CHAPTER 6

Presenting your project in written form

Aims
To introduce the skills needed to present your project effectively in written form.

Learning objectives
When you have completed this chapter, you should be able to:

- Understand how to structure and write professional reports;
- Write clear and concise abstracts;
- Understand how to present data and results clearly;
- Understand how to reference material and avoid plagiarism;
- Document software, comment programs and write user guides.

6.1 Introduction

In Chapter 1 dissemination of your ideas and results was identified as an important part of the research project process. Quite often a report is the only evidence of your project, unless you have developed a substantial piece of software. Although the report represents your project, remember that the good work you have performed can be ruined by a poor report. There is no point in performing a tremendous amount of valuable and important computing work, research and development if you cannot present your findings to other people. Conversely, a bad project cannot be turned into a good one by producing a good report. Although you can improve a poor project with a good report you must remember that your report is a reflection of your project and you *cannot* disguise sloppy investigation, development, implementation, analyses and method with a few carefully chosen words.

This chapter focuses on the presentation of written material for your project: structuring reports, writing abstracts, referencing material and presenting data. It also covers topics such as documenting software, commenting programs and

writing user guides. How you present your project in oral form, through presentations and vivas, is the subject of the next chapter.

6.2 Writing and structuring reports

6.2.1 *Considerations*

There are two main considerations that you should bear in mind as you begin work on your project's report:

- Who is going to read it? What do they already know? What do you want them to learn? What do you want them to gain from your report? How do want to influence them?
- How long should it be? Has your institution set upper (and possibly lower) limits on the length of your report to which you must adhere? Based on the work you have performed and the findings you have obtained, what is a reasonable length for your report?

These considerations will influence what you decide to include and what you omit from your final report. You should not include material merely for the sake of it as this might irritate the reader and appear like 'padding'. Similarly, you should not leave material out of your report if you think it is important. Try to get the balance right – understand what it is you are trying to say, be aware of what the reader already knows, and include material appropriately.

6.2.2 *Approaches to writing*

There are two main approaches that people tend to use when they write reports: the *top-down approach* and the *evolutionary delivery*. These two approaches are not mutually exclusive and you may well find yourself adopting both of them to one extent or another as you develop your project's report.

The top-down approach is used to identify the structure of your report – how many chapters it will have, what each chapter will contain and how each chapter will break down into subsections. Using this approach will enable you to identify specific sections within each chapter as and when you know more about their content. With subheadings identified you can then go on to complete these sections, finishing them at an appropriate point in your project when results are obtained and information is acquired. Figure 6.1 provides an example breakdown for this particular chapter. By identifying the content of this chapter as a number of 'chunks' it makes writing much easier and less daunting as individual sections can be tackled one at a time. By identifying the overall structure of a chapter it also allows you to keep an eye on the overall target of that chapter so that you do not depart along tangents and discuss extraneous ideas that are out of context with the main point. Chapter

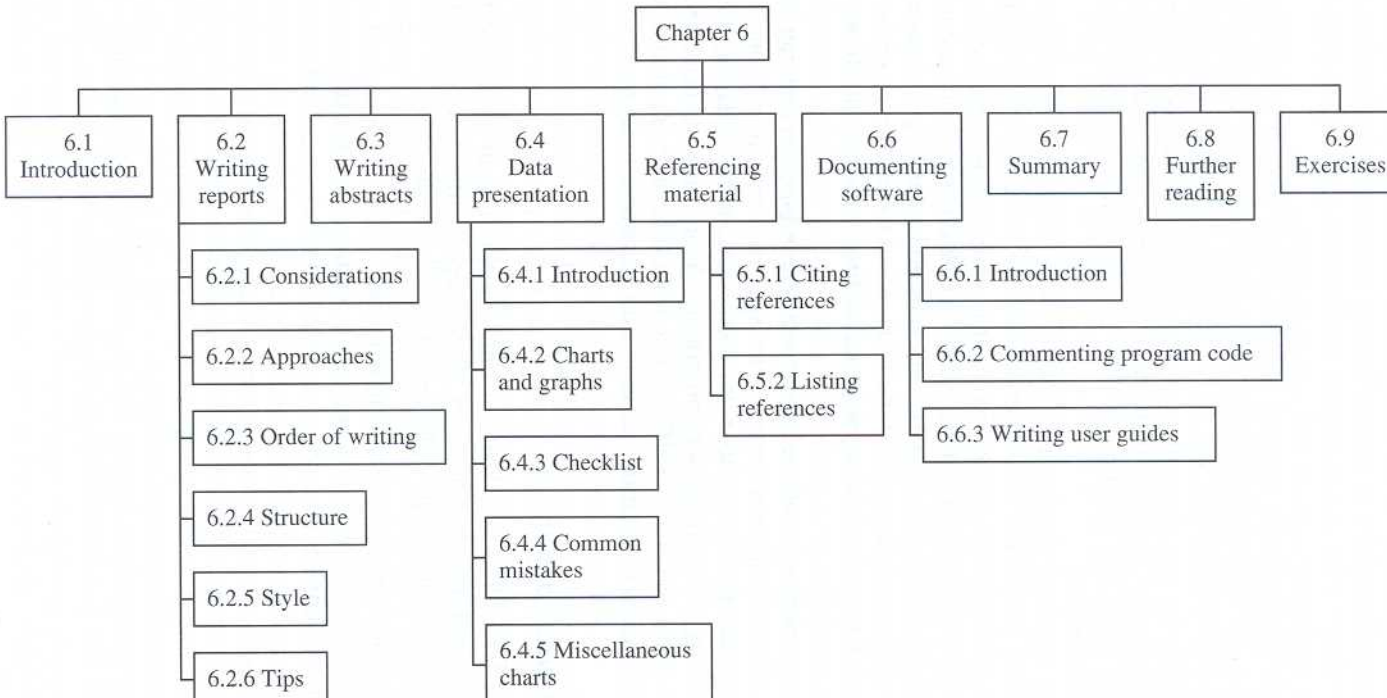

Figure 6.1 *A chapter breakdown structure*

breakdowns also help with time management in that they provide you with a better understanding of the amount of writing you have to do. This stems from an understanding of the complexity of each section, which will give you an idea of how long these sections will take to complete.

You might try to identify sections and subsections in your report very early on in your project. However, as is often the case, it is not until you finally come to complete your project that you fully understand what you want to include and can identify the specific content of every chapter. Whatever happens, you will find that a report breakdown structure is a useful way of structuring your thoughts and ideas and identifying how they will link together within the content of your report.

The other approach that is often used to write reports is the evolutionary delivery. Many people use this approach but are not conscious that they are doing so. In this approach you begin to write parts of your report and rewrite these parts as your project progresses. Each part thus evolves and matures over a period of time as new ideas emerge and your understanding increases. Thus, you do not sit down at the end of your project and write your report as a one-off. You write it over a much longer period of time during the lifetime of your project.

The two approaches introduced above can be combined so that you identify, perhaps at the start of your project, the specific sections of your report's chapters. You can then begin to write these sections but will find that they evolve and change as your project progresses. You might also find that your report breakdown structure itself evolves over time as your understanding increases, your ideas change and develop, and you obtain your results.

6.2.3 *The order of writing*

Whether you leave your final write-up until the end of your project or develop your report as your project progresses, there is a particular order of writing that you should try to follow. This order breaks down as follows:

- *Identify structure*. This relates to both the content of your report, using a report breakdown structure, and the formatting structure of your report in terms of font size and type, page size, numbering conventions and so on.

  Although a specific content structure might not be entirely clear to you at this stage, you should attempt to produce as much detail for each chapter's breakdown as possible. Report breakdown structures were discussed in the previous section.
- *Identify presentational style*. You should also try to set standards at this stage on the presentational aspects of your report – its layout. This will save time later when you are trying to collate your chapters and sections and find they are presented inconsistently. Make sure that you follow

any guidelines that your institution provides. If there are no guidelines, Cornford and Smithson (1996: 154) identify a number of points you should consider for your report's layout:

- avoid broad, open spaces or cramped layouts. Try to make sure figures and tables do not force large gaps into your text;
- use a clear 11 or 12 point font. Use something that is easy to read such as Times or Geneva;
- use a single, justified column with adequate margins for binding. However, it is sometimes argued that two columns are easier to read than one as text lines are shorter. Check your institution's guidelines and ask your supervisor for advice;
- use page numbers centred at the foot of each page.

You might also wish to define your own presentation style such as line spacing ($1\frac{1}{2}$ or double spaced), a section numbering convention (for example, '1.2 Section Title') and paragraph styles (for example, start each paragraph on a new line tabbed in eight spaces).

With the proliferation of colour printers these days, you might also wish to decide how to use colours to enhance text and presentation within your report. Be careful not to introduce a complex style such as red text for chapter titles, blue for section headings and so on. This kind of presentation looks very messy and it is best to stick with black text for the bulk of your report. Colours can, however, be used very effectively to enhance tables and highlight certain points. For example, to distinguish different parts of a table presenting statistical data, you might wish to use colour to highlight significant results.

- *Draft the introduction.* The introduction gives the reader an idea of the report's content so it should also help you to clarify your ideas. At this stage, however, your introduction will only be a first draft as your ideas are bound to evolve and your emphasis change by the time you have completed your report. Remember that your introduction might include, or consist mainly of, your literature review. As such, it should be tackled early so that your grounding in the subject is complete.
- *Main body.* The main body of your report is the next part you should work on. You might include chapters such as methods used, analyses performed and so on. Clearly, the content of the main body of your report will depend on the project you have undertaken. You may find that you write parts of the main body of your report as your project progresses and you will not necessarily write each chapter or section in order. You will find that different aspects of your project are completed at different times – not necessarily in the same order that you decided to present them in your report.
- *Conclusions and recommendations.* Quite clearly your conclusions and recommendations should be one of the last things that you complete.

Only when your project is complete will you fully understand what you have achieved and be able to present your final ideas and recommendations.

- *Complete the introduction.* As part of the evolutionary approach to writing you may well find that your introduction needs some reworking after you have completed the rest of your project's report. You may want to include some text alluding to your final results or introduce more background on a topic you have since focused on in more detail within your report.
- *Write the abstract.* You cannot really write a clear abstract for your report until you know what has been included in the report. How to write effective abstracts is covered in detail later in this chapter.
- *References and appendices.* Although you will be collating references and appendices as your project progresses, you should not complete their presentation until the rest of the report has been written. References may be added or deleted and you may decide to include or exclude material from the appendices.
- *Arrange contents list and index.* Leave the completion of an index (if one is required) and your contents list until the end. Only then will you know the exact content of your report and all page numbers.
- *Proofread, check and correct.* It is vitally important to proofread your report after it is completed. Quite often, because you have been so close to your report for so long, reading through your report straight away might mean that you miss glaring errors or omissions. You know what you meant to write so this is what you read, whether it is written or not. With this in mind it is a good idea to leave your report for a day or two before proofreading it or, preferably, get someone else to do it for you. Bear in mind that if you do this you will need to complete your report a few days before its deadline to allow yourself time for proofreading and correcting or changing any points that emerge.

6.2.4 **Structure**

Your report should be structured into the following sections:

- Title page. Follow any guidelines provided. As a minimum you should include: title, author, date and degree award.
- Abstract.
- Acknowledgements to people you wish to thank for helping you with your project.
- Contents listing.
- List of figures and tables. This is not compulsory and you should include these lists only if you feel they will add value to your report and will be useful for the reader.

- The report itself:
  - Introduction/literature review. The first chapter of your report should always be an introduction. Quite often introductory chapters serve to present the literature review. Alternatively, the introduction serves as a brief overview of the project and the report, and the literature review is presented as a chapter in its own right later. Your introduction should set the scene for the project report, and should include your project's aims and purpose.
  - Main body.
  - Conclusions/recommendations.
- References, presented in an appropriate format. Referencing material is discussed in more detail later.
- Appendices, labelled as Appendix A, Appendix B, Appendix C etc. These may include program listings, test results and project details such as your initial proposal, your project plan and meeting reports.
- Glossary of terms, if required.
- Index, if required, but avoid if possible.

6.2.5 *Style*

The style of writing that you adopt to present your report can be discussed from three points of view. First is the actual presentation style of your report – for example, its layout, font and so on. This kind of style was discussed earlier. Second is the style of grammar that you use within your report. Quite often good reports can be ruined by poor grammar. The author's meaning is unclear as ideas and results are hidden within long complex sentences that include excessive words and jargon. The third point of view is overall content structure, which will be discussed later.

A good writing style comes with practice – the more that you write, the clearer and easier it becomes. Reading also helps to improve your own writing skills as you learn elements of good practice and identify interesting ways of discussing and presenting arguments. Having said this, there are some simple rules that anyone can follow to improve their writing style for professional reports. Try to avoid using personal pronouns such as I, you, we, my and so on, but make sure that you don't end up producing elaborate, complex sentences just to avoid this. Your supervisor should be able to advise you here and it may be that the nature of your project requires you to use the personal approach. Keep sentences short and to the point. Avoid making several points within the same sentence. Avoid abbreviations, jargon and slang. Use simple rather than complex words; the latter are often irritating for the reader, cloud the meaning of your sentence and are often used to hide your own lack of understanding about the subject, which the educated reader will spot.

It is common practice to present your report in the past tense as the report

represents the results of the project which you *have* completed. Having said this, Day (1995) suggests that the present tense should be used when referring to the work of others (just like this sentence does!). Avoid jokes and personal asides. Avoid shortened forms such as 'isn't' instead of 'is not'. Make sure you know how to use apostrophes – for example, 'John's computer' rather than 'Johns computer'. Finally, make sure that you use a spell checker; sloppy spelling puts many reports into a bad light.

Moving away from basic grammar, the third style to consider when writing project reports is overall content structure. Your report should be constructed so that it has:

- *a beginning:* the introduction and literature review which set the scene;
- *a middle:* the bulk of your report where the main component of your project is discussed;
- *an end:* conclusions, summary, recommendations and future work.

This kind of structure should also be evident within individual chapters of your report. They too should have an introduction (possibly a chapter overview), the main body of the chapter and an end (possibly a chapter summary or conclusions from the chapter).

6.2.6 **Tips**

This section on report writing is concluded by presenting a few tips to help you. Bell (1993: 152) identifies a number of points that can help you discipline yourself and improve your writing skills.

- Set deadlines. Your report will take a long time to produce. If you do not set yourself deadlines and stick to them you will not finish on time. Using a report breakdown structure can help you to plan your time commitments to your report.
- Write regularly. Find your best time of day for writing and your favourite location. In other words, make sure that you 'write when your mind is fresh' and 'find a regular writing place' (Saunders *et al.* 1997: 371). People often find they cannot write with distractions or when they are over-tired.
- Create a work rhythm. Once you are under way, keep going. Don't stop to check a reference if the text is flowing, keep going until you reach a natural break.
- Write up sections when they are ready – when they are clear in your mind. This will also save time towards the end of your project when your project write-up might be little more than a collation of your existing text and producing an introduction and conclusion.
- Stop at a point from which it is easy to restart. It can often take a lot of time to get going again after a break so try to stop at a natural break in

your report; for example, when you have completed an entire section. Trying to pick up from where you left off the previous day or week can be difficult as you might have forgotten what it was you intended to write. If a break in your work is unavoidable, make a note of what you intended to do next so that when you come back to your writing later you can pick up from where you left off more easily.

Another tip worth following is to collate all the material you will need together before starting to write. Breaking your writing flow to search for a reference or visit the library to trace a vital book will not help.

For computing students it almost goes without saying that the best way to produce your report is with a word processor of one kind or another. These packages are far more effective than typewritten or handwritten work alone. Almost all word processors these days come with dictionaries and thesaurus facilities built in. In addition, many are equipped with equation editors that can help you produce neat equations embedded within your text. Alternatively, equation editors are available that can be used to 'construct' equations before pasting them into your report. The following is an example of an equation that has been pasted into the text. Notice how this equation has been given a reference number (6.1 in this case), which you should always include to uniquely identify each equation you incorporate in your report.

$$f(N) = \frac{\sum N(N-1)}{\sqrt{S^2(N-1)}} \tag{6.1}$$

Be careful when using in-built spell checkers. Many are based on US English dictionaries and will change words to the US English equivalent; for example 'center' instead of 'centre'. Spell checkers might also change spelling 'errors' within verbatim quotes you have used from other authors.

Grammar checkers should also be used with caution. What might appear an elegant, well-constructed sentence to you, might be changed automatically by a grammar checker. However, if you feel that your grammar is weak, these facilities are invaluable.

6.3 **Writing abstracts**

Blaxter *et al.* (1996: 238) define the function of an abstract as to 'summarize briefly the nature of your research project, its context, how it was carried out, and what its major findings are'. The abstract provides the reader with an overview of your project and is the basis on which many readers will decide whether or not to read your report at all. With this in mind your abstract should be concise (preferably no more than one page long), clear and interesting.

Many abstracts are structured like a contents listing, but this is of little value

to the reader, who can refer to the report's actual contents list for this kind of information. Your report's abstract should be one of the last things you write, when you actually know what you have achieved and what the content of your report is. Avoid using references in your abstract as the reader will not necessarily wish to search through your report to find them or be familiar with the author(s) you have cited. In addition, avoid using jargon and acronyms – these should be introduced only in the main body of your report. Writing good abstracts is something that comes with practice. To get a 'feel' for good and bad abstract presentation pay careful attention to the way others structure the abstracts of articles that you obtain.

Take, as examples, the following abstracts for the same article, based on an artificial neural network approach to predicting software development costs.

Abstract 1

This article investigates the application of ANNs to software development cost estimation. It begins by discussing existing software prediction techniques such as COCOMO (Boehm 1981) and Delphi (Helmer-Heidelberg 1966). The article identifies the process of software cost estimation and uses this as a basis on which to apply the ANNs developed for this project. Equations are presented showing how improvements can be made to the backpropagation algorithm used in ANN training. ANN simulation is also discussed. An evaluation of the results from the ANNs is presented and these results compare favourably with existing techniques identified in the paper.

Abstract 2

One of the major problems with software development projects is that it is extremely difficult to estimate accurately their likely cost, duration and effort requirements. This invariably leads to problems in project management and control. Part of the problem is that during the early stages of these projects very little is known about the problem domain and, consequently, initial estimates tend to be best guesses by a project manager. Artificial neural networks appear well suited to problems of this nature as they can be trained to understand the explicit and inexplicit factors that drive a software project's cost. For this reason, artificial neural networks were investigated as a potential tool to improve software project effort estimation using project data supplied by a software development company. In order to deal with uncertainties that exist in initial project estimates, the concept of neural network simulation was developed and

employed. This paper discusses this concept and comments on the results that were obtained when artificial neural networks were trained and tested on the data supplied.

The first abstract is presented incorrectly, as a contents listing, while the second sets the scene for the article and identifies the content and contribution that the article is making. The first abstract is presented as a breakdown of the article's sections and it includes acronyms and references to papers that may be unfamiliar to the reader. When writing your own abstract try to follow the structure and style of the second abstract presented here.

6.4 Data presentation

6.4.1 *Introduction*

In almost all projects you will have to present data in one format or another – data you obtain from questionnaires or surveys, software test results, algorithm speed trials and so on. While textual presentation of numeric results can often provide a rather 'dry' interpretation of the information gathered, pictures, in the form of graphs and charts, provide a far more pleasing, holistic idea of what is going on. 'A diagram can often simplify quite complex data which could take a paragraph or more to explain' (Bell 1993: 147).

Although a picture is worth a thousand words you must ensure that the picture you are painting is the correct one and you are not presenting results in such a way as to hide their true meaning. According to Mark Twain, Benjamin Disraeli (1804–1881) said that there are three kinds of lies: 'lies, damned lies and statistics', the implication being that you can make statistical results say practically anything you want them to say. Remember, when you compile your report, that you must be objective and present your results in a clear and honest way. This section deals with presenting information using charts and tables, presenting various examples of some of the most popular charts that are used, and showing some instances where charts are used incorrectly.

6.4.2 *Presenting charts and graphs*

All figures and tables that you include within your report should be clearly and uniquely labelled with a number and a short description. The most common approach is to label each figure and table using consecutive numbers prefixed by the current chapter number. The approach used within this book, where we have, for example, 'Figure 6.1 *A chapter breakdown structure*', is quite a common standard which you can follow. Note that it is permissible to label a table and a figure with the same number; for example, Table 6.1 and Figure 6.1 refer

to two different items within a report. Above all, be consistent and don't change the way in which figures and tables are labelled from one chapter to the next.

When you use figures and tables within a report they should be included because they add something of value to the report. They should not be included because you think they look nice. Figures and tables should help to clarify and support information you are presenting within the text of the report and should be included as close to their original reference point as possible, but not before. Take, as an example, Table 6.1. This table presents the final degree classifications of 100 students who completed their Computer Studies course in 1998.

Table 6.1 *Degree classification of 100 students*

1st	*2 : 1*	*2 : 2*	*3rd*	*Pass*	*Fail*
7	23	38	17	10	5

Table 6.1 presents these data in a much clearer way than you could hope to achieve using text alone. For example, compare this table with:

> Seven students obtained first class degrees, twenty three obtained a 2 : 1, thirty eight achieved a 2 : 2, seventeen received 3rd class degrees, ten achieved only a Pass degree, and five students failed.

Although Table 6.1 is easier to follow than the text presented above, it is not necessarily the best way of presenting these data. Figure 6.2 is perhaps a clearer way of interpreting these results and it provides a more 'holistic' view of the spread, pattern or *distribution* of degree grades. Note that the distribution of data is only relevant when the data are of at least ordinal scaling. In other words, the categories into which the data are arranged represent an increasing magnitude of one kind of another (for example, the position of runners in a race; good, average or poor software quality and so on). Data that merely represent classes in which the order is irrelevant (for example, gender, religious belief and so on) have no distribution as such and the order of the columns in these charts is unimportant. In this case the chart can only emphasise the difference between the number of items identified within each category.

Figure 6.2 is a *vertical bar chart* or *column chart*. These charts can also be presented horizontally but, generally, the vertical representation is preferred. Bar charts are used to present categorial data and are useful for presenting the results of questionnaires that have used Likert-type scales. These scales indicate 'strength of agreement or disagreement with a given statement' (Bell 1993: 139); for example, 'Do you think this software is poor, average, or good?'. Note how, on this chart, the data have been split into columns with gaps in between, both axes have been labelled and the chart has been uniquely titled as Figure 6.2 with a corresponding brief label.

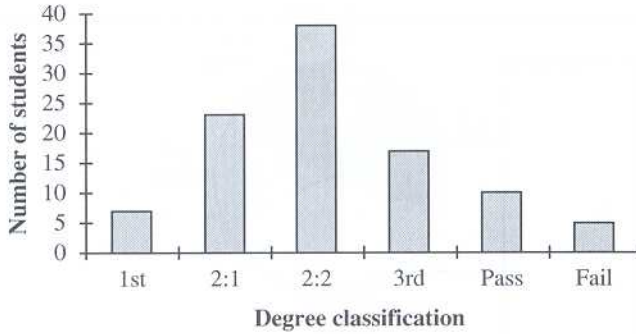

Figure 6.2 *Bar chart showing degree classification of 100 students*

For continuous data an alternative to the bar chart is required as the data are not arranged in distinct categories but can take any *real* value (for example, age, size, weight and so on). In these cases a *histogram* is used. Histograms present data in a similar way to bar charts in that columns are used to represent frequencies of occurrence of a particular data item. However, because histograms present continuous data, it is now up to you how you split the data into unique categories. Remember that bar charts have their categories defined for them based on the categories defined within the data they represent. As an example, Figure 6.3 presents a histogram showing the *age* of the 100 computer studies students.

In Figure 6.3 the age of graduates has been split into ten unique categories: 18 to 20, 20 to 22, 22 to 24, 24 to 26 years old etc. It has been assumed, in this case, that each category's upper boundary is actually one day before the year

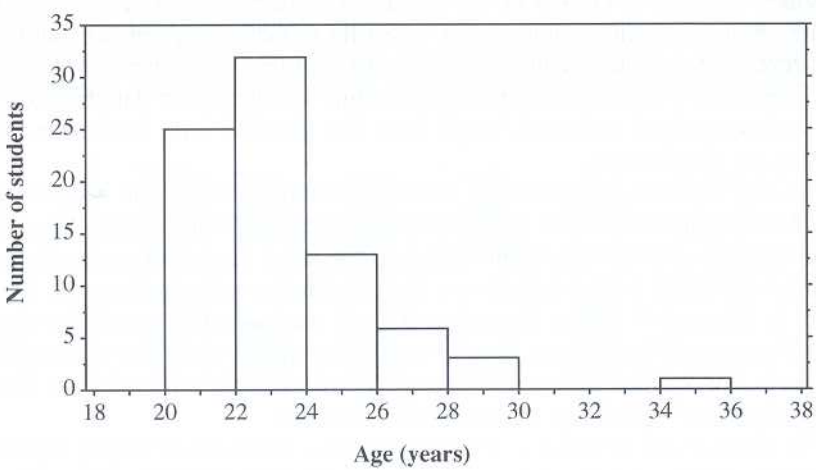

Figure 6.3 *Histogram showing age of 100 students at graduation*

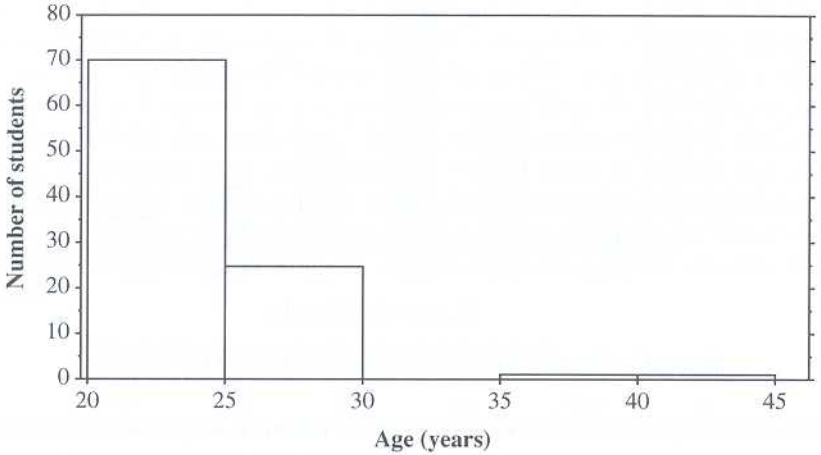

Figure 6.4 *Histogram showing age of 100 students at graduation*

indicated, so that people whose even birthday falls on the day of the survey will be placed in the next category up (that is, 20 to 22 actually represents 20 years to 21 years 364 days old). Each column now represents the number of students who fall within the defined range. Notice how the bars in this chart are now touching. This highlights the fact that the data are continuous and there is no absolute break between the categories.

There is no reason why you could not, alternatively, have defined the categories as 20 to 25, 25 to 30, 30 to 35 and so on. This results in the histogram shown in Figure 6.4.

Figure 6.4 provides a 'coarser' interpretation of the findings and, perhaps, provides a poorer overview of the spread of student ages at graduation. This figure emphasises the importance of carefully selecting appropriate categories for presenting continuous data in histograms. Splitting your data into too many categories can lead to a number of gaps, while splitting your data into too few categories can lead to broad, 'high' bars that provide little indication of the underlying distribution.

Another form of chart you may wish to use within your report is a *pie chart*. Pie charts are used to show *proportions* of categories within your data. Take, as an example, Figure 6.5, which presents the same data as those presented in Figure 6.2. While Figure 6.2 shows the distribution of actual marks, the pie chart in Figure 6.5 shows the proportion of students with particular degree classifications. Which figure you use would depend on what you were trying to emphasise or explain within your report. You would use a pie chart to discuss proportions and a bar chart to discuss distributions.

Pie charts come in various shapes and sizes – three-dimensional, exploded, coloured, shaded, wheels and so on – and most spreadsheet packages provide you with these formats. How you present your charts is clearly up to you, but

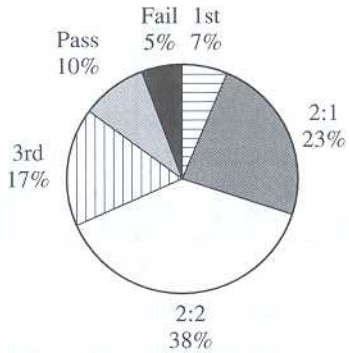

Figure 6.5 *Pie chart showing degree classification of 100 students*

don't get so carried away with a chart's presentation that you obscure the real meaning of the data you are presenting.

While you could use several pie charts next to one another to compare proportions between two or more subjects, a combined bar chart, such as that shown in Figure 6.6, can be used to present this comparison more clearly. In this case the spread of degree grades at four universities is presented. Notice how a legend has been included in this chart to identify the shading used in the columns, and how this legend and shading follows a logical top-down approach based on grades from 1st to Fail.

If you weren't interested in looking at proportions between categories but actual values, you could use a combined bar chart such as that shown in Figure 6.7. In this figure you can see the number of students graduating in Computer Studies categorised according to their gender. The bars are arranged in degree classification order and split according to gender. In this case gender is identified within each degree classification.

Note that the bar chart in Figure 6.7 has been presented in a rather conventional format. These days you will quite often see three-dimensional plots,

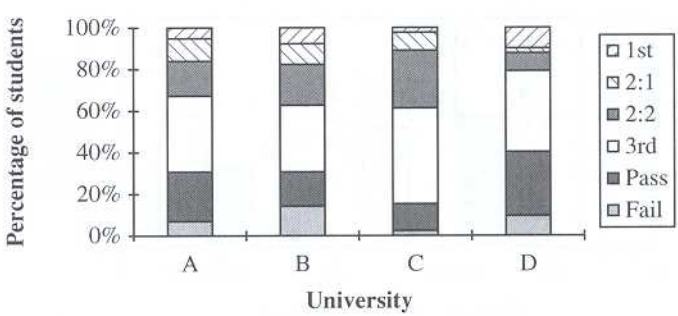

Figure 6.6 *Comparison of pass rates at four universities*

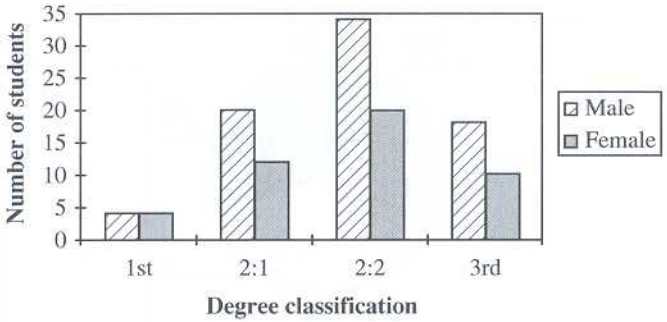

Figure 6.7 *Degree classification and gender of 125 recent graduates*

colours and shading used to enhance the attractiveness of such charts. Beware, however, as mentioned before, that you do not obscure the true meaning of what you are trying to portray or hide insignificant findings behind elaborate diagrams and figures.

Figure 6.8 takes the data used in Figure 6.7 and rearranges the groupings, thus presenting the results of Figure 6.7 in a slightly different way. This time the bars have been split into degree classifications and these grades grouped by gender. Once again, how you present these data is up to you and will depend on what you are trying to emphasise. Figure 6.7 is concerned with showing how each individual grade is spread between men and women. Figure 6.8 is concerned with showing the spread of grades for all men and the spread of grades for all women.

One drawback within Figures 6.7 and 6.8 is that the total numbers of male and female students differ. Ideally one would like to see the proportion of men obtaining Firsts, 2 : 1s, 2 : 2s etc. and be able to compare this with the proportion of women obtaining these grades. For example, do women, on average, obtain more first class degrees than men? Although you would need to perform a statistical analysis on your data to 'prove' this, the charts would present a clear, visual overview of the situation. Your *y*-axis in both of these cases would

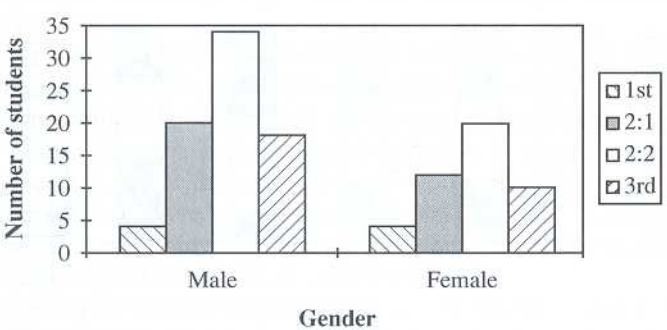

Figure 6.8 *Alternative view of degree classification and gender of 125 recent graduates*

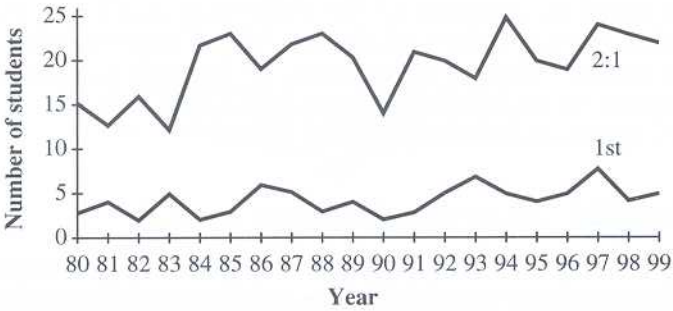

Figure 6.9 *Trends in first class and 2 : 1 degrees, 1980–1999*

be relabelled as 'Percentage of students' as opposed to 'Number of students' and the charts would provide a better comparison of grade spread based on gender – if this is what you wanted.

Another form of chart you may find useful is a *line chart*. These figures are generally used to show trends over periods of time. Figure 6.9 presents such a chart, in this case showing the trend (if indeed there is one) of first class and 2 : 1 degrees awarded between 1980 and 1999. Note that this only provides a visual interpretation of these data. You would need to perform some statistical analyses on your data to determine whether there was actually a significant trend or not. Statistical tests are beyond the intended scope of this book as there are numerous texts available that deal with these issues.

The last form of 'popular' chart to look at within this section is the *scatter diagram*. Scatter diagrams are used to show the relationship between two variables. For example, Figure 6.10 plots the assignment grades of 30 computing students against the number of hours each student worked on their assignment. Notice how the chart shows a general upward trend, perhaps indicating that there is a relationship between these two variables. Although the strength and significance of this relationship would be calculated statistically, the chart

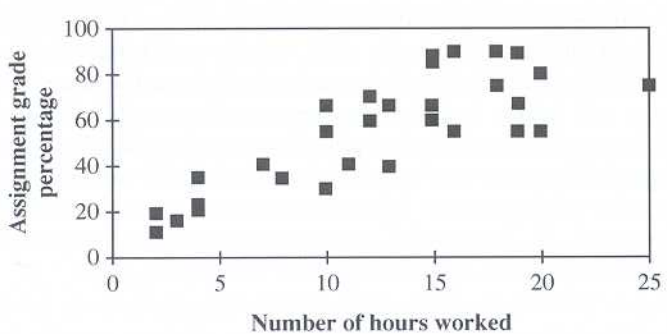

Figure 6.10 *Relationship between assignment grade and hours of effort of 30 students*

provides a visual interpretation of this relationship which is perhaps easier to follow than some statistical calculations. This is not to say that you could omit any rigorous statistical interpretation of data that you obtain but that you can support these calculations and improve their presentation by use of *appropriate* figures and tables within your report.

6.4.3 **Checklist**

Saunders *et al.* (1997: 299) present a checklist of points that you should observe when you have completed tables and figures within your report. For both diagrams and tables they recommend that you should ask yourself the following questions:

- Does it have a brief but clear and descriptive title?
- Are the units of measurement clearly stated?
- Are the sources of data used clearly stated?
- Are there notes to explain any abbreviations?
- Have you stated the sample size?

For diagrams the following checklist of questions is suggested:

- Does it have clear axis labels?
- Are bars and their components in the same logical sequence?
- Is more dense shading used for smaller areas?
- Is a key or legend included (where necessary)?

and for tables:

- Does it have clear column and row headings?
- Are columns and rows in a logical sequence?

6.4.4 **Common mistakes**

You should not include figures and tables within your report just for the sake of it. They should be there to support arguments you make within the text and to clarify, in diagrammatical form, data, results and interpretations you are making. This leads to the first common mistake that people sometimes make in using figures and tables – including them unnecessarily. Figure 6.11 is an example of just such a case where a pie chart is presented (sometimes even on a whole page) adding no value to the report whatsoever. In this case, as 100% of those questioned responded 'Yes', the use of the pie chart, which normally shows proportions, is unnecessary and makes the report look as though it is being padded out because it has little of real value to say.

The second common mistake made when using charts is to use them inappropriately when other charts would present your data in a much clearer light. Figure 6.12 provides just such an example – in this case a line chart is being

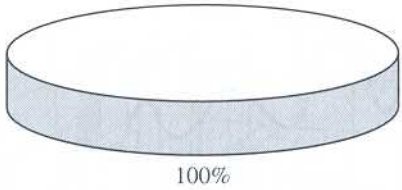

Figure 6.11 *100% of respondents said 'yes'*

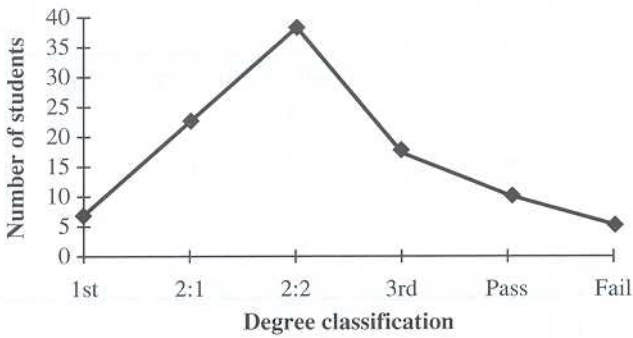

Figure 6.12 *'Incorrect' use of a line chart*

used when a trend is not the focus of attention. Although one might be interested in trying to identify the shape of the underlying distribution of degree grades, a bar chart would be more appropriate in this case.

Another common mistake people tend to make when including charts within reports is to scale them incorrectly. Sometimes this is done deliberately to hide the true meaning of the data that are presented. At other times it is done by accident when you are unsure about what your data are trying to tell you or what your data mean.

Figures 6.13 and 6.14 present a university department's spending between 1980 and 1999. Although both these figures present exactly the same data, using exactly the same type of chart, they appear very differently. Figure 6.13 shows, perhaps, an alarming decrease in spending during this period, while Figure 6.14 puts this 'trend' into perspective and shows that spending has changed only very slightly over this period of time. However, Figure 6.13 provides a good view of the *detail* of the spending changes while Figure 6.14 provides little information on what has happened. In Figure 6.14, it appears, unless you look very closely, that spending has not changed at all throughout this period, but you know this is not the case. These two figures emphasise the importance of getting scales right. You need to decide what it is you are attempting to show, not what you are attempting to hide, and scale your charts accordingly.

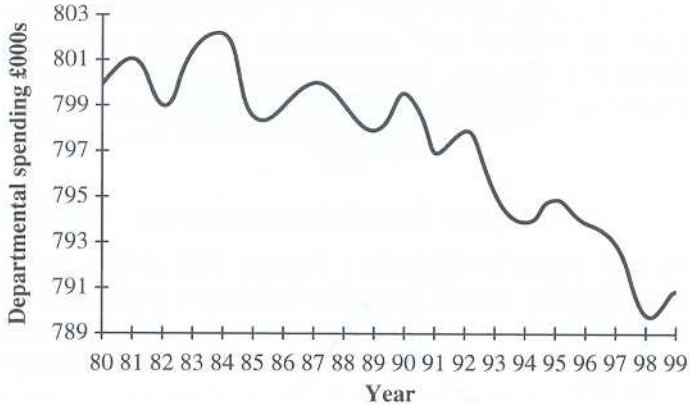

Figure 6.13 *'Dramatic' decline in spending*

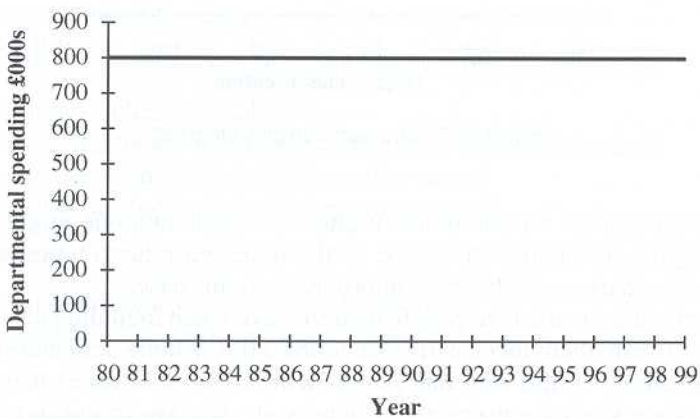

Figure 6.14 *Less dramatic decline in spending*

6.4.5 ***Miscellaneous charts***

Some less common charts that you might come across and wish to use are presented in Figures 6.15–6.18. Figure 6.15 is a three-dimensional bar chart, which is used to enhance the appearance of 'bland' two-dimensional bar charts. While these charts don't necessarily add anything significant to the presentation of the data, they do provide a more visually appealing diagram.

Figure 6.16 is a *polar* chart, which is used to compare variables with several comparable factors. For example, each 'arm' of the polar chart would represent a particular factor and each shape would represent the variable in which you were interested. Each shape would thus provide an indication of the similarities

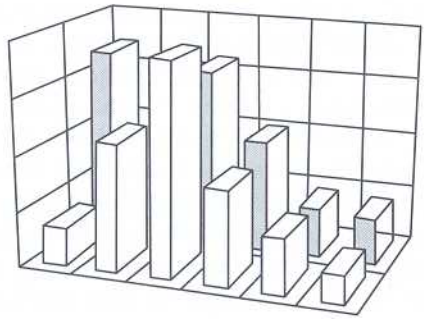

Figure 6.15 *An example three-dimensional bar chart*

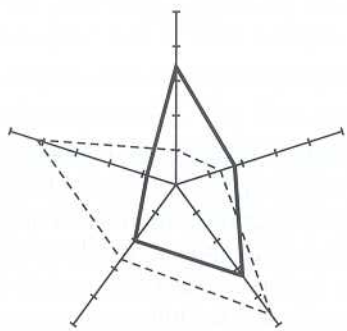

Figure 6.16 *An example polar chart*

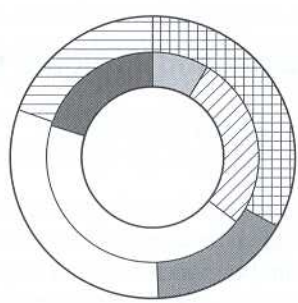

Figure 6.17 *An example doughnut chart*

and differences of each variable for each of the factors presented on each axis.

Figure 6.17 is a *doughnut* chart, which is another way of presenting a pie chart. The advantage of this representation is that you can now plot several pie charts together on the same figure to enable proportional comparisons between variables to be made.

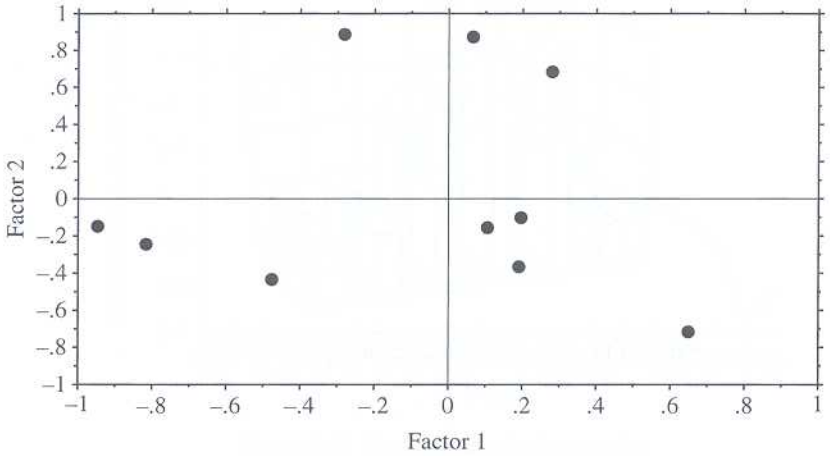

Figure 6.18 *An example factor analysis plot*

Figure 6.18 is a factor analysis plot, which presents the results of two combined factors from a factor analysis. This figure helps to show how variables are grouped together depending on a number of factors in two dimensions. While some of the variables may appear closely related to one another in this diagram, looking at other factors in other dimensions might show that they are not. Factor analysis is a statistical technique that can only really be performed using a computer and a statistical package. The calculations are much too complex to be performed by hand.

6.5 Referencing material and avoiding plagiarism

Nothing is said that has not been said before.
Terence (c. 195–159 BC), *The Eunuch*, Prologue

With Terence's statement in mind it is important that you support the work you are presenting within your report by appropriate references. Much of what you present will have been touched on, discussed, written about or covered by other authors in the past – particularly for undergraduate projects. Thus, any arguments that you make within your report and especially within your literature review should be justified 'by referencing previous research' (Saunders *et al.* 1997: 39). Material is referenced within reports to:

- *Avoid plagiarism.* In other words, you do not present other people's ideas, thoughts, words, figures, diagrams, results and so on without referencing them, in order to make their work look as if it is your own. Plagiarism can be performed accidentally or deliberately but in both

cases it is deemed a serious academic offence. This is one reason why you should perform an extensive literature survey – to ensure that you are not merely repeating the work of others.

- *Identify context*, to place your work in context with other recognised publications. This will strengthen your report by demonstrating how it builds and extends the work of others and showing how your work resides within a recognised academic field of study.
- *Support and validate*. Support your own arguments and validate any statements that you make. If you are making certain claims you will have to support these with either research results or references to other authors.
- *Identify sources*. Provide people reading your report with a comprehensive list of related work that they can use to study your topic in more detail or take your work further. By identifying sources clearly, people reading your report will be able to locate the articles you have used.

There are two aspects to referencing. The first aspect to consider is how to use references correctly within the body of your report – in terms of their presentation and appropriateness – called *citing*. The second aspect is how to present these references correctly at the end of your report. Each of these aspects will be dealt with in turn.

6.5.1 Citing references

Generally speaking, there are two ways to cite references, the *Harvard system* and the *numeric system* (also called the *Vancouver system*). Harvard is the better system to use as the numeric system requires each reference to be identified by a unique number, which needs updating every time you decide to add or remove a reference from your report. Quite often the numeric system also gives no indication of the author to whom you are referring and the reader has to search through the reference list at the back of your report to find this information.

These days, many word processing packages have reference management systems that enable you to maintain and update references within your report quickly and easily. In Chapter 4 a number of software tools were listed that can help you manage your references. However, with or without such a system, it is recommended that you use the Harvard style of referencing, which is more flexible and clearer than the numeric approach.

The Harvard system uses the name of the author(s) and the year of their publication to identify each reference uniquely within a report. For example, consider the following extracts from an undergraduate project report:

> It is often said that computing is an art not a science (Smith and Jones 1993: 20)

and

> It is often said that computing is an art not a science. This was first suggested by Smith and Jones (1993: 20) who justified their proposition by ...

The article by Smith and Jones is identified by its year of publication. If you are referring to more than one of their publications of the same year you would append letters to the date (a, b, c etc.) to uniquely identify each article – thus (Smith and Jones 1993a), (Smith and Jones 1993b) etc. The page number (20), where the point in question was made, has also been identified. This is common when referencing books, which obviously have many pages, but not when referencing journal articles.

An alternative way of presenting this argument, supported by the same reference, could be:

> Smith and Jones (1993: 20) state that 'computing has much more in common with the finer things in life, like art, than science or engineering'

In the previous examples the ideas of Smith and Jones had been put into our own words so quotation marks were unnecessary. However, because their text has now been used verbatim, this text *must* be included within quotation marks to show that these are their words, not ours. If you are quoting a large block of text it is acceptable to present that text without quotation marks providing it stands out from your own text in some way. For example, you would either present that text in italics, in a different font to the one you were using for your main text, or as a justified block of text between wider margins in your report.

According to Cornford and Smithson (1996: 142) there are only three occasions when you should quote other people's work verbatim:

- where the original author has presented something 'more succinctly, elegantly or clearly' than you could;
- 'where you need to prove that it was a particular author who wrote the words, or you are introducing some text in order to analyze it';
- where there is no way of paraphrasing; for example quoting lists.

You should also bear in mind that including too many direct quotations and references to other authors may *give away some authority* from your own work. In other words, you might include so much material from other authors that it is difficult for the reader to identify your contribution as much of the material presented is really the work of others.

Many articles are written by individuals. The Harvard system caters for single authors like this:

> It is often said that computing is an art not a science (Johnson 1992)

However, when there are more than two authors involved with the same article you generally omit all but the first author's name and use *et al.* instead:

It is often said that computing is an art not a science (Peterson *et al.* 1995)

When you wish to refer to more than one reference to support the arguments you are making in your report you would include them alphabetically:

It is often said that computing is an art not a science (Johnson 1992; Peterson *et al.* 1995; Smith and Jones 1993: 20)

Sometimes you will want to present a reference to an article you haven't read (a *secondary* reference) which has been cited by another author. In this case you only need to list the article you've read (the *primary* reference) and you should cite the reference like this:

It is often said that computing is an art not a science (Johnson 1992, cited by Markos *et al.* 1996)

Looking briefly at the numerical referencing format for completeness, in this case each reference is identified by a unique number:

It is often said that computing is an art not a science [1, 2].

Or:

It is often said that computing is an art not a science.[1,2]

Or:

Smith and Jones [2] state that 'computing has much more in common with the finer things in life, like art, than science or engineering'

In this case, each time a new reference is used within your report it is given a new reference number. References are then listed at the back of your report in numerical, rather than alphabetical, order. Notice that, if you decide to remove your reference to Smith and Jones, all subsequent references would need renumbering to replace the deleted reference. Similarly, inserting a new reference into your report would require all subsequent reference numbers to be incremented – something that can take a long time in terms of search and replace if your word processor doesn't have a reference management system. For these reasons, if you have a choice, it is recommended that you use the Harvard system for referencing material if at all possible.

Three abbreviations that you might use when referencing are:

- *op. cit.* – in the work already cited
- *ibid.* – in the same place
- *loc. cit.* – in the place cited

Op. cit. is used to refer to an article you have cited before, earlier in your report, and is used when other references occur in between. You may have to provide the date if other authors of the same name exist. For example:

It is often said that computing is an art not a science (Johnson 1992: 22).

> Smith and Jones (1993) emphasise this point when they state that 'computing has much more in common with the finer things in life, like art, than science or engineering'. However, Johnson (*op. cit:* 34) goes on to discuss ...

Ibid. is used when there are no intervening references. You must provide page numbers if required;

> It is often said that computing is an art not a science (Johnson 1992). [Intervening text here but no references] ... Johnson (*ibid.*) states that computing can be defined in terms of romantic form ...

Loc. cit. is used to refer to the same page of an article you have previously cited. You should provide the date as appropriate. For example:

> It is often said that computing is an art not a science (Johnson 1992: 22). Smith and Jones (1993: 20) emphasise this point when they state that 'computing has much more in common with the finer things in life, like art, than science or engineering'. However, Johnson (*loc. cit.*) goes on to discuss ...

While these abbreviations are often found in short articles and are useful when using a numeric referencing system, they should be used sparingly and with care in longer documents. Try to limit these abbreviations to references that occur on the same page or at most one page earlier in your report. Linking *ibid.*, *op. cit.* and *loc. cit.* to a reference that occurred two or more pages beforehand makes it difficult for the reader to follow.

Above all, make sure from the way you have referenced material within your report that it is clear exactly to which article you are referring and you do not identify two articles in the same way. In addition, make sure that you use a consistent style – don't switch from Harvard form to numeric form and vice versa, and do not mix the two forms together.

6.5.2 **Listing references**

Generally speaking, the best place to list all the references you have used is at the back of your report, as opposed to footnotes at the bottom of pages or lists at the end of each chapter. This provides the reader with a single compendium of all relevant material that can be accessed easily. Articles you have used are presented under the heading of either *References* or *Bibliography*. References list only those articles that have been referred to (cited) within the report itself. A bibliography will list all the articles you have used in your project but that are not necessarily referred to in the body of the report. Bibliographies are useful for the reader in that they identify all material that is relevant for taking your work forward or understanding it in more depth. For undergraduate projects and books it might be more appropriate to include a bibliography, but for

postgraduate projects it would not. Your supervisor should be able to advise you on which approach to use.

How you present references will depend on the referencing system you are using, *Harvard* or *numeric*. Only the Harvard system will be discussed in detail as the numeric system is basically the same. The only difference with the numeric system is that each reference is presented in its numerical order and is presented with its numerical identifier first. For example:

15. Wilson, G. (1992) *The Implications of Art*, Gower, London.
16. Herbert, K. (1991) *The Art of Science*, Chapman & Hall, Manchester.

In the Harvard system the use of italics, commas, colons, upper case letters, abbreviations (such as Vol for Volume) and brackets may well be dictated by your own institution's 'house' style. However, Harvard references should always be presented alphabetically with articles by the same author(s) presented chronologically. Examples are given in the following subsections.

Books

Anderson, J., Jones, J.P. and Peterson, K.K.L. (1982) *The Implications of Science*, 2nd edition, Pitman, London.

Benjamin, T. (1956) *Computer Science Made Easy*, Arnold, Leeds.

Note that it is not necessary to include terms such as 'Ltd', 'Inc.' etc. for publisher's names as long as the publisher is clearly known from the information presented. The date that is presented represents the date on which that edition of the book was *first* published. This provides an indication of the age of the book, which would not be apparent by referencing a reprint date, which could be several years later.

Journal articles

Brown, A. and Wesley, C.W. (1995a) 'An investigation of the Hawthorne effect', *Management Sciences Journal*, **42**(1), 47–66.

Brown, A. and Wesley, C.W. (1995b) 'Adaptation of genetic algorithms in Hawthorne analysis', *Management Monthly*, **28**(2), 21–23.

Notice the use of letters (1995a, 1995b) to uniquely identify these two articles produced by the same authors in the same year.

Web addresses

Gaynor, L. (1993) 'Introduction to artificial intelligence', available from Internet ⟨http://www.cai.com/ai/1086⟩ (25 July 1999).

International Group on Complex Systems (1999), 'Systems analysis', Minutes of Second Meeting, 12 June 1999, ⟨http://www.IGCS.com/Min/two.html⟩ (25 July 1999).

References to Internet sites should include the *full* web address including *http* etc. Make sure that you present the title of the page, article and site name

where appropriate. These references should also include the date on which the site was accessed. Because the Internet is ever-changing, these references may become outdated very quickly.

Trade or company publications

IAEA (1983) *Guidebook on Computer Techniques in Nuclear Plants*, Technical Report Series No. 27, International Atomic Energy Agency, Russia.

National Environment Research Council (1992) *Computers in Hydrology Report*, Vol. II, NERC, London.

Theses

Hampson, J. (1994) 'The effectiveness of AI in calcite modelling', unpublished PhD thesis, Department of Computing, University of Strathclyde.

Conferences

Jowitt, J.D. (1995) 'Information systems in a progressive society', in *Applications of Information Systems XI*, Eds Cartwright, R.A. and Laurence, G., Rowntree Publications, Leeds.

ISAIS (1995) *International Symposium on Applications of Information Systems XI*, proceedings of an international conference organised by the Society of IS, London, 12–16 June 1994, Rowntree Publications, Leeds.

The first reference here (Jowitt 1995) is for an article presented at a conference. The second reference refers to the conference proceedings itself.

Television programmes

The Information Programme (1993) Channel Four Television Corporation, broadcast 8.30 p.m. Tuesday 18 November 1993.

Kay, S. (1992) *The World's a Stage*, BBC1.

The first reference here has no specific 'author' or presenter so is presented using the programme's title as a reference. The second reference is more vague, and perhaps, represents a secondary reference in which as much information as possible has been presented.

CD-ROM

Katlen, P. and Rose, P. (1992) *Information Systems in the 1990s*, CAROM CD-ROM, Solar Information Systems, London.

The references presented above are by no means comprehensive and you will undoubtedly come across an article, some data or some other material from an obscure source that is not covered by these examples. However, unless your institution has specific guidelines to follow when referencing such mat-

erial, you will have to present the reference in a way that you feel is appropriate. If your supervisor is unable to help you, remember two things. First, the reference should be clear enough so that anyone reading your report knows to which article you are referring and, second, you should ensure you have provided sufficient information for the reader to trace that article easily if he or she wishes.

6.6 Documenting software

6.6.1 *Introduction*

The documentation required to support a piece of software can be immense and covers a vast range of issues, from internal commenting of program code, systems analyses and design notes, figures and system documentation, to test plans and user guides. The following list itemises topics and documentation you might be expected to cover and include in your project to support any software that you produce:

- An introduction/overview: simple introduction to the program, what it does, who it is for.
- Technical solution adopted: what technical solution has been implemented, whether it is ideal, whether an alternative exists.
- Design: systems analysis, systems design, human factors, story boards etc.
- Software engineering information: program design, structure, definition languages, test plans etc.
- Development approach used: evolutionary delivery, build and fix etc.
- Problems encountered: bugs, errors, uncompleted sections of code.
- Limitations: what limitations there are to the program; for example, it can only handle files of a certain size, it only calculates results to an accuracy of 10% etc.
- Hardware/software requirements for running the program.
- Next stage: if you were to continue, or somebody else were to take over your project from you, which parts of the software should be developed next? Which parts of the program could be enhanced with new features? Are the code, documentation and comments and so on at a level whereby somebody could take over from you easily in the future?
- Evaluation of the software: how well does it do what it is supposed to do? Does it satisfy the user's needs?
- User guide: written at the right level of detail for the intended user.

Depending on the nature of your project, you will have to present more or less detail in each of these areas. How you complete documentation such as designs, analyses and test plans is beyond the scope of this book as it is

dependent upon the development process, the methods employed and the type of project you have undertaken. For example, a pure programming project would require comprehensive analysis diagrams, test plans and system documentation, whereas a project merely developing a piece of code as a vehicle for presenting some ideas would not. The focus here is on commenting programs and writing user guides as these should be included with any piece of code you produce.

6.6.2 *Commenting program code*

Commenting program code is dependent on the programming language used (for example, a third or fourth generation language, an object oriented language, a formal language and so on), the style of code being developed and the requirements of your course and project. Having said this, there are a number of general guidelines you can follow when commenting your code:

- Understand the purpose of the program you are writing. Who is going to use it, maintain or enhance it, mark it? What is their level of knowledge? If you are merely writing a small program for your own use to test out some ideas you will not need as many comments as for a program that is going to be used and enhanced by somebody else.
- Try to ensure that you provide the right level of comments within your program – don't over-comment or under-comment and avoid comments on every single line of code. Comments should tell the programmer something that is not clear from the code itself and they are not there to explain the programming language used. Provided you have used suitable variable names and a logical structure for your program then comments should be limited.
- It is advisable to comment each function, procedure, object, block, screen and so on (depending on the language used). This will explain, at the very least, what each main component of your program does and may be the depth of commenting required by someone to understand how the program works and is structured.
- Try to make comments stand out from your code so that they don't become buried as a mass of text in your program. For example, tab each *in-line* comment clear of the code to the right and keep line spaces around *full-line* comments.
- Avoid long winded explanations. Keep comments brief and clear – you are not writing an essay.
- Avoid wasting time producing fancy borders, header styles and so on. Your comments are there to provide understanding and explanation to your program; they are not there to make it look pretty.
- Make sure you include vital information at the start of your program such as author, date, version number, a description of what the program

does and, possibly, a brief explanation of how it does it. These comments are often included as *block* comments – several lines of full-line comments providing more detailed explanation.
- Try to make sure that you maintain and update program comments as you amend and develop your software. There is little point in keeping outdated comments in your code that refer to much earlier and different versions of your program.

In summary, it is probably a good idea to get guidance from your supervisor as to the style and level of comments required. Your department may have guidelines on what is expected in the form of program comments and there may be an 'in house' style you have to follow.

6.6.3 Writing user guides

There has been a lot of research in recent years into user guides: their structure, presentation and content, usability, trainability, minimalist training issues and so on, all of which are beyond the intended scope of this book. In this case you are more likely to be interested in user guides from a narrower perspective in that your guide is not going to be used by the 'masses' but within your own institution as part of your computing project and part of its assessment.

In this context any user guides you develop are likely to be presented within separate documents to your final report or included within its appendices. How you present user guides is up to you but the longer they are the more sensible it will be to present them as separate documents. Get advice from your supervisor on the scope of any documentation required. Whatever the case, they should provide the user with at least these pieces of information:

- an overview of the software: what it does, who it is intended for.
- an idea of its hardware requirements: memory requirements, disk space required, additional hardware requirements such as sound cards, platform requirements (PC, Macintosh etc.), operating system requirements etc.
- how to load/install the software.
- how to start the software.
- how to end and perhaps delete/remove the software.
- details of any known problems and restrictions imposed by the program.

More broadly speaking, according to Rogerson (1989: 87), a user manual should satisfy three aims:

- 'provide practical information about the software when help is not at hand';
- 'help inexperienced users get started quickly and with least difficulty';
- 'help experienced users become productive quickly'.

When writing user guides as part of your project you should begin by identifying your target audience. Will you need a comprehensive guide so that complete beginners will be able to understand your software or will a simple overview of its functionality be sufficient as it will only ever be used by your supervisor?

User manuals tend to come in two different forms: first, *training manuals*, where the user is taught how to use the software through a number of examples that build on one another, and second, *reference manuals*, whereby experienced users can 'dip into' the manual at appropriate points for clarification or explanation of specific features of the program. How you structure your documentation will be based largely on your intended users. For experienced users a reference manual may be all that is required. However, for inexperienced users, evolutionary examples may be more appropriate. In addition, depending on the nature of your user you may have to provide detailed explanations describing simpler operating principles such as 'save as', 'page setup' etc. It is also a good idea to include some screen dumps from your program in a user guide so that users feel they are following your guide correctly when it appears that things aren't happening as they would expect. It also provides users with additional confidence to see things mapping out on the screen in the same way they are presented on paper. You might also wish to include a description of possible mistakes that could be made by a user and how the user can avoid or overcome them.

6.7 Summary

- When you begin to write your report consider the reader and be aware of any limitations on its length. Use a top-down approach to structure your report and allow sections within your report to evolve over time. There is a particular order in which you should write your report and a specific way in which it should be structured. Look for ways of practising and improving your writing style.
- Your abstract should be one of the last things that you write. It should be clear and concise, summarising the context, scope and contribution of your report. Avoid presenting your abstract as a contents listing.
- Charts and graphs can do much to enhance the appearance and content of a report. They should be used appropriately (in terms of necessity and type) and each one should be uniquely labelled and titled. You must also ensure that you scale them correctly in order to clarify the point you are trying to portray.
- The Harvard system is the most appropriate system to use for referencing material within your report. Each article should be uniquely identifiable and each reference should be complete so that the reader can trace the article.

- Documenting software covers a multitude of topics, from commenting program code to writing user guides. This chapter has focused on the development of user guides, which are usually presented as training manuals (with worked examples) or reference manuals (for more experienced users).

6.8 Further reading

Collier, J.H. (ed.) (1997) *Scientific and Technical Communication*, Sage, London.
Creme, P. and Lea, M.R. (1997) *Writing at University: A Guide for Students*, Open University Press, Buckingham.
Reynolds, L. and Simmonds, D. (1984) *Presentation of Data in Science*, Kluwer, Lancaster.
Shortland, M. and Gregory, J. (1991) *Communicating Science: A Handbook*, Longman, Harlow.

6.9 Exercises

1. Produce a report breakdown structure for your own project.
2. Write a short abstract of around 200 words for an article you have read recently. Compare your abstract with the one included with the article. Do you think your abstract is better or worse and why?
3. Collect some data from your library on your own institution; for example, number of students entering the university each year, their age, qualifications etc. How are these data presented? Enter these data into a spreadsheet and present them in a different way. Do you think that your presentation is better or worse? Why?