

AGOCG Technical Report

Evaluation of Graphics Packages for the PC

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May 1997

Warning

Whilst every care has been taken to ensure accuracy the author can take no responsibility for decisions taken based upon this report's contents.

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Introduction and Background

During 1996 it became apparent that Visual Numerics was no longer supporting Stanford Graphics which had been the recommended technical graphics package for PC users in the UK Higher Education sector. Clearly this was a most unsatisfactory situation; a support-less Stanford Graphics could no longer be recommended. A re-evaluation of today's suitable PC compatible graphics packages was imperative, with the ultimate aim of securing a CHEST site licence deal for whichever package(s) would be chosen as replacement(s) for Stanford Graphics. In addition, consideration should be given to whether it might be possible to recommend a single package offering comparable facilities on both PC and Apple Macintosh platforms. This evaluation has been performed by the Graphics & Multimedia Group at Edinburgh University Computing Service on behalf of the Advisory Group on Computer Graphics (AGOCG).

Evaluation Environment

The selection of packages to be evaluated was influenced by the perceived multiplicity of PC computers available to Staff and Students in the UK Higher Education community. Packages requiring a very high hardware specification could not be included since such computers were deemed to be few and far between. Any package chosen should be available for running under all of the existing Windows environments, i.e. 3.1, 95 and NT. Also, to be included a package had to exist in a version capable of being mounted on a Network Server and being run from client machines of differing specifications, as well as being mounted and run from standalone machines.

The PC allocated for this evaluation exercise has a 150 MHz Pentium processor, 32Mb RAM, a 1Gb hard disk and 17" Colour VGA Display. Windows 3.1, Windows 95 and Windows NT were all mounted on this platform. Each package selected for assessment was then installed for evaluation under each of these system environments. Since this hardware specification might be considered more powerful than that normally available some additional assessment was performed, for comparison purposes, on a 90MHz Pentium processor with 16Mb RAM, 1Gb hard disk and a 15" VGA Display, running Windows 95. The evaluation was delayed initially owing to the necessity to complete first a similar evaluation exercise of technical graphics packages for use on Apple Macintosh computers. Even so the evaluation has been completed within the agreed timescale.

Package Requirements and Functionality

A comparative Information and Facilities Matrix was created to demonstrate the hardware, system and user environment demands of any package to be included in the evaluation (Appendix Ia). The matrix was based on the General Information Matrix included in (Ref. 1), the relevant parts of which publication are included as Appendix II of this document. Extra sub-sections were included in the matrix in order to comment on the level of "user friendliness", the quality of accompanying documentation, the level of support offered by the publisher during the evaluation period, and the package's estimated cost to Educational Institutions.

A companion matrix was created to demonstrate the data-driven functionality of any package to be included in the evaluation (Appendix Ib). The matrix was based on the Data Driven Graphics Facilities Matrix included in (Ref. 1), the relevant parts of which publication are included as Appendix II of this document.

The areas of functionality within which the evaluation sought positive responses were

- Data Handling Facilities

- 2-Dimensional Data Display

- 3-Dimensional Data Display

- Other Display Options

Chart Axes

Other Chart Facilities

Chart Object Attributes

Since the purpose of the evaluation was to recommend a successor to Stanford Graphics the aim was obviously to identify packages which equal or surpass what Stanford Graphics provided in these areas of functionality. As a consequence Stanford Graphics was included in the Information and Facilities matrices for comparison purposes.

Package Selection and Procurement

The UK_Mac_ademic and Mac_Supporters electronic mailbase lists were surveyed in the Autumn of 1996 to conduct a poll of a number of UK Higher Education sites where Apple Macintosh computers are available to Staff and Students. A number of packages emerged as being most commonly supported by these sites. Part of the remit for this present survey of graphics packages for PCs was to ascertain whether there might be a suitable package available for running on both PCs and Apple Macintoshes - the cross-platform solution. Obviously packages available only for Apple Macintosh were dropped from the original list leaving the following packages to be considered in this survey for PCs.

Microsoft Office (Excel 5.0 for Windows 3.1 and 7.0a for Windows95/NT & PowerPoint 4.0d for Windows 3.1 and 7.0 for Windows95/NT)

Microsoft Works (3.0c for Windows 3.1 and 4.0a for Windows 95/NT)

KaleidaGraph 3.07* - from Synergy Software

DeltaGraph 4.0.3* - from Delta Point

SigmaPlot 3.03* - from Jandel Scientific Software

Later it became apparent that previous reluctance/inability on the part of another package provider to countenance discount pricing arrangements through CHEST had now been overcome, so also included was

Origin 4.1* - from Microcal Software Inc.

* - plus Win 32s for running under Windows 3.1

Procuring the Microsoft products was a simple matter of upgrading software already available at Edinburgh to their latest published versions. Grateful thanks are due to Chris Whitaker of CHEST for his diligent pursuit of Synergy, Delta Point and Jandel Scientific Software who, during Autumn 1996, were each somewhat reluctant to respond to requests for an evaluation copy of the latest Macintosh version of their products, but then also sent the latest PC versions. Chris Whitaker also obtained the evaluation copy of Origin software, from Aston Scientific Ltd.

KaleidaGraph, DeltaGraph, SigmaPlot and Origin are all supplied as 32-bit application software. To run under Windows 3.1 the Win32s interface is required, and the result is slower operation.

Package Assessment

Appendices Ia and Ib present an easy to view comparison of the requirements and capabilities of the selected packages as derived from running them and from perusal of their accompanying documentation. Where applicable all matrix entries were tested to verify claims in the documentation. Every effort has been taken to present correct information as at end-April 1997, although comments on "ease of use" and "documentation" are necessarily subjective.

All of the selected packages offer a spreadsheet-like data input facility, and will also accept text files containing space-separated, comma-separated and tab-separated lines of data. All will also accept data in at least one external proprietary format such as Excel. The data can be sorted or transformed by applying in-built or user-defined transformation functions. Selected data can then be displayed by choosing from a menu of scientific and/or business graph types or possibly by applying a curve fitting algorithm. All of the packages offer a "tools palette" so that you can add extra drawing features, change colours and/or line styles, add annotation, etc. You can save a template copy of the format and style of a graph display for future use thus avoiding having to rebuild it each time it is required.

All of the packages can be mounted on a Network Server machine and run from client PCs.

1. Microsoft Office (Excel & PowerPoint)

This package offers a comprehensive spreadsheet and slide presentation facility including good graphics displays. Excel does not offer as wide a range of 2-dimensional or 3-dimensional displays as Stanford Graphics, and has no contouring facilities. PowerPoint adds a powerful slide presentation capability, but Stanford Graphics also had slide show production facilities. The amount of data Microsoft Office is capable of handling is limited compared with the more dedicated graphing packages. Despite being generally easy to use the package exhibits somewhat inflexible graph editing capabilities, especially those concerned with axis format and labelling.

Microsoft Office is relatively cheap to purchase, but expensive to run in terms of disk space consumption. One comprehensive manual covers both Macintosh and Windows versions of the package.

2. Microsoft Works

This package is a composite featuring word processing, database management, graphical display and slide presentation. It is similar in functionality to Microsoft Office and offers a similar variety of possible 2- and 3-dimensional display formats (except 3-dimensional surface drawing), but there is again no contouring capability. Again the amount of data Microsoft Works is capable of handling is limited compared with the more dedicated graphing packages. Its ease of use is detracted from by these limitations in functionality.

Like Microsoft Office, Microsoft Works is cheap to purchase, but relatively expensive to run in terms of disk space consumption. The manual is specific to the PC implementation and, while the Windows 3.1 manual is excellent, the Windows 95/NT Works Companion is woefully inadequate as a learning/reference document..

3. KaleidaGraph

Surprisingly for such an otherwise competitive package in the area of graphical display of scientific data KaleidaGraph only offers 2-dimensional display options, and even these are limited. There are also no slide show production facilities.

A disturbing feature on data entry is that the default data sheet is only 3 columns wide and 11 rows deep. It is necessary to expand this window for comfortable working, otherwise data disappears from view as it is typed in. Once that idiosyncrasy is overcome, however, the data entry capabilities and capacity are

extensive, and the package is quite easy to use. Display editing facilities are very good, although the ability to add labels to data points is limited to line, scatter, pie and bar charts. Re-drawing after picture modification is quite fast. The manual is comprehensive and covers both Windows and Macintosh versions of the package.

4. DeltaGraph

This is a most comprehensive graphics display package; there are very few negative entries in the information and facilities matrices. Only 3-dimensional histogram and combined surface/contour are missing from a huge list of supplied options in the Chart Menu (which can be displayed by name or by icon), and there is even a Chart Advisor to suggest an appropriate scientific or business chart option given the data selection you have already made. Functions used to create Data columns are associated with those columns, consequently their contents can be recalculated at the touch of a button if there are any dependent source data alterations. A data entry sheet may have many pages, but only one of them can be "in view" at a time, although its capacity is large at up to 256 data sets each of up to 32000 points. Alterations to the Document/Print Setup and various Preferences settings are not retained properly between DeltaGraph sessions - DeltaPoint is addressing these problems for correction in the next maintenance release.

Display editing facilities are excellent and include the ability to preview the effects of any modifications before actually applying them. Re-drawing after modifications is fast, except under Windows 3.1 where it is slow by comparison because of the Win32s interface. There is also a wide range of graphics image filters for Import/Export of graphic images. A full slide show production facility is included. The package comes with a large on-line folder of sample files which can be used to demonstrate technical and business chart displays and curve fitting. One comprehensive manual covers both Windows and Macintosh versions of the package.

5. SigmaPlot

Like KaleidaGraph this scientific graphing package is surprisingly short on the availability of 2-dimensional display options compared with Stanford Graphics. 2-d contouring is included, but in the 3-dimensional display list only scatter and surface plots are offered. Other functionality is very good as in most other packages, but there are no slide show production facilities.

In general the package is quite easy to use, and has an excellent all-in-one window where modifications to the various attributes of the graphic display can be specified. Re-drawing after modifications is fast. One disturbing problem arises when using the Graph page scroll bars - the window goes blank until the mouse button is released, so it is very difficult to tell how far you are moving the picture! There are no example display files. The manual is a comprehensive reference document specific to the Windows version of SigmaPlot.

6. Origin

Like DeltaGraph this is another most comprehensive graphics display package; there are very few negative entries in the information and facilities matrices. Again only 3-dimensional histogram and combined surface/contour drawing formats are missing from a large list of supplied options. The 3D & Contouring module is a standard part of the international version of the Origin package. This module offers an excellent 3-d palette allowing dynamic picture rotation and perspective changing. Worksheet data must be converted to a matrix before performing contouring operations.

Presentation and editing facilities are good, and re-drawing after modifications is fast. However, under Windows 95/NT the package crashes with an invalid page fault when you click the Normal or Bold text option buttons within the Text Control window after changing the font or rotation settings and not re-selecting the text string - a summary demise for a small user error. The range of Import/Export

graphics image filters is very limited and, while the other packages offer full OLE support, Origin is limited to exporting its own images into other Windows applications. There are no slide show production facilities. OLE support is limited to exporting Origin images to other Windows applications.

A disturbing feature on data entry is that the default data sheet is only 2 columns wide and 10 rows deep. It is necessary to expand this window for comfortable working, otherwise data disappears from view as it is typed in. Once that idiosyncrasy is overcome, however, the data entry capacity is huge at up to 600 datasets of 100,000+ points per dataset in each worksheet, and there is a comprehensive range of data analysis and curve fitting functions. It is not possible to select non-contiguous data for drawing though and, if you wish to swap worksheet data rows with columns you have to convert the worksheet into a matrix first, perform the swap, then convert back to a worksheet again.

There is an on-line folder of sample files which can be used to demonstrate technical and business chart displays, curve fitting and the various analysis and editing facilities. The User's and 3D & Contouring Manuals are excellent documents, although those supplied were for Origin version 4.0, not 4.1 as was the software version.

Conclusions and Recommendations

PC Assessment

The purpose of this evaluation exercise was to find a graphics package for PCs which equalled or surpassed **Stanford Graphics** in its provision of facilities. Principally this meant seeking packages offering enhanced data handling (missing data and non-contiguous data selection) and enhanced freedom in determining the appearance and presentation of the graphics images produced.

Whilst **Microsoft Office** and **Microsoft Works** are easy to use and are relatively cheap to purchase they are each essentially Spreadsheet packages with charting facilities added, rather than data driven graphics display packages as such. Overall they do not offer any enhancement in the range of facilities offered. Especially they lack contouring capability.

KaleidaGraph offers no advance over the functionality **Stanford Graphics** offered. Especially there is no contouring or 3-dimensional display capability, nor slide show facilities.

SigmaPlot also offers no advance over the functionality **Stanford Graphics** offered. The limited range of graph menu types is disappointing; again contouring is absent and the 3-dimensional display options are few. It is also a very expensive package.

DeltaGraph offers a huge list of graphic display options, only 3-dimensional histogram and combined surface and contour drawing are missing. Its range of graphics image import/export filters is also extensive. Full slide show production and display facilities are provided. Its display editing is simple to use and consequent re-drawing is very fast. Given the range of functionality it offers it is the most cost-effective of the packages surveyed.

Origin also offers a huge list of graphic display options. Again only 3-dimensional histogram and combined surface and contour drawing are missing. It appears to have a wider range of data analysis and transformation functions. However, it does not offer slide show production facilities, and its range of graphics image import/export filters is very limited. It is also a very expensive package.

It is recommended, therefore, that **DeltaGraph** should be adopted by CHEST as the approved graphics package for use on PC computers in the UK Higher Education community, with the rider that **Origin** would be a contender if a suitably competitive pricing agreement could be reached.

Cross platform Macintosh/Windows assessment

The **AGOCC Technical Report - Evaluation of Graphics Packages for the Apple Macintosh** (January 1997) recommended **DeltaGraph** as the approved graphics package. Given the above recommendations for PCs, and the fact that **Origin** is not a contender on Apple Macintosh since it only works there through SoftWindows, then **DeltaGraph** must also be the recommended package for the cross-platform solution.

Acknowledgements

Thanks are due to:

AGOCC for funding this evaluation;

Chris Whitaker (CHEST) for acquiring the packages not already available in Edinburgh;

Roy Middleton for general guidance;

Alex Nolan, Francis van Millingen and Richard Bacon for their previous work on which the matrices in this report are based;

Roy Middleton and Francis van Millingen for their assistance, proof reading and comment in the compilation of this report.

Reference

1. Selecting a Package for Graphics Presentation, An Overview
(Second edition, November 1994).
Richard Bacon, Alex Nolan, Francis van Millingen
University of Edinburgh

Appendix I

Ia. General Information Matrix

Ib. Data Driven Graphics Facilities Matrix

Appendix II

Extracts from (Ref. 1) including explanations of the matrices of Appendices Ia and Ib

Evaluation of Graphics Packages for PCs and the Apple Macintosh

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August 1997

Contents

Part 1 PC

Part 2 Apple Macintosh

AGOCG Technical Report

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Introduction and Background

During 1996 it became apparent that Computer Associates were no longer supporting Cricket Graph which had for some time been the recommended technical graphics package for Apple Macintosh users in the UK Higher Education sector. Clearly this was a most unsatisfactory situation; a support-less Cricket Graph could no longer be recommended. A re-evaluation of today's suitable Apple Macintosh compatible graphics packages was imperative, with the ultimate aim of securing a CHEST site licence deal for whichever package(s) would be chosen as replacement(s) for Cricket Graph. This evaluation has been performed by the Graphics & Multimedia Group at Edinburgh University Computing Service on behalf of the Advisory Group on Computer Graphics (AGOCG).

Evaluation Environment

The selection of packages to be evaluated was influenced by the perceived multiplicity of Apple Macintosh computers available to Staff and Students in the UK Higher Education community. Packages requiring a very high hardware specification could not be included since such computers were deemed to be few and far between. Also, to be included a package had to exist in a version capable of being mounted on a Network Server and being run from client machines of differing specifications, as well as being mounted and run from standalone machines. The Macintosh machine allocated for the evaluation exercise was obtained on loan from a Computing Services' student laboratory - an LC III with 12Mb of memory, 80MB hard disk and 14" Colour Display, running Apple System 7.5.3 - and is thus typical of machines expected to run the selected software in the UK Higher Education community. The evaluation was delayed initially owing to a hardware fault, and further delays were caused by difficulties in obtaining evaluation copies of some of the packages. Even so the evaluation has been completed within the timescale originally agreed.

Package Requirements and Functionality

A comparative Information and Facilities Matrix was created to demonstrate the hardware, system and user environment demands of any package to be included in the evaluation (Appendix Ia). The matrix was based on the General Information Matrix included in (Ref. 1), the relevant parts of which publication are included as Appendix II of this document. Extra sub-sections were included in the matrix in order to comment on the level of "user friendliness", the quality of accompanying documentation, the level of support offered by the publisher during the evaluation period, and the package's estimated cost to Educational Institutions.

A companion matrix was created to demonstrate the data-driven functionality of any package to be included in the evaluation (Appendix Ib). The matrix was based on the Data Driven Graphics Facilities Matrix included in (Ref. 1), the relevant parts of which publication are included as Appendix II of this document.

The areas of functionality within which the evaluation sought positive responses were

- Data Handling Facilities

- 2-Dimensional Data Display

- 3-Dimensional Data Display

- Other Display Options

- Chart Axes

- Other Chart Facilities

Since the purpose of the evaluation was to recommend a successor to Cricket Graph the aim was obviously to identify packages which surpass what Cricket Graph provides in these areas of functionality. As a consequence Cricket Graph was included in the Information and Facilities matrices for comparison purposes.

Package Selection and Procurement

The UK_Mac_ademic and Mac_Supporters electronic mailbase lists were used to conduct a poll of a number of UK Higher Education sites where Apple Macintoshes are available to Staff and Students. The following packages emerged as being most commonly supported by a number of these sites:

Microsoft Office (Excel 5.0 & PowerPoint 4.0)

Microsoft Works 4.0b

Claris Works 4.0

KaleidaGraph 3.0.8 - from Synergy Software

DeltaGraph 4.0 - from Delta Point

SigmaPlot 5.0 - from Jandel Scientific Software

Further perusal of the mailbase lists indicated that another package could also be a candidate, so

pro Fit 5.0 - from Cherwell Scientific Publishing

was added to the list.

Procuring the Microsoft and Claris products was a simple matter of upgrading software already available at Edinburgh to their latest published versions. Cherwell supplied pro Fit within two days of the initial request. Grateful thanks are due to Chris Whitaker of CHEST for his diligent pursuit of Synergy, Delta Point and Jandel who were each, for some time, somewhat reluctant to respond to requests for an evaluation copy of the latest Macintosh version of their products.

Package Assessment

Appendices Ia and Ib present an easy to view comparison of the requirements and capabilities of the selected packages as derived from running them and from perusal of their accompanying documentation. Where applicable all matrix entries were tested to verify claims in the documentation. Every effort has been taken to present correct information as at end-December 1996, although comments on "ease of use" and "documentation" are necessarily subjective.

All of the selected packages offer a spreadsheet-like data input facility, and will also accept text files containing space-separated, comma-separated and tab-separated lines of data. All except pro Fit will also accept data in an external proprietary format such as Excel. The data can be sorted or transformed by applying in-built or user-defined transformation functions. Selected data can then be displayed by choosing from a menu of scientific and/or business graph types or possibly by applying a curve fitting algorithm. All of the packages offer a "tools

palette" so that you can add extra drawing features, change colours and/or line styles, add annotation, etc. You can save a template copy of the format and style of a graph display for future use thus avoiding having to rebuild it each time it is required.

1. Microsoft Office (Excel & PowerPoint)

This package offers a comprehensive spreadsheet and slide presentation facility including good graphics displays. Excel offers almost as wide a range of 2-dimensional displays as Cricket Graph and surpasses it in enabling 3-dimensional bar, column and surface displays, but contouring facilities are not available. PowerPoint adds a powerful slide presentation capability. The amount of data Microsoft Office is capable of handling is limited compared with the more dedicated graphing packages. Despite being generally easy to use the package exhibits somewhat inflexible graph editing capabilities, especially those concerned with axis format and labelling. Microsoft Office is cheap to purchase, but relatively expensive to run in terms of memory occupancy and disk space consumption. One comprehensive manual covers both Macintosh and Windows versions of the package.

2. Microsoft Works

This package is a composite featuring word processing, database management, graphical display and slide presentation. It is similar in functionality to Microsoft Office but offers less in the variety of possible 2-dimensional display formats, specifically there is no contouring, nor is there any 3-dimensional display capability at all. Again the amount of data Microsoft Works is capable of handling is limited compared with the more dedicated graphing packages. Its ease of use is detracted from by these limitations in functionality. Microsoft Works is cheap to purchase, but relatively expensive to run in terms of memory occupancy and disk space consumption. The manual is specific to the Apple Macintosh implementation.

3. Claris Works

Like Microsoft Works, this package is a composite featuring word processing, database management, graphical display and slide presentation. Its functionality is so similar to Microsoft Works there is little to choose between them, and again there is no contouring nor 3-dimensional display capability at all. Again the amount of data Claris Works is capable of handling is limited compared with the more dedicated graphing packages, and its ease of use is detracted from by its limitations in functionality. Claris Works is cheap to purchase, but relatively expensive to run in terms of memory occupancy and disk space consumption. A very slim manual covers both Macintosh and Windows versions of the package.

4. KaleidaGraph

Surprisingly for such an otherwise competitive package in the area of graphical display of scientific data KaleidaGraph offer only 2-dimensional display options, and even these are limited. A disturbing feature on data entry is that the default data sheet is only 3 columns wide and 128 rows deep, and it is not obvious how to expand that without recourse to the manual. Once that problem is overcome, however, the data entry capabilities and capacity are extensive, and the package is quite easy to use. Display editing facilities are very good, although the ability to add labels to data points is limited to line, scatter, pie and bar charts. Re-drawing after picture modification is quite fast. The manual is comprehensive and covers both Macintosh and Windows versions of the package.

KaleidaGraph could not be assessed by running it from a client Apple Macintosh because it refused to be mounted on a Novell server.

5. DeltaGraph

This is the most comprehensive graphics display package; there are very few negative entries under DeltaGraph in the information and facilities matrices. Only 3-dimensional histogram and combined surface/contour are missing from a huge list of supplied options in the Chart Menu (which can be displayed by name or by icon), and there is even a Chart Advisor to suggest an appropriate scientific or business chart option given the data selection you have already made. Functions used to create Data columns are associated with those columns, consequently their contents can be recalculated at the touch of a button if there are any dependent source data alterations. A data entry sheet may have many pages, but only one of them can be "in view" at a time, although its capacity is large at up to 256 data sets each of up to 32000 points. Display editing facilities are excellent, and re-drawing after modifications is fast. There is also a full slide show production facility. The package comes with a large on-line folder of sample files which can be used to demonstrate technical and business chart displays and curve fitting. One comprehensive manual covers both Macintosh and Windows versions of the package.

6. SigmaPlot

Like KaleidaGraph this scientific graphing package is surprisingly short on the availability of 2-dimensional display options compared with Cricket Graph - histograms are included but area and polar graphs are not - and in the 3-dimensional display list only scatter and surface plots are offered. Other functionality is very good as in most other packages. In general the package is quite easy to use, and there is an excellent all-in-one window where modifications to the various attributes of the graphic display can be specified. However, after display editing re-drawing is painfully slow since the whole screen appears to be redrawn, the package even traverses the entire tool palette window. No means was found to add a frame around a picture and modify the "background" colour/texture.

7. pro Fit

This package for the analysis and display of scientific data will delight the serious technical user who enjoys reading technical documentation with few examples, and writing special functions to display graphically. Pro Fit's window menus are relatively easy to understand, however in default use the screen is cluttered with windows - data, graph, results, preview, tools palette - or so it appears on a 14" screen.

The normal user will be irritated at the dearth of options available by default at the top level of the standard display menu. To obtain pie and bar charts, histograms, contour plots and 3-dimensional plots requires compilation of the relevant external module, linking the compiled module into a library, thus making it available in a sub-menu list. The manual has a full explanation about external modules but nowhere does it mention the availability of the source code for these, and other, extra chart types in a supplied on-line folder. In any case you must have a Power Macintosh to obtain any sort of 3-dimensional plot. Data handling capacity is immense, graphic display editing facilities are good and re-drawing after modification is fairly fast.

Conclusions and Recommendations

The purpose of this evaluation exercise was to find a graphics package for Macintosh systems which surpassed **Cricket Graph** in its provision of facilities. Principally this meant seeking packages offering enhanced data handling, more diversity in the range of 2-dimensional graph types, inclusion of contouring facilities and 3-dimensional graph types, and enhanced freedom in determining the appearance and presentation of the graphics images produced.

Whilst **Microsoft Office**, **Microsoft Works** and **Claris Works** are all easy to use and are relatively cheap to purchase they are each essentially Spreadsheet packages with charting facilities added, rather than data driven graphics display packages as such. Overall they do not offer much, if any, enhancement in the range of facilities offered. Especially they lack contouring capability.

KaleidaGraph appears to offer little or no advance over the functionality **Cricket Graph** offered. Especially there is no contouring or 3-dimensional display capability. A network version could not be loaded on our Novell server.

SigmaPlot is very expensive, both in price and in memory requirements at run-time. Despite having an excellent single window for graph attributes modification, consequent re-drawing of the display is very slow. Also the limited range of graph menu types is disappointing; again contouring is absent and the 3-dimensional display options are few.

Pro Fit is for the serious technical user who enjoys programming to provide an extended range of graph types. The "average" user will miss the provision of some of the usual graph types in the standard menu and will not appreciate having to compile functions and add them to a library in order to make available those graph types other packages provide as standard menu options. The requirement to have a Power Macintosh for any 3-dimensional display is also a possible deterrent. **Pro Fit's** purchase price is expensive.

DeltaGraph offers a huge list of graphic display options, only 3-dimensional histogram and combined surface and contour drawing are missing. It also provides slide show facilities. It's display editing is simple to use and consequent re-drawing is very fast. Given the tremendous range of functionality it offers it is easily the best and most cost-effective of the packages surveyed.

It is recommended, therefore, that **DeltaGraph** should be adopted by CHEST as the approved graphics package for use on Apple Macintosh computers in the UK Higher Education community.

Acknowledgements

Thanks are due to:

AGOCCG for funding this evaluation;

Chris Whitaker (CHEST) for acquiring the packages not already available in Edinburgh;

Roy Middleton for general guidance;

Alex Nolan, Francis van Millingen and Richard Bacon for their previous work on which the matrices in this report are based;

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Appendix I

Ia. General Information Matrix

Ib. Data Driven Graphics Facilities Matrix

Appendix II

Extracts from (Ref. 1) including explanations of the matrices of Appendices Ia and Ib

	Cricket Graph III	Excel 5.0	PowerPoint 4.0	MS Works 4.0b	Claris Works 4.0	pro Fit 5.0	KaleidaGraph 3.0.8	DeltaC
GENERAL								
<i>Licence arrangements</i>	CHEST site licence	Select deal	Select deal	Select deal	Master Volume deal			
<i>Educational price - single /5-user/site-licence</i>		59.80/199.04/?	59.80/199.04/?	29.13/116.17/?	64.50/193.00/?	199.00/850/1250	\$124.50/\$550/1250	79.0/?/?
<i>Package Description</i>	Scientific	Spreadsheet with good charting facilities	Presentation, with simple data handling and chart facilities via Chart 5.0	Spreadsheet with simple database and charting facilities	Spreadsheet with simple database and charting facilities	Scientific	Scientific	Business
<i>Support</i>	None	Microsoft Select Scheme (update to Office 4.2.1 arrived 17 October.).	Microsoft Select Scheme (update to Office 4.2.1 arrived 17 October.).	Microsoft Select Scheme (update to 4.0b arrived 10 October).	Update to 4.0 arrived 30 Sept.	Evaluation copy supplied by return on 9 September. Queries answered within 1 day. E-mail discussion group.	Evaluation copy finally arrived on 19 November. Contact sounds helpful.	Evaluation copy finally arrived on 19 November. Contact sounds helpful.
<i>Web Site of interest</i>		www.microsoft.com/MSoftware/MSoftware/ProductInfo/Brochure/default.htm	www.microsoft.com/MSoftware/MSoftware/ProductInfo/Brochure/default.htm	www.microsoft.com/MSoftware/MSoftware/ProductInfo/Brochure/default.htm	www.claris.com/products/claris/clarisworks/clarisworks.htm	www.cherwell.com/ProdHome/proFit.html	www.synergy.com/kg.htm	www.del...dgpro/dg...
SYSTEM ENVIRONMENT								
<i>Platform required</i>	MAC	MAC 68020+ System 7.0+	MAC 68020+ System 7.0+	MAC 68020+ System 7.0+	Macintosh 68020+ System 7.0+	Any Macintosh System 7.0+	Macintosh Plus etc System 6.0.5+	Macintosh System 7.0+
<i>Memory requirements</i>	1.2Mb	4Mb +	5Mb +	5Mb	4Mb +	2.5Mb - 3Mb	2.5Mb +	3Mb
<i>Disk requirements</i>	4Mb	24Mb	28Mb	16Mb	9.5Mb	8.5Mb	3Mb +	14Mb +
<i>Special Requirements</i>	None	None	None	None	None	Power Mac for 3D	None	None
<i>Network Version Available</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Scripting Language Available</i>	No	No	No	No	Yes	Yes	Yes	Yes
USER ENVIRONMENT								
<i>User interface</i>	WIMP	WIMP	WIMP	WIMP	WIMP	WIMP	WIMP	WIMP
<i>Ease of use</i>	Very intuitive	Good, but graphing facilities quite basic.	Good, but graphing facilities quite basic.	Good, but graphing facilities quite basic.	Good, but graphing facilities quite basic.	Quite good, but too many windows clutter the screen. Cumbersome use of external modules for some simple functions & graphs.	Quite good. Limited no. of graph types. Quick to re-draw.	Very good presentation quick to modify a variety of types.
<i>Documentation</i>	Good	Comprehensive - Mac & Windows	Comprehensive - Mac & Windows	Comprehensive	Good.	Technical	Comprehensive - Mac & Windows	Comprehensive - Mac & Windows
<i>On-line help</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
IMAGE FORMATS								
<i>Import</i>	PICT, EPS MacPaint	BMP CDR, CGM DRW DXF, EPS GIF, HPGL JPEG, PCD PICT, PCX TIFF, TGA WMF, WPG	BMP CDR, CGM DRW DXF, EPS GIF, HPGL JPEG, PCD PICT, PCX TIFF, TGA WMF, WPG	PICT, EPS, TIFF	PICT, RTF, TIFF	PICT	EPS, PICT	PICT, EPS, TIFF

Export	PICT	PICT	n/a	n/a	PICT	PICT, EPS	EPS,PICT	EPS,PICT Illustrator
OTHER FEATURES								
<i>Preview Print Facility</i>	Yes	Yes	n/a	Yes	Yes	Yes	Yes	Yes
<i>Templates/Style-Sheets</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Clip Art Supplied</i>	Yes	No	Yes	Yes	Yes	No	No	Yes
<i>Automatic backup facilities</i>	No	Yes	Yes	No	No	No	No	No
DATE Package entry last altered	<i>October-94</i>	<i>December-96</i>	<i>December-96</i>	<i>December-96</i>	<i>December-96</i>	<i>December-96</i>	<i>December-96</i>	<i>December-96</i>

	Cricket Graph III	Excel 5.0	Powerpoint 4.0	MS Works 4.0b	Claris Works 4.0	pro Fit 5.0	KaleidaGraph 3.0.8
DATA HANDLING FACILITIES							
<i>Input (Keyboard, file)</i>	K,F	K,F	K,F	K,F	K,F	K,F	K,F
<i>Space, Comma, Tab delimited</i>	S,C,T	S,C,T	S,C,T	S,C,T	S,C,T	S,C,T	S,C,T
<i>Proprietary formats</i>	No	RTF	RTF,Excel	WKS,SYLK,Excel	DBF,SYLK,Excel	No	Excel
<i>Editing</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Sorting (Ascending,Descending)</i>	A,D	A,D	No	A,D	A,D	A,D	A,D
<i>Swap rows/columns</i>	No	Yes	Yes	Yes	Yes	Yes	Yes
<i>Transformations (Maths,Algebra,Trigonometry, Bessel,Gamma,Fourier)</i>	M,A,T	M,A,T,F	No	M,A,T	M,A,T	M,A,T,F	M,A,T
<i>Graph & data directly linked</i>	Yes (switchable)	Yes	Yes	Yes	Yes	No	Yes
<i>Statistical analysis</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Maximum number of variables (Data sets)</i>	1000	256	256	255	256	30000	256 per page
<i>Maximum number of data points per data set</i>	30000	16384	16384	4000	16384	30000	32000
<i>Are Missing values handled</i>	No	Blank cell ignored	Blank cells ignored	Blank cells ignored	Blank cells ignored	Blank cells ignored	Blank/masked cells plot/skip
<i>Selects non-contiguous data</i>	No	No	No	No	No	No	Yes
<i>Interpolation (Linear, Parametric,Spline)</i>	L,P	No	No	No	No	L,P,S	L,P,S
2-DIMENSIONAL DATA DISPLAY							
<i>Scatter (XY)</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Line</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Hi-Low</i>	Indirectly(error bars)	Yes	Yes	Yes	Yes	Indirectly(error bars)	Yes
<i>Bar/Column (Overlaid,stacked,total=100%,3D)</i>	O,S,T,3D	S,3D	S,3D	S,3D	S,3D	Program module	O,S
<i>Pie (Explode,3D)</i>	E,3D	E,3D	E,3D	E,3D	E	Program module	E
<i>Histogram</i>	No	No	No	No	No	Program module	Yes
<i>Area (Stacked,totals 100%,3D)</i>	S,3D	S,T,3D	S,3D	No	S	Yes	No
<i>Bubble</i>	No	No	No	No	No	No	No
<i>Polar Graph</i>	Yes	No	No	No	No	Program module	Yes
<i>Vector</i>	No	No	No	No	No	Yes	No
<i>Mixed Styles (when valid)</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>2D Contour</i>	No	No	No	No	No	Program module	No
3-DIMENSIONAL DATA DISPLAY							
<i>3D scatter</i>	No	No	No	No	No	Power MAC only	No
<i>3D Grid or regular column chart</i>	No	Yes	Yes	No	No	Power MAC only	No
<i>3D histogram (X-Y) pairs</i>	No	No	No	No	No	Power MAC only	No
<i>3D Surface</i>	No	Yes	Yes	No	No	Power MAC only	No
<i>4D contour (combined surface+contour)</i>	No	No	No	No	No	Power MAC only	No
OTHER DISPLAY OPTIONS							

<i>X Error-Bars (data/function),(+/-),(asymmetric)</i>	D/F,+ & -A	D/F,+ & -A	No	No	D,+ & -A	D,+ & -A	D/F,+ & -A
<i>Y Error-Bars (data/function),(+/-),(asymmetric)</i>	D/F,+ & -A	D/F,+ & -A	No	No	D,+ & -A	D,+ & -A	D/F,+ & -A
<i>Curve fitting (Linear, Polynomial,Exponential, Logarithmic, Geometric, Hyperbolic, Fourier)</i>	Lin,P,E,Log	Lin,P,E,Log,G (Trendline option)	No	No	No	Lin,P,E,Log,G (General Fit Option)	Lin,P,E,Log,G
<i>Plot maths functions</i>	No	Indirectly	No	No	No	Yes	Yes
<i>View point adjustment</i>	No	No	No	No	No	No	No
<i>Read Data points</i>	No	No	No	No	No	No	No
CHART AXES							
<i>AXIS - Change width/colour</i>	No/No	Yes/Yes	Yes/Yes	Yes/Yes	Yes/Yes	Yes	Yes
<i>Allow Broken or Separated Axes</i>	No	No	No	No	No	Indirectly	Indirectly
<i>Axis scaling user defined</i>	Yes	Yes	Yes	No	Yes	Yes	Yes
<i>Dual X/Y-axes</i>	Dual Y	Dual Y	Dual Y	No	No	Yes	Yes
<i>Logarithmic axes</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Transposition of axes</i>	Yes	No	No	No	No	Yes	Yes
<i>AXIS LABELLING - Allow edit of Axis titles</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Position/move Axis titles</i>	Yes	No	No	Yes	No	Yes	Yes
<i>Orientation of Axis titles</i>	Yes	Horizontal,Vertical	Horizontal,Vertical	Horizontal,Vertical	Horizontal,Vertical	Horizontal/Vertical	Horizontal/Vertical
<i>Scientific notation, Sub/Superscripts</i>	Yes	No	No	Yes	Yes,No	Yes	Yes
<i>Foreign character support</i>	No	No	No	Yes	No	No	Yes
<i>TICK MARKS - Specify position</i>	Yes	Yes	Yes	No	Yes	Yes	Yes
<i>Format options for tick mark labels</i>	Yes	Yes	Yes	No	Yes	Yes	Yes
<i>Orientation options for tick mark labels</i>	Yes	Yes	Yes	No	No	Horizontal, program	Horizontal/Vertical
<i>Allow labelling only every Nth tickmark</i>	No	Yes	Yes	No	No	Yes	Yes
<i>Grid lines on Chart</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
OTHER CHART FACILITIES							
<i>Titles</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Legends</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Data Point labels</i>	Yes, limited	Yes	No	No	Yes	Yes	Line/Scat/Pie/Bar
<i>Text annotation</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Freehand drawing annotation</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Chart size/position adjustment</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Background composition (Coloured,Graduated,Pattern,Bitmap)</i>	C,P	C, P	C, P	C,G,P	C,G,P	C,P	C
<i>Frame/Bounding box</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Multiple charts on page</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CHART OBJECT ATTRIBUTES							
<i>Number of line styles</i>	5+	<5	5	5+	5+	5+	5+
<i>Number of line widths</i>	5+	<5	5+	5+	5+	5+	5+
<i>Number of symbol styles</i>	5+	5+	5+	5+	5+	5+	5+
<i>Type of fill styles (Coloured,Graduated,Pattern,Bitmap)</i>	C,P	C, P	C, G, P, B	C,P	C,G,P	C,P	C,G,P

<i>Size of pre-defined colour palette</i>	64(u)	56	56	256	81	264	64(u)
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Appendix II

Extracts from

Selecting a Package for Graphics Presentation.

An Overview

Richard Bacon

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Second Edition

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3D CHARTS

4 The Anatomy Of Charts and Drawings (The Picture Gallery extended) - coming very soon! Another graphics intensive page -- however, the graphics haven't been properly converted for the WWW yet.

Charts

Drawings

Aspects of Design

5 Using Graphics Files and Images

Popular file formats

Graphics Metafiles

Clip Art

7 Explanatory Notes On Facilities Matrix

GENERAL INFORMATION MATRIX

DATA DRIVEN GRAPHICS FACILITIES MATRIX

GLOSSARY

	Stanford 3.0	Excel 5.0c Win 3.1 7.0a Win 95 7.0a Win NT	PowerPoint 4.0d Win 3.1 7.0 Win 95 7.0 Win NT	MS Works 3.0c Win 3.1 4.0a Win 95 4.0a Win NT	KaleidaGraph 3.07 Win 3.1 3.07 Win 95 3.07 Win NT	DeltaGraph 4.0.3 Win 3.1 4.0.3 Win 95 4.0.3 Win NT	SigmaPlot 3.03 Win 3.1 3.03 Win 95 3.03 Win NT	
GENERAL								
<i>Licence arrangements</i>	CHEST site licence	Select deal	Select deal	Select deal				
<i>Educational price - single /5-user/site-licence</i>		59.80/199.04/?	59.80/199.04/?	29.13/116.17/?	\$124.50/\$550/1250	105.00/?/?	279.84/?/?	330
<i>Package Description</i>	Scientific/Analysis with sophisticated presentation facilities	Spreadsheet with good charting facilities	Presentation, with simple data handling and chart facilities	Spreadsheet with simple database and charting facilities	Scientific	Business/Scientific	Scientific	Sci
<i>Support</i>	None	Microsoft Select Scheme	Microsoft Select Scheme	Microsoft Select Scheme	Contact sounds helpful.	Contact very helpful. E-mail response usually within 24 hours.	No help offered, or requested.	Con help resp hou
<i>Web Site of interest</i>	www.vni.com/stanford.dir/stgrhome.html	www.microsoft.com/MSOffice/MSOfc/ProductInfo/Brochure/default.htm	www.microsoft.com/MSOffice/MSOfc/ProductInfo/Brochure/default.htm	www.microsoft.com/MSOffice/MSOfc/ProductInfo/Brochure/default.htm	www.synergy.com/kg.htm	www.deltapoint.com/dgpro/dg03002.htm	www.jandel.com	ww
SYSTEM ENVIRONMENT								
<i>Platform required</i>	386+	286+ Win 3.1 386+ Win 95/NT	386+	386+	386+	386+ (best 486+)	486/33+	386
<i>Memory requirements</i>	4+Mb (best 8+Mb)	4+Mb	4+Mb	3+Mb	8+Mb	8+Mb (best 16+Mb)	8+Mb (best 16+Mb)	4M
<i>Disk requirements</i>	14+Mb	11Mb	12Mb	16Mb	3.6Mb +	13Mb +	7.2Mb +	6M
<i>Special Requirements</i>	None	None	None	None	Win 3.1+ Win32s	Win 3.1+ Win32s	Win 3.1+ Win32s	Wi
<i>Network Version Available</i>	No	Yes	Yes	Yes	Yes	Yes	Yes	Ye
<i>Scripting Language Available</i>	No	No	No	No	Yes	Yes	No	Ye
USER ENVIRONMENT								
<i>User interface</i>	WIMP	WIMP	WIMP	WIMP	WIMP	WIMP	WIMP	WI
<i>Ease of use</i>		Good, but graphing facilities quite basic.	Good, but graphing facilities quite basic.	Good, but graphing facilities quite basic.	Quite good. Limited no. of graph types. Quick to re-draw.	Good presentation Rich variety of graph types. Excellent preview of editing before fixing. Quick to re-draw after modifications (except Win 3.1).	Quite good, and excellent all-in-one window for altering object characteristics. Graph window blanks out when using scroll bars.	Go Ric gra Ex vie Car cra No Tex Dia 95/
<i>Documentation</i>	Comprehensive - index pagerefs wrong		Comprehensive - Mac & Windows	3.1 Comprehensive 95 Inadequate	Comprehensive - Mac & Windows	Comprehensive - Mac & Windows	Comprehensive	Com (do v4.
<i>On-line help</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Ye
<i>OLE support</i>	Yes	Yes	Yes	Yes	No	Yes	Yes	Ye
IMAGE FORMATS								

Import	AI, BMP CGM,CTM DRW,DXF EPS GIF, HPGL PCX TIFF WMF	BMP CDR, CGM DRW EPS HPGL PICT, PCX TIFF WMF, WPG	BMP CDR, CGM DRW DXF, EPS GIF, HPGL JPEG, PCD PICT, PCX TIFF, TGA WMF, WPG	EPS,PICT,TIFF	EPS,PICT,WMF	BMP CGM DRW,DXF EPS HPGL PICT, PCX TIFF WMF, WPG	WMF	BM
Export	BMP,WMF,CGM, EPS,TIFF	PICT	n/a	n/a	PICT,WMF	BMP,WMF,EPS PICT,PCX,TIFF	WMF	BM
OTHER FEATURES								
<i>Slide Show Facilities</i>	Yes	No	Yes	Yes	No	Yes	No	No
<i>Preview Print Facility</i>	No	Yes	n/a	Yes	Yes	Yes	Yes	Yes
<i>Templates/Style-Sheets</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Clip Art Supplied</i>	Yes	No	Yes	Yes	No	Yes	No	No
<i>Automatic backup facilities</i>	No	Yes	Yes	No	No	No	No	No
DATE Package entry last altered	<i>February-96</i>	<i>April-97</i>	<i>April-97</i>	<i>April-97</i>	<i>April-97</i>	<i>April-97</i>	<i>April-97</i>	<i>Ap</i>

	Stanford 3.0	Excel 5.0c Win 3.1 7.0a Win 95 7.0a Win NT	PowerPoint 4.0d Win 3.1 7.0 Win 95 7.0 Win NT	MS Works 3.0c Win 3.1 4.0a Win 95 4.0a Win NT	KaleidaGraph 3.07 Win 3.1 3.07 Win 95 3.07 Win NT	DeltaGraph 4.0.3 Win 3.1 4.0.3 Win 95 4.0.3 Win NT	SigmaPlot 3.03 Win 3.1 3.03 Win 95 3.03 Win NT
DATA HANDLING FACILITIES							
<i>Input (Keyboard, file)</i>	K,F	K,F	K,F	K,F	K,F	K,F	K,F
<i>Space, Comma, Tab delimited</i>	S	S,C,T	S,C,T	S,C,T	S,C,T	S,C,T	S,C,T
<i>Proprietary formats</i>	DIF,WK3,Excel	WKS,WK1,WK3 WKQ	RTF,Excel	WKS,WK1,DBF SYLK,Excel	Excel	WKS,WK1,WK3 WKQ,DIF,DBF SYLK,Excel	WKS,WKQ,DBF DIF,Excel
<i>Editing</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Sorting (Ascending,Descending)</i>	D	A,D	No	A,D	A,D	A,D	A,D
<i>Swap rows/columns</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Transformations (Maths,Algebra,Trigonometry, Bessel,Gamma,Fourier)</i>	M,A,T,B,G	M,A,T,F	No	M,A,T	M,A,T	M,A,T	M,A,T
<i>Graph & data directly linked</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Statistical analysis</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Maximum number of variables (Data sets)</i>	Limited by memory	256	256	255	256 per page	256 per page	16000
<i>Maximum number of data points per data set</i>	Limited by memory	16384	16384	16384	32000	32000	31000
<i>Are Missing values handled</i>	No	Blank cell ignored	Blank cells ignored	Blank cells ignored	Blank/masked cells plot/skip	Blank cells plot/skip option	Blank cells plot/skip option
<i>Selects non-contiguous data</i>	No	No	No	No	Yes	Yes	Yes
<i>Interpolation (Linear, Parametric,Spline)</i>	L,P,S	No	No	No	L,P,S	L,P,S	L,S
2-DIMENSIONAL DATA DISPLAY							
<i>Scatter (X/Y)</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Line</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Hi-Low</i>	Yes	Yes	Yes	Yes	Yes	Yes	Indirectly(error bars)
<i>Bar/Column (Overlaid,stacked,total=100%,3D)</i>	O,S,T,3D	S,3D	S,3D	S,T,3D	O,S	O,S,3D	O,S
<i>Pie (Explode,3D)</i>	E,3D	E,3D	E,3D	E,3D	E	E,3D	E
<i>Histogram</i>	Yes	No	No	No	Yes	Yes	Yes
<i>Area (Stacked,totals 100%,3D)</i>	Yes	S,T,3D	S,3D	S,T,3D	No	S,T,3D	No
<i>Bubble</i>	Yes	No	No	No	No	Yes	No
<i>Polar Graph</i>	Yes	No	No	No	Yes	Yes	Yes
<i>Vector</i>	Yes	No	No	No	No	Yes	Yes
<i>Mixed Styles (when valid)</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>2D Contour</i>	Yes	No	No	No	No	Yes	Yes
3-DIMENSIONAL DATA DISPLAY							
<i>3D scatter</i>	Yes	No	No	No	No	Yes	Yes
<i>3D Grid or regular column chart</i>	Yes	Yes	Yes	No	No	Yes	No
<i>3D histogram (X-Y) pairs</i>	Yes	No	No	No	No	No	No
<i>3D Surface</i>	Yes	Yes	Yes	No	No	Yes	Yes
<i>4D contour (combined surface+contour)</i>	Yes	No	No	No	No	No	No
OTHER DISPLAY OPTIONS							

<i>X Error-Bars (data/function),(+/-),(asymmetric)</i>	D/F,+ & -	D/F,+ & -,A	No	No	D/F,+ & -,A	D/F,+ & -,A	D/F,+ & -,A
<i>Y Error-Bars (data/function),(+/-),(asymmetric)</i>	D/F,+ & -	D/F,+ & -,A	No	No	D/F,+ & -,A	D/F,+ & -,A	D/F,+ & -,A
<i>Curve fitting (Linear, Polynomial,Exponential, Logarithmic, Geometric, Hyperbolic, Fourier)</i>	Lin,P,E,G,H	Lin,P,E,Log,G (Trendline option)	No	No	Lin,P,E,Log,G (General Fit Option)	Lin,P,E,Log,G,H	Lin,P,E,Log,G,H
<i>Plot maths functions</i>	Yes	Indirectly	No	No	Yes	Yes	Yes
<i>View point adjustment</i>	Yes	No	No	No	No	Yes	No
<i>Read Data points</i>	Yes	No	No	No	No	No	No
CHART AXES							
<i>AXIS - Change width/colour</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Allow Broken or Separated Axes</i>	Yes	No	No	No	Indirectly	Yes	Yes
<i>Axis scaling user defined</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Dual X/Y-axes</i>	Yes	Dual Y	Dual Y	Dual Y	Yes	Yes	Yes
<i>Logarithmic axes</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Transposition of axes</i>	Yes	No	No	No	Yes	Yes	Yes
<i>AXIS LABELLING - Allow edit of Axis titles</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Position/move Axis titles</i>	Yes	No	No	Yes	Yes	Yes	Yes
<i>Orientation of Axis titles</i>	Horizontal,Vertical	Horizontal,Vertical	Horizontal,Vertical	Horizontal,Vertical	Horizontal/Vertical	Yes	Yes
<i>Scientific notation, Sub/Superscripts</i>	Yes	No	No	No	Yes	Yes	Yes
<i>Foreign character support</i>	Yes	No	No	Yes	Yes	Yes	Yes
<i>TICK MARKS - Specify position</i>	Yes	Yes	Yes	No	Yes	Yes	Yes
<i>Format options for tick mark labels</i>	Yes	Yes	Yes	No	Yes	Yes	Yes
<i>Orientation options for tick mark labels</i>	Yes	Yes	Yes	No	Horizontal/Vertical	Yes	Yes
<i>Allow labelling only every Nth tickmark</i>	Yes	Yes	Yes	No	Yes	Yes	No
<i>Grid lines on Chart</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
OTHER CHART FACILITIES							
<i>Titles</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Legends</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Data Point labels</i>	Yes	Yes	No	Pie/Bar only	Line/Scat/Pie/Bar	Yes	No
<i>Text annotation</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Freehand drawing annotation</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Chart size/position adjustment</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Background composition (Coloured,Graduated,Pattern,Bitmap)</i>	C,G,P,B	C, P	C, P	C,G,P	C	C,G,P	No
<i>Frame/Bounding box</i>	Yes	Yes	Yes	Yes	Yes	Yes	No
<i>Multiple charts on page</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CHART OBJECT ATTRIBUTES							
<i>Number of line styles</i>	5+	<5	5	5+	5+	64	5+
<i>Number of line widths (user-defined)</i>	5+ (u)	<5	5+	5+	5+	5+	5+
<i>Number of symbol styles</i>	5+	5+	5+	5+	5+	5+	5+
<i>Type of fill styles (Coloured,Graduated,Pattern,Bitmap)</i>	C,G,P,B	C, P	C, G, P, B	C,P	C,G,P	C,G,P	C,P

<i>Size of pre-defined colour palette (user-defined)</i>	117	56	56	256	64(u)	122(+16u)	64(u)
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Extracts from

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GENERAL INFORMATION MATRIX

DATA DRIVEN GRAPHICS FACILITIES MATRIX

GLOSSARY

7 Explanatory Notes On Facilities Matrix

GENERAL INFORMATION MATRIX

This section of the Matrix tells you about any facilities in the packages which are normally common to all types of presentation graphics packages

GENERAL

Licence Arrangements

Indicates any special deals by which you can obtain a package at less than the full commercial cost.

Possible entries are -

- 'CHEST discount', for a UK-wide education price;
- 'CHEST site licence', for site licences negotiated by CHEST;
- 'Select deal', for software available under the Microsoft Select scheme.
- 'Academic discount', for reduced prices, usually due to some special arrangement;
- 'No', for no special deal.

Package Description

Description gives a very brief summary of what a package is, to give you a quick idea of its intended application area.

Entries in Creative Graphics Matrix

Entry is 'Yes' if there is further information in the 'Creative graphics matrix' section, otherwise 'No'.

Entries in Data Driven Graphics Matrix

Entry is 'Yes' if there is further information in the 'Data Driven graphics matrix' section otherwise 'No'.

SYSTEM ENVIRONMENT

Platform

This entry tells you what sort of machine you need in order to run a package.

Platform indicates the hardware, and operating system if relevant - for example Windows', 'Mac', 'Unix'.

Web Site of interest

Web site URL's of interest. These may be the application vendor or possibly a user group page. Blank if no site exists.

Special requirements

Indicates any special facilities you need in order to get the most out of the package. If extra clipart for instance is supplied on CD, enter 'CD' here.

Scripting language Available

Usually 'Yes' or 'No'. Many packages support some form of scripting language to allow extensions to the functionality of the application.

USER ENVIRONMENT

User interface

This entry tells you about the general overall appearance of each package.

User interface is usually 'WIMP' on PCs and Macs - for "Windows /Icons/ Menus and Pointer". In this case you can control programs by pointing and clicking with a mouse, and manipulating windows and icons on your computer screen. The main alternatives are menu-based programs - driven by a mouse or the keyboard, and command-driven programs.

On-line help

Can be 'Yes' if there is any help information within a package, or 'No'. If 'Yes', the help available is often enough to let you run the package without extensive documentation.

OLE support

Package supports Object Linking and Embedding for MS Windows. This allows graphics objects created by one piece of software to be embedded in a graphical object created by another but still maintain it's link with the original software - i.e. any changes made to the object will start up the original package and allow you to edit the original object .

FONTS

Extra Fonts supplied with package

Most packages simply use the fonts which are available on their host computer, though some provide extra ones. The type of extra fonts which are available with the package are shown here, i.e. 'Truetype'. (See the entry for typeface in the glossary for a definition of the terms 'font' and 'typeface' as used in the matrix.)

Number

Number of fonts supplied.

IMPORT/EXPORT GRAPHICS FILE FORMATS

A great many different formats are used for graphics files, which have evolved over the years. The term "file format" refers to the way in which a graphic is stored in a computer file. Different programs use different formats to store the files they create.

These entries show you the main ones which each package can import (cope with) or export (produce). The entries here should enable you to determine whether you can swap graphical images between two or more of the packages you want to use.

The section 'Using Graphics Files and IMAGES' gives more details on this subject. For extra information, you are recommended to consult Graphics File Formats by David C. Kay and John R. Levine, Windcrest/McGraw-Hill, 1992.

It is sometimes adequate to use cut-and-paste for transferring graphics images between applications on a single machine: this saves you the trouble of choosing a graphics file format for the exchange. OLE is another method by which graphics objects may be embedded in a presentation.

File Type abbreviations

AI	Adobe Illustrator	PCT	MAC PICT
BMP	Windows	PCX	CorelPHOTO-PAINT
CDR	CorelDRAW	PFB	Adobe Type 1 Font
CGM	Computer Graphics Metafile	PIC	Lotus PIC
DRW	Micrographx Draw	SCD	Matrix/Imapro SCODL
DXF	AutoCAD DXF	SUN	Sun raster file
EPS	Encapsulated PostScript	TGA	TARGA Bitmaps
GEM	GEM Files	TIFF	TIFF Bitmaps
GIF	Compuserve Bitmaps	TTF	TrueType Fonts
HPGL	HP Plotter language	WMF	Windows Metafile
JPEG	JPEG Bitmaps	WPG	WordPerfect Graphic
PCD	Kodak Photo-CD	XWD	X-windows dump

OTHER FEATURES

Slide show facilities

Is 'Yes' if the package can show a sequence of images, either under control or unattended, to support a talk or as an unattended demonstration.

Templates/Style sheets

Is 'Yes' if you can store general attributes without specific data, to act as templates for future productions; otherwise 'No'.

Clip Art Supplied

Is 'Yes' if the package includes a library of graphics images for inclusion in your charts, otherwise 'No'.

Automatic backup facilities

Is 'Yes' if you can tell the package to save your work every so often, or 'No' if you have to remember to save it yourself.

Pantone matching

Is 'Yes' if the package supports the internationally recognised Pantone system of specifying colours, otherwise 'No'. This feature is particularly important if you need to get the best output from bureaux.

Extra Drivers with package

Most Windows and Macintosh packages rely on their host system to deal with printers etc. Any extra facilities provided by individual packages are listed in this section, an example of this might be a 35mm type driver.

DATA DRIVEN GRAPHICS FACILITIES MATRIX

DATA HANDLING FACILITIES

This section of the Matrix tells you about any facilities in the packages which can help you prepare your data for graphical display.

Editing facilities

Either 'Yes' or 'No' - indicates whether or not you can edit your data within a package before display.

Calculation facilities

Can be 'No', 'simple' (meaning that you can do simple transformations of data), or 'complex' (if you can carry out complex calculations on the data before displaying it - calculations such as those which you can perform in spreadsheets).

Graph and data directly linked

Tells you if a change to the data or alteration of the graph is automatically represented by an update of the other (i.e. the data or the graphical display)

Statistical analysis

Is either 'Yes' or 'No', to indicate whether a package can calculate statistical information about your data - such as mean and standard deviation.

Maximum number of variables

Indicates the number of variables the package can handle.

Maximum number of data points

Indicates the number of data points for each variable that the package can handle.

Are missing values handled

Indicates what the package does with missing values in your data. Packages with statistical capability tend to do something sensible with such cases, while other packages might ignore them or substitute a special value.

Data Interpolation

Indicates that data interpolation methods are available in the package. These vary and only a general indication is given, reference to the documentation should be made for more specific details.

The cell entries may be 'No', '2D', '3D', '2D+3D'.

2D indicates support for 2D data. - i.e. parametric interpolation etc., similarly 3D indicates support for 3D data - i.e. irregular data converted to regular grid etc.

2-DIMENSIONAL DATA DISPLAY

See CHAPTER 3 - 'TYPES of CHART'

3-DIMENSIONAL DATA DISPLAY

See CHAPTER 3 - 'TYPES of CHART'

OTHER DISPLAY OPTIONS

Error-bars (X or Y)

Indicates if error bars supported - applies to line charts. Entries may be 'No', 'X-axis', 'Y-axis', 'Both'. Sometimes error-bars are also applied to other types of graphs, in such cases an entry (R) will appear in the 'Graph Type' cell., i.e. a bar/column chart supporting error-bars would have an (R) entry.

Curve fitting

Shows there are curve fitting options. These vary and only an indication 'Yes' or 'No' is given, reference to the documentation should be made for more specific details.

Plot Maths functions

Indicates if maths functions be plotted directly, for example from an equation. Entry is 'Yes' or 'No'

View Point adjustment

Indicates that adjustment of the viewing position for 3-D graphical objects supported. Entry is 'Yes' or 'No'

Read Data points

If the value of data points can be displayed by clicking at a position on the graph, entry is 'Yes' otherwise 'No'

CHART AXES

This section of the Matrix deals with the appearance of axes in graph-type graphics. These explanations may be clearer if you refer back to Figure 3 in chapter 4: The anatomy of axes.

Axis

The Axis topics refer to the actual line which makes up the axis, and the positioning of axes.

- Change width/colour

Can be 'Both' if both options are allowed, 'No' if neither of them, or the specific name if only one is available.

- Allow Broken or Separated Axes

Can be 'Both' if both options are allowed, 'No' if neither of them, or the specific name if only one is available. A 'broken' axis has a section missing, for example to allow both ends of an extreme range of values to appear on a graph of manageable size. If axes can be separated, they can be positioned independently in the diagram - for example so they are set back from the data and do not meet at all.

- Axis scaling user-defined

Is either 'Yes' if the user can choose the range of values to be represented along the axis, otherwise 'No' if the package forces the scaling.

- Dual X/Y axes

Is either 'No', the name of the dual axis - (i.e. Dual X or Dual Y), or 'Both'

- Logarithmic axes

Is 'Yes' if the package can produce logarithmic axes, otherwise 'No'.

- Transposition of axes

Is 'Yes' if the X and Y axes can be swapped over, otherwise 'No'.

Axis labelling

The Axis labelling topics refer to the various text items with which you can embellish an axis.

- Allow edit of axis titles

Is either 'Yes' if you can, or 'No'.

- Position/move axis titles

Is 'Yes' if the package allows you to influence the positioning of the axis titles, or 'No'.

- Orientation of Axis titles

Refers chiefly to the Y-axis title, which can be either 'horizontal' or 'vertical'. 'either' means that the package allows you to set the orientation of the title.

- Scientific notation, Sub/Superscripts

Is either 'Yes' if the package can cope with these in the axis title, or 'No'.

- Foreign character support

Is 'Yes', 'No' or 'limited', depending on how easily the package will allow you to use foreign (for example accented) characters in axis titles. Refer to manual for more details.

Tick Marks

The Tick mark topics concern the appearance and labelling of the tick marks along the axis.

- Specify position

Is 'Yes' if you can choose to have ticks inside, outside or across the axis (or indeed to have no tick marks), or 'No' if the package doesn't give you the option.

-Format options

For tick mark labels is 'Yes' if the package lets you choose the style of the tick mark labels (such as scientific, exponential, integer etc), otherwise 'No'.

- Allow labelling only every Nth tickmark

Is 'Yes' if the package lets you choose which tick marks to label, otherwise 'No'.

- Grid lines on chart

Is 'Yes' if you can choose to have tick marks running right across the chart, otherwise 'No'.

OTHER CHART FACILITIES

This section of the Matrix covers floating text of any sort.

Titles

Is 'Yes' if the package lets you add a title, otherwise 'No'.

Legends

Is 'Yes' if you can add text anywhere on the chart, for example to act as a key, otherwise 'No'.

Data Point labels

Is 'Yes' if you can label individual points in the graph, 'yes, some' if you have some scope for labelling points, otherwise 'No'.

Floating labels (annotation)

Is 'Yes' if you can add general annotation to the chart, otherwise 'No'.

Chart size/position adjustment

Is 'Yes' if the package allows you to adjust the size of the chart, otherwise 'No'. It is useful if you can do this: while it won't make any difference to what you see on the screen, you get the best quality when adding a graphic to a printed document if you get its size right in the graphics package, rather than having to adjust its size in the printed document.

Background composition facilities

Gives you an idea of what backgrounds you can add to your chart. The main choices are 'coloured' (a plain coloured background), 'bitmap' (meaning that you can import a picture, logo or other graphic to have as a chart background), 'pattern' (to have the package generate a background pattern), or 'graduated' (for a variably-shaded background). The presence of a background facility in a package doesn't tell you if it is 'easy' or 'difficult', just 'possible'.

Frame/bounding box

Is 'Yes' if the package allows you to put a frame around the chart, otherwise 'No'.

Multiple charts on page

Is 'Yes' if the package lets you create and group several charts on a single page, otherwise 'No'.

CHART OBJECT ATTRIBUTES

This section of the Matrix covers the available attributes of items on the chart, or non-specific items which can be added to a chart.

Number of line styles & widths

The range of styles and widths are indicated by a general indication :-

1, no choice

<5, limited to five or less choices

5+, more than 5, reasonably unlimited

If the package allows the user to produce a customised linestyle or variable width a (u) is added after the entry.

Number of symbol styles

Shows you how many different symbols a package can use in a chart. The range is :-

1, no choice

<5, limited to five or less choices

5+, more than 5, reasonably unlimited

If the package allows the user to produce a customised symbol or change the size of an existing symbol a (u) is added after the entry.

Number of fill styles

Tells you the sort of fill styles which the package supports, for example to fill an area such as the segment of a pie chart or the area under a line graph. The range is :-

C, Coloured Solid fill

G, Graduated fill

P, Pattern or Hatch fill

B, Bitmap texturing

M, Column/Bar type graphs may be substituted by Symbols

If the package allows the user to produce a customised fill pattern a (u) is added after the entry.

Size of pre-defined colour palette

Gives you an idea of how many different colours are pre-defined in package. Colour range is more important in Creative graphics, a large range of simultaneously available colours is necessary to create realistic effects. The actual range of colours may be limited by the Graphics Card, in which cases dithering may be used.

Additionally the user may be allowed to specify their own colour choice from a palette. In such cases a (u) is added after the entry. This will almost always be the case for Creative Graphics facilities.

5 Using Graphics Files and IMAGES

When preparing a document there are a number of sources from which images may be obtained. You may produce them yourself using a Drawing or Charting package or you may obtain them 'already drawn' as Clipart. In either case the image will probably be stored at some point in a file.

If you produce them yourself you need only select a suitable exchange format which is common to the export/import facilities of the packages concerned. Alternatively it may be possible to bypass the file stage completely by the use of the 'Cut and Paste' facilities.

If you use Clipart, it usually supplied in the native image format used by that particular package. Often a package will also support other than it's own native format, so a wide variety of clipart may be available to you.

Popular file formats

There are a large number of different formats for storing graphics information in files. this list below only enumerates some of the more popular ones that are supported by the leading software packages. For more information you are recommended to consult *either Graphics File Formats* by Davis C. Kay and John R. Levine (Windcrest/McGraw-Hill, 1992) or *Encyclopedia of Graphics File Formats* by (O'Reilly & Associates, 1994)

BMP (Windows Bitmaps)

This is ideal for exchanging bitmap data between Windows applications, but is not widely available outside Windows.

CGM (Computer Graphics Metafile)

The CGM is an ISO standard for capturing and transferring picture information. "Computer Graphics Metafile" This is the first official standard for graphics files and should be a reliable solution for the storage and exchange of graphics files - but it is large and unwieldy, and different implementations are not always mutually compatible.

GIF (Graphics Interchange Format)

Bitmap format developed by Compuserve. Good for cross-platform file exchange. Widely used, file compression means smaller storage requirements.

HPGL (Hewlett Packard Graphics Language)

A line based vector format originally developed for driving HP plotters, and available on some non pen plotter devices such as laser printers. It may also be used for transferring line-based information between applications

JPEG (Joint Photographic Experts Group)

JPEG is a standard format developed by the Joint Photographers Experts Group, allowing transfer of files between a wide variety of platforms, using superior compression techniques.

PICT ("QuickDraw Picture Format")

This is a vector and bitmap page description language originating on the Mac. It is one of the commonest graphics standards on the Mac where it is very useful for exchanging both vector and bitmap data, but its colour support is limited, and it can only compress monochrome bitmap images. Versions of PICT are beginning to appear on PCs.

EPS (Encapsulated PostScript)

Postscript is a page description language for both vector and bitmap graphics, which has become a de facto standard (see section 6.1 on page 28). It was originally intended for driving output devices such as printers, but is now widely used for storing and exchanging graphics images - for which it should be used in its "encapsulated" form EPS ("raw" PostScript can disrupt a document if it is inserted into it, rather than being sent straight to a printer). PostScript produces very portable plain text files, but these can become large and unwieldy for bitmap images. It has become a standard for desktop publishing.

PCD (PhotoCD)

This is storage format developed by Kodak for the storage of bitmap images

PCX

Also known as PC Paintbrush, this is a bitmap format for desktop publishing, general graphics, and video. It is particularly useful for exchanging data between PCs. It is one of the oldest, and therefore most widely established, bitmap formats for PCs, supporting colour and large images, but some implementations may not be mutually compatible.

Sun Raster Files

These are bitmap format. Widely supported by Sun utilities and applications

TIFF (Tag IMAGE File Format)

This is a bitmap format for exchanging data between desktop applications, and available on Macs, PCs and Unix workstations. It is widely available, flexible and well-supported, and is excellent for storage, but non-standard extensions to the basic TIFF format mean that exchanging graphics between different platforms can sometimes fail.

WMF (Windows Meta File)

WMF files are useful for storing and exchanging graphics images under the Windows operating system, producing small, well-structured, device-independent files. It supports both bitmap and vector format.

XWD (X-Windows Dump)

This is a bitmap format. It is a useful method of exchanging bitmap based graphics between most X-Windows applications.

Graphics Metafiles

A *Graphics Metafile* is a file which contains a description of a picture (or set of pictures) expressed in some well-defined, formal manner. Graphics metafiles help to provide device independence by allowing pictures to be printed on a variety of devices; metafiles also facilitate picture portability by enabling the image(s) to be transferred to wherever they are required

The ISO standard metafile is the 'Computer Graphics Metafile' (CGM). There are also proprietary standards such as the Microsoft Windows MetaFile (WMF) and the Macintosh PICT file - these are particularly useful for transferring images between applications in the same operating system, although it is often possible to use, say a PICT, file in a Windows environment. CGM, where supported, allow transfers of information between all systems.

Apart from the above three graphics metafiles, there are numerous other graphics file formats in use, particularly on microcomputer software. These other graphics file formats tend to be used both for the compression of picture data and for the interchange of picture information between software packages. What usually happens is that the

package exports the picture in a particular format which is then imported in that format by another package. The list of file formats available is extensive: the commonest are summarised in chapter 5. Additionally the matrix in Appendix 2 shows which files are interchangeable between chosen packages via the import/export mechanism.

Clip Art

The term 'clip-art' applies generally to any collection of computer-based images or symbols which can be readily incorporated within a user's picture. Most popular presentation graphics packages now include clip-art libraries covering a wide range of subjects. The idea is that the user's picture can be enhanced by the judicious use of particular images. For example, a chart which shows motor car production in the UK may be improved by including an image of a motor car. A clip-art library will typically contain a set of images of everyday objects such as space rockets, telephones, washing machines, houses, furniture, airplanes, books, thermometers, ... indeed just about most things imaginable. Exactly how clip-art images are included within a user picture varies from package to package, but it is usually a straightforward process, and - again depending on the package - it is usually possible to expand, shrink or rotate the clip-art symbol so that it can be integrated within the picture to suit the user's requirements.

Note! Users should take care that they do not inadvertently infringe copyright restrictions by including images within their pictures, such as for example company trademarks or logos, which may require copyright permission

4 The Anatomy Of Charts and Drawings (The Picture Gallery extended)

Figure 1 in Chapter 3 gave a pictorial representation of the types of chart. We shall look at the general features of each type and describe many of the terms used in the facilities matrix (see Appendix 2)

Next, we examine the details of charts and the terminology involved. The term ‘data series’ is used to describe a group of numbers or measurements which refer to one variable. Some packages limit the amount of data in any one series, while keeping the total amount of data constant; others set an upper limit on the number of data series while allowing each series to contain large amounts of data. These constraints are often very important in the choice of package appropriate to the analysis and presentation of the data. Always bear in mind that a chart can become overcrowded and unintelligible if there are too many data series, so some of these constraints may be beneficial.

Charts

We cannot cover every possible chart or pictorial representation as each discipline has its own specialities, but the facilities offered by packages continue to develop and expand. If a particular feature is not available today, check again in six months time - a new product may be available or the facilities offered by existing packages may have changed.

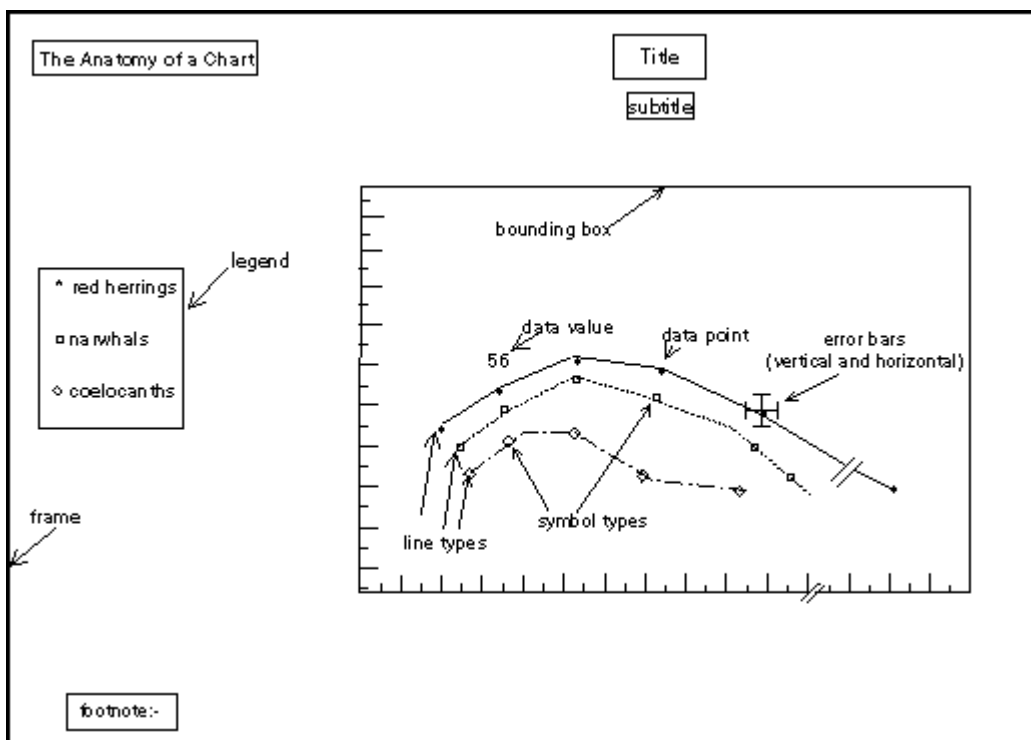


Figure 2: The anatomy of a chart

The *title* and *subtitle*, and perhaps the *footnote*, are common to many types of chart. Sometimes they are identified specifically and sometimes they are added as separate text, not identified specially. The *title* and *subtitle* give the audience an

important ‘handle’ on the message and draw attention to what is being said. Sometimes they emphasise the speaker’s identity or affiliation. The *footnote* is useful in organising charts.

The *legend* explains what each series of data represents. Different line types are required for black and white output, while different colours can be used to distinguish the different data series if colour output devices are available. But bear in mind that colour vision is impaired in a significant number of people, and also that certain colours do not stand out in poor lighting conditions. In some circumstances it can be valuable to give the exact value of a data point, while in others, overall trends are all that is required.

'Missing data' are always a problem. If a data series is likely to be incomplete, how does a package respond? Does it simply skip over the blank or does it interpret absence as zero? Can missing data be coded so that the package knows to skip over the value? Will the package expect a full data series for each variable in a group?

Many series of data contain outliers or extreme values which distort the presentation: will logarithmic axes be necessary? If so, how will the package represent a zero value? Can the axes be split to avoid large areas of empty space?

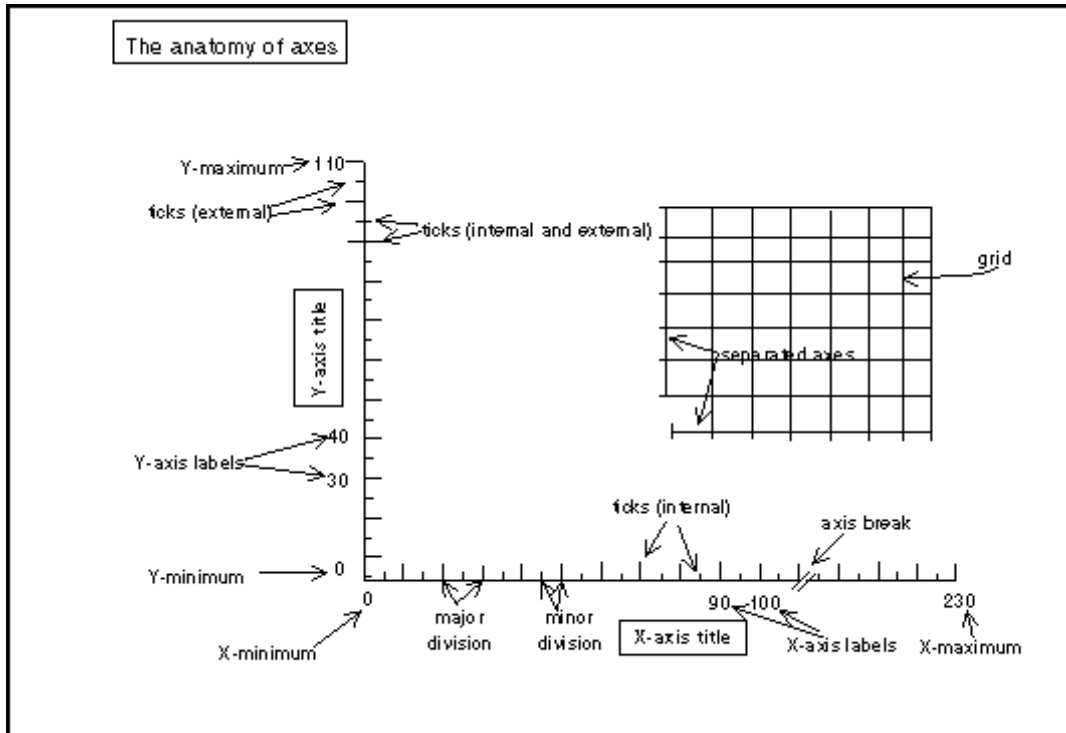


Figure 3: The anatomy of axes

Examination of papers in scientific journals will show that there is a wide variety of methods for presenting axes: does the target journal have a specific style? Will separated axes be necessary? How many

major divisions are appropriate for the data and what is the best number to choose to enhance the message without cluttering the display? Can the maximum and minimum values for the axes be defined? Are subdivisions really necessary or will it be best to give exact data values? Will the placing of the axes' tick marks be important?

What sort of X-data will be employed? Textual, numeric or date? If a time series is required, what is the best way to show the divisions? How will the axes be labelled? Will scientific notation, subscripts, superscripts and non-English characters be necessary? If so, can the printer produce the full range?

Is the orientation of the Y-axis label important? Can it be aligned vertically? How many X and Y axes are needed and how many are optimal to present the data, but to avoid over-crowding the image by presenting too much data? Will contours and Z axes be necessary?

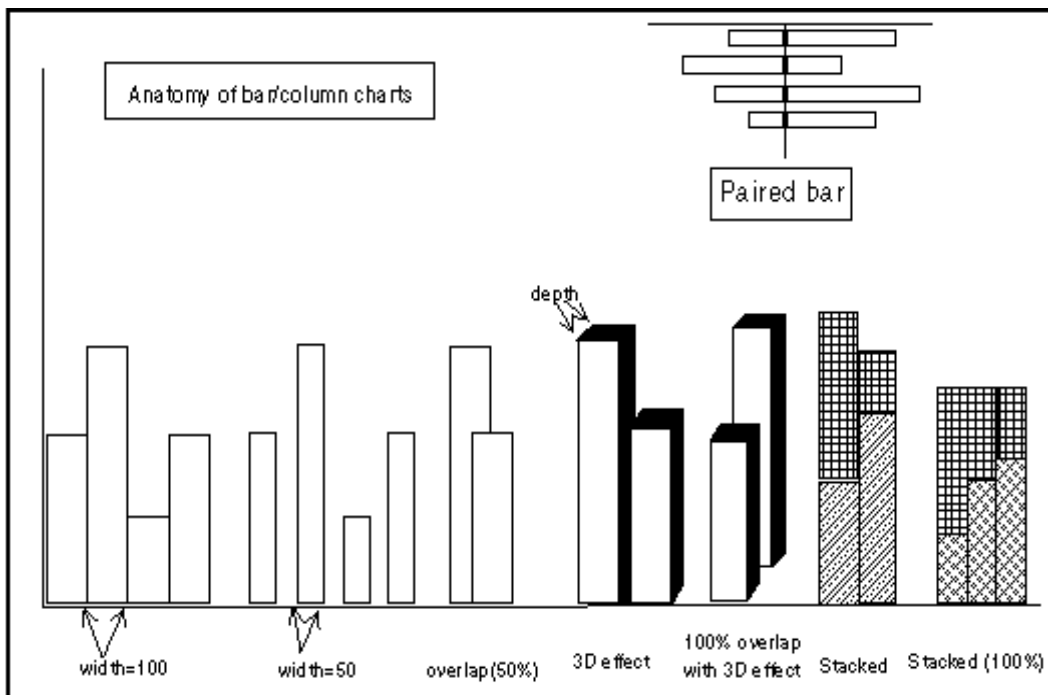


Figure 4: The anatomy of bar and column charts

The line or scatter graph is very widely used for presenting scientific data, while bar and column charts are often used for showing differences between discrete

variables. Many of the ideas introduced here can be applied to other types of chart.

The width can be varied so that columns touch, as they do with histograms, or points can be emphasised by keeping the columns separate. The display can be made less cluttered by overlapping the columns or by stacking the data. Percentages can be emphasised by employing the stacked column (100%) technique and some pleasing results can be obtained by adding 3D effects. The combination of 3D effects and overlapping can, in certain circumstances, hide data if a tall column comes in front of a short column; in this case it may be possible to change the angle of vision by rotating the chart. If this proves necessary, is the choice of chart type appropriate?

The *paired bar chart* is often good at showing differences between two categories, such as the comparative performance of two cars over a number of criteria. The choice of fill pattern can also be important. Solid colour can be easier to distinguish than similar patterns, particularly if there is unfortunate juxtaposition of small data sets.

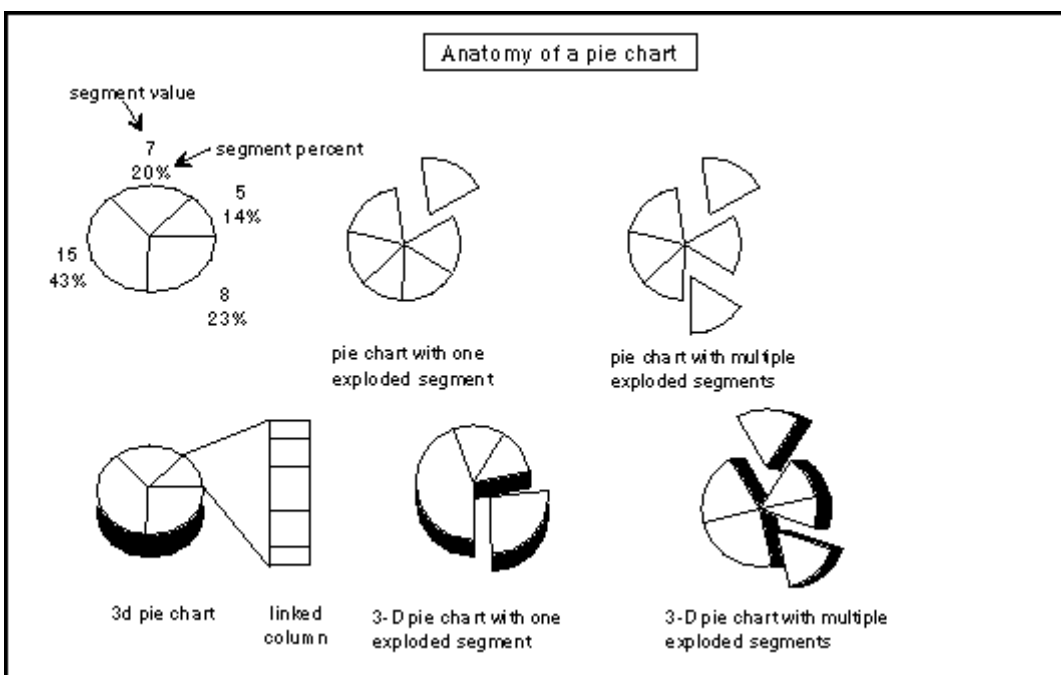


Figure 5: The anatomy of a pie chart

A Pie-chart is a popular and useful way of representing small numbers of variables. Particular aspects can be emphasised by exploding segments. Some packages are poor at

pie charts. Will it be necessary to show data values, or percentages of the total? If there is an aggregated group ('other'), will it be useful to have a linked pie or column chart giving a detailed analysis?

The pie chart is ideally suited to small numbers of variables, so the number of fill patterns or colours available will rarely be an issue, although the appropriate choice of pattern or colour will be important.

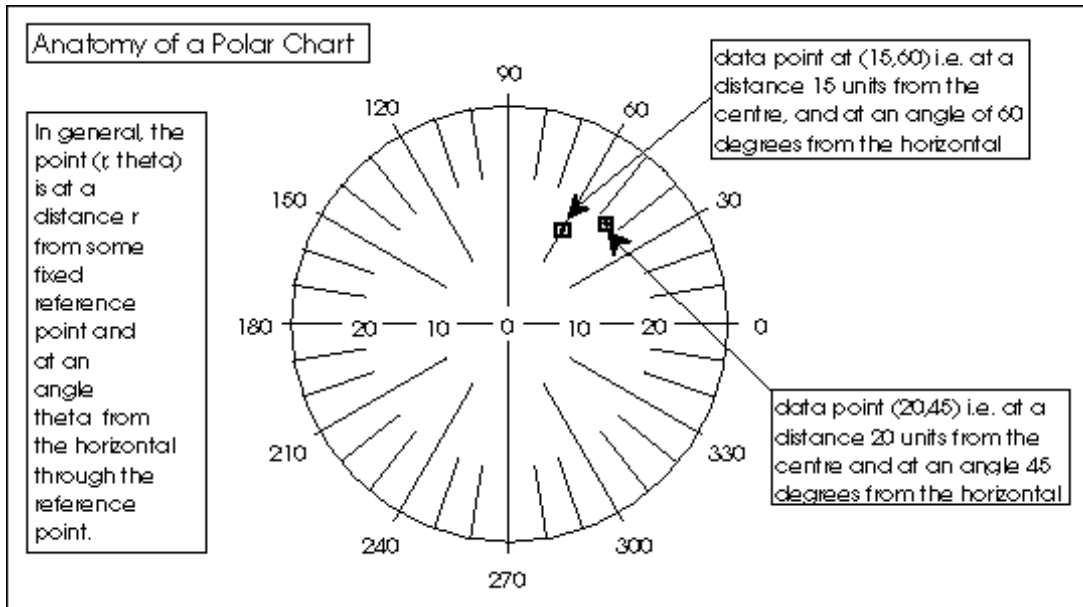


Figure 6:
The anatomy
of a Polar
Chart

Polar charts are used in science and engineering in applications where it is more natural to express coordinates in polar than

in cartesian form.

Drawings

Figures 7 and 8 show some of the tools a skilled artist can use for eye-catching effects. Rotation, skewing and mirroring are available in most drawing packages, but the power of control point adjustment, perspective adjustment and 'enveloping' are confined to specialist programs. In particular, control point adjustment gives incredible power over positioning and the shape of curves. These techniques can be combined with the ability to fill objects with different patterns and colours to create images which are attractive, as well as informative.

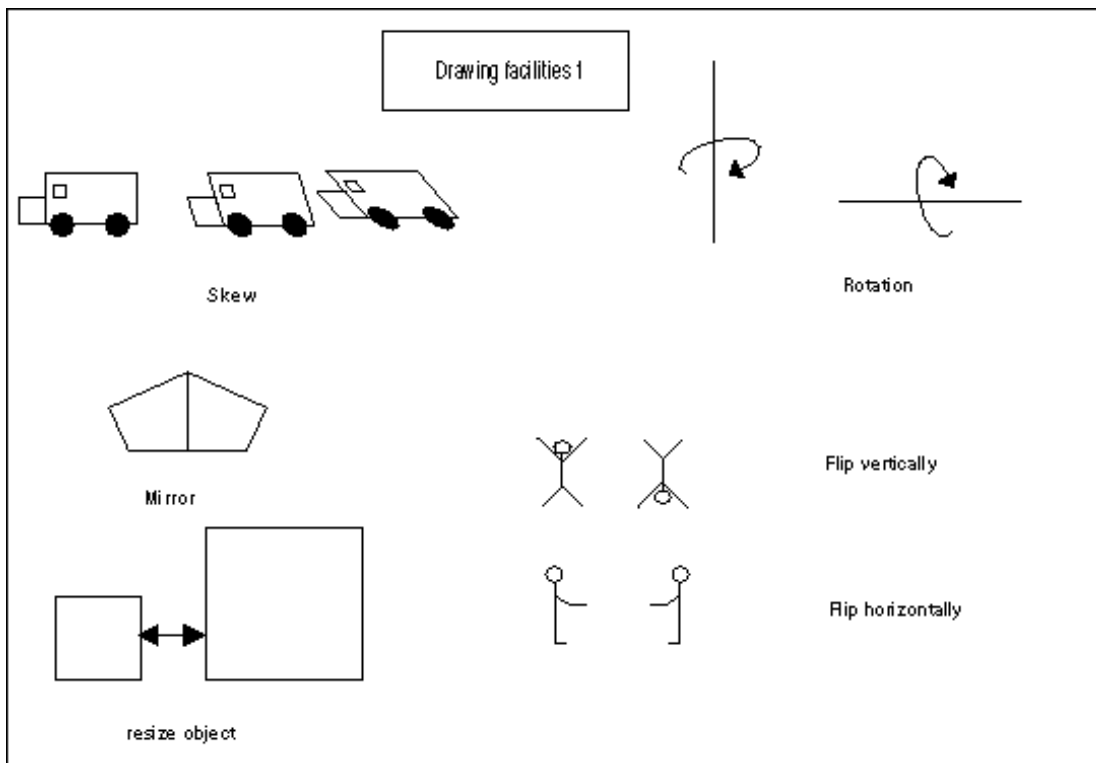
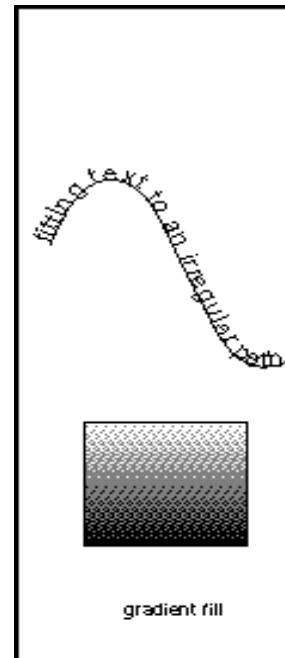


Figure 7:
some
features of
freehand
drawing



of freehand drawing

Aspects of Design

The issue of picture design is a potentially complex one which raises many questions, such as:

Typefaces What sort of font (bold, italic, etc.) should be used? how many different typefaces should be used within any one picture/ What size of typeface would look best?

Layout Where should the various components of a picture be placed in relation to one another? What relative size should each picture component be? What effects can be employed to draw attention to one particular aspect of a picture?

Colour Which colour combinations go well together? Which combinations should be avoided? which combinations should be used to compensate for colour blindness? Should colour be used at all? Would black and white (or some form of grey scale) be more effective in particular circumstances?

If users are uncertain about these or any other aspects of design, professional advice should be sought. Refer to the supplement for references to any such bodies within your organisation.

On the specific issue of colour in computer graphics, there are numerous publications. Some very useful introductory articles/booklets for anyone interested in learning more about colour usage are:

- *Using Colour in Computer Graphics*, F.R.A. Hopgood, published by the Advisory Group on Computer Graphics, Technical Report No 4, January 1991.
- *Picture Perfect: Color Output for Computer Graphics*, J. Rowell, published by Tektronix Inc, 1990.
- *The Effective Use of Color*, G. Murch, Tektronix Inc, Techniques Newsletter, Vol 7 No 4, Winter 1983, Vol 8 No 1, Spring 1984, Vol 8 No 2, Summer 1984.

The specific topic of colour blindness, and how to produce pictures which compensate for it, is covered in:

- *Computer Graphics: Principles and Practice*, Foley, van Dam et al, Second edition, 1990, Addison-Wesley.

Local advice and access to reference documentation may be available locally - refer to the *Supplement* at the end of this document

GLOSSARY

3D	'Three-dimensional' - a term used to describe attempts to draw a three-dimensional object such as a curved surface or xyz graph on a two-dimensional screen or piece of paper. Also called 'two-and-a-half dimensional'.
4D	'Four-dimensional' - a 3D diagram in which colour is used to depict the variation of a fourth variable.
A0/A1/A2/A3/A4/A5	Standard paper sizes: A4 is 297mm by 210 mm; A3 is 420mm by 297mm with sizes A2, A1 and A0 progressively doubling. A5 is 210mm by 148mm
area chart	A chart in which the area of interest is shaded in solid colour: useful for capturing attention but should be used sparingly for best effect.
ASCII	The American Standard Code for Information Interchange - a standard for the representation of textual characters held in a computer system. For example the ASCII value for 'A' is 65, or 01000001 in binary.
bar chart	A 'horizontal histogram', in which data values are represented by horizontal bars. Not used widely, but particularly effective where each individual data point has to be named. See also column chart.
bramble chart	See cluster chart.
business graphics	A general term for methods of presenting data in a formal, structured fashion - such as a line graph, bar chart, pie chart or histogram. See also "creative graphics".
Cartesian coordinates	A measurement system for defining the position of a point with respect to two (or more) straight axes at right angles to each other. This is the commonest coordinate system, the main alternative being polar coordinates
CGM	'Computer Graphics Metafile', an ISO standard by which pictorial information can be stored in a computer file, in which form it can be transferred and reconstituted. CGM is more commonly used for transferring graphical images between software packages than for sending it to output devices such as plotters.
chart	A general term indicating any drawing, graph, image, text, or combination of these elements.
CHEST	Combined Higher Education Software Team. CHEST arranges and administers software deals on behalf of the UK academic community. The CHEST Software Directory is available on-line through the NISS Gateway, and in book form.
clip art	Collections of graphic images or symbols stored in computer form which can be readily incorporated into more complex diagrams, documents or presentations to enliven their appearance. Clip art libraries are available to cover most everyday items and many specialised ones. Care should be taken to observe any copyright restrictions when using clip art.
cluster chart	A form of chart suitable for depicting data which only falls into a few restricted categories, such as 'normal', 'high' or 'low'. The x axis is then usually descriptive rather than numeric. Used particularly in medical and biological work.
column chart	A chart in which data values are represented by vertical columns: histograms are a specific class of column chart used in statistical work. See also bar chart.

contour chart	A method for depicting 3D data such as the heights of a landscape, or in general, for any measurements which are a function of two other, independent, variables. Thus each point is specified by three measurements, two for its position (x,y) and one for its actual value (z). An Ordnance Survey map is a contour chart.
creative graphics	A general term for informal and unstructured graphical presentation, not usually representing any pre-existing data. Common examples are drawings and diagrams produced by hand. See also "business graphics".
curve-fitting	The attempt to find a pattern in data by drawing a line through a set of points so that it goes as close as possible to all of them. This could be a straight line but is more generally a curved one, ideally with an underlying equation which would help to analyse the data.
DDE	See "Dynamic Data Exchange".
device driver	A software module which accepts input in some general form and converts it into specific instructions which are sent to a specific printer, plotter or other output device. For example many graphics packages and word-processors generate their output in device-independent form and rely on specific device drivers to produce the actual output. In this method of working every device must have its own specific device driver.
device independence	The operational mode of many graphics and word-processing packages, which do not produce their output in a form which can be sent to any output device (such as a plotter or printer), but which contains all the necessary information from which a device driver can generate the required output on information from which a device driver can generate the required output on a particular device.
digitiser	A device which converts graphical input into a digital form which can be manipulated in a computer. It consists of a tablet on which a diagram can be mounted, and a pen-like stylus which can be traced around the diagram, Producing digital measurements which are fed into the computer.
digitising tablet	A graphical device which enables pictorial information to be input to a computer. It is especially appropriate for line-based pictures (for example mapping boundaries). The process involves drawing over each line with a special stylus or mouse device.
dithering	The technique of manipulating patterns of dots produced by a printer to generate more colours or shades of grey than it should be capable of. For example if a black-and-white printer can print a small box as a pattern of black and white dots, the overall appearance of the box will be grey, its precise shade depending on the relative proportions of the black and white dots. Similarly a simple colour ink jet printer can produce various shades of orange from patterns of red and yellow dots. This is a very effective technique, but the penalty is loss of resolution in the final image.
dot-matrix printer	A (cheap, noisy and comparatively slow) printing device in which text and graphics are produced by an array of pins forcing a printer ribbon against paper. The alternative is a 'non-impact printer' such as an 'inkjet printer' (relatively cheap) or 'laser printer' (relatively expensive).
dots per inch	('Dpi') a measure of the resolution of an output device such as a computer screen or laser printer, which effectively shows the size of the dots it uses to generate characters and graphics. The bigger this number, the smaller the dots and the finer the resolution. For example, apple mac screens have 72 dpi, and most laser printers have 300 dpi, with 600 dpi starting to appear in desktop machines. The very best publications require at least 1200 dpi devices.

dpi	Acronym for dots per inch.
Dynamic Data Exchange	A proprietary method of linking the data in one application to a graphical or other display in another application. When the data is changed in the first program, the display in the second is updated automatically, allowing a single master set of data to be used for all purposes.
enveloping	"Envelope-ing" - distorting a graphical image by fitting it into a non-rectilinear shape, or envelope.
error bars	Lines which are added to the data points in certain types of graph to indicate the margin of error in that point - that is, the range within which it lies. An error bar indicates the range of values when several measurements are used to generate a single point on a graph, or the maximum possible error in measuring or calculating the position of the point.
font	See 'typeface'.
functionality	A measure of the capability of, or range of facilities available in, an item of software or hardware. Modern computer packages and equipment tend to have much better functionality than older ones, and expensive ones greater functionality than cheaper ones.
Graphical User Interface	A characteristic style of user-program interface in which the computer is controlled graphically - by a mouse acting through windows and icons - rather than by issuing it with textual commands. See also WIMP.
grey scale	The ability of a black-and-white printer or screen to display shades of grey.
GUI	Graphical User Interface, pronounced "goeey". See also WIMP.
hardcopy	Output on a permanent medium such as paper, transparency, film or video, as opposed to temporary output to a computer screen.
histogram	A special form of 'column chart', particularly used in statistical applications, using vertical columns to display the value of the data point or the average value of a range of data points in a limited set of classes.
hot link	A connection between data in one program and its use in another, for example allowing data to be changed in a spreadsheet, whereupon a separate graphics or DTP package - connected to the first by a hot link - automatically changes its representation of that data.
HPGL	'Hewlett-Packard Graphics Language' - a de facto standard language with which to control pen plotters, which is also accepted by a number of non-pen devices such as laser printers and electrostatic plotters.
image	(1) any graphic item, made up of any graphical elements including text. (2) a precise copy of the contents of a computer's memory, elsewhere in memory or on a disk.
impact devices	Printing devices in which text and graphics are produced by an array of pins forcing a printer ribbon against paper. They tend to be cheap, but produce low-quality output and are noisy and comparatively slow.
inkjet printer	Drops of ink at the paper, typically on a 300 dpi matrix. Results are almost as good as a cheap laser printer's, though the ink tends to spread a little, and will run if it gets wet.

Laser printer	A non-impact printing device which operates in similar fashion to a photocopier, in which a laser draws the image of a page on a photosensitive drum which then attracts toner on to the paper, where it is subsequently bonded by heating. Now the most popular type of printer for reasonable
LED printer	Very similar to a laser printer, but using leds (light-emitting diodes) rather than a laser to create the electrostatic charge on the drum.
Line art	A diagram which consists only of lines and text, requiring no complex grey level or colour shading.
Line chart	One of the commonest forms of graph, particularly favoured by scientists, with data points displayed against X and Y axes and all the points connected with a single line. The points themselves need not be shown. Alternatively, all the data points may be shown and a line drawn which doesn't necessarily go through them all but which gives a reasonable 'best fit' to them all.
media	Plural of 'medium', referring to the types of material on which computer output can be stored. The commonest media are disks (hard and floppy), magnetic tape (reel and cartridge), optical disks, punched paper and punched cards, ordinary paper, photographic film, video, and semiconductor 'flash-cards'.
metafile	A file which contains a description of a picture or set of pictures in a well- defined, formal manner. This allows diagrams to be transferred between different graphics packages, and also allows programs to ignore the specific details of particular output hardware - but just use a common 'device- driver' to translate the metafile into printer-specific instructions.
mirroring	Transforming a graphical image into its horizontally reversed form, as though reflected in a mirror.
mono(chrome)	An output device which can only show one colour, though possibly in several shades. Monochrome printers and some screens tend to be black- and-white.
non-impact devices	Printers and plotters which do not use physical force to transfer ink to paper, common examples being inkjet, thermal-wax and laser printers.
paired bar chart	A special kind of 'bar chart' which uses horizontal columns in pairs to emphasise the differences in measurements taken at two different times, places, experiments etc.
pen plotter	A reasonably cheap type of output device which uses pens to draw graphic images on paper. It is fine for producing smooth lines and is therefore the natural way to draw line charts, but it has few colours, is not sensible for area fill, and is slow for complex drawings.
perspective	A technique for making three-dimensional objects look more natural when represented on paper or screen, by for example making distant objects smaller than closer ones, and parallel lines converge in the distance.
pie chart	An effective method of displaying (preferably no more than) about six variables, rather like looking down on a circular apple pie which has been cut into slices. The size of each slice reflects the size of each variable.
polar chart	A chart on which data points are plotted in polar coordinates rather than 'Cartesian coordinates'. Each point is defined in terms of its distance from the centre of a circle and the angle a notional connecting line makes to the horizontal.

PostScript	A de facto standard page-description language from the Adobe Corporation, which is now the most widely used way of sending text and graphics to printers such as laser printers - many of which now have postscript interpreters built-in for speed and flexibility.
prepress	Final preparation of material to be printed to the highest standards, probably by an external, professional printer. This includes the specification of all the fonts and graphics used in a document.
presentation	In the normal sense of the word, a presentation is some kind of talk to an audience, possibly enhanced with visual or audio material. A 'presentation package' runs on a computer to assist with the production of illustrative material to be used in a presentation, either in generating such aids as overhead or 35mm transparencies, or - increasingly - used at the presentation itself, with the on-screen images viewed directly by the audience.
QC chart	A chart which shows the acceptable range of measurements, perhaps on some manufactured item or experimental data, on which actual measurements can be plotted to show whether the manufacture or experiment is proceeding satisfactorily.
Quality control chart	
raster	The technique of building up a graphical image as a series of on/off or coloured dots along a set of lines on a screen or other output device. A television set is the commonest form of raster device. In a laser printer or computer display, for example, the image is built up by a signal which is swept along each line in succession, and variously attenuated to produce the required pattern. The alternative method of producing images is 'vector'.
resolution	The fineness of detail which a computer device can detect or produce. For example a high-resolution screen or printer can show fine detail, and a high- resolution scanner or digitiser can detect fine detail.
rotation	Transforming a graphical image by rotating it about some axis, to some degree. 'Mirroring' is a special case of rotation.
scanner	A device which scans a light across a page of text or graphics and feeds a digitised representation of the image into a computer for storage or further processing. Scanners are typically flat-bed (like a photocopier), rotating- drum, or hand-held. If the image is text, there are software packages which can convert it from an image to actual characters which can for example be loaded into a word-processor.
scatter chart	A classic 'x vs y' graph consisting of two axes, with each data point marked with its own symbol: like a 'line chart' but without the connecting lines.
site licence	An agreement between a software publisher and an educational establishment which allows software to be acquired at a reduced price, on condition that it is only used for academic, non-commercial purposes.
skewing	Transforming a graphical image by distorting it about some axis, to some degree. For example, a square can be skewed into a diamond shape.
subscript	Text which is written on a lower baseline, and usually in a smaller font, than its surrounding text, as for example the x in lx.
superscript	Text which is written on a higher baseline, and usually in a smaller font, than its surrounding text, as for example the 2 in x ² .
text chart	

A chart consisting mainly or exclusively of text, added graphical elements including colour, font and background. Text charts are commonly used on overhead and 35mm transparencies and in 'presentation' packages, for example.

typeface

A character design, specifying the shape of all the upper and lower case characters, numerals and punctuation symbols. Different typefaces are useful in different contexts, for example in running text or in headlines, and to give an old-fashioned, or conservative, or modem, or striking appearance. Commonly used typefaces include times, helvetica and courier. Each typeface is actually a family of individual 'fonts', each of which represent the typeface in a particular size (such as 12 point) and style (such as bold or italic). The words 'font' and 'typeface' are increasingly - and inaccurately - used interchangeably.

Uniras

A large and powerful graphics package available on a range of computer platforms to enable users to generate most types of graphical output

vector

A straight line drawn from one point to another point. Vector devices, of which the commonest type is the 'pen plotter', are designed specifically to draw or plot vectors, making them ideal for graphical objects such as line charts which consist only of lines. The more versatile alternative is a 'raster' device.

WIMP

"Windows, /Icons/, Menus and Pointer", or "Windows, /Icons/, Mouse and Pull-down menus" This is a graphical interface which makes access to computers much more straightforward and intuitive than the main alternative, the command-line interface. The WIMP interface has been used on Apple Macintosh computers since they were invented, and are coming into use on PCs through Microsoft Windows and on Unix and other workstations through the X Window system.

Windowing System

A graphical (GUI) interface to a computer's Operating System, giving the user such features as windows, a mouse and pull-down menus by which to drive the computer, rather than having to type in command words.

workstation

Any computer which can sit on a desk, though usually taken to indicate amore powerful machine such as those from Sun or Silicon Graphics, rather than a less powerful PC or Apple Mac.

WYSIWYG

"What You See Is What You Get" - the description of systems or packages which faithfully represent on the screen what a document will look like when printed.