Presenting numerical data

This guide offers practical advice on how to incorporate numerical information into essays, reports, dissertations, posters and presentations. The guide outlines the role of text, tables, graphs and charts as formats for presenting numerical data. It focuses on issues that should be addressed when presenting numerical data for different audiences and highlights ways that will maximise the impact of such data and ensure that they are easy to read and interpret.

Other useful guides: ***Bar charts, Histograms, Pie charts***

Introduction

It is likely that there will be occasions when you have numerical information that you want to include in your work, for example figures and other statistics from secondary sources (such as books, journal articles or newspaper reports); the results of experiments; or data that you have collected and analysed as part of a project or dissertation. Such information can be used to illustrate an argument or convey complex or detailed information in a concise manner.

There are three main methods of presenting such information:

- it can be incorporated into the main body of text;
- it can be presented separately as a table; or
- it can be used to construct a graph or chart.

Determining which of these methods is the most appropriate depends upon the amount of data you are dealing with and their complexity. The choice about whether to use text, tables or graphs requires careful consideration if you are to ensure that your reader or audience understands your argument and is not left struggling to interpret data that are poorly presented or in an inappropriate format. It is crucial to remember that when using a table or graph the associated text should describe what the data reveal about the topic; you should not need to describe the information again in words.

Including numbers in the main body of text

Numbers are most effective in the main body of the text of an essay, report or dissertation when there are only two values to compare.

For example:

86% of male students said they regularly ate breakfast compared to 62% of female students.

If you are discussing three or more numbers, including them within the main body of text does not facilitate comprehension or comparison and it is often more useful to use a table incorporated within the text.

For example,

53% of male students said that they always ate breakfast, 33% said that they usually did, and 14% said that they never ate breakfast.

Is more clearly expressed as:

Male students said they ate breakfast:

Always	*53%*
Usually	*33%*
Never	*14%*

In order to help the reader compare the numbers it is also useful to list them according to their magnitude (e.g. from large to small) unless there is a particular pattern or trend in the data that you want to highlight.

In general, numbers are usually given as digits rather than spelt out in the text, e.g. 400 rather than four hundred. However, in some academic journals the convention is to spell out whole numbers between one and ten and use values for all other numbers - so you may wish to find out what the usual practice is within your own discipline.

Presenting numbers in tables

Tables are used to present numerical data in a wide variety of publications from newspapers, journals and textbooks to the sides of grocery packets. They are the format in which most numerical data are initially stored and analysed and are likely to be the means you use to organise data collected during experiments and dissertation research. However, when writing up your work you will have to make a decision about whether a table is the best way of presenting the data, or if it would be easier to understand if you were to use a graph or chart.

This section of the guide identifies the appropriate uses of tables, and discusses some design issues for constructing clear tables which are easy to interpret. The points covered in this guide apply equally to primary data that you have collected yourself, and to data that you have found in secondary sources and which you wish to include in your work. The latter may already be presented as a table in the original work but you do not have to reproduce it exactly. It may be that you only require an extract from the table to support your argument, or that the design of the table could be improved, or that you wish to merge information from two different publications. There is no problem in doing any of these as long as you ensure that you reference the original source of the data in your table.

When to use tables

Tables are an effective way of presenting data:

- when you wish to show how a single category of information varies when measured at different points (in time or space). For example, a table would be an appropriate way of showing how the category *unemployment rate* varies between different countries in the EU (different points in space);

- when the dataset contains relatively few numbers. This is because it is very hard for a reader to assimilate and interpret many numbers in a table . In particular, avoid the use of complex tables in talks and presentations when the audience will have a relatively short time to take in the information and little or no opportunity to review it at a later stage;

- when the precise value is crucial to your argument and a graph would not convey the same level of precision. For example, when it is important that the reader knows that the result was 2.48 and not 2.45;

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- when you don't wish the presence of one or two very high or low numbers to detract from the message contained in the rest of the dataset. For example if you are presenting information about the annual profits of an organisation and don't want the underlying variability from one year to the next to be swamped by a large loss in a particular year.

Table design

In order to ensure that your table is clear and easy to interpret there are a number of design issues that need to be considered. These are listed below:

- Since tables consist of rows and columns of information it is important to consider how the data are arranged between the two. Most people find it easier to identify patterns in numerical data by reading down a column rather than across a row. This means that you should plan your row and column categories to ensure that the patterns you wish to highlight are revealed in the columns. It is also easier to interpret the data if they arranged according to their magnitude so there is numerical progression down the columns, although this may not always be possible.

- If there are several columns or categories of information a table can appear complex and become hard to read. It also becomes more difficult to list the data by magnitude since the order that applies to one column may not be the same for others. In such cases you need to decide which column contains the most important trend and this should be used to structure the table. If the columns are equally important it is often better to include two or more simple tables rather than using a single more complex one.

- Numbers in tables should be presented in their most simple format. This may mean rounding up values to avoid the use of decimal places, stating the units (e.g. £4.6 million rather than £4,600,000) or using scientific notation (e.g. 6.315×10^{-2} rather than 0.06315).

- All tables should be presented with a title that contains enough detail that a reader can understand the content without needing to consult the accompanying text. There should also be information about the source of the data being used; this may be a reference to a book or journal, or could indicate that the data are results from an experiment carried out on a particular date.

- Where more than one table is being presented it is standard practice to give each one a unique reference number, and in larger pieces of work, such as dissertations, a list of tables with their page number is usually provided in addition to the contents page.

- The formatting of the table should not resemble a spreadsheet where each entry is bounded by a box since this makes it difficult to read across rows or down columns. However, the design of the table should help the reader interpret the data and so the use of lines and/or bold text to separate headings from the body of data, or highlighting/shading specific rows or may be effective. Avoid large gaps between columns since this also makes it difficult to read along a row.

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Examples of poor and better practice in the presentation of data in tables

Region	% adults taking a holiday
East Anglia	50
East Midlands	64
Greater London	56
Humberside and Yorkshire	64
North	54
North West	59
South East	60
South West	61
West Midlands	56

Poor example:

- ***The table lacks a title and the source of the information is not provided***
- ***Row titles straddle two lines***
- ***Each cell is bounded as if in a spreadsheet***
- ***The alphabetical listing of regions results in non-numerical ordering of data down the columns***

Table 1: Regional Differences in the Percentage of Adults Taking a Holiday in 1998

Region	%
East Midlands	64
Humberside & Yorks.	64
South West	61
South East	60
North West	59
Greater London	56
West Midlands	56
North	54
East Anglia	50

Better example

Graphs

Graphs are a good means of describing, exploring or summarising numerical data because the use of a visual image can simplify complex information and help to highlight patterns and trends in the data. They are a particularly effective way of presenting a large amount of data but can also be used instead of a table to present smaller datasets. There are many different graph types to choose from and a critical issue is to ensure that the graph type selected is the most appropriate for the data. Having done this, it is then essential to ensure that the design and presentation of the graph help the reader or audience interpret the data.

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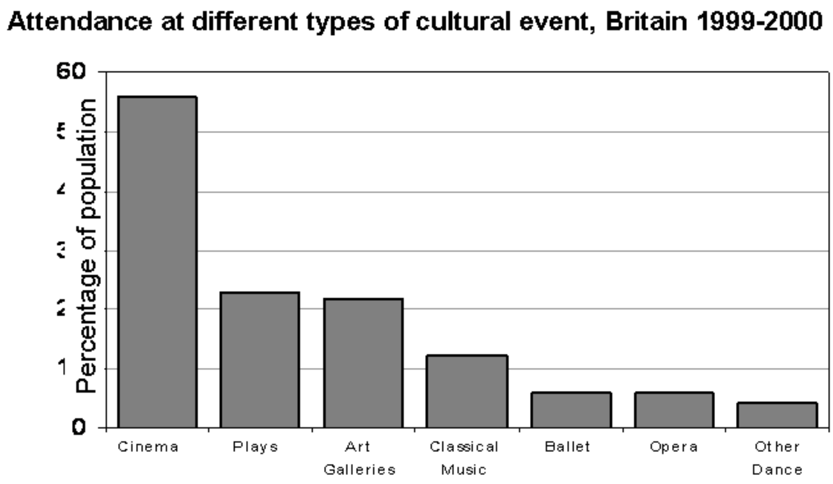
A summary of the types of data that can be presented in the most common types of graphs is provided below and this is followed by some general guidelines for designing readily understandable graphs. There is more detailed information on the uses and good design of particular types of graph in the companion study guides covering bar charts, histograms, pie charts, line graphs and scatter plots available from the Student Development Zone.

Types of Graph

Bar charts

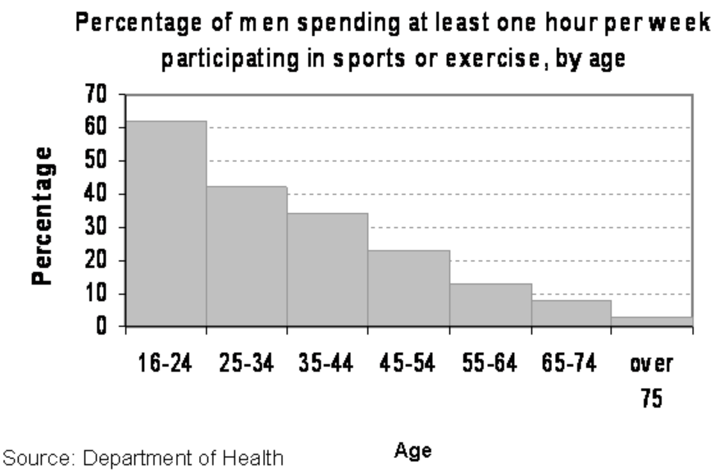
Bar charts are one of the most commonly used types of graph and are used to display and compare the number, frequency or other measure (e.g. mean) for different discrete categories or groups. The graph is constructed such that the heights or lengths of the different bars are proportional to the size of the category they represent. Since the x-axis (the horizontal axis) represents the different categories it has no scale. The y-axis (the vertical axis) does have a scale and this indicates the units of measurement. The bars can be drawn either vertically or horizontally depending upon the number of categories and length or complexity of the category labels. There are various ways in which bar charts can be constructed and this makes them a very flexible chart type. For example, if there is more than one set of values for each category then grouped or component bar charts can be used to display the data. Further details about each of these different types of bar chart can be found in the associated study guide ***Bar Charts.***



Source: www.statistics.gov.uk

Histograms

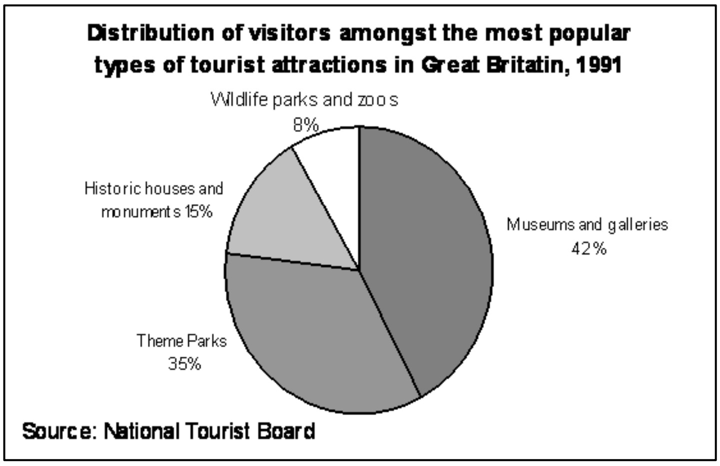
Histograms are a special form of bar chart where the data represent continuous rather than discrete categories. For example a histogram could be used to present details of the average number of hours exercise carried out by people of different ages because age is a continuous rather than a discrete category. However, because a continuous category may have a large number of possible values the data are often grouped to reduce the number of data points. For example, instead of drawing a bar for each individual age between 0 and 65, the data could be grouped into a series of continuous age ranges such as 16-24, 25-34, 35-44 etc. Unlike a bar chart, in a histogram both the x- and y-axes have a scale. This means that it is the area of the bar that is proportional to the size of the category represented and not just its height Further information on constructing histograms is available in the associated study guide ***Histograms.***



Source: Department of Health

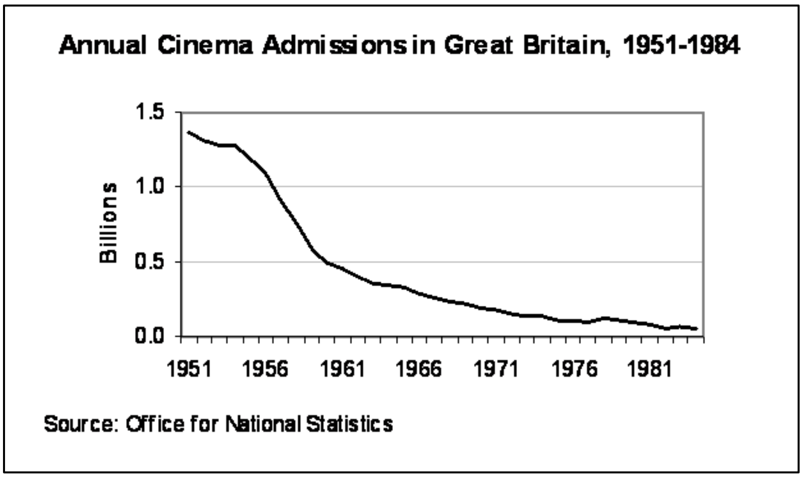
Pie charts

Pie charts are a visual way of displaying how the total data are distributed between different categories. The example here shows the proportional distribution of visitors between different types of tourist attractions. Similar uses of a pie chart would be to show the percentage of the total votes received by each party in an election. Pie charts should only be used for displaying nominal data (i.e. data that are classed into different categories). They are generally best for showing information grouped into a small number of categories and are a graphical way of displaying data that might otherwise be presented as a simple table. The study guide ***Pie Charts*** gives more details about designing pie charts and using them to compare data.



Line graphs

Line graphs are usually used to show time series data – that is how one or more variables vary over a continuous period of time. Typical examples of the types of data that can be presented using line graphs are monthly rainfall and annual unemployment rates. Line graphs are particularly useful for identifying patterns and trends in the data such as seasonal effects, large changes and turning points. As well as time series data, line graphs can also be appropriate for displaying data that are measured over other continuous variables such as distance. For example, a line graph could be used to show how pollution levels vary with increasing distance from a source, or how the level of a chemical varies with depth of soil. However, it is important to consider whether the data have been collected at sufficiently regular intervals so that estimates made for a point lying half-way along the line between two successive measurements would be reasonable. In a line graph the x-axis represents the continuous variable (for example year or distance from the initial measurement) whilst the y-axis has a scale and indicates the measurement. Several data series can be plotted on the same line chart and this is particularly useful for analysing and comparing the trends in different datasets.



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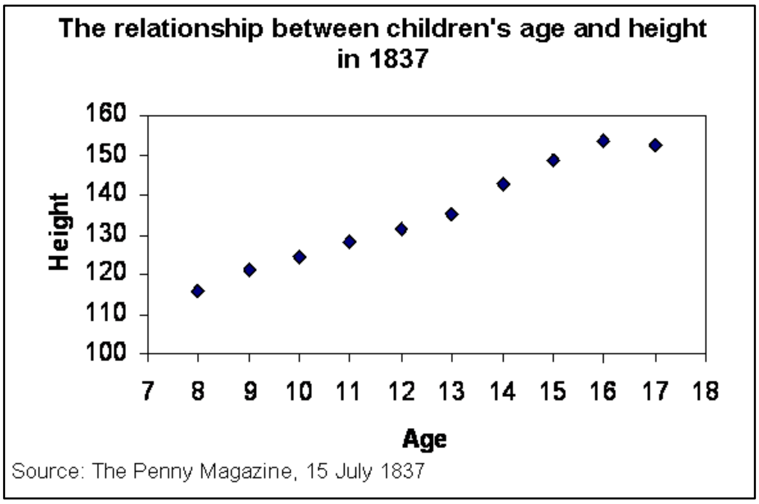
Scatter Plots



Scatter plots are used to show the relationship between pairs of quantitative measurements made for the same object or individual. For example, a scatter plot could be used to present information about the examination and coursework marks for each of the students in a class. In the example here, the paired measurements are the age and height of children in 1837. In a scatter plot a dot represents each individual or object (child in this case) and is located with reference to the x-axis and y-axis, each of which represent one of the two measurements. By analysing the pattern of dots that make up a scatter plot it is possible to identify whether there is any systematic or causal relationship between the two measurements. For example, in this case it is clear from the upward trending pattern of dots that children's height increases with age. Regression lines can also be added to the graph and used to decide whether the relationship between the two sets of measurements can be explained or if it is due to chance.

Good graph design

Although there are many different types of graph, there are a number of elements that are common to the majority of them such as axes. This section provides some general guidelines to help you design your graph and ensure that you apply these elements in a way that will help the reader or audience interpret the data you are presenting.

Components of a graph

The different components of a graph are identified in the diagram on the next page and this is followed by a description that highlights some of the specific design and presentation issues related to each component.

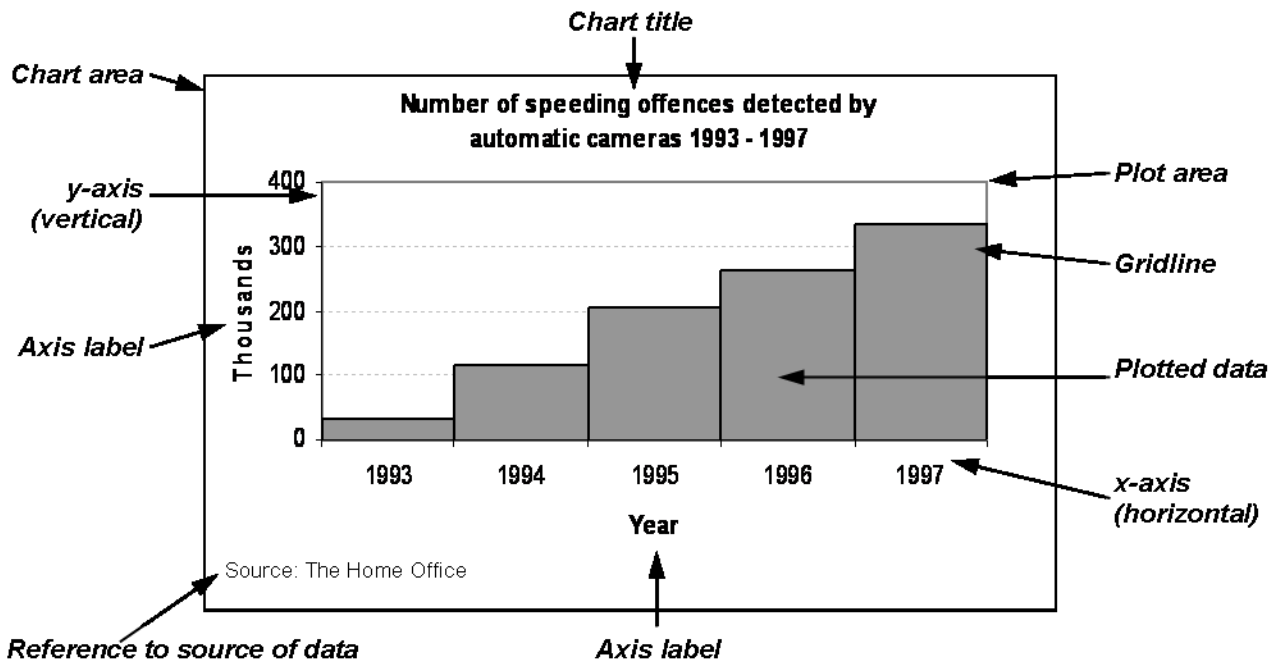


Chart area

The chart area defines the boundary of all the elements related to the graph including the plot itself and any headings and explanatory text. It emphasises that these elements need to be considered together and that they are separate from the surrounding text. The boundary of the chart area can be imaginary rather than defined by a frame.

Plot area

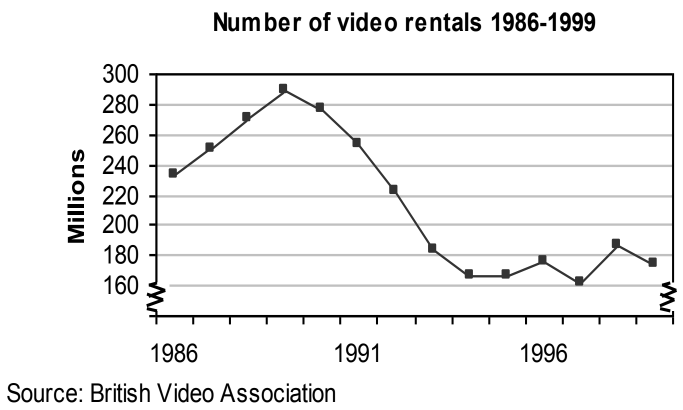
The plot area is the region containing the data. It is bounded by the x- and y-axes to the bottom and left side. The frame can be completed by drawing around the top and right sides too, but this is not essential.

The x-axis

The x-axis is the horizontal line that defines the base of the plot area. Depending upon which type of graph is being considered different locations on the x -axis represent either different categories (such as years) or different positions along a numerical scale (such as temperature or income). Details are placed just below the x-axis and an axis label is usually provided to clarify the units of measurement. However, if the category details are mentioned somewhere else such as in the title of the graph, or are very obvious (such as years) then it is not necessary to include an axis label.

The y-axis

The y-axis is the vertical line that usually defines the left side of the plot area, but if more than one variable is being plotted on the graph then the vertical lines on both the left and right sides of the plot area may be used as y-axes. The y-axis always has a numerical scale and is used to show values such as counts, frequencies or percentages. Intervals on the scale are marked by numbers and tick marks, indicating the major divisions, to the left of the y-axis. Like the x-axis, the y-axis usually has a label that provides details of the units of measurement. The label is often written vertically to follow the line of the y-axis but can instead be placed just above the top of the y-axis.In order to best highlight a trend in the data, it may be necessary to start the y-axis scale at a point other than zero. In such cases the starting value on the y-axis should be clearly labelled and the readers' attention drawn to the non-zero start by breaking the y-axis just below the first value as shown in the example opposite.



Gridlines

Gridlines are the vertical and horizontal lines placed within the plot area to help read values from the graph. The gridlines should be subtle and not detract from the data. In the case of simple graphs it is not always necessary to include them. Gridlines are usually drawn at regular intervals based on the major divisions of the y-axis scale.

Title

All graphs should include a title that summarises what the graph shows. The title should identify what is being described (e.g. speeding offences detected by automatic cameras) and the units of measurements (e.g. percentages, total number, frequency). The title may be placed within the chart area, as in the example above, or above or below the chart.

Reference to source of information

If the graph you are presenting is based on data from another publication then you should acknowledge the source of the original data somewhere within the chart area or title. If however, the graph is based on data that you have collected yourself then there is usually no need to provide details of the information source since this is usually clear from the accompanying text.

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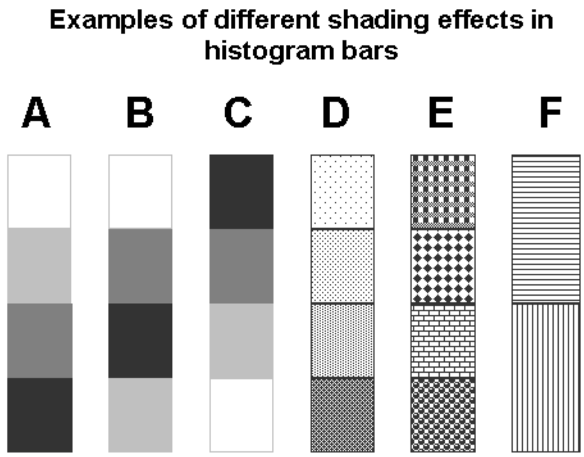
Other design considerations

Use of colour and shading

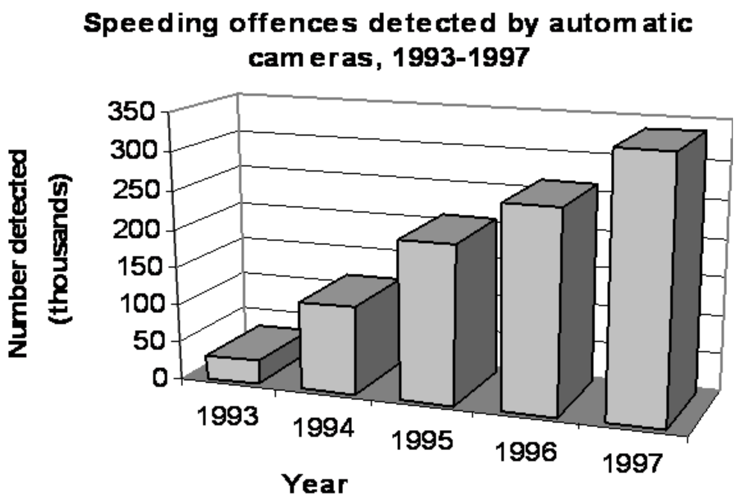
In bar charts, histograms, and pie charts, shading and colour are often used to distinguish the areas representing different categories. The choice of which colour combinations and shading patterns to use is ultimately a personal matter but there are some general points that will help ensure your chart is easy to interpret.

If there is a natural order or sequence to the data you are plotting then the colours or shading patterns used to represent the categories should reflect this so that the colours of adjacent areas grade from dark tones to light tones or vice versa.



In the example opposite therefore, A and D show a better use of shading than B. The darkest colours should also be placed at the bottom of the column otherwise they dominate the bar and can give the impression that it is top heavy. For example compare A and C which show the same colour sequence but in reverse order. Similar optical effects can occur with the use of some shading patterns. For example the patterns used in E are too busy and make distinguishing the different areas of the bar difficult. In F, the use of vertical lines results in the apparent lengthening of the bottom area of the bar whilst the horizontal lines have the effect of shortening the upper area of the bar when in fact the two areas are equal in size.

3D effects



Many PC-based graphing packages offer the possibility of producing graphs and charts with a 3D effect. However, in general the use of 3D makes it much more difficult to interpret the data presented in chart or graph because the false depth and perspective that are added to the chart make reading and comparing values extremely difficult. This can be seen in the example given here where it is difficult to judge the heights of the columns and the use of perspective results in some bars covering parts of others.

Similar problems occur with the use of 3D in pie charts which make it difficult to judge the size of the slices. Even when they represent similar sized categories, those slices at the rear of the chart automatically appear smaller than those at the front due to the false perspective.

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Where next?

This guide has outlined the role of text and tables as formats for presenting numerical data and summarised the most common graph types and the types of data that they can be used to present. The guide has focussed on providing general design and presentation advice for making numerical data easy to read and interpret. More detailed information about the individual graph and chart types and any specific design issues related to them can be found in the companion study guides: ***Bar charts, Histograms and Pie charts.***

This study guide is one of a series produced by Student Learning Development at the University of Leicester. As part of our services we provide a range of resources for students wishing to develop their academic and transferable skills.

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