5.5	18.2	-1.56
5	7	12	1.73
6	8.5	11.1	0.92
7	10	10.2	0.12
8	11.5	5.4	2.33
9	13	6.3	0.13
10	14.5	5	-0.36
11	16	4.5	-1.48
12	17.5	2	-1.04

Note: If you type decimals using a comma (eg 3,2) you should enter this formula as ResidualX(A; B; 1) - using the ; as a separator

9.2.1.29 Round(column, decimalplaces)

Rounds data points in *column* to *decimalplaces* number of decimal places. If *decimalplaces* is negative, the data points are rounded to the nearest 10, 100, 1000 and so on.

Data	54.0513321	93.5850093	79.5159764	78.2189397	52.4185918
Round(A,2)	54.05	93.59	79.52	78.22	52.42
Round(A,0)	54	94	80	78	52
Round(A,-1)	50	90	80	80	50

Note: If you type decimals using a comma (eg 3,2) you should enter this formula as Round(A; 1) - using the ; as a separator

9.2.1.30 Row / @

The word Row or the @ symbol can be used in any formula and it will be replaced by the row number when performing the calculation.

9.2.1.31 Seasonalise(column, cyclelen)

Generates de-seasonalised data from *column* assuming a cycle length of *cyclelen*.

Seasonal data often shows cyclic variations. This function removes cyclic variations and allows you to see the underlying trends. Seasonalise analyses cyclic deviations and removes them.

Please note that the output of the seasonalise function is dependent on the System Options settings. De-seasonalising data involves particularly localised procedures.

The parameters in the Seasonalise function are optional. If they are omitted, the Seasonalise function will seasonalise whatever column is currently selected in the Statistics View and will assume a cycle length of 4.

Example: Seasonalise(A, 4)

Note: If you type decimals using a comma (eg 3,2) you should enter this formula as Seasonalise(A; 4) - using the ; as a separator

9.2.1.32 Sort(column) / SortA(column)

These functions are equivalent.

Sort the entire data set using *column* as the sort key. Sorts into ascending order. All columns are affected.

Example: Sort(A)

9.2.1.33 SortD(column)

Sort the entire data set using *column* as the sort key. Sorts into descending order. All columns are affected.

Example: SortD(A)

9.2.1.34 SortCol(column) / SortColA(column)

These functions are equivalent.

Sorts only the data in *column* into ascending order. No other column is affected.

Example: SortCol(A)

9.2.1.35 SortColD(column)

Sorts only the data in *column* into descending order. No other column is affected.

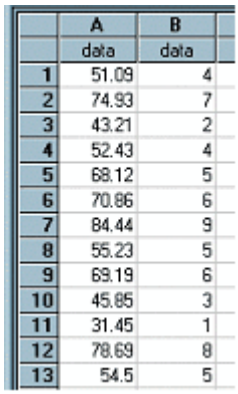
Example: SortColD(A)

9.2.1.36 Stanine(column)

Calculates the stanine score for each data point in column. Stanines allocate a score from 1 to 9 to each score in a data set. The width of each stanine group is approximately equal, in other words if stanine 1 is allocated to scores from 10-20, stanine 2 will be allocated to scores from approximately 20-30.

Because stanines are usually allocated to normally distributed data, even though they have approximately equal widths, 54% of all scores are allocated stanines of 4, 5 and 6.

The example shows stanines in column B. They were calculated using Stanine(A).



	A	B
	data	data
1	51.09	4
2	74.93	7
3	43.21	2
4	52.43	4
5	68.12	5
6	70.86	6
7	84.44	9
8	55.23	5
9	69.19	6
10	45.85	3
11	31.45	1
12	78.69	8
13	54.5	5

9.2.1.37 Standardise(column, mean, sd)

Standardises the data in *column* so that it has a new mean of *mean* and a new standard deviation of *sd*. Each data point maintains its zscore (each score stays the same number of standard deviations from the mean).

Example: Standardise(A,60,15)

Note: If you type decimals using a comma (eg 3,2) you should enter this formula as Standardise(A; 60; 15) - using the ; as a separator

9.2.1.38 Triangular(number)

Generates *number* triangular numbers.

Example: Triangular(10)

9.2.1.39 Tribonacci(first, second, third, number)

Generates *number* scores in a Tribonacci sequence starting with *first*, *second* and *third*.

Example: Tribonacci(1,1,1,20)

Note: If you type decimals using a comma (eg 3,2) you should enter this formula as Tribonacci(1; 1; 1; 20) - using the ; as a separator

9.2.1.40 ZScore(column)

Calculates the zscore for each data point in column. The zscore is the number of standard deviations from the mean. Alternatively, Zscore effectively standardises the data to have a mean of 0 and a standard deviation of 1.

Example: Zscore(A)

9.2.2 Other Functions

9.2.2.1 Trigonometric Functions

Sin(x), Cos(x), Tan(x), Sec(x), Cosec(x), Cot(x) calculate the appropriate trigonometric ratios. x can be in degrees, radians or grads as chosen in System Options.

9.2.2.2 Inverse Trigonometric Functions

asin(x), acos(x), atan(x) calculate the inverse trigonometric functions.

9.2.2.3 Hyperbolic Functions

cosh(x), sinh(x), tanh(x) calculates the appropriate hyperbolic functions.

9.2.2.4 Abs(x)

Calculates the absolute value of the parameter x.

9.2.2.5 Exp(x)

Calculates e^x

9.2.2.6 Ln(x)

Calculates the natural logarithm of x

9.2.2.7 Log(x)

Calculates the base 10 logarithm of x

9.2.2.8 Sqrt(x) / SR(x)

Calculates the square root of x

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- R -

- S -

- T -

- U -

- V -

- W -

- X -

- Z -