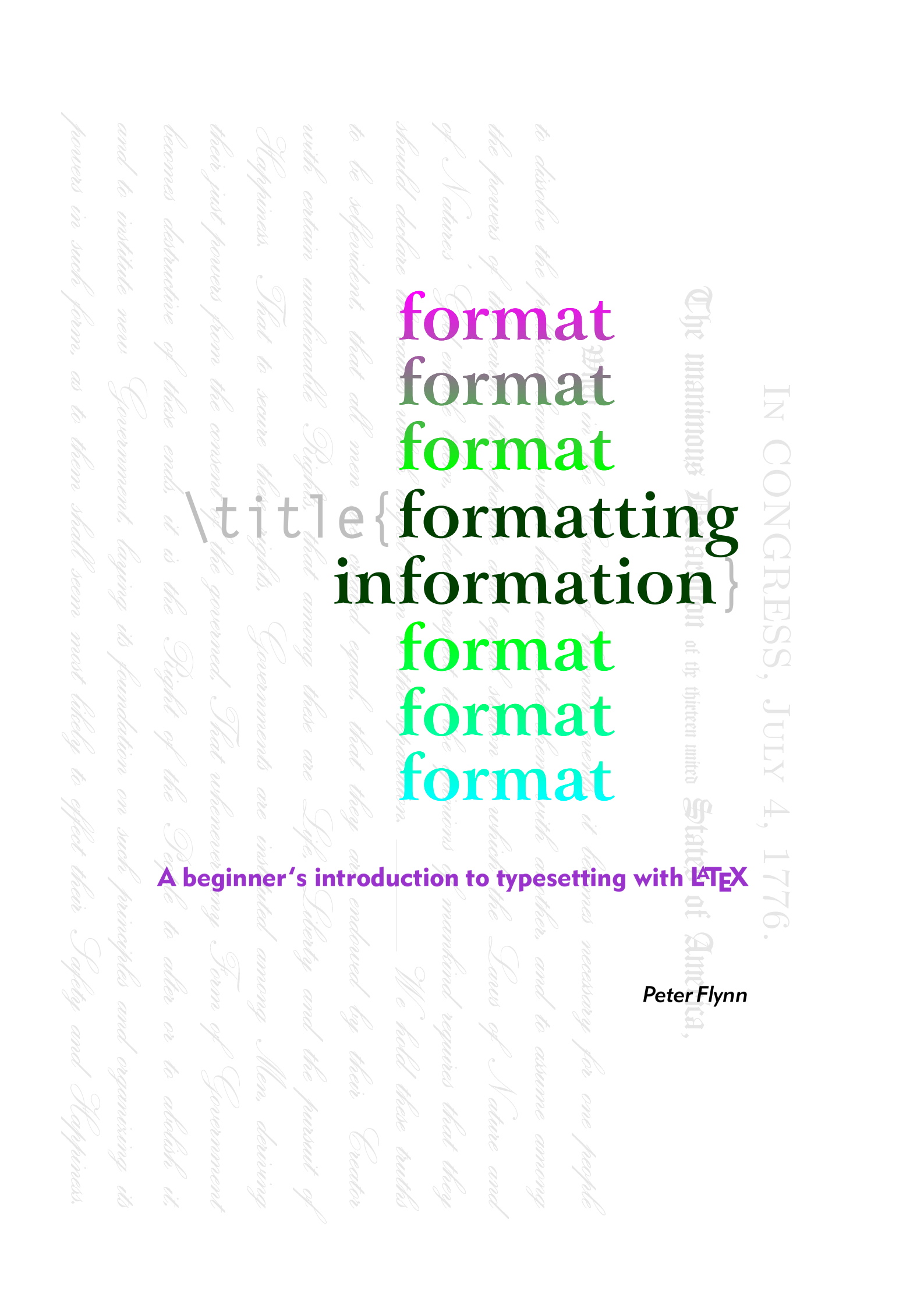

A beginner's introduction to typesetting with LaTeX

Peter Flynn

Formatting information

A beginner's introduction to typesetting with LaTeX

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[1] FSF (2003/02/10 23:42:49)

Acknowledgments

This edition of *Formatting Information* was prompted by the generous help I have received from TEX users too numerous to mention individually. Shortly after TUGboat published the November 2003 edition, I was reminded by a spate of email of the fragility of documentation for a system like LATEX which is constantly under development. There have been revisions to packages; issues of new distributions, new tools, and new interfaces; new books and other new documents; corrections to my own errors; suggestions for rewording; and in one or two cases mild abuse for having omitted package X which the author felt to be indispensable to users.

I am grateful as always to the people who sent me corrections and suggestions for improvement. Please keep them coming: only this way can this book reflect what people want to learn. The same limitation still applies, however: no mathematics, as there are already a dozen or more excellent books on the market — as well as other online documents — dealing with mathematical typesetting in TEX and LATEX in finer and better detail than I am capable of.

The structure remains the same, but I have revised and rephrased a lot of material, especially in the earlier chapters where a new user cannot be expected yet to have acquired any depth of knowledge. Many of the screenshots have been updated, and most of the examples and code fragments have been retested.

As I was finishing this edition, I was asked to review an article for *The PracTEX Journal*[2], which grew out of the Practical TEX Conference in 2004. The author specifically took the writers of documentation to task for failing to explain things more clearly, and as I read more, I found myself agreeing, and resolving to clear up some specific problems areas as far as possible. It is very difficult for people who write technical documentation to

[2] Carnes/Berry (2004)

remember how they struggled to learn what has now become a familiar system. So much of what we do is second nature, and a lot of it actually has nothing to do with the software, but more with the way in which we view and approach information, and the general level of knowledge of computing. If I have obscured something by making unreasonable assumptions about *your* knowledge, please let me know so that I can correct it.

Peter Flynn is author of *The HTML Handbook* and *Understanding SGML and XML Tools*, and editor of *The XML FAQ*.

Technical note

The text is written and maintained in DocBook with a customization layer for typographics. XSLT is used to generate HTML (for the Web and plain-text versions) and LaTeX (for PDF and PostScript). The November 2003 edition was published in *TUGboat*[3]. This edition contains extensive revisions and simplifications to the text, and many corrections to the way in which the packages and their capabilities are presented.

[3] Beeton (Since 1980)

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Introduction

This book originally accompanied a 2-day course on using the LaTeX typesetting system. It has been extensively revised and updated and can now be used for self-study or in the classroom. It is aimed at users of Linux, Macintosh, or Microsoft Windows but it can be used with LaTeX systems on any platform, including other Unix workstations, mainframes, and even your Personal Digital Assistant (PDA).

Who needs this book?

The audience for the original training course was assumed to be computer-literate and composed of professional, business, academic, technical, or administrative computer users. The readers of the book (you) are mostly assumed to be in a similar position, but may also come from many other backgrounds, including hobbyists, students, and just people interested in quality typesetting. You are expected to have one or more of the following or similar objectives:

- producing typesetter-quality formatting;
- formatting long, complex, highly-structured, repetitive, or automatically-generated documents;[4]
- saving time and effort by automating common tasks;
- achieving or maintaining your independence from specific makes or models of proprietary hardware, software, or file formats (portability);
- using Open Source software (free of restrictions, sometimes also free of charge).

[4] LaTeX can easily be used for once-off or short and simple documents as well, but its real strengths lie in consistency and automation.

Skills needed

LaTeX is a very easy system to learn, and requires no specialist knowledge, although literacy and some familiarity with the publishing process is useful. It is, however, assumed that you are completely fluent and familiar with using your computer before you start. Specifically, effective use of this document requires that you already know and understand the following very thoroughly:

- how to use a good plain-text editor (*not* a wordprocessor like *OpenOffice*, *WordPerfect*, or Microsoft *Word*, and *not* a toy like Microsoft *Notepad*); 2.1.3
- where to find all 95 of the printable ASCII characters on your keyboard and what they mean, and how to type accents and symbols, if you use them; 3.2.1.2
- how to create, open, save, close, rename, move, and delete files and folders (directories); 2.3
- how to use a Web browser and/or File Transfer Protocol (FTP) program to download and save files from the Internet; 7.3.1.6
- how to uncompress and unwrap (unzip or detar) downloaded files. 2.3.7

If you don't know how to do these things yet, it's important to go and learn them first. Trying to become familiar with the fundamentals of using a computer *at the same time* as learning LaTeX is not likely to be as effective as doing them in order.

These are not specialist skills — they are all included in the European Computer Driving Licence (ECDL) and the relevant sections of the ECDL syllabus are noted in the margin above, so they are well within the capability of anyone who uses a computer.

Objectives of this book

By the end of this book, you should be able to undertake the following tasks:

- use a plain-text editor to create and maintain your documents;
- add LaTeX markup to identify your document structure and formatting requirements;
- typeset LaTeX documents, correct simple formatting errors, and display or print the results;
- identify, install, and use additional packages (using CTAN for downloading where necessary);
- recognise the limitations of procedural markup systems and choose appropriate generic markup methods where appropriate.

Synopsis

The original course covered the following topics as separate sessions, which are represented in the book as chapters:

1. Where to get and how to install LaTeX (*teTeX*, *fpTeX*, or *proTeXt* from the TeX Collection disks);
2. How to type LaTeX documents: using an editor to create files (half a dozen editors for LaTeX);
3. Basic structures (the Document Class Declaration and its layout options; the document environment with sections and paragraphs);
4. Typesetting, viewing, and printing;
5. The use of packages and CTAN to adapt formatting using standard tools;

6. Other document structures (lists, tables, figures, images, and verbatim text);
7. Textual tools (footnotes, marginal notes, cross-references, indexes and glossaries, and bibliographic citations);
8. Typographic considerations (white-space and typefaces; inline markup and font changes; extra font installation and automation);
9. Programmability and automation (macros and modifying LaTeX's behaviour);
10. Conversion and compatibility with other systems (XML, *Word*, etc.).

A few changes have been made in the transition to printed and online form, but the basic structure is the same, and the document functions as a workbook for the course as well as a standalone self-teaching guide.

Where's the math?

It is important to note that the document *does not cover* mathematical typesetting, complex tabular material, the design of large-scale macros and document classes, or the finer points of typography or typographic design, although it does refer to these topics in passing on a few occasions. There are several other guides, introductions, and 'get-started' documents on the Web and on CTAN which cover these topics and more. Among the more popular are:

- *Getting Started with TeX, LaTeX, and friends*[5], where all beginners should start;
- *The (Not So) Short Guide to LaTeX 2ε: LaTeX 2ε in 131 Minutes*[6] is a good beginner's tutorial;

[5] TUG (November 2003)
[6] Oetiker et al. (2001)

- *A Gentle Introduction to TEX: A Manual for Self-Study*[7] is a classic tutorial on Plain TEX;
- *Using imported graphics in LATEX 2ε*[8] shows you how to do (almost) anything with graphics: side-by-side, rotated, etc.;
- *Short Math Guide for LATEX*[9] gets you started with the American Math Society's powerful packages;
- *A comprehensive list of symbols in TEX*[10] shows over 2,500 symbols available.

This list was taken from the CTAN search page. There are also lots of books published about TEX and LATEX: the most important of these for users of this document are listed in the last paragraph of the Foreword on p. xviii.

Availability of LATEX systems

Because the TEX program (the 'engine' which actually does the typesetting) is separate from whichever editor you choose, TEX-based systems are available in a variety of different modes using different interfaces, depending on how you want to use them.

Graphical interface

The normal way to run LATEX is to use a toolbar button (icon), a menu item, or a keystroke in your editor. Click on it and your document gets saved and typeset. All the other features of LATEX systems (the typeset display, spellchecker, related programs like *makeindex* and BIBTEX) are run the same way. This works both in a normal Graphical User Interface (GUI) as well as in text-only interfaces.

[7] Doob (2002)
[8] Reckdahl (1997)
[9] AMS (2001)
[10] Pakin (2002)

In the popular LaTeX editors like *Emacs*, *TEXshell*, *TEXnicCenter*, *WinShell*, or *WinEdt*, a record of the typesetting process is shown in an adjoining window so that you can see the progress of pages being typeset, and any errors or warnings that may occur.[11]

Command-line interface

However, the graphical interface is useless if you want to run LaTeX unattended, as part of an automated system, perhaps in a web server or e-commerce environment, where there is no direct connection between user and program. The underlying TeX engine is in fact a Command-Line Interface (CLI) program, that is, it is used as a 'console' program which you run from a standard Unix or Mac terminal or shell window (or from an MS-DOS command window in Microsoft Windows systems). You type the command `latex` followed by the name of your document file (see Figure 4.1 in § 4.1.2 for an example).

Commands like these let you run LaTeX in an automated environment like a Common Gateway Interface (CGI) script on a web server or a batch file on a document system. All the popular distributions for Unix and Windows, both free and commercial, include this interface as standard (teTeX, fpTeX, MiKTeX, proTeXt, PC-TeX, TrueTeX, etc.).

Typeset displays

LaTeX usually displays your typeset results in a separate window, redisplayed automatically every time the document is reprocessed, because the typesetting is done separately from the editing. Some systems, however, can format the typesetting while you type, at the expense of some flexibility.

Asynchronous typographic displays This method is called an ***asynchronous typographic display*** because the typeset window

[11] Recent versions of some editors hide this display by default unless errors occur in the typesetting.

only updates *after* you have typed something and reprocessed it, not *while* you are still typing, as it would with a wordprocessor.[12]

Synchronous typographic displays Some distributions of LaTeX offer a ***synchronous typographic interface***. In these, you type directly into the typographic display, as with a wordprocessor. Three popular examples are *Textures*, *Scientific Word*, and *VTEX* (see table below). At least one free version (LyX, see Figure 2.2 in § 2.3) offers a similar interface.

With a synchronous display you get Instant Textual Gratification™, but your level of control is restricted to that of the GUI you use, which cannot provide access to everything that LaTeX can do. For complete control of the formatting you may still need access to your normal source (input) file in the same way as for asynchronous implementations.

Near-synchronous displays There are several other methods available free for Unix and some other systems for close-to-synchronous updates of the typeset display (including Jonathan Fine's *Instant Preview* and the TeX daemon), and for embedding typographic fragments from the typeset display back into the editor window (David Kastrup's preview-latex package).

Commercial distributions

Whatever method you choose, the TeX Collection CD and CTAN are not the only source of software. The vendors listed in Table offer excellent commercial implementations of TeX and LaTeX, and if you are in a position where their enhanced support and additional features are of benefit, I urge you to support them. In most cases their companies, founders, and staff have been good friends of the TeX and LaTeX communities for many years.

[12] Among other reasons, TeX typesets whole paragraphs at a time, not line-by-line as lesser systems do, in order to get the hyphenation and justification (H&J) right (see § 2.8).

Table 1: Popular commercial implementations of TEX systems

Product	Platform	Company	URI
PCTEX	MS-Windows	Personal TEX, Inc	www.pctex.com/
TrueTEX	MS-Windows	True TEX	truetex.com/
Textures	Apple Mac	Blue Sky Research	www.bluesky.com/
Scientific Word	MS-Windows	Mackichan Software	www.mackichan.com/
VTEX	MS-Windows, Linux, OS/2	MicroPress, Inc	www.micropress-inc.com/

Production note

This document is written and maintained in XML, using a customized version of the *DocBook* DTD. Conversions were made to HTML and LATEX using XSLT scripts and Michael Kay's *Saxon* processor.

The complete source, with all ancillary files, is available online at http://www.ctan.org/tex-archive/info/beginlatex/src/ but if you want to try processing it yourself you must install *Java* (from Sun, IBM, or a number of others) and *Saxon* (from http://saxon.sourceforge.net/), in addition to LATEX.

This document is published under the terms and conditions of the GNU Free Documentation License. Details are in Appendix D.

Symbols and conventions

The following typographic notations are used:

Notation	Meaning
`\command`	Control sequences which perform an action, e.g. `\newpage`
`\length`	Control sequences which store a dimension (measurement in units), e.g. `\parskip`
`counter`	Values used for counting (whole numbers, as opposed to measuring in units), e.g. *`secnumdepth`*
term	Defining instance of a new term
environment	A LaTeX formatting environment
package	A LaTeX package (available from CTAN)
product	Program or product name
`typewriter type`	Examples of source code (stuff you type)
`mybook` or *`value`*	Mnemonic examples of things you have to supply real-life values for
x	A key on your keyboard
Ctrl–x	Two keys pressed together
Esc q	Two keys pressed one after another
Submit	On-screen button to click
Menu Item	Drop-down menu with items

Examples of longer fragments of input are shown with a border round them. Where necessary, the formatted output is shown immediately beneath. Warnings are shown with a shaded background. Exercises are shown with a double border.

Foreword

As noted in the Introduction on p. viii, this document accompanies a two-day introductory training course. It became obvious from repeated questions in class and afterwards, as well as from general queries on `comp.text.tex` that many people do not read the FAQs, do not use the TUG web site, do not buy the books and manuals, do not use the newsgroups and mailing lists, and do not download the free documentation. Instead, they try to get by using the training technique known as 'sitting by Nelly', which involves looking over a colleague's shoulder in the office, lab, library, pub, or classroom, and absorbing all his or her bad habits.

In the summer of 2001 I presented a short proposal on the marketing of LaTeX to the annual conference of the TeX Users Group held at the University of Delaware, and showed an example of a draft brochure[13] designed to persuade newcomers to try LaTeX for their typesetting requirements. As a result of questions and suggestions, it was obvious that it needed to include a pointer to some documentation, and I agreed to make available a revised form of this document, expanded to be used outside the classroom, and to include those topics on which I have had most questions from users over the years.

It turned out to mean a significant reworking of a lot of the material. Some of it appears in almost every other manual and book on LaTeX but it is essential to the beginner and therefore bears repetition. Some of it appears other forms elsewhere, and is included here because it needs explaining better. And some of it appears nowhere else but this document. I took the opportunity to revise the structure of the training course in parallel with the book (expanding it from its original one day to two days), and to include a more comprehensive index. It is by no means perfect (in both senses), and I would be grateful for comments

[13] `http://www.silmaril.ie/documents/latex-brochure/leaflet.pdf`

and corrections to be sent to me at the address given under the credits.

I had originally hoped that the LaTeX version of the document would be processable by any freshly-installed default LaTeX system, but the need to include font samples which go well beyond the default installation, and to use some packages which the new user is unlikely to have installed, means that this document itself is not really a simple piece of LaTeX, however simply it may describe the process itself.

However, as the careful reader will have already noticed, the master source of the document is not maintained in LaTeX but in XML. A future task is therefore to compare the packages required with those installed by default, and flag portions of the document requiring additional features so that an abbreviated version can be generated which can be guaranteed to process even with a basic LaTeX installation.

If you are just starting with LaTeX, at an early opportunity you should buy or borrow a copy of *LaTeX: A Document Preparation System*[14] which is the original author's manual. More advanced users should get the *The LaTeX Companion*[15] or one of its successors. In the same series there are also the *The LaTeX Graphics Companion*[16] and the *The LaTeX Web Companion*[17]. Mathematical users might want to read *Short Math Guide for LaTeX*[18].

[14] Lamport (1994)
[15] Mittelbach et al. (2004)
[16] Goossens/Rahtz/Mittelbach (1997)
[17] Goossens et al. (1999)
[18] AMS (2001)

Preface

Many people discover LaTeX after years of struggling with word-processors and desktop publishing systems, and are amazed to find that TeX has been around for over 25 years and they hadn't heard of it. It's not a conspiracy, just 'a well-kept secret known only to a few million people', as one anonymous user has put it.

Perhaps a key to why it has remained so popular is that it removes the need to fiddle with the formatting while you write. Although playing around with fonts and formatting is attractive to the newcomer, it is completely counter-productive for the serious author or editor who wants to concentrate on *writing* — ask any journalist or professional writer.

A few years ago a new LaTeX user expressed concern on the `comp.text.tex` newsgroup about 'learning to write in LaTeX'. Some excellent advice[19] was posted in response to this query, which I reproduce with permission below [the bold text is my emphasis]:

> No, the harder part might be *writing*, period. TeX/LaTeX is actually easy, once you relax and stop worrying about appearance as a be-all-and-end-all. Many people have become 'Word Processing Junkies' and ***no longer 'write' documents, they 'draw' them***, almost at the same level as a pre-literate 3-year old child might pretend to 'write' a story, but is just creating a sequence of pictures with a pad of paper and box of *Crayola*s --- this is perfectly normal and healthy in a 3-year old child who is being creative, but is of questionable usefulness for, say, a grad student writing a Master's or PhD thesis or a business person writing a white paper, etc. For this reason, *I* strongly recommend *not* using any sort of fancy GUI 'crutch'. Use a plain vanilla text editor and treat it like an old-fashioned typewriter. Don't waste time playing with your mouse.

[19] news:comp.text.tex/MPG.18d82140d65ddc5898968c@news.earthlink.net

> Note: I am *not* saying that you should have no concerns about the appearance of your document, just that you should *write* the document (completely) first and tweak the appearance later…*not* [spend time on] lots of random editing in the bulk of the document itself.
> [Heller, *New To LaTeX…Unlearning Bad Habits* (11 March 2003)]

Learning to write well can be hard, but authors shouldn't have to make things even harder for themselves by using manually-driven systems which break their concentration every few seconds for some footling adjustment to the appearance, simply because the software is incapable of doing it right by itself.

Don Knuth originally wrote TeX to typeset mathematics for the second edition of his master-work *The Art of Computer Programming*[20], and it remains pretty much the only typesetting program to include fully-automated mathematical formatting done the way mathematicians want it. But he also published a booklet called *Mathematical Writing*[21] which shows how important it is to think about what you write, and how the computer should be able to help, not hinder.

And TeX is much more than math: it's a programmable typesetting system which can be used for almost any formatting task, and LaTeX has made it usable by almost anyone. Professor Knuth generously placed the entire system in the public domain, so for many years there was no publicity of the commercial kind which would have got TeX noticed outside the technical field.

Nowadays, however, there are many companies selling TeX software or services,[22] dozens of publishers accepting LaTeX documents for publication, and hundreds of thousands of users using LaTeX for millions of documents.[23]

[20] Knuth (1980)

[21] Knuth/Larrabee/Roberts (1989)

[22] See, for example, the list of TeX vendors on p. xv, and the list of consultants published by TUG.

[23] A guesstimate. With free software it's impossible to tell how many people are using it, but it's a *lot*.

To count yourself as a TEX or LATEX user, visit the TEX Users Group's 'TEX Counter' web site (and get a nice certificate!).

There is occasionally some confusion among newcomers between the two main programs, TEX and LATEX:

- TEX is a typesetting program, originally written by Prof Knuth at Stanford around 1978. It implements a macro-driven typesetters' programming language of some 300 basic operations and it has formed the core of many other desktop publishing (DTP) systems. Although it is still possible to write in the raw TEX language, you need to study it in depth, and you need to be able to write macros (subprograms) to perform even the simplest of repetitive tasks.

- LATEX is a user interface for TEX, designed by Leslie Lamport at Digital Equipment Corporation (DEC) in 1985 to automate all the common tasks of document preparation. It provides a simple way for authors and typesetters to use the power of TEX without having to learn the underlying language. LATEX is the recommended system for all users except professional typographic programmers and computer scientists who want to study the internals of TEX.

Both TEX and LATEX have been constantly updated since their inception. Knuth has now frozen development of the TEX engine so that users and developers can have a virtually bug-free, rock-stable platform to work with.[24] Typographic programming development continues with the New Typesetting System (NTS), planned as a successor to TEX. The LATEX3 project has taken over development of LATEX, and the current version is LATEX 2ε, which is what we are concentrating on here. Details of all developments can be had from the TUG at `http://www.tug.org`

[24] Knuth still fixes bugs, although the chances of finding a bug in TEX these days approaches zero.

Debunking the mythology

Naturally, over all the years, a few myths have grown up around LaTeX, often propagated by people who should know better. So, just to clear up any potential misunderstandings…

MYTH: 'LaTeX has only got one font' Most LaTeX systems can use any OpenType, TrueType, Adobe (PostScript) Type1 or Type3, or METAFONT font. This is more than most other known typesetting system. LaTeX's default font is Computer Modern (based on Monotype Series 8: see the table on p. 149), not Times Roman, and some people get upset because it 'looks different' to Times. Typefaces differ: that's what they're for — get used to it.

MYTH: 'LaTeX isn't WYSIWYG' Simply not true. DVI and PDF preview is better WYSIWYG than any wordprocessor and most DTP systems. What people mean is that LaTeX's typographic display is asynchronous with the edit window. This is only true for the default CLI implementations. See the Introduction on p. xiv for details of synchronous versions.

MYTH: 'LaTeX is obsolete' Quite the opposite: it's under constant development, with new features being added almost weekly. Check the `comp.text.tex` for messages about recent uploads to CTAN. It's arguably more up-to-date than most other systems: LaTeX had the Euro (€) before anyone else, it had Inuktitut typesetting before the Inuit got their own province in Canada, and it still produces better mathematics than anything else.

More mythology

MYTH: 'LaTeX is a Unix system' People are also heard saying: 'LaTeX is a Windows system', 'LaTeX is a Mac system', etc., etc. *ad nauseam*. TeX systems run on almost every computer in use, from some of the biggest supercomputers down to handhelds (PDAs like the Sharp *Zaurus*). That includes Windows and Linux PCs, Macs, and all other Unix systems. If you're using something TeX doesn't run on, it must be either incredibly new, incredibly old, or unbelievably obscure.

MYTH: 'LaTeX is "too difficult"' This has been heard from physicists who can split atoms; from mathematicians who can explain why π exists; from business people who can read a balance sheet; from historians who can grasp Byzantine politics; from librarians who can understand LoC and MARC; and from linguists who can decode Linear 'B'. It's nonsense: most people grasp LaTeX in 20 minutes or so. It's not rocket science (or if it is, I know any number of unemployed rocket scientists who will teach it to you).

MYTH: 'LaTeX is "only for scientists and mathematicians"' Untrue. Although it grew up in the mathematical and computer science fields, two of its biggest growth areas are in the humanities and business, especially since the rise of XML brought new demands for automated web-based typesetting.

1 Installing TEX and LATEX

This course is based on using one of the following distributions of TEX on the 2004 TEX Collection DVD or the 2003 TEX Live CD:

teTEX for Linux and other Unix-like systems, including Mac OS X (Thomas Esser);

proTEXt for Microsoft Windows (Thomas Feuerstack), based on Christian Schenk's MikTEX;

fpTEX for Microsoft Windows (Fabrice Popineau) from the 2003 TEX Live CD.

Many other implementations of TEX, such as Tom Kiffe's CMacTEX for the Apple Macintosh, can be downloaded from CTAN. LATEX is included with all modern distributions of TEX.

The TEX Collection CD is issued annually on behalf of most of the local TEX user groups around the world (see `http://www.tug.org/lugs.html` for addresses), and edited by Sebastian Rahtz, Karl Berry, Manfred Lotz, and the authors of the software

mentioned above. These people give an enormous amount of their personal time and energy to building and distributing these systems, and they deserve the thanks and support of the user community for all they do.

There are many other distributions of LaTeX both free and commercial, as described in the Introduction on p. viii: they all process LaTeX identically, but there are some differences in size, speed, packaging, and (in the case of commercial distributions) price, support, and extra software provided.

One final thing before we start: publicly-maintained software like TeX is updated faster than commercial software, so *always check to see if there is a more recent version of the installation*. See the list on p. 12 in § 1.4.3 for more details.

1.1 Editing and display

When you install LaTeX you will have the opportunity to decide *a*) which plain-text editor[s] you want to use to create and maintain your documents; and *b*) which preview programs you want to use to see your typesetting. This isn't much use to you if you're unfamiliar with editors and previewers, so have a look at the table below, and maybe flip ahead to § 2.3 for a moment, where there are descriptions and screenshots.

The best bet is probably to install more than one — if you've got the disk space — or maybe all of them, because you can always delete the ones you don't like.

Editors There is a wide range of editors available: probably no other piece of software causes more flame-wars in Internet and other discussions than your choice of editor. It's a highly personal choice, so feel free to pick the one you like. My personal biases are probably revealed below, so feel equally free to ignore them.

Previewers For displaying your typesetting before printing, you will need a previewer. All systems come with a DVI pre-

viewer for standard LaTeX, but if you are intending to produce industry-standard PostScript or PDF (Adobe Acrobat) files you will need a previewer for those formats. *GSview* displays both PostScript and PDF files; *xpdf* and Adobe's own *Acrobat Reader* just display PDF files.

For brief details of some of the most popular editors used for LaTeX, see § 2.3.

Additional downloads

For licensing reasons, the *GSview* PostScript/PDF previewer, the *Acrobat Reader* PDF previewer, and the *WinEdt* editor could not be distributed on the 2003 CDs. In those cases you have to download and install them separately.

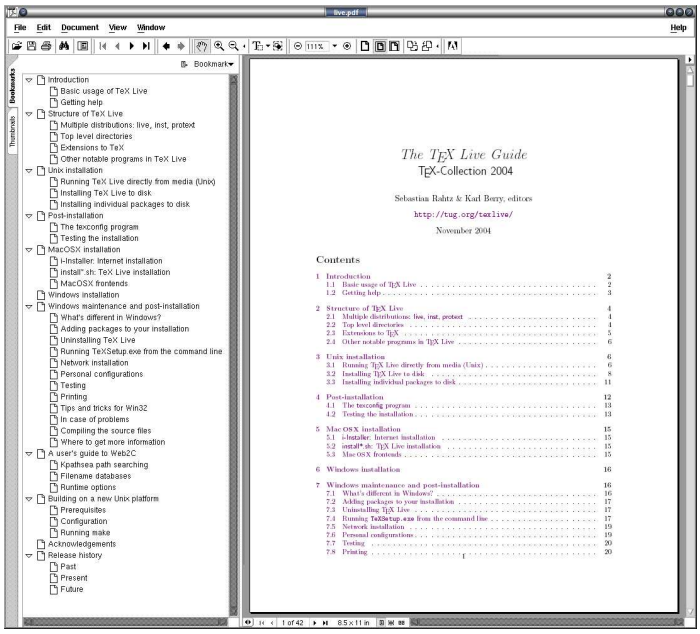
- *GSview* is available for all platforms from `http://www.ghostscript.com/gsview/index.htm` (on Unix and VMS systems it's also available as *GhostView* and *gv*: see `http://www.cs.wisc.edu/^ghost/`)
- *Acrobat Reader* (all platforms) can be downloaded from `http://www.adobe.com/products/acrobat/readstep2.html`
- *WinEdt* (Microsoft Windows only) comes from `http://www.winedt.com`

1.2 Installation for Linux and Unix

Make sure your system libraries and utilities are up to date. If you are using Red Hat Linux, use *yum* or *up2date* to download and install updates. For Debian and other distributions, use *apt-get* or similar. On Red Hat systems, remove any RPM version of teTeX and associated utilities which may have been preinstalled, in order to avoid version conflicts.

If you are installing TeX Live to a new partition, and you have the opportunity to reformat the partition before use, use *mkfs* with

Figure 1.1: TEX Live installation manual



a granularity as small as it will go (usually 1024 bytes). This avoids the partition running out of inodes because TEX uses very large numbers of very small files.

Plan the installation carefully if you are installing for multiple users (a shared machine): read § 5.2 for some comments on where to put additional files downloaded later, and see the FAQ on the same topic at `http://www.tex.ac.uk/cgi-bin/texfaq2html?label=wherefiles`

Above all, Read The Fine Manual (RTFM). The documentation is in `live.html` and `live.pdf` on the disk in the directory `texlive2004/texmf-doc/doc/english/texlive-en/`

```
# cd /mnt/cdrom/texlive2004
# sh install-tl.sh
```

Figure 1.2: The Unix installation program

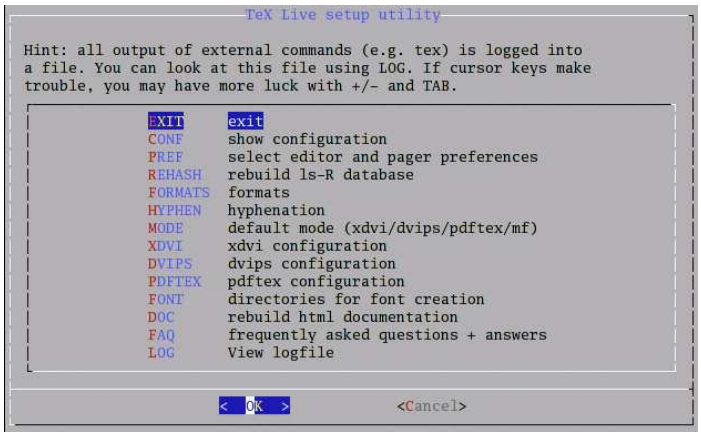
```
==================> TeX Live installation procedure <=================

===> Note: Letters/digits in <angle brackets> indicate menu items <===
===>       for commands or configurable options                    <===

    Proposed platform: Intel x86 with GNU/Linux
    <P> over-ride system detection and choose platform
    <B> binary systems:         1 out of 10
    <S> Installation scheme (scheme_recommended)
    [customizing installation scheme:
       <C> standard collections   <L> language collections]
    20 out of 75, disk space required: 246857 kB
    <D> directories:
      TEXDIR      (The main TeX directory)        : /usr/TeX
      TEXMFLOCAL  (Directory for local styles etc): /usr/TeX/texmf-local
      VARTEXMF    (Directory for local config)    : /usr/TeX/texmf-var
    <O> options:
       [ ] alternate directory for generated fonts ()
       [ ] create symlinks in standard directories
       [ ] do not install macro/font doc tree
       [ ] do not install macro/font source tree
    <R> do not install files, set up to run off CD or DVD
    <I> start installation
    <H> help,  <Q> quit

Enter command:
```

The installer runs in a shell window, so it can be done even from headless systems (those with no X Window client), but it does need to be installed as root if you want to stick with the default directory locations or install it system-wide for multiple users. To install, just type the commands shown above.

The options are mostly self-explanatory, and beginners should pick the recommended scheme and leave all other settings at their defaults. The character-driven interface lets you browse around the settings changing things and looking at options before you commit to installing anything.

'Collections' (the `C` and `L` options) are groups of LaTeX packages that you can include or exclude. It's best to leave this alone

Figure 1.3: Running the post-installation program *texconfig*



unless you know you need something specific. The only options I sometimes set are under 0: the 'alternate directory for generated fonts' may need to be on a different partition for performance reasons on a shared system; and I always select 'create symlinks in standard directories' so that the system works immediately after the post-installation configuration (after installation, run *texconfig* to adjust your local settings.

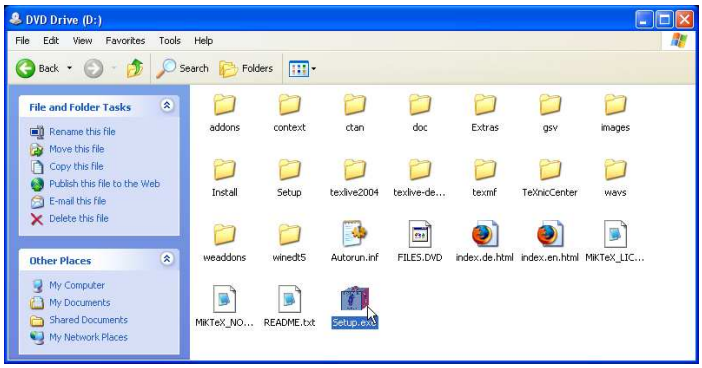
Note that the Linux/Unix installation does not install any editors: it is assumed you can do this yourself from your distribution's standard package system (most likely you will already be using *Emacs* or *vi* anyway).

1.3 Installation for Apple Mac

This is exactly the same interface as for the Linux/Unix installation. You need the *bash* shell (see the warning in the manual for users of older systems).

There is a choice of graphical editors for the Mac: two are included on the DVD, *TEXShop* and *ITEXMac*, but they need to be installed separately, after installing TEX.

Figure 1.4: TEX Collection 2004 DVD



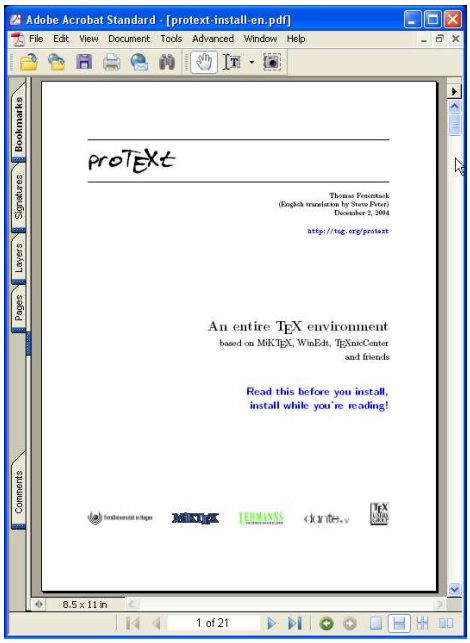
1.4 Installation for Microsoft Windows

Before you install TEX, make sure you have enough disk space: the default installation takes about 350Mb on a modern filesystem. The installation assumes you have a fully updated version of Windows, so visit the Microsoft Web site first (`http://www.microsoft.com/`) and click on *Windows Update*. Select and install all the relevant updates for your operating system (Windows 95, 98, ME, 2000, NT, or XP). You should be doing this regularly anyway, to keep your system healthy. You may want to run *ScanDisk* and give your hard disks a full surface check. TEX consists of a very large number of quite small files, so it's important that your disk is in good order.

When you insert the distribution DVD or CD, it should start the setup program automatically. If you have auto-run turned off, open *My Computer*, double-click on the DVD or CD drive, and then double-click *Autorun* to start the setup program.[1]

[1] Some builds of Windows seem to have a bug that stops *Autorun* starting the installation. In that case (for the TEX Collection 2004 DVD) double-click `Setup.exe` instead, or (for the TEX Collection 2003 CD) go to the `tpm` folder and double-click on `TeXSetup.exe`.

Figure 1.5: proTEXt comes with its own installation guide



1.4.1 proTEXt (TEX Collection 2004)

For proTEXt from the TEX Collection DVD, follow the instructions in the PDF documentation which opens automatically when you start the setup.

The documentation contains links (in large blue type) that you click on in sequence to run the installation process. (This is actually very good: everything worked first time when I did it on XP.) Basically, you need to install *a*) *MIKTEX*; *b*) ***either*** *WinEdt* (with or without some of its add-ons) ***or*** *TEXnicCenter*; and *c*) *GhostScript* and *GSview*.

> You only need to install items step 3 in the procedure on p. 9 to step 5 in the procedure on p. 10 if you install *WinEdt*.

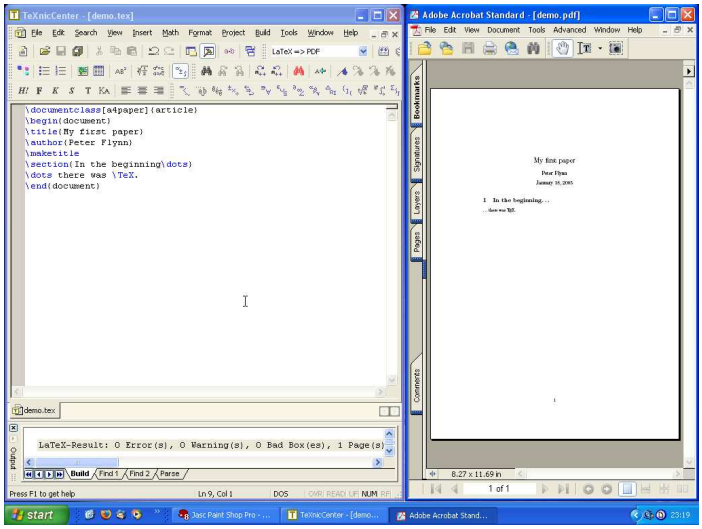
1. **Install *MIKTEX***
   proTEXt uses the *MIKTEX* distribution as its core, a long-established and popular distribution for Windows.

2. **Install *WinEdt***
   This is optional: it's a good editor, especially for the heavy user of a *MIKTEX*-based system. This is a free month's trial — after that it reminds you to cough up and register.

3. **Install the *WinEdt* New LATEX Document Interface**
   Optional again, and only applicable if you installed *WinEdt* anyway. It lets you save commonly-used document settings for use in other documents of the same type.

4. **Install the *WinEdt* Graphics Interface**
   Another optional add-on for *WinEdt* to provide drag-and-drop graphics insertion.

Figure 1.6: First document in *TEXnicCenter*



5. **Install the *WinEdt* Table Designer**
   Last optional add-on for *WinEdt*, providing a new table editor.

6. **Install *TEXnicCenter***
   This is a free equivalent to *WinEdt*. The interface is slightly different (see Figure 1.6) but it is becoming very popular.

7. **Install *GhostScript* and *GSview***
   These are essential for viewing the PostScript and PDF output, especially if you don't have any other PDF viewer installed.

You get a choice of editors, but the one which features in *proTEXt* is *TEXnicCenter*. This is an Integrated Development Environment (IDE) which lets you manage all the files related to each document. In many cases, of course, you'll only have one (the text itself) but if you are working with anything beyond simple articles, you'll probably have illustrations (images or diagrams), and possibly separate chapter files for larger documents, plus indexes, glossaries, bibliographies, etc. I recommend that you create a new project for each new document, even if it's a single-file article, as I did for the example in Figure 1.6.

1.4.2 TEX Live (TEX Collection 2003)

Once the installation program is running:

1. **LATEX**
   Install LATEX itself from the TeXLive Software → Install on Hard Disk menu. If you're new to LATEX, pick Quick Install on the following screen. This gives you everything you need to get started, and doesn't ask any questions, it just installs it all straight away.

   If you're installing under Windows NT, 2000, or XP, you may want to click on the option to install for all users if you have other users on your system.

If you want to use *Emacs* as your editor, click the option for XemTEX Support.[2]

2. **Emacs**
   After installation, right-click and drag `Xemacs.exe` from the `C:\ProgramFiles\TeXLive\bin\win32` folder out onto your desktop and let go, then pick 'Create Shortcut'. This places *Emacs* on your desktop for easy access.

3. **WinShell and WinEdt**
   If you want to install *WinShell*, run the installer program in the `support/winshell` directory. For *WinEdt* you must go to their Web site (`http://www.winedt.com/`) for a downloadable version.

   You don't have to install just one editor: if you've got the space, install them all so you can try them out. You can always uninstall the ones you don't want afterwards.

4. **GSView**
   Ghostscript is installed automatically, but for *GSView* you need to go to `http://www.cs.wisc.edu/^ghost/gsview/`, and download the most recent version.

   If you use *GSView*, please register your copy with Ghostgum, Pty. (`http://www.ghostgum.com.au/`).

Please read the TEX Live update pages at `http://www.tug.org/texlive/bugs.html` for details of any changes since the disks were released, and download and install any additional software required.

1.4.3 Installation problems

It's always annoying when a program that's supposed to install painlessly causes trouble, and none the more so when everyone

[2] Note this unfortunate choice of name is nothing to do with Eberhard Matthes' MS-DOS implementation of TEX called emTEX — the 'Xem' is short for *Xemacs*.

else seems to have been able to install it without problems. I've installed TEX hundreds of times and very rarely had any difficulties, but these are a few of the occasions when I did.

Bad hard disks As recommended in § 1.4, run a scan and defragmentation of your hard disk[s] before you start. It should take under an hour on a modern machine unless you have a very large disk, and it may need overnight on an older machine. Clean your CD or DVD drive if it's been in heavy use. TEX uses a very large number of very small files, so there is a lot of disk activity during an installation. As also recommended in § 1.2, if you have the chance to reformat the hard disk, pick the smallest granularity (cluster size) possible.

Registry errors This only affects Microsoft Windows users. The Registry is where Microsoft want software companies automatically to store details of all the programs you install. Unfortunately the Registry is grossly abused by marketing departments to try and foist undesirable links on you, the user. You will see this with many commercial programs, where a particular type of file you've been able to double-click on for years suddenly runs a different program. Some programs install obsolete or broken copies of program libraries (DLL files), overwriting ones which were working perfectly. Worse, the viruses, trojans, and worms which typically infect unprotected Windows systems can leave unwanted links to web pages, or change some of the ways in which Windows operates. The overall effect can be that the whole machine slows down, or that files which are expected to do one thing do another. The best solution is a thorough Registry clean-out, using one of the many programs available for the purpose.

Use the latest versions Before installing, check the CTAN web site (`http://www.ctan.org/` for any updated copy of the installation program. This is called `install-tl.sh` for

Linux and Mac systems, and `Setup.exe` for Microsoft Windows (on the TEX Collection 2003 CD it was called `TeXSetup.exe`). Just occasionally a bug slips through onto the production CD or DVD, and although it's always fixed and notified on `comp.text.tex`, that's a high-volume newsgroup and even the sharpest eyes may miss an announcement.

Stick to the defaults Unless you're a computer scientist or a software engineer, I suggest you never change or fiddle with the default directories for installation. I know some of them look odd, but they're that way for a purpose, especially when it comes to avoiding directories will spaces in their names, like the notorious `C:\Program Files`. Although most modern systems cope happily with spaces in filenames and directory names, they are usually A Bad Design Idea, and should be avoided like the plague (spaces are forbidden in web addresses for the same reason: the people who designed them knew the pitfalls). It may look snazzier to put the installation in `My Cute Stuff`, but please don't: you'll just make it harder to find, harder to fix problems, and more embarrassing if you have to explain it to someone else trying to help you.

2 Using your editor to create documents

LaTeX documents are all ***plain-text*** files.[1] You can edit them with any editor, and transfer them to any other computer system running LaTeX and they will format exactly the same. Because they are plain text they cannot corrupt your system, as they cannot be used for hiding or transporting virus infections as binary wordprocessor files can. Everything you can see is in the file and everything in the file is there for you to see: there is nothing hidden or secret and there are no manufacturers' proprietary 'gotchas' like suddenly going out of date with a new version.

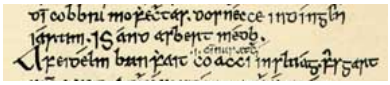
[1] 'Plain-text' originally meant just the 95 printable characters of the American Standard Code for Information Interchange (ASCII) — see Table C.1 — but now more commonly includes both these *and* the relevant 8-bit characters from *one* (only) character set such as ISO-8859-1 (Western Latin–1) or ISO-8859-15 (Western Latin plus the Euro sign). These are international standards which work everywhere: you should avoid using manufacturers' proprietary character sets like Microsoft Windows–1252 or Apple Macintosh Roman–8, because they may make your documents unusable on some other systems.

2.1 Markup

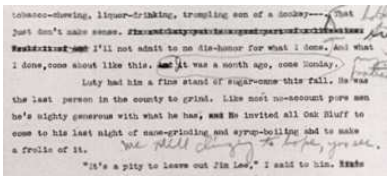
In a LaTeX document, you type your text along with ***markup*** which identifies the important parts of your document by name, for example 'title', 'section', 'figure', etc. LaTeX does all the formatting for you automatically, using the markup to guide its internal rules and external stylesheets for typesetting.

Markup

This is a term from printing, and originally meant the notes on how to lay the document out, or the instructions which a proofreader might add during correction. It now also means instructions or descriptions added to a computer document to act as guidelines for identification or formatting. Markup has been around for *ages*.



Táin bó Cúailnge[a]



Varmints[b]

`.h1 Interest Rates`	Runoff	*c.* 1970
`\section{Interest Rates}`	LaTeX	1984
`<sec><ttl>Interest Rates</ttl>...`	SGML	1985
`<H1>Interest Rates</H1>`	HTML	1991

[a] (1100)
[b] Rawlings (1936)

You do not need to format any of your text *in your editor*, because LaTeX does it all by itself when it typesets. You can of course

regularise or neaten its appearance *in your editor* for ease of editing (for example, keeping each item in a list on a separate line), but this is not required.

You will often hear LaTeX markup referred to as 'commands' or sometimes 'control sequences' (the proper TeXnical term for them). For all practical purposes these terms all mean the same thing.

This course assumes that users have one of *TeXshell*, *TeXnicCenter*, *WinShell*, or *WinEdt* (Windows only), or *Emacs* or LyX (any platform) installed. These are discussed briefly in § 2.3, and the menus and toolbars for running LaTeX are explained in Chapter 4.

2.2 Quick start for the impatient

If you already know all this stuff about editors and plain-text files and running programs, and you know your system is already correctly installed (including your editor), you'd probably like to type something in and see LaTeX do its job. If you don't, then skip forward to § 2.4 and read a bit more about LaTeX first.

Up and running in a few minutes

1. **Install the software**
   Make sure you have a properly-installed LaTeX system and a copy of a suitable editor.

2. **Create a sample document**
   Open your editor and type in the text *exactly* as shown in Figure 2.1. Do *not* make any changes or miss anything out or add anything different at this stage.

3. **Save the document**
   Save the document as `demo.tex`

4. **Run LaTeX or *pdfLaTeX***
   Click on the LaTeX or pdfLaTeX toolbar icon or the TeX TeX File menu item; or type `latex demo` or `pdflatex demo` in a command window.

Figure 2.1: Sample document

```
\documentclass[12pt]{article}
\usepackage{palatino,url}
\begin{document}
\section*{My first document}

This is a short example of a \LaTeX\ document I wrote
on \today. It shows a few simple features of automated
typesetting, including

\begin{itemize}
\item setting the default font size to 12pt;
\item specifying 'article' type for formatting;
\item using the Palatino typeface;
\item adding special formatting for URIs;
\item formatting a heading in 'section' style;
\item using the \LaTeX\ logo;
\item generating today's date;
\item formatting a list of items;
\item centering and italicizing;
\item autonumbering the pages.
\end{itemize}

\subsection*{More information}

This example was taken from 'Formatting Information',
which you can download from
\url{http://www.ctan.org/tex-archive/info/beginlatex/}
and use as a teach-yourself guide.

\begin{center}
\textit{Have a nice day!}
\end{center}

\end{document}
```

5. **Preview the typesetting**
   Click on the DVI or PDFview toolbar icon or the TeX → TeX View menu item; or type your previewer command in a terminal shell.

   (Note that there may be a pause the first time you use your DVI viewer, while WYSIWYG font files are created.[2])

6. **Print it**
   Click on the Print toolbar icon within the viewer, or use the TeX → TeX Print menu item, or type `dvips -f demo | lpr` (Unix/Linux).

If you encounter any errors, it means you *do* need to study this chapter after all!

2.3 Editors

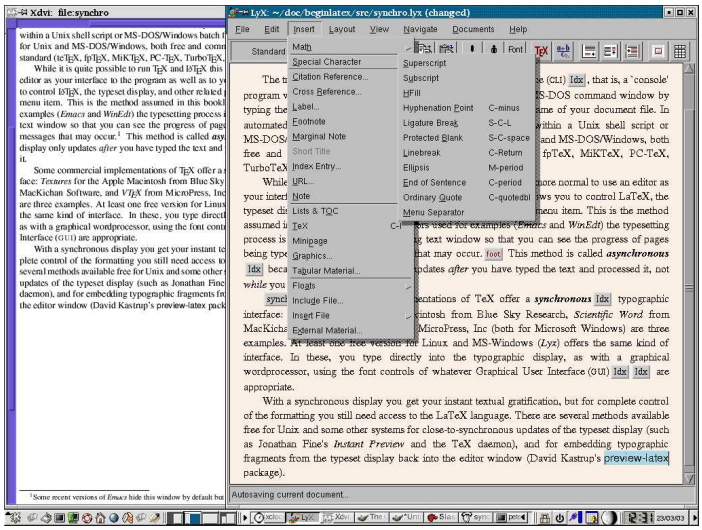
All the text of your documents can be typed into your LaTeX document from a standard keyboard using any decent plain-text editor. However, it is more convenient to use an editor with special features to make using LaTeX easier. Some of the most popular are *TeXshellWinShell*, *TeXnic Center*, and *WinEdt* (Windows only); and *LyX* and *Emacs* (all platforms).

2.3.1 LyX

The LyX document editor (all platforms) is a special case, as it uses the What You See Is What You Mean (WYSIWYM) model of synchronous typographic editing as opposed to What You See Is What You Get (WYSIWYG), and many users prefer this interface (but see the reservations in the Introduction on p. xiv).

[2] DVI previewers use their own font files specially created from the font outlines (TrueType, OpenType, PostScript, METAFONT, etc). The first time you use a font at a size not used before, there will be a second or two's pause while it gets created. The more you use LaTeX, the less this happens.

Figure 2.2: The LyX document editor

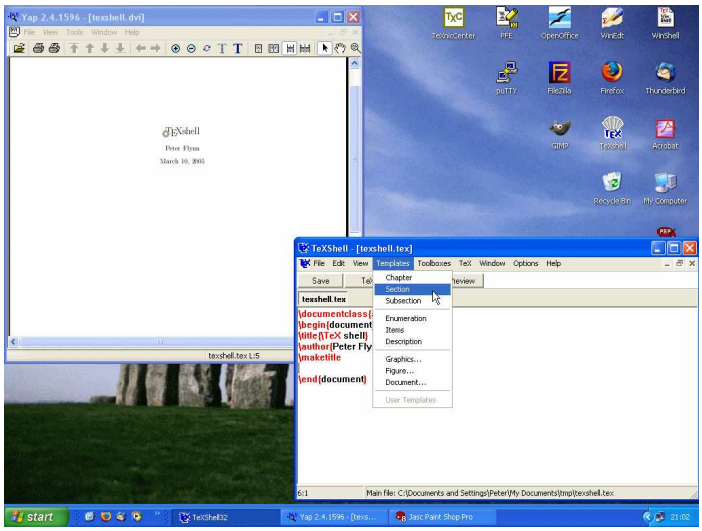


LyX makes a strong case for using synchronous typographical editing: it is possible to create even quite large and complex documents without seeing a backslash very often, although with math or complex macros there is probably no way to avoid having to do some manual insertion of LaTeX code.

The free availability on multiple platforms makes this a clear answer to the myth of 'having to edit like a programmer', and as it is an Open Source project, there is constant improvement, both to the facilities and to the interface.

Probably the only real reservation is that it does not save native LaTeX files by default. It uses its own internal format, and it can export LaTeX for use in other editors, but the exported files are not designed for human legibility, only for LaTeX processing. In a co-operative environment this would be a serious drawback, but for the individual user this interface is an excellent tool.

Figure 2.3: The TEXshell editor



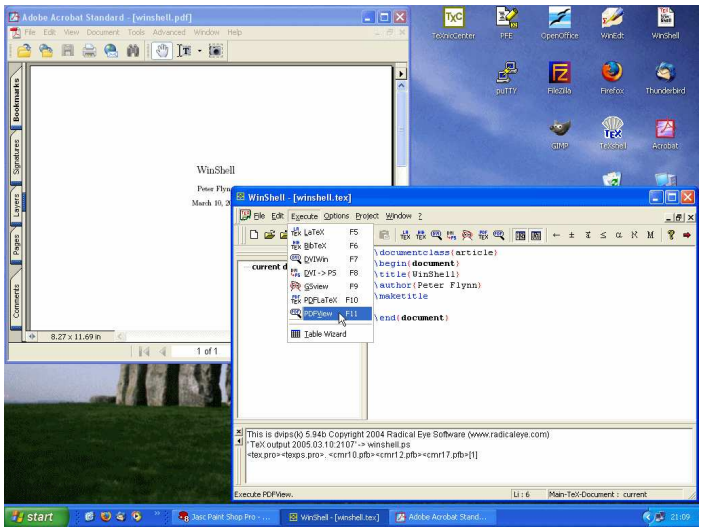
2.3.2 TEXshell

This is one of the simplest of all the plaintext Windows editors, but it has most of the tools needed to begin with. Sectioning, lists, and graphics can be inserted from the menus, and there are buttons for running LATEX on the open document and for previewing the typeset document.

The syntactic highlighting distinguishes between commands and your text, and it comes with options for spellchecking (you need to install *ispell*), and for adding math, Greek (math), and some symbol characters from a pickchart. The typeset display is done using your installed DVI viewer (there is no provision for PDF, although as it is configurable, that could probably be edited into the menus).

Download the `.tar.gz` file from CTAN in the `support/TeXshell/` directory and unwrap it into somewhere like `C:\ProgramFiles\`

Figure 2.4: The WinShell editor



`TeXshell\`.[3] There is a *tsconfig* program in the same directory on CTAN, which is designed to help with reconfiguring TEXshell.

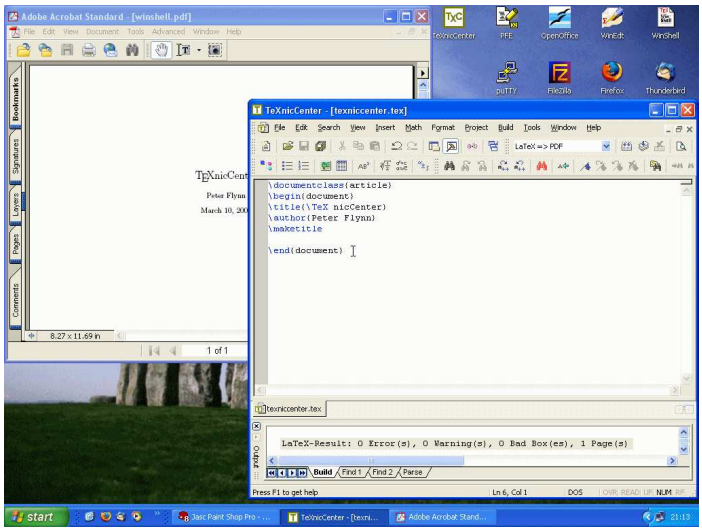
2.3.3 WinShell

This is another free Windows editor for beginners with LATEX. Despite its simplicity, it is capable of a considerable amount of document management and assistance with editing. As well as handling stand-alone LATEX files, you can create a 'Project' for larger documents, which helps you keep track of additional files like separate chapters, illustrations, diagrams, indexes, etc.

You run LATEX direct from the toolbar icons or with F-key shortcuts. Both standard LATEX and *pdfLATEX* are supported, as well as creation and previewing of PostScript and PDF output. There are additional toolbars for math characters, and there is

[3] Yes, I know I said don't use directory names with spaces in them — and so you shouldn't, for your LATEX documents — but Windows programs are usually safe enough in them.

Figure 2.5: The TEXnicCenter editor



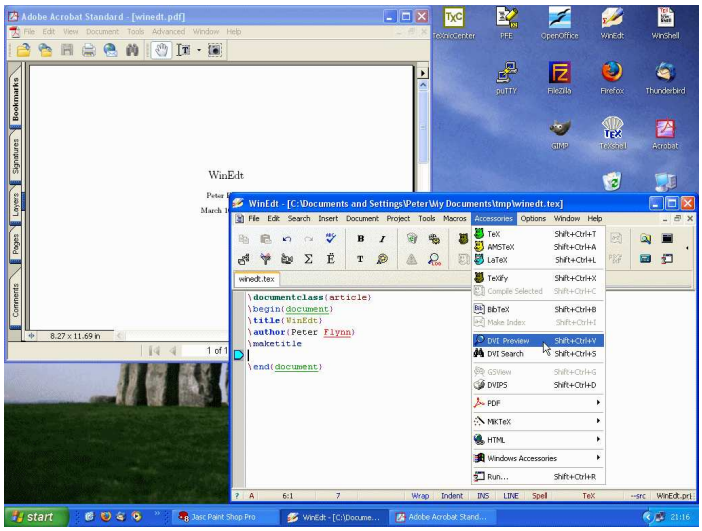
a 'Table Wizard' for handling tables. The syntax highlighting distinguishes between commands (in blue) and delimiters (in red), leaving your text in black.

Download the `WinShell`*`nn`*`.exe` program (self-contained setup: the *nn* changes with the version) from CTAN in the `systems/win32/winshell/` directory and double-click it to start the setup.

2.3.4 TEXnicCenter

TEXnicCenter is a powerful Windows editor suitable both for the beginner and the more advanced user. Its 'Project' environment keeps track of multiple files, and the processing function (the bit which actually runs LATEX, here called 'Build') tries to ensure that all the files you need for a large or complex document are in place before you start typesetting, to avoid errors like missing illustrations.

Figure 2.6: The *WinEdt* editor



It's a much more wordprocessor-like control interface, with configurable toolbars and button-controls for lists, math, tables, and previewing options.

Download the `TXCSetup`*`xxx`*`.exe` program (self-contained setup: the *xxx* bit changes with the version) from CTAN in the `systems/win32/TeXnicCenter/` directory and double-click it to start the setup.

2.3.5 WinEdt

WinEdt is a highly configurable plain-text editor for Windows. It comes with a host of special functions and shortcuts for TEX and LATEX, based on the MikTEX distribution. It is supplied on the TEX Collection 2004 DVD and the *proTEXt* CD. You can also download it from `http://www.winedt.com` — in either case there's a 1-month free trial, then it reminds you to buy it.

WinEdt uses a built-in toolbar of configurable buttons, preset for use with LATEX, and it provides syntactic coloring of LATEX

commands. Both the positioning and effect of the buttons can be changed, using an editable file of icons and a configuration panel. This flexibility lets you bind a program and arguments (equivalent to a typed command) to a particular icon.

There are default buttons on the toolbar for one-click typesetting, previewing, and PostScript or PDF generation from LaTeX documents, and it manages multi-file document projects like most of the other editors. *Winedt* is also used by many people for normal plaintext file-editing tasks, in preference to more limited programs like *Notepad*. If you're using the fpTeX which came with the 2003 TeX Collection, some editing of the menus is required (explained in the local installation document) because the default setup is for MikTeX/proTeXt.

2.3.6 GNU Emacs

Emacs is a product of the GNU Project.[4] Versions are available for all makes and models of computer, and it has a LaTeX-mode which provides syntactic colouring ('fontification' in *Emacs*-speak) and mouseclick processing from a menu or toolbar.

Emacs is a very large and powerful editor, with 'modes' (plug-ins) to handle almost everything you do on a computer. Many users run *Emacs* once on logging in, and never leave it for the rest of the day — or month. As well as edit, you can use it to read your mail, browse the Web, read Usenet news, do wordprocessing and spreadsheets, compile programs, help you write in any computer language — including XML and LaTeX — and it provides a few games as well.

Emacs knows about LaTeX and how to process it, so it comes with a menu full of LaTeX operations to click on. If you are editing complex documents with mathematics, there is a mode (*AUCTeX*) which has even more functionality. LaTeX support is well-developed, and there is a hierarchy of newsgroups for *Emacs* support.

[4] 'GNU's Not Unix (GNU)' is a project to make a computing environment completely free of restrictions.

Figure 2.7: Emacs editing LaTeX

Because *Emacs* runs on Microsoft Windows, Macs, Linux, and most other platforms, many LaTeX users who have multiple machines (and those who have multiple users to support) prefer it to other editors because it provides the same environment regardless of which platform they are using.

It's sometimes criticised for a steep learning curve, but in fact it's no worse in this respect than any other editor, given the power

that it provides, and it is significantly better than most which lack many of the authorial tools available in Emacs.

2.3.7 Mac editors

Mac users will be disappointed that I haven't included any of the Mac interfaces here. It's simple: I don't have a Mac right now to try them out on. I hope to remedy this for a future edition.

2.4 LaTeX commands

LaTeX commands all begin with a ***backslash*** (\)[5] and are usually made up of lowercase letters only, for example:

```
\tableofcontents
```

The **\tableofcontents** command is an instruction to LaTeX to insert the Table of Contents at this point. You would usually use this in a book or report (or perhaps a very long article) somewhere close to the beginning. You don't have to do anything else. Provided that you have used the sectioning commands described in § 3.5, all the formatting and numbering for the Table of Contents is completely automated.

2.4.1 Simple commands

Simple one-word commands like **\tableofcontents** must be separated from any following text with ***white-space***. This means a normal space, or a newline [linebreak] or a TAB character. For example either of these two forms will work:

[5] Do not confuse the backslash with the forward slash (/). They are two different characters. The forward slash is used on the Web and on Unix systems to separate directory names and filenames. The backslash is used in Microsoft Windows (only) for the same purpose, and in LaTeX to begin a command.

```
\tableofcontents Thanks to Aunt Mabel for all her help
with this book.
```

```
\tableofcontents
Thanks to Aunt Mabel for all her help with this book.
```

If you forget the white-space, as in the following example, LaTeX will try to read it as a command called `\tableofcontentsThanks`. There's no such command, of course, so LaTeX will complain at you by displaying an error message (see § 4.2.3.2).

```
\tableofcontentsThanks to Aunt Mabel for all her help
with this book.
```

LaTeX swallows any white-space which follows a command ending in a letter. It does this automatically, so you don't get unwanted extra space in your typeset output, but it does mean that any simple command which ends in a letter and has no arguments (see below) must be followed by white-space before normal text starts again, simply to keep it separate from the text.

2.4.2 Commands with arguments

Many LaTeX commands are followed by one or more ***arguments***, a term from the field of Computer Science, meaning information to be acted upon. Here are two examples:

```
\chapter{Poetic Form}
\label{pform}
```

Such arguments always go in {***curly braces***} like those shown above. Be careful not to confuse the curly braces on your keyboard with round parentheses `( )`, square brackets `[ ]`, or

angle brackets < >. They are all different and they do different things.

With commands that take arguments you do *not* need to use extra white-space after the command, because there is an argument following it which will keep it separate from any normal text with follows after that. The following is therefore perfectly correct (although unusual because it's harder to edit: normally you'd leave a blank line between the chapter title or label and the start of the first paragraph).

```
\chapter{Poetic Form}\label{pform}The shape of poetry
when written or printed distinguishes it from prose.
```

2.4.3 White-space in LaTeX

In LaTeX documents, all *multiple* spaces, newlines (linebreaks), and TAB characters are treated as if they were a *single* space or newline during typesetting. LaTeX does its own spacing and alignment using the instructions you give it, so you have extremely precise control. You are therefore free to use extra white-space in your editor for optical ease and convenience when editing.

The following is therefore exactly equivalent to the example in the preceding section:

```
\chapter       {Poetic
         Form}\label
           {pform}

The shape of poetry when written or printed
distinguishes it from prose.
```

That is, it will get typeset exactly the same. In general, just leave a blank line between paragraphs and a single space between words and sentences. LaTeX will take care of the formatting.

2.5 Special characters

There are ten keyboard characters which have special meaning to LaTeX, and cannot be used on their own except for the following purposes:

Key	Meaning	*If you need the actual character itself, type:*	Character
\	The command character	`\textbackslash`	\
$	Math typesetting delimiter	`\$`	$
%	The comment character	`\%`	%
^	Math superscript character	`\^`	^
&	Tabular column separator	`\&`	&
_	Math subscript character	`\_`	_
~	Non-breaking space	`\~`	~
#	Macro parameter symbol	`\#`	#
{	Argument start delimiter	`$\{$`	{
}	Argument end delimiter	`$\}$`	}

These characters were deliberately chosen, either because they are rare in normal text, or (in the case of $, #, &, and %) they already had an established special meaning on computers as ***metacharacters*** (characters standing as symbols for something else) by the time TeX was written, and it would have been misleading to choose others.

2.5.1 Using the special characters

We have already seen (the first paragraph of § 2.4) how to use the backslash to start a command, and curly braces to delimit an argument. The remaining special characters are:

$ Because of the special mathematical meaning LaTeX uses for the dollar-sign on its own, if you want to print $35.99 you type `\$35.99`

% The ***comment character*** makes LaTeX ignore the remainder of the line in your document, so you can see it in

your editor, but it will never get typeset. For example `Today's price per kilo is £22.70 % get Mike to update this` If you want to print 45% you need to type `45\%`

[^] The caret sign lets you type `\(E=mc^2\)` to get $E = mc^2$. If you need the circumflex accent on a letter like ê, just type the letter or use the symbolic notation `\^e`.

[&] The ampersand is used in tables to separate columns (see § 6.3). If you want to print AT&T you need to type `AT\&T`.

[_] The underscore lets you type `\(r_2\)` for r_2. If you want to underline text (extremely rare in typesetting) see the last paragraph of § 8.2.3.

[~] The tilde prints as a space, but prevents a linebreak ever occurring at that point. It's often used between a person's initials and their surname, eg `Prof D.E.~Knuth`

[#] If you want a ***hash mark*** (the ***octothorpe*** or American number or 'pound' [weight] sign) you type `\#`. For a pound (sterling) sign £, now nearly obsolete except in the UK and some of its former dependencies, use your [£] key or type **`\textsterling`**.

While we're on the subject of money, an unusual but interesting serif-font Euro sign € is got with the **`\texteuro`** command from the textcomp package. The standard sans-serif € needs the marvosym package and is done with the **`\EUR`** command.[6]

2.6 Quotation marks

Do *not* use the unidirectional typewriter keyboard ["] key for quotation marks. Correct typographic quotes are got with the [`] key and the ['] key, doubled if you want double quotes:

[6] The European Commission has specified that everyone use the sans-serif design, even in serif text, but this is amazingly ugly and most designers rightly ignore it.

```
He said, ``I'm just going out.''
```

He said, "I'm just going out."

This ensures you get real left-hand and right-hand (opening and closing) quotes (usually shaped like tiny ^{66} and ^{99} or as symmetrically-balanced strokes). If you are using *Emacs* as your editor, the " key is specially programmed in LaTeX-mode to think for itself and produce correct `` and '' characters (so this is one occasion when you *can* use the " key).

If you are reading this in a browser, or if you have reprocessed the file using different fonts, it may not show you real quotes (some old browser fonts are defective) and the **\thinspace** below may be too wide. Download the typeset (PDF) version of this document to see the real effect.

When typing one quotation inside another, there is a special command **\thinspace** which provides just enough separation between double and single quotes (a normal space is too much and could allow an unwanted linebreak):

```
He said, 'Her answer was ``never''\thinspace'.
```

He said, 'Her answer was "never" '.

2.7 Accents

For accented letters in western European languages[7] or other Latin-alphabet character sets just use the accented keys on your

[7] ISO 8859-1 (Latin–1, Western European) to 8859-15 (includes the Euro).

keyboard — if you have the right ones. You must also tell LaTeX what character repertoire ('input encoding') you are using. You specify this by using the inputenc package[8] in your preamble with the relevant option. For example, to tell LaTeX you will be typing ISO Latin–1 accented characters, use:

```
\usepackage[latin1]{inputenc}
```

If you have a real Unicode editor, which lets you insert any letter or symbol from any language on the planet (for example, mixed European, Asian, and other languages), use `utf8` instead of `latin1`. The encoding definitions that are available on your system are in `/texmf/tex/latex/base` (all files ending in `.def`).

If you don't have accented letters

This is for users whose keyboards do not have native accent characters on them. See your Operating System manual for full details. Here are two common examples:

- Under Linux systems the letter é is usually got with AltGr–; e. Refer to the *xkeycaps* utility for a table of key codes and combinations (get it from `http://www.jwz.org/xkeycaps/`).
- Under Microsoft Windows the letter é is got with Ctrl–' e or by holding down the Alt key and typing 0 1 3 0 on the numeric keypad (*not* the top row of shifted numerals). Refer to the *charmap* utility for a table of key codes and combinations (find it in the `C:\Windows` folder).

If you don't have accented letter keys on your keyboard, you'll need to use your operating system's standard keyboard Ctrl or Alt

[8] We haven't covered the use of packages yet. Don't worry, see § 5.1 if you're curious.

key combinations to generate the characters (see the panel 'If you don't have accented letters' above).

If you cannot generate accented characters from your keyboard at all, or if you need additional accents or symbols which are not in any of the keyboard tables, you can use the symbolic notation in Table 2.1. In fact, this can be used to put any accent over any letter: if you particularly want a g̃ you can have one with the command `\~g` (and Welsh users can get ŵ with `\^w`).

If you use this symbolic method only, you do not need to use the inputenc package. Before the days of keyboards and screens with their own real accented characters, the symbolic notation was the *only* way to get accents, so you may come across a lot of older documents (and users!) using this method all the time: it does have the advantage in portability that the LaTeX file remains plain ASCII, which will work on all machines everywhere, regardless of their internal encoding, and even with very old TeX installations.[9]

Irish and Turkish dotless-ı is done with the special command `\i`, so an í-fada (which is normally typed with [í]) requires `\'\i` if you need to type it in the long format, followed by a backslash-space or dummy pair of curly braces if it comes at the end of a word and there is no punctuation, because of the rule that LaTeX control sequences which end in a letter (see the first paragraph of § 2.4.1) always absorb any following space. So what you might see as *Rí Teamrać* has to be `R\'\i\ Tea\.mra\.c` when typed in full (there are not usually any keyboard keys for the dotless-ı or the lenited characters). A similar rule applies to dotless-ȷ and to uppercase Í.

[9] Remember not everyone is lucky enough to be able to install new software: many users on corporate and academic networks still have to use old versions of TeX because their system administrators are too busy to install new ones.

Table 2.1: Built-in LaTeX accents

Accent	Example	Characters to type
Acute (fada)	é	`\'e`
Grave	è	`\'e`
Circumflex	ê	`\^e`
Umlaut or diæresis	ë	`\"e`
Tilde	ñ	`\~n`
Macron	ō	`\=o`
Bar-under	o̲	`\b o`
Dot-over (séıṁıú)	ṁ	`\.m`
Dot-under	ṣ	`\d s`
Breve	ŭ	`\u u`
Háček (caron)	ǔ	`\v u`
Long umlaut	ő	`\H o`
Tie-after	o͡o	`\t oo`
Cedilla	ç	`\c c`
O-E ligature	œ, Œ	`\oe`, `\OE`
A-E ligature	æ, Æ	`\ae`, `\AE`
A-ring	å, Å	`\aa`, `\AA`
O-slash	ø, Ø	`\o`, `\O`
Soft-l	ł, Ł	`\l`, `\L`
Ess-zet (scharfes-S)	ß	`\ss`

2.8 Dimensions, hyphenation, justification, and breaking

LaTeX's internal measurement system is extraordinarily accurate. The underlying TeX engine conducts all its business in units smaller than the wavelength of visible light, so if you ask for 15mm space, that's what you'll get — within the limitations of your screen or printer, of course. Most screens cannot show dimensions of less than $\frac{1}{96}''$ without resorting to magnification

or scaling; and on printers, even at 600dpi, fine oblique lines or curves can still sometimes be seen to stagger the dots.

At the same time, many dimensions in LaTeX's preprogrammed formatting are specially set up to be flexible: so much space, plus or minus certain limits to allow the system to make its own adjustments to accommodate variations like overlong lines, unevenly-sized images, and non-uniform spacing around headings.

TeX uses a very sophisticated justification algorithm to achieve a smooth, even texture to normal paragraph text. The programming for this has been borrowed by a large number of other DTP systems, and users of these are often quite unaware that they are in fact using a significant part of TeX in their work. Occasionally, however, you will need to hand-correct an unusual word-break or line-break, and there are facilities for doing this on individual occasions as well as throughout a document.

2.8.1 Specifying size units

Most people in printing and publishing habitually use points and picas and ems. Some designers use cm and mm. Many English-language speakers still use inches. You can specify lengths in LaTeX in any of these units, plus some others (see Table 2.2).

The em can cause beginners some puzzlement because it's based on the 'point size' of the type, which is itself misleading. The point size refers to the depth of the metal body on which foundry type was cast in the days of metal typesetting, *not* the printed height of the letters themselves. Thus the letter-size of 10pt type in one face can be radically different from 10pt type in another (look at the table on p. 150, where all the examples are 10pt). An em is the height of the type-body in a specific size, so 1em of 10pt type is 10pt and 1em of 24pt type is 24pt.

Another name for a 1em space is a 'quad', and LaTeX has a command **\quad** for leaving exactly that much horizontal space. A special name is given to the 12pt em, a 'pica' em, as it has become a fixed measure in its own right.

Table 2.2: Units in LaTeX

Unit	Size
	Printers' fixed measures
pt	Anglo-American standard points (72.27 to the inch)
pc	pica ems (12pt)
bp	Adobe 'big' points (72 to the inch)
sp	TeX 'scaled' points (65,536 to the pt)
dd	Didot (European standard) points (67.54 to the inch)
cc	Ciceros (European pica ems, 12dd)
	Printers' relative measures
em	ems of the current point size (historically the width of a letter 'M' but see below)
ex	x-height of the current font (height of letter 'x')
	Other measures
cm	centimeters (2.54 to the inch)
mm	millimeters (25.4 to the inch)
in	inches

If you are working with other DTP users, watch out for those who think that Adobe points (bp) are the only ones. The difference is only .27pt per inch, but in 10″ of text (a full page of A4) that's 2.7pt, which is nearly 1mm, enough to be clearly visible if you're trying to align one sample with another.

2.8.2 Hyphenation

LaTeX hyphenates automatically according to the language you use (see § 2.8.6). To specify different breakpoints for an individual word, you can insert soft-hyphens (discretionary hyphens, done with `\-`) wherever you need them, for example:

```
When in Mexico, we visited Popoca\-tépetl by helicopter.
```

To specify hyphenation points for all occurrences of a word, use the **\hyphenation** command in your preamble (see the panel 'The Preamble' on p. 54) with one or more words in its argument, separated by spaces. This will even let you break 'helicopter' correctly. In this command you use normal hyphens, not soft-hyphens.

```
\hyphenation{helico-pter Popoca-tépetl
im-mer-sion}
```

If you have frequent hyphenation problems with long, unusual, or technical words, ask an expert about changing the value of `\spaceskip`, which controls the flexibility of the space between words. This is not something you would normally want to do, as it can change the appearance of your document quite significantly.

If you are using a lot of unbreakable text (see next section and also § 6.6.1) it may also cause justification problems. One possible solution to this is shown in § 9.3.

2.8.3 Unbreakable text

To force LaTeX to treat a word as unbreakable, use the **\mbox** command: `\mbox{pneumonoultramicroscopicsilicovolcanoconiosis}`. This may have undesirable results, however, if you change margins or the width of the text: pneumonoultramicroscopicsilicovolcanoconiosis…

To tie two words together with an unbreakable space (hard space), use a tilde (~) instead of the space (see the list on p. 31 in § 2.5.1). This will print as a normal space but LaTeX will never break the line at that point. You should make this standard typing practice for things like people's initials followed by their surname, as in Prof. D. E. Knuth: `Prof.\ D.~E.~Knuth`.

Note that a full point after a lowercase letter is treated as the end of a sentence, and creates more space before the next word. Here, after 'Prof.', it's *not* the end of a sentence, and the backslash-space forces LaTeX to insert just an ordinary word-space because it's OK to break the line after 'Prof.', whereas it would look wrong to have initials separated with Prof. D.E. Knuth broken over a line-end.

2.8.4 Dashes

For a long dash — what printers call an 'em rule' like this — use three hyphens typed together, `like~--- this`, and bind them to the preceding word with a tilde to avoid the line being broken before the dash. It's also common to see the dash printed without spaces—like that: the difference is purely æsthetic. *Never* use a single hyphen for this purpose.

Between digits like page ranges (35–47), it is normal to use the short dash (what printers call an en-rule) which you get by typing two hyphens together, as in `35--47`. If you want a minus sign, use math mode (§ 2.9).

2.8.5 Justification

The default mode for typesetting is justified (two parallel margins, with word-spacing adjusted automatically for the best optical fit). In justifying, LaTeX will never add space between letters, only between words. There is a special package called so ('space-out') if you need special effects like letter-spacing, but these are best left to the expert.

There are two commands **`\raggedright`** and **`\raggedleft`** which set ragged-right (ranged left) and ragged-left (ranged right). Use them inside a group (see the panel 'Grouping' on p. 154) to confine their action to a part of your text.

These modes also exist as 'environments' (see the last paragraph of § 3.2) called **raggedright** and **raggedleft** which are more convenient when applying this formatting to a whole paragraph or more, like this one.

```
\begin{raggedleft}
These modes also exist as environments called raggedright
and raggedleft which is more convenient when applying this
formatting to a whole paragraph or more, like this one.
\end{raggedleft}
```

Ragged setting turns off hyphenation. There is a package ragged2e which retains hyphenation in ragged setting, useful when you have a lot of long words.

2.8.6 Languages

LaTeX can typeset in the native manner for several dozen languages. This affects hyphenation, word-spacing, indentation, and the names of the parts of documents used as headings (e.g. Table of Contents).

Most distributions of LaTeX come with US English and one or more other languages installed by default, but it is easy to add the babel package and specify any of the supported languages or variants, for example:

```
\usepackage[frenchb]{babel}
...
\selectlanguage{frenchb}
```

Changing the language with babel automatically changes the names of the structural units and identifiers like 'Abstract', 'Index', etc. to their translated version. For example, using French as above, chapters will start with '*Chapitre*'.[10]

[10]Note that the babel package also sets the hyphenation patterns *provided your version of LaTeX has them precompiled* (see the start of your log files for a list). For other languages you need to set the hyphenation separately (outside the scope of this book).

2.9 Mathematics

As explained in the Preface on p. xx, TEX was originally written to automate the typesetting of books containing mathematics. The careful reader will already have noticed that mathematics is handled differently from normal text, which is why it has to be typeset specially. This document does not cover mathematical typesetting, which is explained in detail in many other books and Web pages, so all we will cover here is the existence of the math mode commands, and some characters which have special meaning, so they don't trip you up elsewhere.

In addition to the 10 special characters listed in §2.5, there are three more characters which only have any meaning inside mathematics mode:

Key	Meaning
|	Vertical bar
<	Less-than
>	Greater-than

If you type any of these in normal text (ie outside math mode), you will get very weird things happening and lots of error messages. If you need to print these characters, you *must* type them using math mode, or use their symbolic names from the **textcomp** package (**\textbrokenbar**, **\textlangle**, and **\textrangle**).

The hyphen also has an extra meaning in math mode: it typesets as a minus sign, so if you want to write about negative numbers you need to type the number in math mode so the minus sign and the spacing come out right.

To use math mode within a paragraph, enclose your math expression in **\(** and **\)** commands. You can get the much-quoted equation $E = mc^2$ by typing `\(E=mc^2\)`, and to get a temperature like $-30°$ you need to type `\(-30\)°`.[11]

To typeset a math expression as 'displayed math' (centered between paragraphs), enclose it in the commands **\[** and **\]**.[12]

```
\[\bar n^*_j(s)=\frac{\left\{s\sum_{i=1}^k
n_i(0)p^*{i,k+1}(s)+M^*(s)\right\}\sum_{i=1}^k
p_{0i}p^*{ij}(s)}{1-s\sum_{i=1}^kp_{0i}p^*_{i,
k+1}(s)}+\sum_{i=1}^kn_i(0)p^*_{ij}(s)[j=
1,2,\dots,k].\]
```

$$\bar{n}^*_j(s) = \frac{\left\{s\sum_{i=1}^k n_i(0)p^*_{i,k+1}(s)+M^*(s)\right\}\sum_{i=1}^k p_{0i}p^*ij(s)}{1-s\sum_{i=1}^k p_{0i}p^*_{i,k+1}(s)} + \sum_{i=1}^k n_i(0)p^*_{ij}(s)\,[\mathrm{j}=1,2,\ldots,\mathrm{k}]$$

Displayed equations can be auto-numbered with the **equation** environment instead of the **\[** and **\]** commands.

[11] Bear in mind that the degree symbol is a non-ASCII character, so you must specify what input encoding you are using if you want to type it: see the example of the inputenc package in § 2.7. If you don't want to use non-ASCII characters (or if you are using a system which cannot generate them), you can use the command **\textdegree** to get the degree sign.

[12] You will also see dollar signs used for math mode. This is quite common but deprecated: it's what plain TEX used in the days before LATEX, and the habit got ingrained in many mathematicians. It still works as a convenient shorthand like `$x=y$`, as do double-dollars for display-mode math like `$$E=mc^2$$`, but they are only mentioned here to warn readers seeing them in other authors' work that **\(**...**\)** and **\[**...**\]** are the proper LATEX commands.

3 Basic document structures

LaTeX's approach to formatting is to aim for consistency. This means that as long as you identify each ***element*** of your document correctly, it will be typeset in the same way as all the other elements like it, so that you achieve a consistent finish with minimum effort. Consistency helps make documents easier to read and understand.

Elements are the component parts of a document, all the pieces which make up the whole. Almost everyone who reads books, newspapers, magazines, reports, articles, and other classes of documents will be familiar with the popular structure of chapters, sections, subsections, subsubsections, paragraphs, lists, tables, figures, and so on, even if they don't consciously think about it.

Consistency is also what publishers look for. They have a house style, and often a reputation to keep, so they rightly insist that if you do something a certain way once, you should do it the same way each time.

To help achieve this consistency, every LaTeX document starts by declaring what ***document class*** it belongs to.

3.1 The Document Class Declaration

To tell LaTeX what class of document you are going to create, you type a special first line into your file which identifies it.[1] To start a report, for example, you would type the **\documentclass** command like this as your first line:

```
\documentclass{report}
```

There are four built-in classes provided, and many others that you can download (some may already be installed for you):

report for business, technical, legal, academic, or scientific reports;

article for white papers, magazine or journal articles, reviews, conference papers, or research notes;

book for books and theses;

letter for letters.[2]

The article class in particular can be used (some would say 'abused') for almost any short piece of typesetting by simply omitting the titling and layout (see below).

The built-in classes are intended as starting-points, especially for drafts and for compatibility when exchanging documents with other LaTeX users, as they come with every copy of LaTeX and are therefore guaranteed to format identically everywhere. *They are* **not** *intended as final-format publication-quality layouts.* For most other purposes, especially for publication, you use add-in packages (§ 5.1) to extend these classes to do what you need:

[1] Readers familiar with SGML, HTML, or XML will recognize the concept as similar to the Document Type Declaration.

[2] The built-in letter class is rather idiosyncratic: there are much better ones you can download, such as the memoir and komascript packages.

- The memoir and komascript packages contain more sophisticated replacements for all the built-in classes;
- Many academic and scientific publishers provide their own special class files for articles and books (often on their Web sites for download);
- Conference organisers may also provide class files for authors to write papers for presentation;
- Many universities provide their own thesis document class files in order to ensure exact fulfillment of their formatting requirements;
- Businesses and other organizations can provide their users with corporate classes on a central server and configure LaTeX installations to look there first for packages, fonts, etc.

Books and journals are not usually printed on office-size paper. Although LaTeX's layouts are designed to fit on standard A4 or Letter stationery for draft purposes, it makes them look odd: the margins are too wide, or the positioning is unusual, or the font size is too small, because the finished job will normally be trimmed to a different size entirely — try trimming the margins of the PDF version of this book to 185mm by 235mm (the same as *The LaTeX Companion*[3] series) and you'll be amazed at how it changes the appearance!

3.1.1 Document class options

The default layouts are designed to fit as drafts on US Letter size paper.[4] To create documents with the correct proportions

[3] Mittelbach et al. (2004)

[4] Letter size is 8½″×11″, which is the trimmed size of the old Demi Quarto, still in use in North America. The other common US office size is 'Legal', which is 8½″×14″, a bastard cutting close to the old Foolscap (8¼″×13¼″). ISO standard 'A', 'B', and 'C' paper sizes are still virtually unknown in many parts of North America.

for standard A4 paper, you need to specify the paper size in an optional argument in square brackets before the document class name, e.g.

```
\documentclass[a4paper]{report}
```

The two most common options are *a4paper* and *letterpaper*. However, many European distributions of TEX now come preset for A4, not Letter, and this is also true of all distributions of *pdfLATEX*.

The other default settings are for: *a*) 10pt type (all document classes); *b*) two-sided printing (books and reports) or one-sided (articles and letters); and *c*) separate title page (books and reports only). These can be modified with the following document class options which you can add in the same set of square brackets, separated by commas:

11pt to specify 11pt type (headings, footnotes, etc. get scaled up or down in proportion);

12pt to specify 12pt type (again, headings scale);

oneside to format one-sided printing for books and reports;

twoside to format articles for two-sided printing;

titlepage to force articles to have a separate title page;

draft makes LATEX indicate hyphenation and justification problems with a small square in the right-hand margin of the problem line so they can be located quickly by a human.

If you were using pdfLATEX for a report to be in 12pt type on Letter paper, but printed one-sided in draft mode, you would use:

```
\documentclass[12pt,letterpaper,oneside,draft]{report}
```

There are extra preset options for other type sizes which can be downloaded separately, but 10pt, 11pt, and 12pt between them cover probably 99% of all document typesetting. In addition there are the hundreds of add-in packages which can automate other layout and formatting variants without you having to program anything by hand or even change your text.

EXERCISE 1

Create a new document

1. **Use your editor to create a new document.**
2. **Type in a Document Class Declaration as shown above.**
3. **Add a font size option if you wish.**
4. **In North America, omit the *a4paper* option or change it to *letterpaper*.**
5. **Save the file (make up a name) ensuring the name ends with `.tex`**

3.2 The document environment

After the Document Class Declaration, the text of your document is enclosed between two commands which identify the beginning and end of the actual document:

```
\documentclass[11pt,a4paper,oneside]{report}

\begin{document}
...
\end{document}
```

(You would put your text where the dots are.) The reason for marking off the beginning of your text is that LaTeX allows you to

insert extra setup specifications before it (where the blank line is in the example above: we'll be using this soon). The reason for marking off the end of your text is to provide a place for LaTeX to be programmed to do extra stuff automatically at the end of the document, like making an index.

A useful side-effect of marking the end of the document text is that you can store comments or temporary text underneath the `\end{document}` in the knowledge that LaTeX will never try to typeset them.

```
...
\end{document}
Don't forget to get the extra chapter from Jim!
```

This **`\begin`**…**`\end`** pair of commands is an example of a common LaTeX structure called an ***environment***. Environments enclose text which is to be handled in a particular way. All environments start with `\begin{...}` and end with `\end{...}` (putting the name of the environment in the curly braces).

EXERCISE 2

Adding the document environment

1. Add the **document** environment to your file.
2. Leave a blank line between the Document Class Declaration and the `\begin{document}` (you'll see why later).
3. Save the file.

3.3 Titling

The first thing you put in the **document** environment is almost always the document title, the author's name, and the date (except in letters, which have a special set of commands for

addressing which we'll look at later). The title, author, and date are all examples of ***metadata*** or ***metainformation*** (information *about* information).

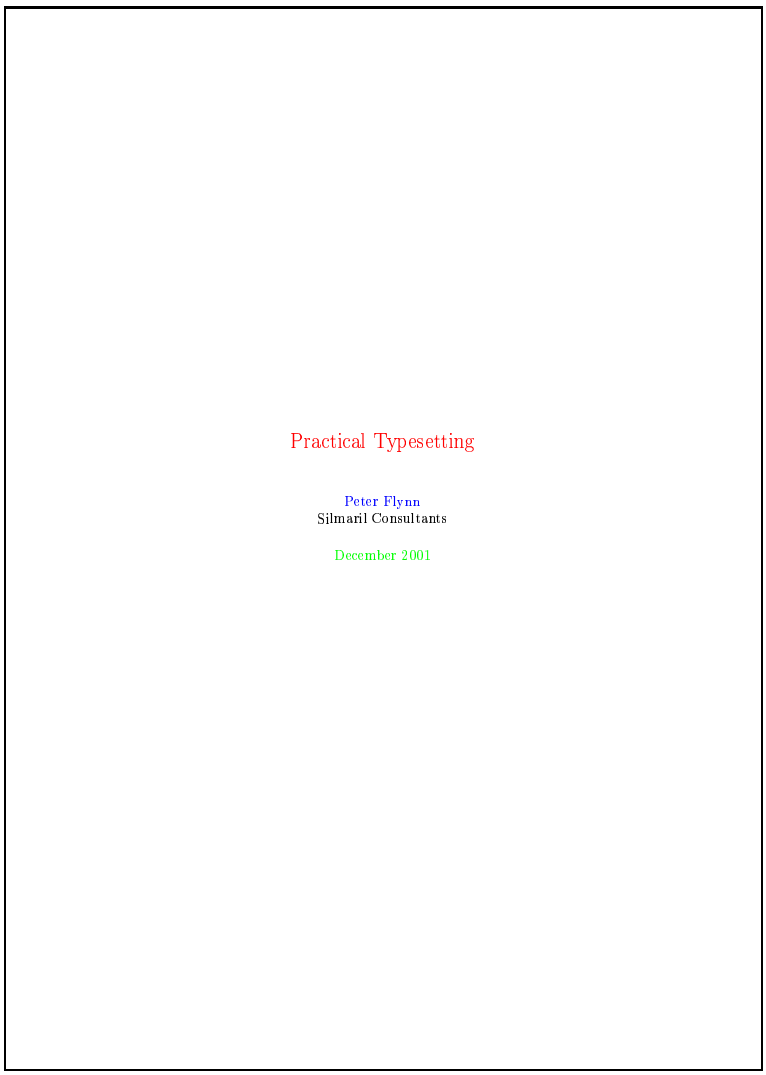
```
\documentclass[11pt,a4paper,oneside]{report}

\begin{document}

\title{Practical Typesetting}
\author{Peter Flynn\\Silmaril Consultants}
\date{December 2004}
\maketitle

\end{document}
```

The **\title**, **\author**, and **\date** commands are self-explanatory. You put the title, author name, and date in curly braces after the relevant command. The title and author are usually compulsory; if you omit the **\date** command, LaTeX uses today's date by default.

You always finish the metadata with the **\maketitle** command, which tells LaTeX that it's complete and it can typeset the titling information at this point. If you omit **\maketitle**, the titling will never be typeset. This command is reprogrammable so you can alter the appearance of titles (like I did for the printed version of this document).

The double backslash (\\) is the LaTeX command for forced linebreak. LaTeX normally decides by itself where to break lines, and it's usually right, but sometimes you need to cut a line short, like here, and start a new one. I could have left it out and just used a comma, so my name and my company would all appear on the one line, but I just decided that I wanted my company name on a separate line. In some publishers' document classes, they provide a special **\affiliation** command to put your company or institution name in instead.

When this file is typeset, you get something like this (I've cheated and done it in colour (§ 5.1.1) for fun — yours will be in black and white for the moment):



EXERCISE 3

Adding the metadata

1. Add the `\title`, `\author`, `\date`, and `\maketitle` commands to your file.
2. Use your own name, make up a title, and give a date.

The order of the first three commands is not important, but the `\maketitle` command must come last.

The document isn't really ready for printing like this, but if you're really impatient, look at Chapter 4 to see how to typeset and display it.

3.4 Abstracts and summaries

In reports and articles it is normal for the author to provide an Summary or Abstract, in which you describe briefly what you have written about and explain its importance. Abstracts in articles are usually only a few paragraphs long. Summaries in reports can run to several pages, depending on the length and complexity of the report and the readership it's aimed at.

In both cases (reports and articles) the Abstract or Summary is optional (that is, LaTeX doesn't force you to have one), but it's rare to omit it because readers want and expect it. In practice, of course, you go back and type the Abstract or Summary *after* having written the rest of the document, but for the sake of the example we'll jump the gun and type it now.

```
\documentclass[11pt,a4paper,oneside]{report}
\usepackage[latin1]{inputenc}
\renewcommand{\abstractname}{Summary}
\begin{document}

\title{Practical Typesetting}
\author{Peter Flynn\\Silmaril Consultants}
\date{December 2004}
\maketitle

\begin{abstract}
This document presents the basic concepts of
typesetting in a form usable by non-specialists. It
is aimed at those who find themselves (willingly or
unwillingly) asked to undertake work previously sent
out to a professional printer, and who are concerned
that the quality of work (and thus their corporate
æsthetic) does not suffer unduly.
\end{abstract}

\end{document}
```

After the **\maketitle** you use the **abstract** environment, in which you simply type your Abstract or Summary, leaving a blank line between paragraphs if there's more than one (see § 3.6 for this convention).

In business and technical documents, the Abstract is often called a Management Summary, or Executive Summary, or Business Preview, or some similar phrase. LaTeX lets you change the name associated with the **abstract** environment to any kind of title you want, using the **\renewcommand** command to give the command **\abstractname** a new value:

```
\renewcommand{\abstractname}{Executive Summary}
```

EXERCISE 4

Using an Abstract or Summary

1. Add the `\renewcommand` as shown above to your Preamble.

   The Preamble is at the start of the document, in that gap *after* the `\documentclass` line but *before* the `\begin{document}` (remember I said we'd see what we left it blank for: see the panel 'The Preamble' on p. 54).

2. Add an **abstract** environment after the `\maketitle` and type in a paragraph or two of text.

3. Save the file (no, I'm not paranoid, just careful).

Notice how the name of the command you are renewing (here, **`\abstractname`**) goes in the first set of curly braces, and the new value you want it to have goes in the second set of curly braces (this is an example of a command with two arguments). The environment you use is still called **abstract** (that is, you still type `\begin{abstract}`…`\end{abstract}`). What the **`\abstractname`** does is change the name that gets displayed and printed, not the name of the environment you store the text in.

If you look carefully at the example document, you'll see I sneakily added an extra command to the Preamble. We'll see later what this means (Brownie points for guessing it, though, if you read § 2.7).

The Preamble

Modifications which you want to affect a whole document go at the start of your LaTeX file, immediately after the **\documentclass** line and before the \begin{document} line:

```
\documentclass[11pt,a4paper,oneside]{report}
\renewcommand{\abstractname}{Sneak Preview}
\begin{document}
...
\end{document}
```

This position, between the Document Class Declaration and the beginning of the **document** environment, is called the ***preamble***, and it is used for small or temporary modifications to the style and behaviour of the document. Major or permanent modifications should go in a .sty file and be invoked with a **\usepackage** command.

3.5 Sections

In the body of your document, LaTeX provides seven levels of division or sectioning for you to use in structuring your text. They are all optional: it is perfectly possible to write a document consisting solely of paragraphs of unstructured text. But even novels are normally divided into chapters, although short stories are often made up solely of paragraphs.

Chapters are only available in the book and report document classes, because they don't have any meaning in articles and letters. Parts are also undefined in letters.[5]

[5] It is arguable that chapters also have no place in reports, either, as these are conventionally divided into sections as the top-level division. LaTeX,

Depth	Division	Command	Notes
−1	Part	**\part**	Not in letters
0	Chapter	**\chapter**	Books and reports
1	Section	**\section**	Not in letters
2	Subsection	**\subsection**	Not in letters
3	Subsubsection	**\subsubsection**	Not in letters
4	Titled paragraph	**\paragraph**	Not in letters
5	Titled subparagraph	**\subparagraph**	Not in letters

In each case the title of the part, chapter, section, etc. goes in curly braces after the command. LaTeX automatically calculates the correct numbering and prints the title in bold. You can turn section numbering off at a specific depth: details in § 3.5.1.

```
\section{New recruitment policies}
...
\subsection{Effect on staff turnover}
...
\chapter{Business plan 2005--2007}
```

There are packages[6] to let you control the typeface, style, spacing, and appearance of section headings: it's much easier to use them than to try and reprogram the headings manually. Two of the most popular are the ssection and sectsty packages.

Headings also get put automatically into the Table of Contents, if you specify one (it's optional). But if you make manual styling changes to your heading, for example a very long title, or some special line-breaks or unusual font-play, this would appear in the Table of Contents as well, which you almost certainly *don't* want. LaTeX allows you to give an optional extra version of the heading text which only gets used in the Table of Contents and any running heads, if they are in effect (§ 8.1.2). This optional

however, assumes your reports have chapters, but this is only the default, and can be changed very simply (see § 9.6).

[6] Details of how to use LaTeX packages are in § 5.1.

alternative heading goes in [square brackets] before the curly braces:

```
\section[Effect on staff turnover]{An analysis of the
effect of the revised recruitment policies on staff
turnover at divisional headquarters}
```

EXERCISE 5

Start your document text

1. **Add a \chapter command after your Abstract or Summary, giving the title of your first chapter.**
2. **If you're planning ahead, add a few more \chapter commands for subsequent chapters. Leave a few blank lines between them to make it easier to add paragraphs of text later.**
3. **By now I shouldn't need to tell you what to do after making significant changes to your document file.**

3.5.1 Section numbering

All document divisions get numbered automatically. Parts get Roman numerals (Part I, Part II, etc.); chapters and sections get decimal numbering like this document, and Appendixes (which are just a special case of chapters, and share the same structure) are lettered (A, B, C, etc.).

You can change the depth to which section numbering occurs, so you can turn it off selectively. In this document it is set to 3. If you only want parts, chapters, and sections numbered, not subsections or subsubsections etc., you can change the value of the *secnumdepth* counter using the the **\setcounter** command, giving the depth value from the table on p. 55:

```
\setcounter{secnumdepth}{1}
```

A related counter is *tocdepth*, which specifies what depth to take the Table of Contents to. It can be reset in exactly the same way as *secnumdepth*. The current setting for this document is 2.

```
\setcounter{tocdepth}{3}
```

To get an *unnumbered* section heading which does *not* go into the Table of Contents, follow the command name with an asterisk before the opening curly brace:

```
\subsection*{Shopping List}
```

All the divisional commands from **\part*** to **\subparagraph*** have this 'starred' version which can be used on special occasions for an unnumbered heading when the setting of *secnumdepth* would normally mean it would be numbered.

3.6 Ordinary paragraphs

After section headings comes your text. Just type it and leave a blank line between paragraphs. That's all LaTeX needs.

The blank line means 'start a new paragraph here': it does *not* (repeat: ***not***) mean you get a blank line in the typeset output. Now read this paragraph again and again until that sinks in.

The spacing between paragraphs is a separately definable quantity, a ***dimension*** or ***length*** called `\parskip`. This is normally zero (no space between paragraphs, because that's how books are normally typeset), but you can easily set it to any size you want with the **\setlength** command in the Preamble:

```
\setlength{\parskip}{1cm}
```

This will set the space between paragraphs to 1cm. See § 2.8.1 for details of the various size units LaTeX can use. *Leaving multiple blank lines between paragraphs in your source document achieves nothing*: all extra blank lines get ignored by LaTeX because the space between paragraphs is controlled only by the value of `\parskip`.

White-space in LaTeX can also be made flexible (what Lamport calls 'rubber' lengths). This means that values such as `\parskip` can have a default dimension plus an amount of expansion minus an amount of contraction. This is useful on pages in complex documents where not every page may be an exact number of fixed-height lines long, so some give-and-take in vertical space is useful. You specify this in a **`\setlength`** command like this:

```
\setlength{\parskip}{1cm plus4mm minus3mm}
```

Paragraph indentation can also be set with the **`\setlength`** command, although you would always make it a fixed size, never a flexible one, otherwise you would have very ragged-looking paragraphs.

```
\setlength{\parindent}{6mm}
```

By default, the first paragraph after a heading follows the standard Anglo-American publishers' practice of *no* indentation. Subsequent paragraphs are indented by the value of `\parindent` (default 18pt).[7] You can change this in the same way as any other length.

[7] Paragraph spacing and indentation are cultural settings. If you are typesetting in a language other than English, you should use the babel package, which alters many things, including the spacing and the naming of sections, to conform with the standards of different countries and languages.

In the printed copy of this document, the paragraph indentation is set to 10.0ptand the space between paragraphs is set to 0.0pt plus 1.0pt. These values do not apply in the Web (HTML) version because not all browsers are capable of that fine a level of control, and because users can apply their own stylesheets regardless of what this document proposes.

EXERCISE 6

Start typing!

1. **Type some paragraphs of text. Leave a blank line between each. Don't bother about line-wrapping or formatting — LaTeX will take care of all that.**
2. **If you're feeling adventurous, add a `\section` command with the title of a section within your first chapter, and continue typing paragraphs of text below that.**
3. **Add one or more `\setlength` commands to your Preamble if you want to experiment with changing paragraph spacing and indentation.**

To turn off indentation completely, set it to zero (but you still have to provide units: it's still a measure!).

```
\setlength{\parindent}{0in}
```

If you do this, though, and leave `\parskip` set to zero, your readers won't be able to tell easily where each paragraph begins! If you want to use the style of having no indentation with a space between paragraphs, use the parskip package, which does it for you (and makes adjustments to the spacing of lists and other structures which use paragraph spacing, so they don't get too far apart).

3.7 Table of contents

All auto-numbered headings get entered in the Table of Contents (ToC) automatically. You don't have to print a ToC, but if you want to, just add the command **\tableofcontents** at the point where you want it printed (usually after the Abstract or Summary).

Entries for the ToC are recorded each time you process your document, and reproduced the *next* time you process it, so you need to re-run LaTeX one extra time to ensure that all ToC page-number references are correctly calculated.

We've already seen in § 3.5 how to use the optional argument to the sectioning commands to add text to the ToC which is slightly different from the one printed in the body of the document. It is also possible to add extra lines to the ToC, to force extra or unnumbered section headings to be included.

> EXERCISE 7
>
> **Inserting the table of contents**
>
> 1. Go back and add a `\tableofcontents` command after the `\end{abstract}` command in your document.
>
> 2. You guessed.

The commands **\listoffigures** and **\listoftables** work in exactly the same way as **\tableofcontents** to automatically list all your tables and figures. If you use them, they normally go after the **\tableofcontents** command.

The **\tableofcontents** command normally shows only numbered section headings, and only down to the level defined by the *tocdepth* counter (see § 3.5.1), but you can add extra entries with the **\addcontentsline** command. For example if you use an unnumbered section heading command to start a preliminary piece of text like a Foreword or Preface, you can write:

```
\subsection*{Preface}
\addcontentsline{toc}{subsection}{Preface}
```

This will format an unnumbered ToC entry for ‘Preface’ in the ‘subsection’ style. You can use the same mechanism to add lines to the List of Figures or List of Tables by substituting `lof` or `lot` for `toc`.

4 Typesetting, viewing and printing

We've now got far enough to typeset what you've entered. I'm assuming at this stage that you have typed some sample text in the format specified in the previous chapter, and you've saved it in a plain-text file with a filetype of `.tex` and a name of your own choosing.

EXERCISE 8

Saving your file

If you haven't already saved your file, do so now (some editors and interfaces let you typeset the document without saving it!).

Pick a sensible filename in a sensible directory. Names should be short enough to display and search for, but descriptive enough to make sense. See the panel 'Picking suitable filenames' on p. 64 for more details.

Picking suitable filenames

Never, ever use directories (folders) or file names which contain spaces. Although your operating system probably supports them, some don't, and they will only cause grief and tears with TEX.
Make filenames as short or as long as you wish, but strictly avoid spaces. Stick to upper- and lower-case letters without accents (A–Z and a–z), the digits 0–9, the hyphen (`-`), and the full point or period (`.`), (similar to the conventions for a Web URI): it will let you refer to TEX files over the Web more easily and make your files more portable.

4.1 Typesetting

Typesetting your document is usually done by clicking on a button in a toolbar or an entry in a menu. Which one you click on depends on what output you want — there are two formats available:

- The standard (default) LATEX program produces a device-independent (DVI) file which can be used with any TEX previewer or printer driver on any make or model of computer. There are dozens of these available: at least one of each (previewer and printer driver) should have been installed with your distribution of TEX.
- The *pdfLATEX* program produces an Adobe Acrobat PDF file which can be used with any suitable previewer, such as *GSview*, *PDFview*, *Xpdf*, the *Opera* browser, or Adobe's own *Acrobat Reader*.

Depending on which one you choose, you may have to [re]configure your editor so that it runs the right program. They

can all do all of them, but they don't always come pre-set with buttons or menus for every possible option, because they can't guess which one you want.

4.1.1 Standard LaTeX

There are also two ways of running LaTeX: from the toolbar or menu, or from the command line. Toolbars and menus are most common in graphical systems, and are the normal way to run LaTeX. Command lines are used in non-graphical systems and in automated processes where LaTeX is run unattended (so-called 'batch' or 'scripted' processing).

Whichever way you run LaTeX, it will process your file and display a log or record of what it's doing (see Exercise 10: it looks the same no matter what system you use). This is to let you see where (if!) there are any errors or problems.

> EXERCISE 9
>
> **Running LaTeX from the toolbar or menu**
>
> **Run LaTeX on your file. According to which system you're using this will either be the LaTeX toolbar icon or the TeX → TeX File menu item.**
>
> **Your editor may suggest you save your file if you haven't already done so. Do it.**

If LaTeX reports any errors — easily identifiable as lines in the log beginning with an exclamation mark (!) — *don't panic!* Turn to § 4.2, identify what went wrong, and fix it in your input file. Then re-run LaTeX. If there were no errors, your file is ready for displaying or printing.

4.1.2 Running LaTeX from a command window

This is worth practising even if you normally use a GUI, so that you understand what it does. See Figure 4.1 for an example.

EXERCISE 10

Running LaTeX in a terminal or console window

- Under graphical Unix-based systems (Linux and Mac) you open a command (shell) window by clicking on the shell or screen icon in the control panel at the bottom of your screen.
- Under Microsoft Windows you open a command window by clicking on the Start Programs MS-DOS or Start Command Prompt menu item.

When the command window appears, type

```
cd documents
latex mybook
```

Substitute the relevant directory and file name. Remember to press the Enter key at the end of each line.

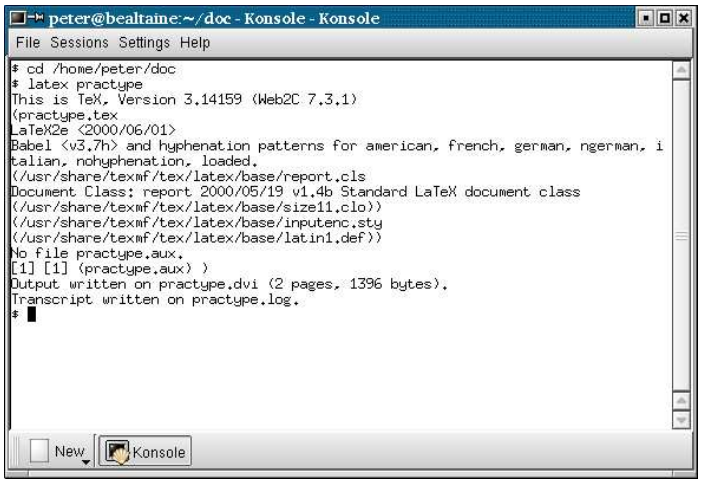
4.1.3 pdfLaTeX

If your editor is set up to generate PDF files direct instead of DVI files, then you can click the pdfLaTeX toolbar icon or type the command `pdflatex` *`filename`* in a terminal (console) window. *Emacs* does not have a default menu configured for *pdfLaTeX* but if you have already run standard LaTeX on the file, you can type ther `pdflatex` command in the `*TeX-Shell*` pane.

4.2 Errors and warnings

LaTeX describes what it's typesetting while it does it, and if it encounters something it doesn't understand or can't do, it will display a message saying what's wrong. It may also display warnings for less serious conditions.

Figure 4.1: Command-line usage



Don't panic if you see error messages: it's very common for beginners to mistype or mis-spell commands, forget curly braces, type a forward slash instead of a backslash, or use a special character by mistake. Errors are easily spotted and easily corrected in your editor, and you can then run LaTeX again to check you have fixed everything. Some of the most common errors are described in § 4.2 with an explanation of how to fix them.

4.2.1 Error messages

The format of an error message is always the same. Error messages begin with an exclamation mark at the start of the line, and give a description of the error, followed by another line starting with the number, which refers to the line-number in your document file which LaTeX was processing when the error was spotted. Here's an example, showing that the user mistyped the **\tableofcontents** command:

```
! Undefined control sequence.
l.6 \tableofcotnetns
```

When LaTeX finds an error like this, it displays the error message and pauses. You must type one of the following letters to continue:

Key	Meaning
x	Stop immediately and e***x***it the program.
q	Carry on ***q***uietly as best you can and don't bother me with any more error messages.
e	Stop the program but re-position the text in my ***e***ditor at the point where you found the error.[a]
h	Try to give me more ***h***elp.
i	(followed by a correction) means ***i***nput the correction in place of the error and carry on.[b]

a. This only works if you're using an editor which LaTeX can communicate with.

b. This is only a temporary fix to get the file processed. You still have to make that correction in the editor.

Some systems (*Emacs* is one example) run LaTeX with a 'non-stop' switch turned on, so it will always process through to the end of the file, regardless of errors, or until a limit is reached.

4.2.2 Warnings

Warnings don't begin with an exclamation mark: they are just comments by LaTeX about things you might want to look into, such as overlong or underrun lines (often caused by unusual hyphenations, for example), pages running short or long, and other typographical niceties (most of which you can ignore until later).

Unlike other systems, which try to hide unevennesses in the text — usually unsuccessfully — by interfering with the letter-spacing, LaTeX takes the view that the author or editor should be able to contribute. While it is certainly possible to set LaTeX's parameters so that the spacing is sufficiently sloppy that you will almost never get a warning about badly-fitting lines or pages, you will almost certainly just be delaying matters until you start to get complaints from your readers or publishers.

4.2.3 Examples

Only a few common error messages are given here: those most likely to be encountered by beginners. If you find another error message not shown here, and it's not clear what you should do, ask for help.

Most error messages are self-explanatory, but be aware that the place where LaTeX spots and reports an error may be later in the file than the place where it actually occurred. For example if you forget to close a curly brace which encloses, say, italics, LaTeX won't report this until something else occurs which can't happen until the curly brace is encountered (eg the end of the document!) Some errors can only be righted by humans who can read and understand what the document is supposed to mean or look like.

Newcomers should remember to check the list of special characters in (§ 2.5): a very large number of errors when you are learning LaTeX are due to accidentally typing a special character when you

didn't mean to. This disappears after a few days as you get used to them.

4.2.3.1 Too many }'s

```
! Too many }'s.
l.6 \date December 2004}
```

The reason LaTeX thinks there are too many }'s here is that the opening curly brace is missing after the **\date** control sequence and before the word `December`, so the closing curly brace is seen as one too many (which it is!).

In fact, there are other things which can follow the **\date** command apart from a date in curly braces, so LaTeX cannot possibly guess that you've missed out the opening curly brace — until it finds a closing one!

4.2.3.2 Undefined control sequence

```
! Undefined control sequence.
l.6 \dtae
       {December 2004}
```

In this example, LaTeX is complaining that it has no such command ('control sequence') as `\dtae`. Obviously it's been mistyped, but only a human can detect that fact: all LaTeX knows is that `\dtae` is not a command it knows about — it's undefined.

Mistypings are the commonest source of error. If your editor has drop-down menus to insert common commands and environments, use them!

4.2.3.3 Runaway argument

```
Runaway argument?
{December 2004 \maketitle
! Paragraph ended before \date was complete.
<to be read again>
                \par
l.8
```

In this error, the closing curly brace has been omitted from the date. It's the opposite of the error in § 4.2.3.1, and it results in **\maketitle** trying to format the title page while LaTeX is still expecting more text for the date! As **\maketitle** creates new paragraphs on the title page, this is detected and LaTeX complains that the previous paragraph has ended but **\date** is not yet finished.

4.2.3.4 Underfull hbox

```
Underfull \hbox (badness 1394) in paragraph
at lines 28--30
[][]\LY1/brm/b/n/10 Bull, RJ: \LY1/brm/m/n/10
Ac-count-ing in Busi-
[94]
```

This is a warning that LaTeX cannot stretch the line wide enough to fit, without making the spacing bigger than its currently permitted maximum. The ***badness*** (0–10,000) indicates how severe this is (here you can probably ignore a badness of 1394). It says what lines of your file it was typesetting when it found this, and the number in square brackets is the number of the page onto which the offending line was printed.

The codes separated by slashes are the typeface and font style and size used in the line. Ignore them for the moment: details are in step 11 in the procedure on p. 173 if you're curious.

4.2.3.5 Overfull hbox

```
[101]
Overfull \hbox (9.11617pt too wide) in paragraph
at lines 860--861
[]\LY1/brm/m/n/10 Windows, \LY1/brm/m/it/10 see
\LY1/brm/m/n/10 X Win-
```

And the opposite warning: this line is too long by a shade over 9pt. The chosen hyphenation point which minimises the error is shown at the end of the line (*Win-*). Line numbers and page numbers are given as before. In this case, 9pt is too much to ignore (over 3mm or more than $\frac{1}{8}''$), and a manual correction needs making (such as a change to the hyphenation), or the flexibility settings need changing (outside the scope of this book).

4.2.3.6 Missing package

```
! LaTeX Error: File 'paralisy.sty' not found.

Type X to quit or <RETURN> to proceed,
or enter new name. (Default extension: sty)

Enter file name:
```

When you use the **\usepackage** command to request LaTeX to use a certain package, it will look for a file with the specified name and the filetype `.sty`. In this case the user has mistyped the name of the paralist package, so it's easy to fix. However, if you get the name right, but the package is not installed on your machine, you will need to download and install it before continuing (see Chapter 5).

4.3 Screen preview

Once the file has been processed without errors (or even if there are still errors, but you want to see what it's doing with them), standard LaTeX will have created a DVI file with the same name as your document but the filetype `.dvi`. If you're using *pdfLaTeX*, a PDF file will have been created, and you can skip to § 4.3.3.

4.3.1 Previewing DVI output

To see the typeset output, click on the dvi Preview toolbar icon or use the TeX TeX View menu item. A WYSIWYG preview window will appear with your typeset display (see Figure 4.2).

Bitmap preview fonts in DVI viewers

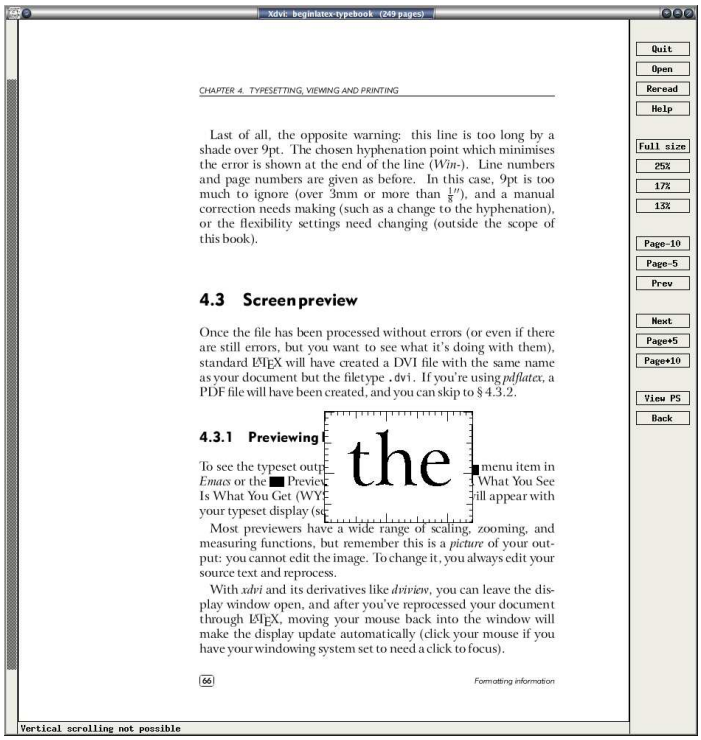
The first time you display your DVI output with a new installation of TeX, there may be a short pause if the previewer needs to create the special bitmaps used for screen previews of some fonts. These give greater accuracy on low-resolution devices like screens. As you continue to work with LaTeX and your system accumulates these font files, the pause for generating them will disappear. Recent versions of TeX work directly with Type 1 fonts, however, and don't have this delay.

Most previewers have a wide range of scaling, zooming, and measuring functions, but remember this is a *picture* of your output: you cannot edit the image. To change it, you always edit your source text and reprocess the file.

With *xdvi* and its derivatives like *dviview*, you can leave the display window open, and after you've reprocessed your document through LaTeX, moving your mouse back into the window will make the display update automatically (click your mouse if your windowing system needs a click to focus).

Figure 4.2 shows *xdvi* displaying a page. With a standard three-button mouse you get three levels of micro-zoom to let you inspect fine details.

Figure 4.2: DVI preview



4.3.2 Previewing with PostScript

PostScript is a page description language invented by Adobe and used in laser printers and high-end typesetters. It's been the universal standard for electronically-formatted print files for nearly two decades, and all printers and publishers are accustomed to using it. PDF is a descendant of PostScript, and is rapidly taking over, but PostScript itself is still extremely common, largely because it is very robust, and is usually an ASCII file, which makes it very portable and easy to generate (it is actually a programming language in its own right). The drawback is the

large size of PostScript files, especially if they contain bitmapped graphics.

The *dvips* program which comes with all TEX systems is used to generate PostScript files directly from your DVI output. These `.ps` files can be viewed, printed, sent to a platemaker or filmsetter, or put online for downloading.

DVI viewers cannot render some PostScript graphical manipulations like rotating and deforming, so an alternative to viewing the DVI file direct is to generate a PostScript file and use a PostScript viewer. You may have to to do this for your publisher anyway, and many editors can be configured to do this by default. Look for a dvips toolbar icon or menu entry and click on it.

It's also very simple to do manually: let's assume your LATEX file was called `mydoc.tex`, so processing it has created `mydoc.dvi`. Just type:

```
dvips -o mydoc.ps mydoc
```

in a command window (see Exercise 10 for how to use one) and *dvips* will create `mydoc.ps` which can be used both for previewing and printing.

To view a PostScript file, you need a PostScript previewer like *GSview*, which works with the PostScript interpreter *Ghostscript*, which should have been installed automatically along with your TEX system (if not, install both now: *GSview* is separately licensed and cannot legally be included in some older TEX distributions, so you may have to download it yourself).

GSview can be set to watch the PostScript file and automatically update the display any time the file is changed, without you even having to click on the window.

4.3.3 Previewing with PDF

The Portable Document Format (PDF) is a derivative of PostScript. Whereas PostScript is a programming language in itself,

PDF is in effect the *result* of processing a document through PostScript: it's a binary file format, extremely compact, and well-supported on all platforms.

If your system is configured to generate PDF files direct instead of DVI files, just open the `.pdf` file using any PDF previewer or browser.

Most editors are configured to display a toolbar icon which will pop up *Acrobat Reader* or some other viewer with the current PDF output file.

Adobe's *Acrobat Reader* cannot automatically update the view if you reprocess your document, in the way that *xdvi* and *GSview* can. You have to close the display with Ctrl–W and reload the file with Alt–F 1.

Bitmap preview fonts in Acrobat Reader

Acrobat Reader is extremely poor at rendering Type 3 (bitmap) fonts. If you are using these (either in an old LaTeX installation which has not been upgraded to Type 1, or with files using specialist fonts only available in Type 3 format), you will see a very fuzzy display at low magnifications. It will print perfectly, but Acrobat Reader's display is disappointing. The solution is to use a better previewer or to upgrade to the Type 1 versions of the fonts if possible, or both. If you need to use Type 3 fonts in PDFs, you probably need to warn your readers to expect a fuzzy display from Acrobat Reader (but good printout), and to change to a better reader if they can.

4.4 Printer output

TeX systems print on almost anything from the simplest dot-matrix printers to the biggest phototypesetters, including all the laser printers and a host of other devices in between. *How* you do it varies slightly according to how you do your typesetting and previewing:

If you are using DVI and you have a previewer which has a **print** function configured for your printer, you can use that. If not, create a PostScript file and use *GSview* instead.

If you are using PDF you can print directly from your PDF viewer. Be careful about using the 'Fit to page' options, as they will change the size of your document so all your measurements will be different.

Non-PostScript printers You can create a PostScript file with *dvips* (see § 4.3.2) and use *GSview* to print it (*GSview* can print PostScript files to almost any make or model of non-PostScript printer).

If you have a real PostScript printer or you are using a system with built-in PostScript printing support (such as Linux or Mac), you can create and send PostScript output directly from your editor to the printer without the need to open it in a previewer first. In *Emacs*, for example, this is what happens when you use the 

menu item.

Both the *dvips* program and all the previewers that print tend to have facilities for printing selected pages, printing in reverse, scaling the page size, and printing only odd or even pages for two-sided work. If you are using PostScript there are programs for manipulating the output (*pstops*), for example to perform page imposition to get 4, 8, or 16 pages to a sheet for making booklets (*psnup*).

EXERCISE 11

Print it!

Show that you have understood the process of typesetting, previewing, and printing, by displaying your document and printing it.

If you need a non-PostScript/*Ghostscript* solution, install a separate TEX print driver for your printer. Some may be supplied with your TEX installation, and there are dozens more on CTAN. Their names all start with `dvi` and are followed by an abbreviation for the printer make or model like *dvieps* for Epson, *dvihp* for Hewlett-Packard, *dvialw* for Apple LaserWriters, etc.. Configure the driver to print directly to the print queue, or pipe it to the print queue manually. On Linux with an HP printer, for example, this would be

```
dvihp mydoc | lpr
```

Microsoft Windows has no easy way to bypass the print spool, but you can do it from an MS-DOS command window with (using a HP printer as an example):

```
dvihp mydoc -o mydoc.hp
copy /b mydoc.hp LPT1:
```

Read the documentation for the driver, as the options and defaults vary.

5 CTAN, packages, and online help

The Comprehensive TEX Archive Network (CTAN) is a repository of Web and FTP servers worldwide which contain copies of almost every piece of free software related to TEX and LATEX.

CTAN is based on three main servers, and there are several online indexes available. There are complete TEX and LATEX systems for all platforms, utilities for text and graphics processing, conversion programs into and out of LATEX, printer drivers, extra typefaces, and (possibly the most important) the LATEX packages. The three main servers are:

- TEX Users Group: `http://www.ctan.org/`
- UK TEX Users Group: `http://www.tex.ac.uk/`
- Deutschsprachige Anwendervereinigung TEX e.V. (DANTE, the German-speaking TEX Users Group); `http://dante.ctan.org/`

> CTAN should *always* be your first port of call when looking for a software update or a feature you want to use. Please don't ask the network help resources (§ 5.3) until you have checked CTAN and the FAQ (§ 5.3.1).

5.1 Packages

Add-on features for LaTeX are known as ***packages***. Dozens of these are pre-installed with LaTeX and can be used in your documents immediately. They should all be stored in subdirectories of `texmf/tex/latex` named after each package. To find out what other packages are available and what they do, you should use the CTAN search page[1] which includes a link to Graham Williams' comprehensive package catalogue.

A package is a file or collection of files containing extra LaTeX commands and programming which add new styling features or modify those already existing. Installed package files all end with `.sty` (there may be ancillary files as well).

When you try to typeset a document which requires a package which is not installed on your system, LaTeX will warn you with an error message that it is missing (see § 4.2.3.6), and you can then download the package and install it using the instructions in § 5.2. You can also download updates to packages you already have (both the ones that were installed along with your version of LaTeX as well as ones you added).

There is no limit to the number of packages you can have installed on your computer (apart from disk space!), but there is probably a physical limit to the number that can be used inside any one LaTeX document at the same time, although it depends on how big each package is. In practice there is no problem in having even a couple of dozen packages active (the style file for this document uses over 30).

[1] `http://www.ctan.org/search`

5.1.1 Using an existing package

To use a package already installed on your system, insert a **\usepackage** command in your document preamble with the package name in curly braces, as we have already seen in earlier chapters. For example, to use the color package, which lets you typeset in colours (I warned you this was coming!), you would type:

```
\documentclass[11pt,a4paper,oneside]{report}
\usepackage{color}
\begin{document}
...
\end{document}
```

You can include several package names in one **\usepackage** command by separating the names with commas, and you can have more than one **\usepackage** command.

Some packages allow optional settings in square brackets. If you use these, you must give the package its own separate **\usepackage** command, like geometry shown below:

```
\documentclass[11pt,a4paper,oneside]{report}
\usepackage{pslatex,palatino,avant,graphicx,color}
\usepackage[margin=2cm]{geometry}
\begin{document}

\title{\color{red}Practical Typesetting}
\author{\color{blue}Peter Flynn\\Silmaril Consultants}
\date{\color{green}December 2005}
\maketitle

\end{document}
```

(Incidentally, this is a rather crude way to do colours in titling on a once-off basis: if it's for a repeatable style we'll see

in Chapter 9 how it can be automated and kept out of the author's way.)

Many packages can have additional formatting specifications in optional arguments in square brackets, in the same way as geometry does. Read the documentation for the package concerned to find out what can be done.

> **EXERCISE 12**
>
> **Add colour**
>
> **Use the** color **package to add some colour to your document. Stick with primary colours for the moment.**
>
> **Use the** geometry **package to change the margins.**
>
> **Reprocess and print your document if you have a colour printer (monochrome printers should print it in shades of grey).**

CMYK and RGB are not the only colour models. Uwe Kern's xcolor package defines half a dozen, and includes facilities for converting colour values from one model to another.

5.1.2 Package documentation

To find out what commands a package provides (and thus how to use it), you need to read the documentation. In the `texmf/doc` subdirectory of your installation there should be directories full of `.dvi` files, one for every package installed. These can be previewed or printed like any other DVI file (see § 4.3.1). If your installation procedure has not installed the documentation, the DVI files can all be downloaded from CTAN.

Before using a package, you should read the documentation carefully, especially the subsection usually called 'User Interface', which describes the commands the package makes available. You cannot just guess and hope it will work: you have to read it and find out.

See the next section for details of how to create the documentation `.dvi` file for additional packages you install yourself.

EXERCISE 13

Read all about it

Find and view (or print) the documentation on the geometry **package you used in Exercise 12.**

Investigate some of the other package documentation files in the directory.

5.2 Downloading and installing packages

Once you have identified a package you need and haven't already got (or you have got it and need to update it), use the indexes on any CTAN server to find the package you need and the directory where it can be downloaded from.

5.2.1 Downloading packages

What you need to look for is always *two files*, one ending in `.dtx` and the other in `.ins`. The first is a DOCTEX file, which combines the package program and its documentation in a single file. The second is the installation routine (much smaller). You *must always* download *both* files.

If the two files are not there, it means one of two things:

- *Either* the package is part of a much larger bundle which you shouldn't normally update unless you change version of LATEX;[2]
- *or* it's one of a few rare or unusual packages still supplied as a single `.sty` file intended for the now obsolete LATEX 2.09.[3]

[2] For example, there is no `color.dtx` and `color.ins` for the color package because it forms part of the graphics bundle, which is installed on all LATEX systems anyway. Such packages change very rarely, as they

form part of the core of LATEX and are very stable. In general you should never try to update these packages in isolation.

Download both files to a ***temporary directory***. If you use Windows, keep a folder like `C:\tmp` or `C:\temp` for this; Mac and Linux systems already have a `/tmp` directory.

5.2.2 Installing a package

There are four steps to installing a LaTeX package:

1. **Extract the files**
   Run LaTeX on the `.ins` file. That is, open the file in your editor and process it as if it were a LaTeX document (which is it), or if you prefer, type `latex` followed by the `.ins` filename in a command window in your temporary directory.

   This will extract all the files needed from the `.dtx` file (which is why you must have both of them present in the temporary directory). Note down or print the names of the files created if there are a lot of them (read the log file if you want to see their names again).

2. **Create the documentation**
   Run LaTeX on the `.dtx` file twice. This will create a `.dvi` file of documentation explaining what the package is for and how to use it. Two passes through LaTeX are needed in order to resolve any internal crossreferences in the text (a feature we'll come onto later). If you prefer to create PDF then run *pdfLaTeX* instead. View or print this file in the usual manner (see § 4.3).

3. **Install the files**
   While the documentation is printing, move or copy the files created in step 1 from your temporary directory to the right place[s] in your TeX *local* installation directory tree — always your 'local' directory tree, *a*) to prevent your

[3] You can try to use these if you wish but they are not guaranteed to work, and have now almost all been replaced by LaTeX 2ε versions. Always look for the `.dtx` and `.ins` pair of files first.

Table 5.1: Where to put files from packages

Type	Directory (under `texmf-local/`)	Description
`.cls`	`tex/latex/base`	Document class file
`.sty`	`tex/latex/`*packagename*	Style file: the normal package content
`.bst`	`bibtex/bst/`*packagename*	BibTeX style
`.mf`	`fonts/source/public/`*typeface*	METAFONT outline
`.fd`	`tex/latex/mfnfss`	Font Definition files for METAFONT fonts
`.fd`	`tex/latex/psnfss`	Font Definition files for PostScript Type 1 fonts
`.pfb`	`/fonts/type1/`*foundry*`/`*typeface*	PostScript Type 1 outline
`.afm`	`/fonts/afm/`*foundry*`/`*typeface*	Adobe Font Metrics for Type 1 fonts
`.tfm`	`/fonts/tfm/`*foundry*`/`*typeface*	TeX Font Metrics for METAFONT and Type 1 fonts
`.vf`	`/fonts/vf/`*foundry*`/`*typeface*	TeX virtual fonts
`.dvi`	`/doc`	package documentation
`.pdf`	`/doc`	package documentation
others	`tex/latex/`*packagename*	other types of file unless instructed otherwise

new package accidentally overwriting files in the main TeX directories; and *b*) to avoid your newly-installed files being overwritten when you next update your version of TeX.

'The right place' sometimes causes confusion, especially if your TeX installation is old or does not conform to the TeX Directory Structure. For a TDS-conformant system, this is either *a*) for LaTeX packages, a suitably-named subdirectory of `texmf-local/tex/latex/`[4]; or *b*) a suitably-named subdi-

rectory of `texmf-local/` for files like BIBTEX styles which are not just for LATEX but can be used in other TEX systems.

'Suitably-named' means sensible and meaningful (and probably short). For a package like paralist, for example, I'd call the directory `paralist`.

Often there is just a `.sty` file to move but in the case of complex packages there may be more, and they may belong in different locations. For example, new BIBTEX packages or font packages will typically have several files to install. This is why it is a good idea to create a subdirectory for the package rather than dump the files into `misc` along with other unrelated stuff.

If there are configuration or other files, read the documentation to find out if there is a special or preferred location to move them to.

4. **Update your index**
   Finally, run your TEX indexer program to update the package database. This program comes with every modern version of TEX and is variously called *texhash*, *mktexlsr*, or even *configure*, or it might just be a mouse click on a button or menu in your editor. Read the documentation that came with your installation to find out which it is.

This last step is *utterly essential*, otherwise nothing will work.

EXERCISE 14

Install a package

Download and install the paralist **package (which implements inline lists).**

[4] See § 5.2.3 for how to create a parallel structure in your local directory if your installation didn't create one for you.

The reason this process has not been automated widely is that there are still thousands of installations which do not conform to the TDS, such as old shared Unix systems and some Microsoft Windows systems, so there is no way for an installation program to guess where to put the files: *you* have to know this. There are also systems where the owner, user, or installer has chosen *not* to follow the recommended TDS directory structure, or is unable to do so for political or security reasons (such as a shared system where she cannot write to a protected directory).

The reason for having the `texmf-local` directory (called `texmf.local` on some systems) is to provide a place for local modifications or personal updates, especially if you are a user on a shared or managed system (Unix, Linux, VMS, Windows NT/2000/XP, etc.) where you may not have write-access to the main TEX installation directory tree. You can also have a personal `texmf` subdirectory in your own login directory. Your installation must be configured to look in these directories first, however, so that any updates to standard packages will be found there *before* the superseded copies in the main `texmf` tree. All modern TEX installations should do this anyway, but if not, you can edit `texmf/web2c/texmf.cnf` yourself. There is an example in Appendix A.

5.2.3 Replicating the TDS

The TEX Directory Structure (TDS) is documented at `http://www.tug.org/tds/`. I find it useful to make the directory structure of `texmf-local` the same as that of `texmf`. Examine the subdirectories of `texmf/tex/latex/` for examples. For updates of packages which came with your LATEX distribution (as distinct from new ones you are adding yourself), you can then use the same subdirectory name and position in `texmf-local/...` as the original used in `texmf/...`.

If you want to create the entire subdirectory structure ready for use, you can do it under Unix with the following commands:

```
cd /usr/TeX/texmf
find . -type d -exec mkdir -p /usr/TeX/texmf-local/{} \;
```

If you are using Microsoft Windows, you can download *Cygwin*, which provides you with the standard Unix tools in a shell window. The above command should also work on a Mac running OS X. In all cases, if your installation directory is not `/usr/TeX`, you need to substitute the actual paths to your `texmf` and `texmf-local` directories.

5.3 Online help

The indexes and documentation files on CTAN are the primary online resource for self-help on specific packages, and you should read these carefully before asking questions about packages.

5.3.1 The FAQ

For general queries you should read the Frequently-Asked Questions (FAQ) document so that you avoid wasting online time asking about things for which there is already an easily-accessible answer.

The FAQ is managed by the UK TEX Users Group and can be found at `http://www.tex.ac.uk/faq/`.

5.3.2 The TEXhax mailing list

Another support resource is the mailing list `texhax@tug.org`. Again, feel free to ask questions, but again, try to answer the question yourself first (and say what you've tried in your message).

5.3.3 Web sites

The TEX Users Group, as well as most local user groups, maintains a web site (`http://www.tug.org`) with lots of information

about various aspects of the TEX system. See Appendix B for information on joining TUG.

5.3.4 News

The Usenet newsgroup `comp.text.tex` is the principal forum for other questions and answers about LATEX. Feel free to ask questions, but please do not ask frequently-asked questions: read the FAQ instead. The people who answer the questions do so voluntarily, unpaid, and in their own time, so please don't treat this as a commercial support service.

To access Usenet news, type the following URI into your browser's 'Location' or 'Address' window: `news:comp.text.tex` (if your browser doesn't support Usenet news properly, change it for one that does, like *Mozilla*[5]), or download one of the many free newsreaders.[6]

5.3.5 Commercial support

If you need commercial levels of support, such as 24-hour phone contact, or macro-writing services, you can buy one of the several excellent commercial versions of TEX, or contact a consultancy which deals with TEX (details on the TUG Web site).

[5] `http://www.mozilla.org/`

[6] Note that this means newsreaders for the Usenet News (NNTP) service. It does *not* mean syndication readers for RSS, which are a different thing entirely — these are unfortunately also sometimes referred to as 'newsreaders'.

6 Other document structures

It is perfectly possible to write whole documents using nothing but section headings and paragraphs. As mentioned in §3.5, novels, for example, usually consist just of chapters divided into paragraphs. However, it's more common to need other features as well, especially if the document is technical in nature or complex in structure.

It's worth pointing out that 'technical' doesn't necessarily mean 'computer technical' or 'engineering technical': it just means it contains a lot of τηχνε (*tekne*), the specialist material or artistry of its field. A literary analysis such as *La Textualisation de* Madame Bovary[1] (on the marginal notes in the manuscripts of Flaubert's novel) is every bit as technical in the literary or linguistic field as the maintenance manual for the Airbus 380 is in the aircraft engineering field.

This chapter covers the most common features needed in writing structured documents: lists, tables, figures (including images), sidebars like boxes and panels, and verbatim text (computer

[1] Mac Namara (2003)

program listings). In Chapter 7 we will cover footnotes, cross-references, citations, and other textual tools.

6.1 A little think about structure

It's very easy to sit down at a keyboard with a traditional word-processor and just start typing. If it's a very short document, or something transient or relatively unimportant, then you just want to type it in and make it look 'right' by highlighting with the mouse and clicking on font styles and sizes.

In doing so, you may achieve the effect you wanted, but your actions have left no trace behind of *why* you made these changes. This is usually unimportant for trivial or short-term documents, but if you write longer or more complex documents, or if you often write documents to a regular pattern, then making them consistent by manual methods becomes a nightmare. LaTeX's facilities for automation are based on you providing this 'why' information.

If your documents have any of the features below, then you have probably already started thinking about structure.

- ☐ The document naturally divides into sections (parts, chapters, etc.).
- ☐ The document is long.
- ☐ There is lots of repetitive formatting in the document.
- ☐ The document is complex (intellectually or visually).
- ☐ There are lots of figures or tables (or examples, exercises, panels, sidebars, etc.).
- ☐ Accuracy is important in formatting the document.
- ☐ A master copy is needed for future reference or reprinting.

- ☐ This is a formal or official document needing special care and attention.
- ☐ It's *my* thesis, book, leaflet, pamphlet, paper, article, etc. *That*'s why I care.
- ☐ The document (or part of it) may need ongoing or occasional re-editing and republishing.

If you've got that far, you're over half-way done. Using a structural editor — even a simple outliner — can make a huge difference to the quality of your thinking because you are consciously organising your thoughts before setting them down. And it can make just as big a difference to your formatting as well: more consistent, better presented, easier for the reader to navigate through, and more likely to be read and understood — which is presumably why you are writing the document in the first place.

6.2 Lists

Lists are useful tools for arranging thoughts in a digestible format, usually a small piece of information at a time. There are four basic types of list, shown in Table 6.1.

There are actually two other types, segmented lists and reference lists, but these are much rarer, and outside the scope of this document. The structure of lists in LaTeX is identical for each type, but with a different environment name. Lists are another example of this LaTeX technique (environments), where a pair of matched commands surrounds some text which needs special treatment.

Within a list environment, list items are always identified by the command **`\item`** (followed by an item label in [square brackets] in the case of labelled lists). You don't type the bullet or the number or the formatting, it's all automated.

Table 6.1: Types of lists

Random or arbitrary lists (sometimes called 'itemized' or 'bulleted' lists) where the order of items is unimportant. The items are often prefixed with a bullet or other symbol for clarity or decoration, but are sometimes simply left blank, looking like miniature paragraphs (when they are known as 'simple' or 'trivial' lists).

Enumerated or sequential lists (sometimes called 'numbered' lists) where the order of items is critical, such as sequences of instructions or rankings of importance. The enumeration can be numeric (Arabic or Roman), or lettered (uppercase or lowercase), and can even be programmed to be hierarchical (1.a.viii, 2.3.6, etc.).

Descriptive or labelled lists (sometimes called 'discussion' lists), which are composed of subheadings or topic labels (usually unnumbered but typographically distinct), each followed by one or more indented paragraphs of discussion or explanation.

Inline lists which are sequential in nature, just like enumerated lists, but are *a*) formatted *within* their paragraph; and *b*) usually labelled with letters, like this example. The items are often mutually inclusive or exclusive, with the final item prefixed by 'and' or 'or' respectively.

6.2.1 Itemized lists

To create an itemized list, use the the **itemize** environment:

```
\begin{itemize}

\item Itemized lists usually have a bullet;

\item Long items use 'hanging indentation',
whereby the text is wrapped with a margin
which brings it clear of the bullet used in
the first line of each item;

\item The bullet can be changed for any other
symbol, for example from the \textsf{bbding}
or \textsf{pifont} package.

\end{itemize}
```

- Itemized lists usually have a bullet;
- Long items use 'hanging indentation', whereby the text is wrapped with a margin which brings it clear of the bullet used in the first line of each item;
- The bullet can be changed for any other symbol, for example from the bbding or pifont package.

The default list bullet is round and solid[2] (•) which is also available with the command **\textbullet** if you load the textcomp package. See § 9.6.1 for details of how to change the settings for list item bullets.

[2] If your browser font doesn't show it, don't worry: most don't. LaTeX will.

6.2.2 Enumerated lists

To create an enumerated list, use the **enumerate** environment:

```
\begin{enumerate}

\item Enumerated lists use numbering on each
item (can also be letters or roman numerals);

\item Long items use 'hanging indentation'
just the same as for itemized lists;

\item The numbering system can be changed for
any level.

\end{enumerate}
```

1. Enumerated lists use numbering on each item (can also be letters or roman numerals);
2. Long items use 'hanging indentation', just the same as for itemized lists;
3. The numbering system can be changed for any level.

See § 6.2.6 for details of how to change the numbering schemes for each level.

In standard LaTeX document classes, the vertical spacing between items, and above and below the lists as a whole, is more than between paragraphs. If you want tightly-packed lists, use the mdwlist package, which provides 'starred' versions (**itemize***, **enumerate***, etc).

6.2.3 Description lists

To create a description list, use the **description** environment:

```
\begin{description}

\item[Identification:] description lists
require a topic for each item given in
square brackets;

\item[Hanging indentation:] Long items use
this in the same way as all other lists;

\item[Reformatting:] Long topics can be
reprogrammed to fold onto multiple lines.

\end{description}
```

Identification: description lists require a topic for each item given in square brackets;

Hanging indentation: Long items use this in the same way as all other lists;

Reformatting: Long topics can be reprogrammed to fold onto multiple lines.

All three of these types of lists can have multiple paragraphs per item: just type the additional paragraphs in the normal way, with a blank line between each. So long as they are still contained within the enclosing environment, they will automatically be indented to follow underneath their item.

6.2.4 Inline lists

Inline lists are a special case as they require the use of the paralist package which provides the **inparaenum** environment (with an optional formatting specification in square brackets):

```
\usepackage{paralist}
...
\textbf{\itshape Inline lists}, which are
sequential in nature, just like enumerated
lists, but are \begin{inparaenum}[\itshape
a\upshape)]\item formatted within their
paragraph; \item usually labelled with
letters; and \item usually have the final
item prefixed with 'and' or
'or'\end{inparaenum}, like this example.
```

Inline lists, which are sequential in nature, just like enumerated lists, but are *a*) formatted within their paragraph; *b*) usually labelled with letters; and *c*) usually have the final item prefixed with 'and' or 'or' , like this example.

See Chapter 8 for details of the font-changing commands used in the optional argument to **inparaenum**.

EXERCISE 15

List practice

Add some lists to your document. Pick any two of the ones described here to practice with.

If you successfully installed paralist **in Exercise 14 then you can use inline lists as described in § 6.2.4.**

6.2.5 Reference lists and segmented lists

Reference lists are visually indistinguishable from numbered or lettered lists, but the numbering or lettering does *not* imply a sequence. The numbers or letters are just used as labels so that the items can be referred to from elsewhere in the text (as in 'see item 501(c)3'). In this sense they are really a kind of sub-sectional division, and LaTeX's **\paragraph** or **\subparagraph** commands (with appropriate renumbering) would probably be a far better solution than using a list. Label them and refer to them with **\label** and **\ref** as for any other cross-reference (see § 7.4).

Segmented lists are a highly specialised structure and outside the scope of this document. For details of their usage, see the the chapter 'Segmentation and Alignment' in *Guidelines for the Text Encoding Initiative*[3].

6.2.6 Lists within lists

You can start a new list environment within the item of an existing list, so you can embed one list inside another up to four deep. The lists can be of any type, so you can have a description list containing an item in which there is a numbered sub-list, within which there is an item containing a bulleted sub-sub-list.

1. by default an outer enumerated list is numbered in Arabic numerals;

   (a) an embedded enumerated list is lettered in lowercase;

      i. a third level is numbered in lowercase Roman numerals;

         A. the fourth level uses uppercase alphabetic letters.

Multiple embedded lists automatically change the bullet or numbering scheme so that the levels don't get confused, and the

[3] Burnard/Sperberg-McQueen (1995)

spacing between levels is adjusted to become fractionally tighter for more deeply nested levels.

These are only defaults and can easily be changed by redefining the relevant set of values. You could also add a fifth and further levels, although I suspect that would mean your document structure needed some careful analysis, as lists embedded five deep will probably confuse your readers.

The values for lists come in pairs: for each level there is a counter to count the items and a command to produce the label:[4]

Level	Default	Counter	Label command
1	digit.	*enumi*	**\theenumi**
2	(letter)	*enumii*	**\theenumii**
3	roman.	*enumiii*	**\theenumiii**
4	LETTER.	*enumiv*	**\theenumiv**

Note that each counter and command ends with the Roman numeral value of its level (this is to overcome the rule that LaTeX commands can only be made of letters — digits wouldn't work here). To change the format of a numbered list item counter, just renew the meaning of its label:

```
\renewcommand{\theenumi}{\Alph{enumi}}
\renewcommand{\theenumii}{\roman{enumii}}
\renewcommand{\theenumiii}{\arabic{enumiii}}
```

This would make the outermost list use uppercase letters, the second level use lowercase roman, and the third level use ordinary Arabic numerals. The fourth level would remain unaffected.

[4] In fact, any time you define a counter in LaTeX, you automatically get a command to reproduce its value. So if you defined a new counter *example* to use in a teaching book, by saying `\newcounter{example}`, that automatically makes available the command `\theexample` for use when you want to display the current value of *example*.

EXERCISE 16

Nesting

Extend your use of lists by nesting one type inside a different one.

Lists: a caution to the unwary

Treat lists with care: people sometimes use tables for labelled information which is really a list and would be better handled as such. They often do this because their wordprocessor has no way to do what they want (usually to place the item label level with the description or explanation) *except* by using a table, hence they are misled into believing that their text is really a table when it's actually not.

6.3 Tables

Tabular typesetting is the most complex and time-consuming of all textual features to get right. This holds true whether you are typing in plain-text form, using a wordprocessor, using LaTeX, using HTML or XML, using a DTP system, or some other text-handling package. Fortunately, LaTeX provides a table model with a mixture of defaults and configurability to let it produce very high quality tables with a minimum of effort.

Terminology

LaTeX, in common with standard typesetting practice, uses the word 'Table' to mean a formal textual feature, numbered and with a caption, referred to from the text (as in 'See Table 5'). Sometimes you can get 'informal' tables, which simply occur between two paragraphs, without caption or number.
The arrangement of information in rows and columns *within* either of these structures is called a 'tabulation' or 'tabular matter'.
It is important to keep this distinction firmly in mind for this section.

6.3.1 Floats

Tables and Figures are what printers refer to as 'floats'. This means they are not part of the normal stream of text, but separate entities, positioned in a part of the page to themselves (top, middle, bottom, left, right, or wherever the designer specifies). They always have a caption describing them and they are always numbered so they can be referred to from elsewhere in the text.

LaTeX automatically floats Tables and Figures, depending on how much space is left on the page at the point that they are processed. If there is not enough room on the current page, the float is moved to the top of the next page. This can be changed by moving the Table or Figure definition to an earlier or later point in the text, or by adjusting some of the parameters which control automatic floating.

Authors sometimes have many floats occurring in rapid succession, which raises the problem of how they are supposed to fit on the page and still leave room for text. In this case, LaTeX stacks them all up and prints them together if possible, or leaves them to the end of the chapter in protest. The skill is to space them out within your text so that they intrude neither on the thread of your argument or discussion, nor on the visual balance of the typeset pages. But this is a skill few authors have, and it's one point at which professional typographic advice or manual intervention may be needed.

There is a **float** package which lets you create new classes of floating object (perhaps Examples or Exercises).

6.3.2 Formal tables

To create a LaTeX Table, use the **table** environment containing a **\caption** command where you type the caption, and a **\label** command to give the Table a label by which you can refer to it.

```
\begin{table}
\caption{Project expenditure to year-end 2006}
\label{ye2006exp}
...
\end{table}
```

Numbering is automatic, but the **\label** command *must follow* the **\caption** command, not precede it. The numbering automatically includes the chapter number in document classes where this is appropriate (but this can of course be overridden). The **\caption** command has an optional argument to provide a short caption if the full caption would be too long for the List of Tables (§ 3.7):

```
\caption[Something short]{Some very long caption that
will only look reasonable in the full figure.}
```

6.3.3 Tabular matter

Within a Table, you can either typeset the tabular matter using LaTeX, or include a table captured as an image from elsewhere. We will see how to include images in § 6.4 on Figures, where they are more common.

To typeset tabular matter, use the **tabular** environment. The `\begin{tabular}` command must be followed by a compulsory second argument in curly braces giving the alignment of the columns. These are specified for each column using one of single letters `l`, `c`, and `r` for left-aligned, centered, or right-aligned text, or the letter `p` followed by a width argument if you want a long entry to wrap to several lines (a miniature paragraph as a single cell on each row).

TeX's original tabular settings were designed for classical numerical tabulations, where each cell contains a single value. The `p` specification allows a cell to be a miniature paragraph set to a specific width. These are `p` column specifications are *not* multi-row

entries, they are single cells which contain multiple lines of typesetting: the distinction is very important. Auto-adjusting space between columns is possible with the tabularx package, but the auto-resizing column widths used in web pages are not available in LaTeX.

The array package provides for many other typographic variations such as left-aligned, right-aligned, and centred multi-line columns, and other packages provide decimal-aligned columns, row-spanning and column-spanning, multi-page, and rotated (landscape format) tables.

As an example, a tabular setting with three columns, the first one centered, the second left-aligned, and the third one right-aligned, would therefore be specified as `{clr}`, as in the example below. Note the use of indentation to make the elements of the table clear for editing, and note also how the typeset formatting is unaffected by this (see Table 6.2).

Table 6.2: Project expenditure to year-end 2006

	Item	**€ Amount**
a)	Salaries (2 research assistants)	28,000
	Conference fees and travel expenses	14,228
	Computer equipment (5 workstations)	17,493
	Software	3,562
b)	Rent, light, heat, etc.	1,500
	Total	**64,783**

The Institute also contributes to (a) and (b).

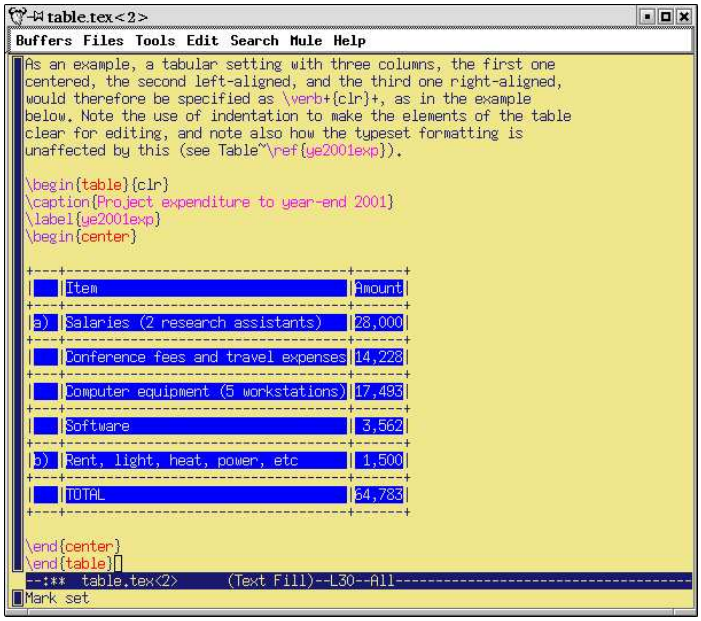
```
\begin{table}
  \caption{Project expenditure to year-end 2006}
  \label{ye2006exp}
  \begin{center}
    \begin{tabular}{clr}
      &Item&\EUR\ Amount\\
    \hline
      a)&Salaries (2 research assistants)&28,000\\
      &Conference fees and travel expenses&14,228\\
      &Computer equipment (5 workstations)&17,493\\
      &Software&3,562\\
      b)&Rent, light, heat, etc.&1,500\\\cline{3-3}
      &Total&64,783
    \end{tabular}
    \par\medskip\footnotesize
The Institute also contributes to (a) and (b).
  \end{center}
\end{table}
```

You do not need to format the tabular data in your editor: LaTeX does this for you when it typesets the table, using the column specifications you provided. Extra space is automatically added between columns, and can be adjusted by changing the `\tabcolsep` dimension. Takaaki Ota provides an excellent Tables mode for *Emacs* which provides a spreadsheet-like interface and can generate LaTeX table source code (see Figure 6.1).

It is conventional to centre the tabular setting within the Table, using the **center** environment (note US spelling) or the **\centering** command. The entries for each cell are separated by an ampersand character (&) and the end of a row is marked by the double-backslash (\\).

The **\hline** command draws a rule across all columns and the **\cline** command draws a rule across a range of columns (here, under column three only — the argument needs a range). If used, these commands *follow* the \\ of the row they apply to. There are

Figure 6.1: Tables mode for *Emacs*



some extra formatting commands after the tabular material in the example. These are explained in Chapter 8.

If there is no data for a cell, just don't type anything — but you still need the & separating it from the next column's data. The astute reader will already have deduced that for a table of n columns, there must always be $n-1$ ampersands in each row. The exception to this is when the **\multicolumn** command is used to create cells which span multiple columns. There is also a package (**multirow**) to enable cells to span multiple rows, but both of these techniques are outside the scope of this document.

6.3.4 Tabular techniques for alignment

As mentioned earlier, it's also perfectly possible to typeset tabular matter outside a formal Table, where you want to lay out an informal tabulation between paragraphs where a fully floating

formal Table would be unnecessary (these are usually quite short: there are several of them in this document).

Tabular mode can also be used wherever you need to align material side by side, such as in designing letterheads, where you may want your company logo and address on one side and some other information on the other.

By default, LaTeX typesets **tabular** environments inline to the surrounding text, so if you want your alignment displayed by itself, put it inside a positioning environment like **center**, **flushright**, or **flushleft**, or leave a blank line or **\par** before and after so it gets typeset separately.

There is much more to tabular setting: full details are in the manuals mentioned in the last paragraph of the Foreword on p. xviii. One final note to remind you of the automated cross-referencing features: because the example table is labelled, it can be referenced from anywhere in the document as Table 6.2 just by using `\ref{ye2006exp}`, regardless of how much the surrounding document or structure is moved or edited.

EXERCISE 17

Create a tabulation

Create one of the following in your document:

- **a formal Table with a caption showing the number of people in your class broken down by age and sex;**
- **an informal tabulation showing the price for three products;**
- **the logo 2 YEAR 0 0 0 (hint: § 6.7.2)**

6.4 Figures

As explained in § 6.3.1, Figures and Tables float to a vacant part of the page, as they are not part of the sequence of sentences making up your text, but illustrative objects that you refer to.

Figures can contain text, diagrams, pictures, or any other kind of illustration. To create a figure, use the **figure** environment: like Tables, they automatically get numbered, and must include a caption (with a label after the caption, if needed, exactly the same as for Tables)

```
\begin{figure}
\caption{Total variable overhead variance (after
        \citeauthor[p.191]{bull}}
\label{workeff}
\begin{center}
\includegraphics[width=.75\columnwidth]{diagram}
\end{center}
\end{figure}
```

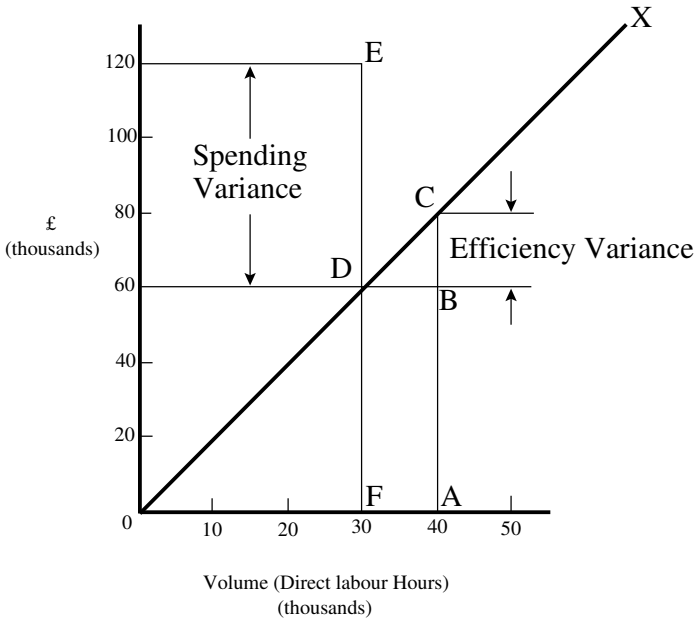
You can see that the structure is very similar to the **table** environment, but in this case we have a graphic included. Details of this command (**\includegraphics**) are in the next section. Details of the bibliographic citation mechanism are in § 7.4.2

The content of the Figure could of course also be textual, in the form of a list or a text diagram. LaTeX has a simple drawing environment called **picture**, which lets you create a limited set of lines and curves, but for a diagram of any complexity, you should use a standard vector drawing program (see § 6.5.1).

6.5 Images

Images (graphics) can be included anywhere in a LaTeX document, although in most cases of formal documents they will occur in

Figure 6.2: Total variable overhead variance (after Bull (1972) *p.191*)



Figures (see preceding section). To use graphics, you need to use the graphicx package in your preamble: `\usepackage{graphicx}`[5]

This enables the command **`\includegraphics`** which is used to insert an image in the document. The command is followed by the name of your graphics file *without the filetype*, for example: `\includegraphics{myhouse}` (we'll see in a minute why you don't include the filetype).

In most cases you should just make sure the image file is in the same folder (directory) as the document you use it in. This avoids a lot of messing around remembering where you put the files. If you have images you want to use in several different documents in

[5] You may find a lot of old files which use a package called epsf. Don't use it. It's obsolete.

different places on your disk, there is a way to tell LaTeX where to look (see § 6.5.2).

For standard LaTeX with *dvips*, graphics files *must* be in Encapsulated PostScript (EPS) format: this has been the publishing industry standard for portable graphics for many years, and no other format will work portably in standard LaTeX.[6]

All good graphics packages can save images as EPS, but be very careful because some packages, especially on Microsoft Windows platforms, use a very poor quality driver, which creates very poor quality EPS files. If in doubt, check with an expert. If you find an EPS graphic doesn't print, the chances are it's been badly made by the graphics software. Download Adobe's own PostScript driver from their Web site instead.

For *pdfLaTeX*, graphics files can be in Portable Network Graphic (PNG), Joint Photographic Experts Group (JPG), or PDF format, *not* EPS. This means if you want to use both standard LaTeX as well as *pdfLaTeX*, you need to keep your graphics in two formats, EPS and one of the others. This is why you don't include the filetype in the filename you give with **\includegraphics**: LaTeX will assume EPS and *pdfLaTeX* will look for JPG, PNG or PDF files matching the name.

The **\includegraphics** command can take optional arguments within square brackets before the filename to specify either the height or width, and the other dimension will automatically change to scale. If you specify both, the image will be distorted to fit. You can scale an image by a factor instead of specifying height or width; clip it to specified coordinates; and rotate it in either direction. Multiple optional arguments are separated with commas.

[6] Some distributions of TeX systems allow other formats to be used, such as PNG, Microsoft Bitmap (BMP) files, Hewlett-Packard's Printer Control Language (PCL) files, and others; but you cannot send such documents to other LaTeX users and expect them to work if they don't have the same distribution installed as you have. Stick to EPS.

```
\begin{center}
\includegraphics[width=3cm]{twithcat}
\end{center}
```

For details of all the arguments, see the documentation on the graphicx package or a copy of the *The LaTeX Companion*[7]. This package also includes commands to rotate, mirror, and scale text.

It is in fact possible to tell LaTeX to generate the right file format by itself, but this requires an external command-line graphics converter, and as it gets done afresh each time, it slows things down rather a lot.

EPS files, especially bitmaps, can be very large indeed, because they are stored in ASCII format. Staszek Wawrykiewicz has drawn my attention to a useful MS-DOS program to overcome this, called *cep* ('Compressed Encapsulated Postscript') available from CTAN in the `support/pstools` directory, which can compress EPS files to a fraction of their original size. The original file can be replaced by the new smaller version and still used directly with **`\includegraphics`**.

6.5.1 Making images

There are two types of image: bitmaps and vectors.

Bitmaps Bitmap images are made of coloured dots, so if you enlarge them, they go jagged at the edges, and if you shrink

[7] Mittelbach et al. (2004)

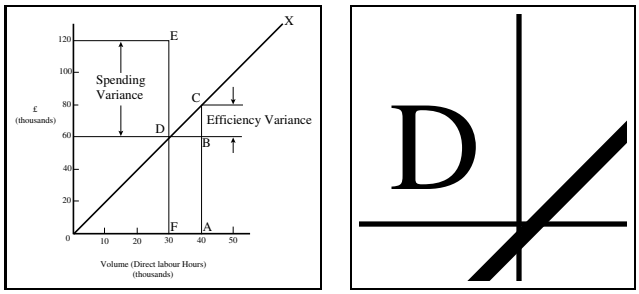
them, they go blurry. Bitmaps are fine for photographs, where every dot is a different colour, and no-one will notice if you don't shrink or enlarge too much. Bitmaps for diagrams and drawings, however, are almost always the wrong choice, and often disastrously bad.

Vectors Vector drawings are made from instructions (eg 'draw this from here to here, using a line this thick'). They can be enlarged or shrunk as much as you like, and never lose accuracy, because they *get redrawn* automatically at any size. You can't do photographs as vectors, but it's the only acceptable method for drawings or diagrams.

Vector graphic packages are also better suited for saving your image directly in EPS or PDF format (both of which use vectors internally). All the major graphics-generating packages in all disciplines output vector formats: *AutoCAD*, *ChemDraw*, *MathCAD*, *Maple*, *Mathematica*, *ArcInfo*, and so on. EPS is the universally-accepted format for creating vector graphics for publication, with PDF a close second. Most of the major graphics (drawing) packages can also save as EPS, such as *PhotoShop*, *PaintShop Pro*, Adobe *Illustrator*, Corel *Draw*, and *GIMP*. There are also some free vector plotting and diagramming packages available like *tkPaint* and *GNUplot* which do the same. Never, ever (except in the direst necessity) save any *diagram* as a bitmap.

Bitmap formats like JPG and PNG are ideal for photographs, as they are also able to compress the data substantially without too much loss of quality. However, compressed formats are bad for screenshots, if you are documenting computer tasks, because too much compression makes them blurry. The popular Graphics Interchange Format (GIF) is good for screenshots, but is not supported by TEX: use PNG instead, with the compression turned down to minimum. Avoid uncompressible formats like BMP as they produce enormous and unmanageable files. The Tagged Image File Format (TIFF), popular with graphic designers, should also be avoided because far too many companies have

Figure 6.3: The diagram from Figure 6.2 shrunk and enlarged



designed and implemented non-standard, conflicting, proprietary extensions to the format, making it virtually useless for transfer between different types of computers (except in faxes, where it's still used in a much stricter version).

EXERCISE 18

Adding pictures

Add `\usepackage{graphicx}` to the preamble of your document, and copy or download an image you want to include. Make sure it is a JPG, PNG, or PDF image if you use *pdfLaTeX*, or an EPS image if you use standard LaTeX.

Add `\includegraphics` and the filename in curly braces (without the filetype), and process the document and preview or print it.

Make it into a figure following the example in § 6.4.

Be aware that some DVI previewers are not able to display all types of graphics, and some cannot display colour. For best results, use PDF or PostScript preview.

6.5.2 Graphics storage

I mentioned earlier that there was a way to tell LaTeX where to look if you had stored images centrally for use in many

different documents. The answer is in a command **\graphicspath** which you supply with an argument giving the name of an additional directory path you want searched when a file uses the **\includegraphics** command, for example:

```
\graphicspath{c:\mypict~1\camera}
\graphicspath{/var/lib/images}
\graphicspath{HardDisk:Documents:Reports:Pictures}
```

I've used the 'safe' (MS-DOS) form of the Windows `MyPictures` folder because it's A Bad Idea to use directory names containing spaces (see the panel 'Picking suitable filenames' on p. 64). Using **\graphicspath** does make your file less portable, though, because file paths tend to be specific both to an operating system and to your computer, like the examples above.

6.6 Verbatim text

If you are documenting computer procedures, you probably need fixed-width type for examples of programming or data input or output. Even if you are writing about completely non-computer topics, you may often want to quote a URI or email address which needs to be typeset specially. It is particularly important in these two examples to avoid hyphenating them if they have to break over a line-end, because the hyphen might be taken by the user as a part of the address.

Standard LaTeX includes two features for handling fixed-format text, and there are many more available in packages.

6.6.1 Inline verbatim

To specify a word or phrase as verbatim text in typewriter type within a sentence, use the special command **\verb**, followed by your piece of text surrounded by any suitable character which

does *not* occur in the text itself. This is a very rare exception to the rule that arguments go in curly braces. I often use the plus sign for this, for example to show a LaTeX command, I type `\verb+\includegraphics[width=3in]{myhouse}+` in order to display `\includegraphics[width=3in]{myhouse}`, but sometimes I use the ***grave accent*** (***backtick*** or open-quote) or the vertical bar when the phrase already has a plus sign in it, like `\verb|\(y=a+2x^2\)|` when illustrating the LaTeX equation `\(y=a+x^2\)`.

This command has the advantage that it turns off all special characters (see § 2.5) except the one you use as the delimiter, so you can easily quote sequences of characters in any computer syntax without problems. However, LaTeX will never break the argument of **`\verb`** at a line-end when formatting a paragraph, even if it contains spaces, so if it happens to be long, and falls towards the end of a line, it will stick out into the margin. See § 2.8.2 for more information on line-ends and hyphenation.

The `url` package avoids this by providing the command **`\url`** which works in the same way as **`\verb`**, with the argument enclosed in a pair of characters, but performs a hyphenless break at punctuation characters, as in `http://www.ucc.ie:8080/cocoon/cc/docs/siteowner.xml`. It was designed for Web URIs,[8] so it understands their syntax and will never break mid-way through an unpunctuated word, only at slashes and full points. Bear in mind, however, that spaces are forbidden in URIs, so using spaces in **`\url`** arguments will fail, as will using other non-URI-valid characters.

[8] The original term Uniform Resource Locator (URL) is now strongly deprecated in the Web community in favour of the more accurate Uniform Resource Indicator (URI). For details see `http://www.w3.org/Addressing/`. Unfortunately the older term still persists, especially in LaTeX and XML markup.

6.6.2 Display verbatim

For longer (multiline) chunks of fixed-format text, use the **verbatim** environment:

```
\begin{verbatim}
\documentclass[11pt,a4paper,oneside]{report}
\begin{document}

\title{Practical Typesetting}
\author{Peter Flynn\\Silmaril Consultants}
\date{December 2004}
\maketitle

\end{document}
\end{verbatim}
```

Like **\verb**, this turns off all special characters, so you can include anything at all in the verbatim text except the exact line `\end{verbatim}`

For more control over formatting, however, I recommend the use of the fancyvrb package, which provides a **Verbatim** environment (note the capital letter) which lets you draw a rule round the verbatim text, change the font size, and even have typographic effects inside the **Verbatim** environment. It can also be used in conjunction with the fancybox package (see § 6.7.3), and it can add reference line numbers (useful for chunks of data or programming), and it can even include entire external files.

EXERCISE 19

Try some fixed-format text

Add your email address and home page URI using the **\verb** and **\url** commands. You'll need to `\usepackage{url}` for the latter.

If you know some programming, try a few lines enclosed in **verbatim** and **Verbatim** environments.

6.7 Boxes, sidebars, and panels

LaTeX, like most typesetting systems, works by setting text into boxes. The default box is the width of the current page, and works like an old compositor's galley (tray) from the days of metal type: it accumulates typeset text until it's a bit longer than the specified page height. At this stage LaTeX works out how much of it really will fit on a page, snips it off and ships it out to the DVI or PDF file, and puts the rest back into the galley to accumulate towards the following page.

6.7.1 Boxes of text

Because of this 'box' model, LaTeX can typeset any text into a box of any width wherever on the page you need it.

The simplest command for small amounts of text is **\parbox**. This command needs two arguments in curly braces: the first is the width you want the text set to, and the second is the text itself, for example:

```
\parbox{1in}{Please make sure you send in your
           completed forms by January 1st
           next year, or the penalty clause
           2(a) will apply}
```

Please make sure you send in your completed forms by January 1st next year, or the penalty clause 2(a) will apply

The text is typeset to the required width, and the box is extended downwards for as long as is required to fit the text. Note that the baseline of a **\parbox** is set to the midpoint of the box; that is, if you include a **\parbox** in mid-sentence, the centre of the box will be lined up with the line of type currently being set. Like this small paragraph. You can specify that it should be the top or bottom by adding an optional *t* or *b* in square brackets before the width. For example, `\parbox[t]{1in}{...}` will produce a box with the baseline aligned with the top line of the text in the box.

Notice that when setting very narrow measures with type that is too large, the spacing may become uneven and there may be too much hyphenation. Either use **\raggedright** or reduce the type size, or (in extreme cases) reword the text or break each line by hand. It is rare for LaTeX to need this: the example above was deliberately chosen to be obtuse as an illustration.

Where the contents is more extensive or more complicated, you can use the **minipage** environment.

Within this you can use virtually everything that occurs in normal text (e.g. lists, paragraphs, tabulations, etc.) with the exception of floats like tables and figures. The **minipage** environment has an argument just like **\parbox** does, and it means the same: the width you want the text set to.

Note that in **minipage**s and **\parbox**es, the paragraph indentation (`\parindent`) is reset to zero. If you need to change it, set it inside the **minipage** or **\parbox** using the **\setlength** command (see § 3.6).

```
\begin{minipage}{3in}
Please make sure you send in your completed
forms by January 1st next year, or the
penalty clause 2(a) will apply.
\begin{itemize}
\item Incomplete forms will be returned to
you unprocessed.
\item Forms must be accompanied by the
correct fee.
\item There is no appeal. The adjudicators'
decision is final.
\end{itemize}
\end{minipage}
```

Please make sure you send in your completed forms by January 1st next year, or the penalty clause 2(a) will apply.

- Incomplete forms will be returned to you unprocessed.
- Forms must be accompanied by the correct fee.
- There is no appeal. The adjudicators' decision is final.

There are two other ways of typesetting text to widths other than the normal text width: you can use a one-row, one-cell **tabular** environment with the `p` column type specification, or you can use the **\vbox** command, which is raw TEX, and outside the scope of this document.

6.7.2 Framed boxes

To put a frame round some text, use the **\fbox** command: `\fbox{some text}`. This works for a few words in mid-line, but the framed box and its contents won't break over the end of a line. To typeset multiline text in a box, put it in a **\parbox**, or use a **minipage** or **tabular** environment as described above, and enclose the whole thing in a **\fbox**.

```
\fbox{\begin{minipage}{3in}
This multiline text is more flexible than
a tabular setting:
\begin{itemize}
\item it can contain any type of normal
\LaTeX{} typesetting;
\item it can be any specified width;
\item it can even have its own
footnotes\footnote{Like this}.
\end{itemize}
\end{minipage}}
```

This multiline text is more flexible than a tabular setting:

- it can contain any type of normal LaTeX typesetting;
- it can be any specified width;
- it can even have its own footnotes.[a]

[a] Like this.

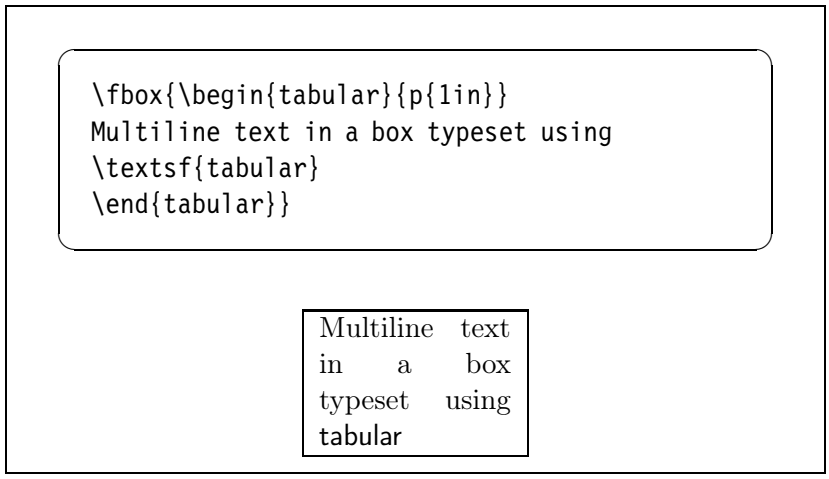
The spacing between text and box is controlled by the value of `\fboxsep`, and the thickness of the line by `\fboxrule`. The following values were used above:

```
\setlength{\fboxsep}{1em}
\setlength{\fboxrule}{2pt}
```

As we saw before, setting justified text in narrow measures will produce poor spacing: either use the **\raggedright** command, or change the font size, or add explicit extra hyphenation points.

Note the \begin{tabular} and \begin{minipage} commands still need the width specifying: in the case of the \begin{tabular} by the use of the p column type with its width specification, and in the case of \begin{minipage} by the second argument.

```
\fbox{\begin{tabular}{p{1in}}
Multiline text in a box typeset using
\textsf{tabular}
\end{tabular}}
```



6.7.3 Sidebars and panels

The fancybox package lets you extend the principle of **\fbox** with commands to surround text in square, oval (round-cornered), and drop-shadow boxes (e.g. **\ovalbox**, **\shadowbox**, etc.: see the documentation for details).

You can create panels of any size with these borders by using the **minipage** environment to typeset the text inside a special **Sbox** environment which fancybox defines. The **minipage** formats the text but the **Sbox** 'captures' it, allowing you to put the frame round it as it prints.

The printed version of this document uses this extensively and there is a useful example shown in § 9.5.

7 Textual tools

Every text-handling system needs to support a repertoire of tools for doing things with text. LaTeX implements many dozens, of which a small selection of the most frequently used is given here:

- offset quotations (sometimes called 'block quotes');
- footnotes and end-notes;
- marginal notes;
- cross-references, both normal ones and bibliographic citations;
- indexes and glossaries;
- typesetting in multiple columns.

7.1 Quotations

Direct speech and short quotes within a sentence 'like this' are done with simple quotation marks as described in § 2.6.

Sometimes, however, you may want longer quotations set as a separate paragraph. Typically these are indented from the surrounding text. LaTeX has two environments for doing this.

Such quotations are often set in a smaller size of type, although this is not the default, hence the use of the **\small** command in the second example. The inclusion of the bibliographic citation at the end is optional: here it is done with a non-standard command **\citequote** which I invented for this example (there is more about how to do things like this in Chapter 9).

The quote **environment** is for up to a line of text each per (short) quotation, with the whole thing indented from the previous paragraph but with no additional indentation on each quote;

```
\begin{quote}
Do, Ronny, Do. \textit{Nancy Reagan}

Da Do Ron Ron. \textit{The Crystals}
\end{quote}
```

> Do, Ronny, Do. *Nancy Reagan*
>
> Da Do Ron Ron. *The Crystals*

The quotation **environment** is for longer passages (a paragraph or more) of a single quotation, where not only is the block of text indented, but each paragraph of it also has its own extra indentation on the first line.

```
\begin{quotation}\small
At the turn of the century William Davy,
a Devonshire parson, finding errors in
the first edition of his \titleof{davy},
asked for a new edition to be printed.
His publisher refused and Davy purchased
a press, type, and paper. He harnessed
his gardener to the press and apprenticed
his housemaid to the typesetting. After
twelve years' work, a new edition
of fourteen sets of twenty-six volumes
was issued---which surely indicates that,
when typomania is coupled with religious
fervour, anything up to a miracle may be
achieved.\citequote[p.76]{ryder}
\end{quotation}
```

> At the turn of the century William Davy, a Devonshire parson, finding errors in the first edition of his *A System of Divinity*[a], asked for a new edition to be printed. His publisher refused and Davy purchased a press, type, and paper. He harnessed his gardener to the press and apprenticed his housemaid to the typesetting. After twelve years' work, a new edition of fourteen sets of twenty-six volumes was issued—which surely indicates that, when typomania is coupled with religious fervour, anything up to a miracle may be achieved.
>
> [Ryder, *Printing for Pleasure* (1976)], p.76

[a] Davy (1806)

7.2 Footnotes and end-notes

The command **\footnote**, followed by the text of the footnote in curly braces, will produce an auto-numbered footnote with a raised small number where you put the command, and the numbered text automatically printed at the foot of the page.[1] The number is reset to 1 at the start of each chapter (but you can override that and make them run continuously throughout the document, or even restart at 1 on each page or section).

LaTeX automatically creates room for the footnote, and automatically reformats it if you change your document in such a way that the point of attachment and the footnote would move to the next (or preceding) page.

Because of the way LaTeX reads the whole footnote before doing anything with it, you can't use **\verb** (§ 6.6.1) alone in footnotes: either precede it with **\protect** or use [abuse?] the **\url** command instead, which you should be using for Web and email addresses in any case).

Footnotes inside minipages (see § 6.7) produce lettered notes instead of numbered ones, and they get printed at the bottom of the minipage, *not* the bottom of the physical page (but this too can be changed).

There is a package to hold over your footnotes and make them print at the end of the chapter instead (endnote) or at the end of the whole document, and there is a package to print many short footnotes in a single footnoted paragraph so they take up less space (fnpara). It is also possible to have several separate series of footnotes active simultaneously, which is useful in critical editions or commentaries: a numbered series may be used to refer to an original author's notes; a lettered series can be used for notes by a commentator or authority; and a third series is available for your own notes. It is also possible to format footnotes within footnotes.

[1] Like this.

If your footnotes are few and far between, you may want to use footnote symbols instead of numbers. You can do this by redefining the output of the footnote counter to be the **\fnsymbol** command:

```
\renewcommand{\thefootnote{\fnsymbol{footnote}}
```

There are also ways to refer more than once to the same footnote, and to defer the positioning of the footnote if it occurs in a float like a Table or Figure, where it might otherwise need to move to a different page.

7.3 Marginal notes

You can add marginal notes to your text instead of (or as well as) footnotes. You need to make sure that you have a wide-enough margin, of course: use the geometry package (see § 5.1.1) to allocate enough space, otherwise the notes will be too cramped. There are several packages to help with formatting marginal notes, but the simplest way is to define it yourself. Add this new command to your preamble:

Like this.

```
\newcommand{\marginal}[1]{%
     \leavevmode\marginpar{\tiny\raggedright#1\par}}
```

Then you can use `\marginal{Some text}` Be careful, however, because marginal notes are aligned with the line where the command starts, so a very long one followed too closely by another will cause LaTeX to try and adjust the position so they don't overlap.

Some text where you need it.

We're jumping ahead a bit here, as we haven't covered how to define your own commands yet. I won't even try to explain it here, although the attentive reader can probably deduce some of it by inspection. See Chapter 9 for more information about making up your own commands.

7.4 Cross-references

This is one of the most powerful features of LaTeX. You can label any point in a document with a name you make up, and then refer to it by that name from anywhere else in the document, and LaTeX will always work out the cross-reference number for you, no matter how much you edit the text or move it around.

A similar method is used to cite documents in a bibliography or list of references, and there are packages to sort and format these in the correct manner for different journals.

7.4.1 Normal cross-references

You label a place in your document by using the command **\label** followed by a short name you make up, in curly braces:[2] we've already seen this done for labelling Figures and Tables.

```
\section{New Research}
\label{newstuff}
```

You can then refer to this point from anywhere in the same document with the command **\ref** followed by the name you used, e.g.

```
In \S~\ref{newstuff} there is a list of recent
projects.
```

In § 7.4.1 there is a list of recent projects.

(The **\S** command produces a section sign (§) and the **\P** command produces a paragraph sign (¶).)

[2] This section is labelled '`normalxref`', for example.

If the label is in normal text, the reference will provide the current chapter or section number or both (depending on the current document class).[3] If the label was inside a Table or Figure, the reference provides the Table number or Figure number prefixed by the chapter number. A label in an enumerated list will provide a reference to the item number. If there is no apparent structure to this part of the document, the reference will be null. Labels must be unique (that is, each value must occur only *once* as a label within a single document), but you can have as many references to them as you like.

Note the use of the unbreakable space (~) between the **\ref** and the word before it. This prints a space but prevents the line ever breaking at that point, should it fall close to the end of a line.

The command **\pageref** followed by any of your label values will provide the page number where the label occurred, regardless of the document structure. This makes it possible to refer to something by page number as well as its **\ref** number, which is useful to readers in very long documents.

Unresolved references are printed as two question marks, and also cause a warning message at the end of the log file. There's never any harm in having **\label**s you don't refer to, but using **\ref** when you don't have a matching **\label** is an error.

7.4.2 Bibliographic references

The mechanism used for references to reading lists and bibliographies is almost identical to that used for normal cross-references. Although it is possible to type the details of each citation manually, there is a companion program to LaTeX called BibTeX, which manages bibliographic references automatically. This reduces the time needed to maintain and format them, and dramatically improves accuracy. Using BibTeX means you only ever have to type the bibliographic details of a work once. You can then cite it in

[3] Thus I can refer here to `\ref{normalxref}` and get the value § 7.4.1.

any document you write, and it will get formatted automatically to the style you specify.

7.4.2.1 Citing references

BIBTEX works exactly the same way as other bibliographic databases: you keep details of every document you want to refer to in a separate file, using BIBTEX's own format (see example below). Many writers make a habit of adding the details of every book and article they read, so that when they write a document, these entries are always available for reference. You give each entry a short label, just like you do with normal cross-references (see § 7.4.1), and it is this label you use to refer to in your own documents when you cite the work using the **\cite** command:

```
...as has clearly been shown by Fothergill~\cite{fg}.
```

By default, this creates a cross-reference number in square brackets [1] which is a common style in the Natural Sciences (see § 7.4.2.5 for details of how to change this). There are dozens of alternative citation formats in extra packages, including the popular author/year format:

```
...as has clearly been shown
by~\citeauthoryear{fg}.
```

...as has clearly been shown by Fothergill (1929).

Note that in this case you don't type the author's name because it is automatically extracted by BIBTEX. There are lots of variants on this technique in many packages, allowing you to phrase your sentences with references in as natural a way as possible, and rely

on BIBTEX to insert the right data. (If you examine the source of this document you'll find I use some homebrew commands like **\authorof** and **\titleof** which I use for a similar purpose.)

To print the bibliographic listing (usually called 'References' in articles and 'Bibliography' in books and reports), add these two lines towards the end of your document, or wherever you want it printed, substituting the name of your own BIBTEX file and the name of your chosen bibliography style:

```
\bibliographystyle{ieeetr}
\bibliography{mybib}
```

- The **\bibliography** command is followed by the filename of your BIBTEX file *without* the `.bib` extension.
- The **\bibliographystyle** command is followed by the name of any of LATEX's supported bibliography styles, of which there are many dozens available from CTAN.[4]

The styles *plain* and *alpha* are two common generic styles used for drafts. The example above uses Transactions of the Institute of Electrical and Electronics Engineers (IEEETR).

7.4.2.2 Running *bibtex*

When you run the *bibtex* program, the details of every document you have cited will be extracted from your database, formatted according to the style you specify, and stored in a temporary bibliographic (`.bbl`) file with a label corresponding to the one you used in your citation, ready for LATEX to use. This is entirely automatic: all you do is cite your references in your LATEX document using the labels you gave the entries in your BIBTEX file, and run the *bibtex* program.

After processing your file with LATEX, run BIBTEX on it by clicking on the BibTeX toolbar icon (if your editor has one),

[4] The style shown in the example here provides formatting according to the specifications for Transactions of the IEEE (revised).

or use the TeX BibTeX File menu entry, or type the command `bibtex` followed by the name of your document (without the `.tex` extension). When you run LaTeX again it will use the `.bbl` file which BibTeX created, and subsequent runs of LaTeX will format the correct citation numbers (or author/year, or whatever format you are using).

```
$ latex mybook
$ bibtex mybook
$ latex mybook
$ latex mybook
```

Because of this three-stage process, you always get a warning message about an 'unresolved reference' the first time you add a new reference to a previously uncited work. This will disappear after subsequent runs of *bibtex* and LaTeX.

In practice, authors tend to run LaTeX from time to time during writing anyway, so they can preview the document. Just run BibTeX after adding a new **`\cite`** command, and subsequent runs of LaTeX will incrementally incorporate all references without you having to worry about it. You only need to follow the full formal sequence (LaTeX, BibTeX, LaTeX, LaTeX) when you have finished writing and want to ensure that all references have been resolved.

7.4.2.3 BibTeX format

The format for the BibTeX file is specified in the BibTeX documentation (see § 5.1.2 for how to find and print it). You create a file with a name ending in `.bib`, and add your entries, for example:

```
@book{fg,
   title       = {{An Innkeeper's Diary}},
   author      = {John Fothergill},
   edition     = {3rd},
   publisher   = {Penguin},
   year        = 1929,
   address     = {London}
}
```

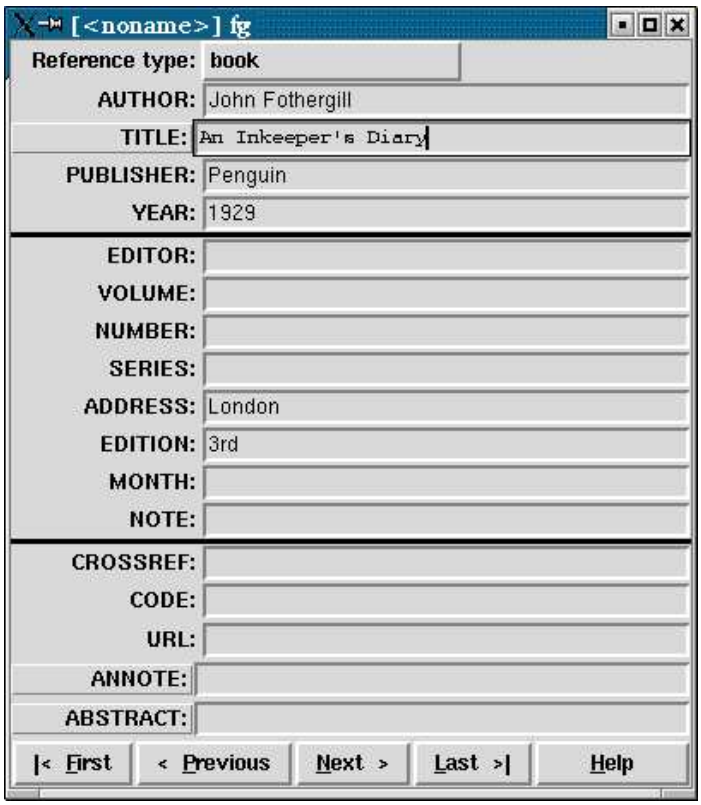
There is a prescribed set of fields for each of a dozen or so types of document: book, article (in a journal), article (in a collection), chapter (in a book), thesis, report, paper (in a Proceedings), etc. Each entry identifies the document type after the '`@`' sign, followed by the entry label that you make up, and then each field (in any order), using the format:

```
keyword = {value},
```

Most TEX-sensitive editors have a BIBTEX mode which understands these entries. *Emacs* automatically uses its `bibtex-mode` whenever you open a filename ending in `.bib`. When editing BIBTEX databases, the rules are simple:

- Omit the comma after the last field in the entry (only — eg after {`London`} in the example).
- Titles may have their case changed in some styles: to prevent this, enclose the title in double curly braces as in the example.
- Values which are purely numeric (e.g. years) may omit the curly braces.
- Fields can occur in any order but the format must otherwise be strictly observed.

Figure 7.1: tkBIBTEX, one of several graphical interfaces to BIBTEX databases



- Fields which are not used do not have to be included (so if your editor automatically inserts them as blank or prefixed by `OPT` [optional], you can safely delete them as unused lines).

To help with this, there are several interfaces to creating and maintaining BIBTEX files, such as *tkbibtex* (see Figure 7.1), or *pybliographic*.

7.4.2.4 Changing the layout

To change the title printed over the reference listing, just change the value of **\refname** (articles) or **\bibname** (books and reports) by adding a line like this in your preamble:

```
\renewcommand{\bibname}{Reading List}
```

The formatting specifications (BIBTEX styles) are based on standard settings for journals and books from dozens of publishers: you just pick the one you want by name. The `texmf/bib/bst` subdirectory of your installation contains the ones installed by default, and you can search on CTAN for others (look for `.bst` files). Many of them are named after university press styles (e.g. *harvard*, *oxford*) or the publisher or journal which specified them (e.g. *elsevier*, *kluwer*, etc.).

Some of them have an accompanying package (`.sty`) file which you need to include with the normal **\usepackage** command in your preamble. In this case the format may be distributed as `.dtx` and `.ins` files and will need installing in the same way as any other package (see § 5.2). Always read the documentation, because most of the formats are very specific to the journal they were designed for, and may have fairly absolute requirements.

> If you are writing for a specific publisher, you should remember that the rules or formats are laid down by the typographic designer of that journal or publisher: you cannot arbitrarily change the format just because you don't happen to like it: it's not your choice!

It is also possible to write your own BIBTEX (`.bst`) style files, although it uses a language of its own which really needs a computer science background to understand. However, this is rendered unnecessary in most cases: there is an extensive program (actually written in LATEX) called *makebst*, which makes `.bst` files by asking you a (long) series of questions about exactly how

you want your citations formatted. Just type `latex makebst` in a command window, but give it a dummy run first, because some of the questions are very detailed, so you need to have thought through how you want your citations to appear before you start.

7.4.2.5 Other modes of citation

The method of citing a work by numeric reference is common in the Natural Sciences but is not used in Law or the Humanities. In these fields, citations are usually done with short references (author/short-title/year) in a numbered footnote. Sometimes they are actually called 'footnotes' to the exclusion of ordinary footnotes, although they are really citations which happen by convention to be *displayed* as footnotes: an important distinction rarely appreciated by authors until they come to need a normal footnote.

For these fields, the bibliography at the back of the document is printed *unnumbered* in alphabetic order of author, or perhaps chronologically if the time-frame is very large. This unnumbered format is why it is conventionally called 'References' rather than 'Bibliography': a sufficient working citation has already been provided in the footnote, and the list at the back is for reference purposes only; whereas in the Natural Sciences, the citation is just a number, or possibly an author and year only, so the full listing is called a Bibliography.

The jurabib package (originally intended for German law articles but now extended to other fields in the Humanities, and to other languages) has extensive features for doing this style of citation and is strongly recommended.

7.5 Indexes and glossaries

LaTeX has a powerful, automated indexing facility which uses the standard *makeindex* program. To use indexing, use the package

makeidx and include the **\makeindex** command in your preamble:

```
\usepackage{makeidx}
\makeindex
```

When you want to index something, using the command **\index** followed by the entry in curly braces, as you want it to appear in the index, using one of the following formats:

Plain entry Typing `\index{beer}` will create an entry for 'beer' with the current page number.

Subindex entry For an entry with a subentry use an exclamation mark to separate them: `\index{beer!lite}`. Subsubentries like `\index{beer!lite!American}` work to another level deep.

Cross-references 'See' entries are done with the vertical bar (one of the rare times it does *not* get interpreted as a math character): `\index{Microbrew|see{beer}}`

Font changes To change the style of an entry, use the @-sign followed by a font change command:

```
\index{beer!Rogue!Chocolate
      Stout@\textit{Chocolate Stout}}
```

This example indexes '*Chocolate Stout*' and italicises it at the same time. Any of the standard `\text...` font-change commands work here: see the table on p. 156 for details.

You can also change the font of the index number on its own, as for first-usage references, by using the vertical bar in a similar way to the 'see' entries above, but substituting a font-change command name (*without* a backslash) such as `textbf` for bold-face text (see the index):

```
\index{beer!Rogue!Chocolate Stout|textbf}
```

Out of sequence The same method can be used as for font changes, but using the alternate index word instead of the font command name, so `\index{Oregon Brewing Company@Rogue}` will add an entry for 'Rogue' in the 'O' section of the index, as if it was spelled 'Oregon Brewing Company'.

When the document has been processed through LaTeX it will have created a `.idx` file, which you run through the *makeindex* program by typing (for example):

```
makeindex mythesis
```

Some editors may have a button or menu entry for this. The program will look for the `.idx` file and output a `.ind` file. This gets used by the command **`\printindex`** which you put at the end of your document, where you want the index printed. The default index format is two columns.

Glossaries are done in a similar manner using the command **`\makeglossary`** in the preamble and the command **`\glossary`** in the same way as **`\index`**. There are some subtle differences in the way glossaries are handled: both the books by Lamport (1994) and by Mittelbach et al. (2004) duck the issue, but there is some documentation on `glotex` on CTAN.

7.6 Multiple columns

Use the multicol package: the environment is called **multicols** (note the plural form) and it takes the number of columns as a separate argument in curly braces:

```
\usepackage{multicol}
...
\begin{multicols}{3}
...
\end{multicols}
```

LaTeX has built-in support for two-column typesetting via the `twocolumn` option in the standard Document Class Declarations, but it is relatively inflexible in that you cannot change from full-width to double-column and back again on the same page, and the final page does not balance the column heights. However, it does feature special **figure*** and **table*** environments which typeset full-width figures and tables across a double-column setting.

The more extensive solution is the multicol package, which will set up to 10 columns, and allows the number of columns to be changed or reset to one in mid-page, so that full-width graphics can still be used. It also balances the height of the final page so that all columns are the same height — if possible: it's not always achievable — and you can control the width of the gutter by setting the **\columnsep** length to a new dimension.

Multi-column work needs some skill in typographic layout, though: the narrowness of the columns makes typesetting less likely to fit smoothly because it's hard to hyphenate and justify well when there is little space to manœuvre in.

8 Fonts and layouts

This is the chapter that most users want first, because they come to structured documents from a wordprocessing environment where the *only* way to convey different types of information is to fiddle with the font and size drop-down menus.

As I hope you have seen, this is normally completely unnecessary in LaTeX, which does most of the hard work for you automatically. However, there are occasions when you need to make manual typographic changes, and this chapter is about how to do them.

8.1 Changing layout

The design of the page can be a very subjective matter, and also rather a subtle one. Many organisations large and small pay considerable sums to designers to come up with page layouts to suit their purposes. Styles in page layouts change with the years, as do fashions in everything else, so what may have looked attractive in 1991 may look rather dated in 2011.

As with most aspects of typography, making the document readable involves making it consistent, so the reader is not interrupted or distracted too much by apparently random changes in margins, widths, or placement of objects. However, there are a number of different occasions where the layout usually *does* change, related to the frequency with which the format appears.

- The title page, the half-title, copyright page, dedication, and other one-page preliminaries (if you use them) are usually designed individually, as the information on it only occurs once in that format anywhere in the document.
- The table of contents and other related lists like figures and tables all need to share one design.
- The prelims like Foreword, Introduction, and Preface should likewise follow the same format between them.
- Chapter and Appendix start pages usually share a layout.
- Other (normal) pages have a single layout, but it may specify individual variations to handle tables, lists, figures, sidebars, exercises, footnotes, etc.

If you are going to design a whole document, it's probably a good idea to read a couple of books on layout design first, to get a feel for the conventions which contribute to making the reader comfortable reading.

While unusual or radical layouts have an important role in attention-grabbing, or in making a socio-political statement (*WIRED*[1] magazine is an obvious recent example), they are usually out of place in business reports, white papers, books, theses, and journals. In ephemera, on the other hand, as in advertising, they are probably critical.

[1] Anderson (1993–)

8.1.1 Spacing

We mentioned in § 7.3 and elsewhere the existence of the geometry package which lets you change margins. It also lets you set the text-area height and width and a lot of other layout settings: read the documentation for details (see § 5.1.2 for how to read package documentation).

```
\usepackage[left=2cm,top=1cm,bottom=2cm,right=3cm,
          nohead,nofoot]{geometry}
```

The spacing around the individual textual components (headings, paragraphs, lists, footnotes, etc.) can also be changed on a document-wide basis, as we saw with paragraph spacing and indentation in § 3.6.

Changing the spacing of section headings for the whole document can be done with the sectsty package, designed to let you adjust section-head spacing without having to know about the internal LaTeX coding, which is quite complex.

The spacing for lists can be adjusted with the mdwlist package. In both cases the user with highly specific requirements such as a publisher's Compositor's Specification should read the relevant sections in the *The LaTeX Companion*[2] or ask for expert help, as there are many internal settings which can also be changed to fine-tune your design, but which need some knowledge of LaTeX's internals.

All the above are for automating changes so that they occur every time in a consistent manner. You can also make manual changes whenever you need:

Flexible vertical space There are three commands **`\smallskip`**, **`\medskip`**, and **`\bigskip`**. These output flexible (dynamic, or 'rubber') space, approximately 3pt, 6pt, and 12pt high respectively, and they will automatically compress or expand

[2] Mittelbach et al. (2004)

a little, depending on the demands of the rest of the page (for example to allow one extra line to fit, or a heading to be moved to the next page without anyone except a typographer noticing the change). These commands can only be used after a paragraph break (a blank line or the command **\par**).

Fixed vertical space For a fixed-height space which will *not* stretch or shrink, use the command **\vspace** followed by a length in curly braces, e.g. `\vspace{18pt}` (again, this has to be after a paragraph break). Bear in mind that extra space which ends up at a page-break when the document is formatted *will get discarded entirely* to make the bottom and top lines fall in the correct places. To force a vertical space to remain and be taken into account even after a page break (very rare), use the starred variant **\vspace***, e.g. `\vspace*{19pt}`.

Double spacing Double-spacing normal lines of text is usually a bad idea, as it looks very ugly. It is still unfortunately a requirement in some universities for thesis submission, a historical relic from the days of typewriters. Nowadays, 1⅓ or 1½ line spacing is considered acceptable, according to your font size. If your institution still thinks they should have double line spacing, they are probably wrong, and just don't understand that the world has moved on since the typewriter. Show them this paragraph and explain that they need to enter the 21st century and adapt to the features of computer typesetting. If they still insist, use the setspace package,which has commands for double line-spacing and one-and-a-half line spacing, but be prepared for some very ugly output (so warn your supervisor and extern).

The space between lines is defined by the value of the length variable `\baselineskip` multiplied by the value of the **\baselinestretch** command. In general, *don't meddle with `\baselineskip` at all*, and with **\baselinestretch** only if you know what you are doing. (Both can, how-

ever, safely be used as reference values in commands like `\vspace{\baselineskip}` to leave a whole line space.) The value of `\baselineskip` changes with the font size (see § 8.2.4) but is conventionally set to 1.2 times the current nominal font size. This is a value derived from long experience: only change it if you understand what it means and what effect it will have.

Quite separately, there are some perfectly genuine and normal reasons for wanting wide line spacing, for example when typesetting a proof of a critical or variorum edition, where editors and contributors are going to want to add notes manually by writing between the lines, or where the text is going to be overprinted by something else like Braille, or in advertising or display text for special effects.

Horizontal space There is a horizontal equivalent to the **\vspace** command: **\hspace**, which works in the same way, so I can force a 1″ space like this in mid-paragraph. There are also some predefined (shorter) spaces available:

- **\thinspace** (⅙ em), which we saw between single and double quotes in the last paragraph of § 2.6. It's also sometimes used between the full point after abbreviations and a following number, as in page references like p. 199, where a word space would look too big, and setting it solid would look too tight.
- **\enspace** (½em). There is no direct equivalent predefined in LaTeX for mid and thick spaces as used by metal typesetters, although it would be possible to define them. The en as a unit is often used as the width of a single digit in some fonts, as a convenience so that tables of figures are easy to line up.
- **\quad** (1em).
- **\qquad** (2em).

Beyond this, all horizontal space within paragraphs is automatically flexible, as this is what LaTeX uses to achieve justification. Never be tempted to try and change the spacing between letters unless you have some professional training in typography. Some systems use letterspacing (incorrectly called 'tracking') as an aid to justification and it is almost always wrong to do so (and looks it). While it *is* possible to change letterspacing (with the soul package), it should only be done by a typographer, and then only very rarely, as the settings are very subtle and beyond the scope of this book.

8.1.2 Headers and footers

LaTeX has built-in settings to control the page style of its default page layouts. These are implemented with the **\pagestyle** command, which can take one of the following arguments.

plain for a page number centered at the bottom;

empty for nothing at all, not even a page number;

headings for running heads based on the current chapter and section;

myheadings which lets you use your own reprogrammed definitions of how **\markright** and **\markboth** commands, which control how chapter and section titles get into page headers.

The command **\thispagestyle** (taking the same arguments) can be used to force a specific style for the current page only.

However, the easiest way is to use the fancyhdr package, which lets you redefine the left-hand, centre, and right-hand page headers and footers for both odd and even pages (twelve objects in all). These areas can contain a page number, fixed text, variable text (like the current chapter or section title, or the catch-words of a dictionary), or even a small image. They can also be used to do page backgrounds and frames, by making one of them the top

corner of an invisible box which 'hangs' text or images down over the whole page.

The settings for the downloadable version of this document can be used as an example: for the whole story you have to read the documentation.

```
\pagestyle{fancy}\fancyhead{}
\renewcommand\headrulewidth{.1pt}
\fancyhead[LO,RE]{\footnotesize\sffamily\lite\leftmark}
\fancyhead[LE,RO]{\footnotesize\sffamily\lite\itshape
                \rightmark}
\fancyfoot[C]{}
\fancyfoot[LE,RO]{\setlength{\fboxsep}{2pt}\ovalbox%
                {\footnotesize\sffamily\thepage}}
\fancyfoot[LO,RE]{\footnotesize\sffamily\lite\@title}
\fancypagestyle{plain}{\fancyhf{}
   \fancyfoot[R]{\setlength{\fboxsep}{2pt}\ovalbox{%
                \footnotesize\sffamily\thepage}}
   \fancyfoot[L]{\footnotesize\sffamily\lite\@title}
   \renewcommand{\headrulewidth}{0pt}}
```

This is probably more complex than most documents, but it illustrates some common requirements:

1. Settings are prefixed by making the **\pagestyle** 'fancy' and setting the **\fancyhead** to null to zap any predefined values.

2. The thickness of the rule at the top of the page can be changed (or set to 0pt to make it disappear).

3. The header and footer settings are specified with L, C, and R for left, centre, and right; and with O and E for Odd and Even numbered pages. In each setting, the typeface style, size, and font can be specified along with macros which implement various dynamic texts (here, the current chapter and section titles, which LaTeX stores in **\rightmark** and **\leftmark**).

4. The 'plain' variant is used for chapter starts, and resets some of the parameters accordingly.

8.2 Using fonts

The default typeface in LaTeX is Computer Modern (CM). This typeface was designed by Knuth for use with TeX because it is a book face, and he designed TeX originally for typesetting books. Because it is one of the very few book typefaces with a comprehensive set of fonts, including a full suite of mathematics, it has remained the default, rather than the Times you find in wordprocessors, because until recently the mathematical symbols for Times were a commercial product often unavailable to users of free software.

Computer Modern is based on a 19th-century book typeface from Monotype, which is why it looks a little like an old-fashioned school book. This paragraph is set in Computer Modern so you can see what it looks like. The typeface was designed using METAFONT, the font-drawing program made by Knuth to accompany TeX systems, but it is now also available in Type 1 and TrueType formats.

> If you are reading this in a web browser, the above paragraph is only a low-resolution copy because browsers don't usually have the Computer Modern font available. All the rest of this document is set in Bitstream Arrus, with Geometric 415 for some of the headings and Courier Narrow for the fixed-width type.

In addition to CM, there are many other METAFONT fonts which can be downloaded from CTAN, including a large collection of historical, symbol, initial, and non-Latin fonts. LaTeX also comes with the 'Adobe 35' typefaces which are built into laser printers and other DTP systems, and some more fonts donated by the X Consortium. Plus, of course, standard LaTeX can use any of the thousands of Type 1 fonts available, and *pdfLaTeX* can use any of the thousands of TrueType fonts as well.

In the following lists, if there is a package available, its name is given in parentheses after the name of the typeface. The font-family name is shown on the right-hand side. If a non-standard font-encoding is needed, its name is shown before the font-family name.

Latin-alphabet typefaces (METAFONT)

Computer Modern Roman	cmr
The quick brown fox jumps over the lazy dog	
Computer Modern Sans	cmss
The quick brown fox jumps over the lazy dog	
Computer Modern Typewriter	cmtt
The quick brown fox jumps over the lazy dog	
Pandora (pandora)	panr
The quick brown fox jumps over the lazy dog	
Pandora Sans	pss
The quick brown fox jumps over the lazy dog	
Pandora Typewriter	pntt
The quick brown fox jumps over the lazy dog	
Universal	uni
The quick brown fox jumps over the lazy dog	
Concrete (ccr)	ccr
The quick brown fox jumps over the lazy dog	
Éireannach (eiad)	eiad
Níl aon cineáin mar do chineáin féin	
Rustic	rust
THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG	
Uncial	uncl
The quick brown fox jumps over the lazy dog	
Dürer	zdu
THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG	
Fraktur	U yfrak
Fuchs, Du hast die Gansgestohlen, gib sie wieder her!	
Gothic	U ygoth
If it plese any man spirituel or temporel	
Schwäbische	U yswab
Fuchs, Du hast die Gansgestohlen, gib sie wieder her!	

Latin-alphabet typefaces (PostScript Type 1) from Adobe

Avant Garde (avant)	pag
The quick brown fox jumps over the lazy dog	
Bookman[3] (bookman)	pbk
The quick brown fox jumps over the lazy dog	
Courier (courier)	pcr
The quick brown fox jumps over the lazy dog	
Helvetica (helvet)	phv
The quick brown fox jumps over the lazy dog	
New Century Schoolbook[4] (newcent)	pnc
The quick brown fox jumps over the lazy dog	
Palatino[5] (palatino)	ppl
The quick brown fox jumps over the lazy dog	
Symbol	U psy
Τηε θυιχκ βροων φοξ φυμπσ οϖερ τηε λαζψ δογ	
Times New Roman[6] (times)	ptm
The quick brown fox jumps over the lazy dog	
Zapf Chancery (zapfchan)	pzc
The quick brown fox jumps over the lazy dog	
Zapf Dingbats (pifont)	U pzd
✴❊❋ ❑◆❉❋✱ ✪❒❑◗■ ❄❑❙ ❊◆❍❒▲ ❑❖❋❒ ▼❊❋ ●❁❚❄❑❊	

As mentioned in § 4.4, the 'Adobe 35' fonts can be used with any printer, not just a laser printer or typesetter. The *Ghostscript* interpreter and the *GSview* viewer come with a large set of printer drivers, so you just create PostScript output and print from *GSview*.

Incidentally, the 35 refers to the total number of fonts for the 10 typefaces, including their bold, italic, and bold-italic variants.

Postscript Type 1 fonts have been the mainstay of the graphic arts industries for many years, as they allow much better definition of variance ('hinting') than most other formats. However, the font format remains proprietary to Adobe, even though they

[3] Uses Avant Garde as the sans-serif and Courier for monospace.

[4] Uses Helvetica as the sans-serif font and Courier for monospace.

[5] Uses Avant Garde as the sans-serif and Courier for monospace.

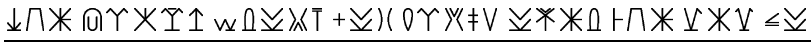
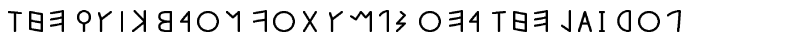
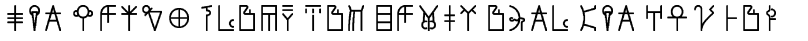
[6] Uses Helvetica as the sans-serif font and Courier for monospace. Mathematical symbols for Times are available both free and commercially.

have released it for public use, which means they could change it without warning. A new format called 'OpenType' is designed to overcome this, and some versions of TEX are already able to use OpenType fonts.

Latin-alphabet fonts (PostScript Type 1) from the X Consortium

Charter (charter)	bch
The quick brown fox jumps over the lazy dog	
Nimbus Roman	unm
The quick brown fox jumps over the lazy dog	
Nimbus Sans	unms
The quick brown fox jumps over the lazy dog	
URW Antiqua	uaq
The quick brown fox jumps over the lazy dog	
URW Grotesk	ugq
The quick brown fox jumps over the lazy dog	
Utopia[7] (utopia)	put
The quick brown fox jumps over the lazy dog	

Non-Latin-alphabet typefaces (METAFONT)

BB Dingbats	U ding
	
Cypriot	cypr
	
Etruscan	etr
	
Linear 'B'	linb
	
Phoenician	phnc
	
Runic	fut
	
Bard	U zba
	

Just to make it clear: standard LATEX uses only METAFONT and PostScript Type 1 fonts. *pdfLATEX* can use TrueType fonts as well.

[7] Removed from recent distributions as it is not free.

8.2.1 Changing the default font family

LaTeX expects to work with three font families as defaults:

Font family	Code
Roman (serif, with tails on the uprights), the default	`rm`
Sans-serif, with no tails on the uprights	`sf`
`Monospace (fixed-width or typewriter)`	`tt`

The start-up default for LaTeX equates the `rm` default with the `cmr` font-family (Computer Modern Roman), `sf` with `cmss`, and `tt` with `cmtt`. If you use one of the packages listed in the tables on pp. 149–151, it will replace the defaults of the same type: for example, `\usepackage{bookman}` makes the default `rm` font-family Bookman (`pbk`), but leaves the sans-serif (`sf`) and monospace (`tt`) families untouched. Equally, `\usepackage{helvet}` changes the default sans-serif family to Helvetica but leaves the serif (Roman) and monospace families untouched. Using both commands will change both defaults because they operate independently.

However…as it is common to want to change all three defaults at the same time, some of the most common 'suites' of typefaces are provided as packages:

times changes to Times/Helvetica/Courier.

pslatex same as times but uses a specially narrowed Courier to save space (normal Courier is rather inelegantly wide). This is the preferred setting if you want Times.[8]

newcent changes to New Century Schoolbook/Helvetica/Courier.

palatino changes to Palatino/Avant Garde/Courier.

[8] The pslatex package is also said to be outdated by some experts because it implements rather long-windedly what can now be done in three commands. However, until these replace the current version, I recommend continuing to use pslatex when you want Times with Helvetica and narrow Courier.

palatcm changes the roman to Palatino only, but with CM mathematics

Where no package name is given in the tables on pp. 149–151, it means the font is rarely used as a default by itself except in special cases like users' own homebrew packages. To use such a font you have to specify it manually, or make a little macro for yourself if you use it more than once.

8.2.2 Changing the font-family temporarily

To shift to another font family on a temporary basis, use the commands **\fontencoding** (if needed), **\fontfamily**, and **\selectfont**, and *enclose the commands **and** the text in curly braces*. Note that this is a *different* way of using curly braces to how we have used them before: it limits the effect of a change to the material inside the braces.

```
{\fontfamily{phv}\selectfont
Helvetica looks like this}:
{\fontencoding{OT1}\fontfamily{bch}\selectfont
Charter looks like this}.
```

Helvetica looks like this: Charter looks like this.

In this example, the **\fontencoding** command has been used to ensure that the typeface will work even if the sentence is used in the middle of something typeset in a different encoding (like this document).[9]

[9] Test for the observant reader: in what typeface will the colon (:) in the example be set?

Grouping

Note carefully this use of curly braces to restrict the scope of a change rather than delimit the argument to a command. This is called 'grouping' and it makes the effect any changes made *inside* the braces local, so that they do not interfere with the text following. Any changes to fonts or other values made within the curly braces cease when the closing curly brace is processed.

In a normal document, of course, random typeface changes like this are rather rare. You select your typeface[s] once at the start of the document, and stick with them.

Most cases where people want to do unusual typeface changes involve things like special symbols on a repetitive basis, and LaTeX provides much easier programmable ways to make these changes into shorthand commands (called macros: see Chapter 9). You could, for example, make a macro called **\product** which would let you typeset product names in a distinct typeface:

```
Andlinger, Inc., has replaced \product{Splosh} with
\product{SuperSplosh}.
```

This is one of LaTeX's most powerful features. It means that if you needed to change your **\product** command at some later stage to use a different font, you only have to change three characters in the macro (the font-family name), and you don't need to edit your document text at all! What's more, a macro could do other things at the same time, like add an entry to an index of products.

However, vastly more common are changes to type *style*, while staying with the same font-family.

8.2.3 Changing font style

Within each typeface or font family there are usually several different 'looks' to the type design. LaTeX distinguishes between font ***family***, font ***shape***, and font ***series***:

Type style	Command	Example (using Computer Modern)
Upright	**\upshape***	The quick brown fox jumps over the lazy d
Italic	**\itshape**	*The quick brown fox jumps over the lazy dog*
Slanted	**\slshape***	*The quick brown fox jumps over the lazy d*
Small Capitals	**\scshape***	THE QUICK BROWN FOX JUMPS OVER THE
Bold	**\bfseries***	**The quick brown fox jumps over the lazy d**
Bold Extended	**\bfseries†**	**The quick brown fox jumps over the lazy**
Sans-serif	**\sffamily**	The quick brown fox jumps over the lazy dog
Monospace	**\ttfamily**	`The quick brown fox jumps over the laz`

* Not all typefaces have all variants! Some only have bold and italics.
† Some typefaces do not have both bold and bold extended: by default LaTeX uses **\bfseries** for bold extended.

These 'shape', 'series', and 'family' commands are ***commutative***, so you can combine a shape with a series and/or a family, without the need to use **\selectfont**:

```
This gives you {\bfseries\itshape\sffamily bold
italic sans-serif type}, but beware
```

This gives you ***bold italic sans-serif type***, but beware of pushing your fonts beyond their limits unless you are a typographer. It is not normally meaningful to combine one shape or series class with another of the same class, such as trying to get slanted-italics. It's an impossibility to combine one family with another (such as a seriffed sans-serif typeface!). Slanted plus italics, for example, doesn't make sense, as italics are already slanted (although it is technically possible); and while some typefaces may well possess italic small caps, they are not in common

use. Sans-serif and monospace (typewriter) are different fonts, and often different typeface families entirely.[10]

There is an alternative syntax for the most common type shape and series commands which uses curly braces in the normal 'argument' manner:

Type style	Command	Example
Italic	`\textit{text}`	puts *text* into italics
Slanted	`\textsl{text}`	puts *text* into slanted type*
Small Capitals	`\textsc{text}`	puts TEXT into small caps
Bold	`\textbf{text}`	puts **text** into bold type
Sans-serif	`\textsf{text}`	puts **text** into sans-serif type
Monospace	`\texttt{text}`	puts `text` into typewriter type

* If slanted is available separately from italics.

You can nest these inside one another too:

```
...\textbf{\itshape\textsf{bold italic
sans-serif type}}...
```

Underlining isn't a font, and it is extremely rare in typography except for special purposes. If you think you need it, use the ulem package with the `normalem` option, and the **`\uline`** command.

8.2.4 Font sizes

LaTeX has built into its defaults a set of predefined font size steps corresponding more or less to the traditional sizes available to metal typesetters. This is deliberate, as these sizes have grown up over 500 years of printing as those which go best together for book-work, which is where TeX originated.

[10] Although if you're a typographer wanting to experiment with typewriter typefaces with and without serifs, you can use METAFONT to do exactly this kind of thing. But that's way outside the scope of this document.

These sizes are also reflected in the size steps at which Computer Modern was designed. It often comes as a surprise to new users that many typefaces are not designed as a single font and just scaled up or down, but specially drawn at different sizes to make them more legible.

As an example, here's 12pt Computer Modern, and here's 5pt Computer Modern scaled up to 12pt, and here's 17pt Computer Modern scaled down to 12pt so you can see there really is a significant difference. In general, you probably don't want to go scaling fonts too much beyond their design size because they will start to look very odd.

The default sizes (and the commands that operate them) are based on the use of a 10pt font, which is the normal size for most texts. Using the larger defaults (11pt and 12pt) for the body font will use 11pt and 12pt designs, with other sizes (eg headings) resized to match. The exact sizes used are listed in the macros in the Class Option files `size10.clo`, `size11.clo` and `size12.clo`. TEX's default fonts above 10pt are in fact scaled by a factor of 1.2, as shown in the fourth column of the table below.

Command	Example	Nominal point size	Exact point size
`\tiny`	The quick brown fox jumps over the lazy dog	5	5
`\scriptsize`	The quick brown fox jumps over the laz	7	7
`\footnotesize`	The quick brown fox jumps over the l	8	8
`\small`	The quick brown fox jumps over th	9	9
`\normalsize`	The quick brown fox jumps over	10	10
`\large`	The quick brown fox jumps	12	12
`\Large`	The quick brown fox ju	14	14.40
`\LARGE`	The quick brown fo	18	17.28
`\huge`	The quick brown	20	20.74
`\Huge`	The quick bro	24	24.88

While these 'shorthand' commands relieve the beginner of having to worry about the 'right' size for a given task, when you need a specific size there is the **\fontsize** command:

```
\fontsize{22}{28}\selectfont This is 22pt
type 6pt leaded
```

'Leading' comes from the old metal-type practice of adding a lead strip between lines to increase the spacing.

The **\fontsize** command takes two arguments: the point size and the baseline distance. The above example gives you 22pt type on a 28pt baseline (i.e. with 6pt extra space or 'leading' between the lines).

> Computer Modern fonts (the default) come fixed at the named size steps shown in the table, and if you try to use an odd size in between, LaTeX will pick the closest step instead. If you really need to use CM at arbitrary sizes there is a package type1cm which lets you override the default steps. If you use PostScript (Type 1) fonts, the step sizes do not apply and the font scaling is infinitely variable.

8.2.5 Logical markup

All this playing around with fonts is very pretty but you normally only do it for a reason, even if that reason is just to be decorative. Italics, for example, are used for many things:

Cause	Effect
Foreign words	*ex officio*
Scientific names	*Ranunculus ficaria*
Emphasis	*must not*
Titles of documents	*The LaTeX Companion*
Product names	Corel's *WordPerfect*
Variables in maths	$E = mc^2$
Subtitles or headings	*How to get started*
Decoration	*FREE UPGRADE!!!*

Humans usually have no problem telling the difference between these reasons, because they can read and understand the meaning and context. Computers cannot (yet), so it has become conventional to use descriptive names which make the distinction explicit, even though the appearance may be the same.

LaTeX has some of these built in, like **\emph**, which provides *emphasis*. This has a special feature because *when the surrounding text is already italic,* emphasis *automatically reverts to* upright type, which is the normal practice for typesetting.

```
This has a special feature because {\itshape when the
surrounding text is already italic, \emph{emphasis}
automatically reverts to upright type, which is the
```

This sensitivity to logic is programmed into the definition of **\emph** and it's not hard to make up other commands of your own which could do the same, such as **\foreign** or **\product**.

But why would you bother? In a short document it's probably not important, but if you're writing a long report, or a formal document like an article, a book, or a thesis, it makes writing and editing hugely easier if you can control whole groups of special effects with a single command, such as italicising, indexing, or cross-referencing to a glossary. If a format needs changing, you only have to change the definition, and every occurrence automatically follows suit.

> Beware of this 'vaine conceipt of simple men, which judge things by ther effects, and not by ther causes'. (Edmund Spenser, 1633) It's hugely more efficient to have control of the cause than the effect.

It also makes it possible to find and act on groups of meanings — such as making an index of scientific names or product names (as in this document) — if they are identified with a special command. Otherwise you'd spend weeks hunting manually through every **\textit** command to find the ones you wanted.

This is the importance of automation: it can save you time and money.

In Chapter 9 we will see how to make your own simple commands like this.

8.2.6 Colour

You can typeset anything in LaTeX in any colour you want using the color package. First, you need to add the command `\usepackage{color}` to your preamble (note the US spelling of color!). This makes available a default palette of primary colours: red, green, and blue for the RGB colour model used for emitted light (television screens), and cyan, magenta, yellow, and black for the CMYK colour model used for reflected light (printing).

For the occasional word or phrase in colour, use the command **`\textcolor`** with two arguments, the colour name and the text: `\textcolor{red}{like this}`. There is a **`\color`** command as well, for use within groups:

```
...{\color{blue}some text in blue}...
```

If you have the PostScript printer driver *dvips* installed, you also get a separate 64-colour palette of predefined ***color names***. These represent approximately the colours in the big box of *Crayola* colouring pencils much favoured by artists and designers. This adds a new colour model called '`named`', so if you want the *Crayola* colour RubineRed, you can use the **`\color`** or **`\textcolor`** commands with a preceding optional argument '*named*':

```
\color[named]{RubineRed}
\textcolor[named]{RubineRed}{some red text}
```

As some of the '`named`' colour names are quite long, you can create a short name of your own for colours you use frequently, using the **`\definecolor`** command:

```
\definecolor{mb}{named}{MidnightBlue}
```

The **\definecolor** command needs three arguments: your shorthand name, the name of the colour model, and the colour specification. In the case of the 'named' model, the last argument is one of the 64 colour names. To use these names with *pdfLaTeX*, you need to use the *pdftex* option to the color package.

Using the **\definecolor** command, you can define any colour you want by giving it a name, specifying which colour model, and providing the Red-Green-Blue (RGB) or Cyan-Magenta-Yellow-Black (CMYK) colour values expressed as decimals, separated by commas. For example, an RGB shade given as (37,125,224) in decimal (#250FE0 in hexadecimal as used on the Web) can be given as

```
\definecolor{midblue}{rgb}{0.145,0.490,0.882}
```

(divide each value by 255, the maximum for each of the hues in the Red-Green-Blue colour model). You can then use **\textcolor** with your new colour name: the midblue looks like this if you're reading in colour.

The color package also provides a colour version of **\fbox** (see § 6.7.2) called **\colorbox**:

```
\colorbox{midblue}{\color{magenta}Magenta on midblue}
```

Magenta on midblue: you can see how careful you need to be with colours!

8.3 Installing new fonts

Different fonts come in a variety of packagings: the three most common used with TeX systems are PostScript fonts, TrueType

fonts, and METAFONT fonts. How you install them and where they go depends on how you installed LaTeX: all I can deal with here are the standard locations within the TDS.

Typefaces come supplied as one or more font 'outline' files and a number of ancillary files:

METAFONT **typefaces** have a number of `.mf` source (outline) files, possibly also some `.fd` (font definition) files and a `.sty` (style) file. The `.tfm` (TeX font metric) files are not needed, as they can be generated from the outlines.

PostScript typefaces come as a pair of files: a `.pfb` (PostScript font binary) or `.pfa` (PostScript font ASCII) outline, and an `.afm` (Adobe font metric) file. There may also be `.inf` and other files but these are not needed for use with TeX systems.

TrueType typefaces are a single `.ttf` file, which combines outline and metrics in one.

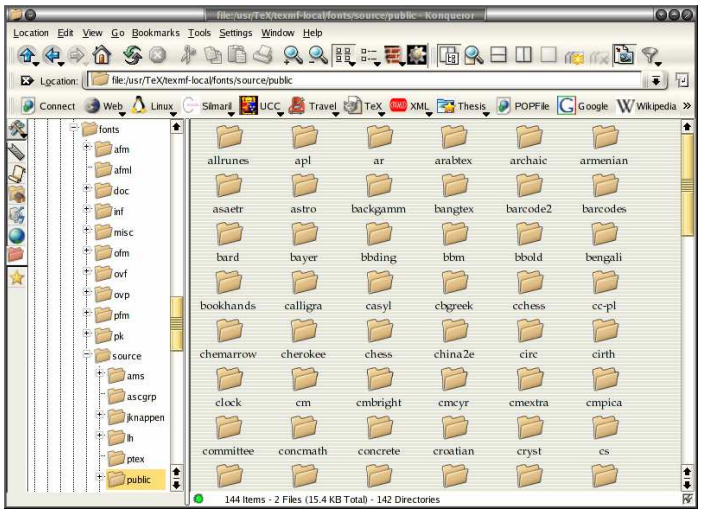
The instructions here assume the use of the New Font Selection Scheme (NFSS) used in LaTeX 2ε. If you are running the obsolete LaTeX 2.09, upgrade it now.

8.3.1 Installing METAFONT fonts

This is the simplest installation. When you download METAFONT fonts from CTAN, you'll usually find a large number of outline files (`.mf` files) and maybe some other types as well (see below).

1. Create a new subdirectory named after the typeface you're installing in `texmf-local/fonts/source/public/`:
2. Copy all the `.mf` files to this directory.
3. Copy the `.fd` (Font Definition) file[s] and the `.sty` (style) file to your `texmf/tex/latex/mfnfss` directory.

Figure 8.1: Creating a new subdirectory for a font



4. Run your TEX indexer program (see step 4 in the procedure on p. 86).

That's it. Unlike PostScript fonts, METAFONT fonts can be used to generate the font metric file (`.tfm` files) automatically on-the-fly the first time the typeface is used, so there should be nothing else to install.

Now you can put a **`\usepackage`** command in your preamble with whatever name the `.sty` file was called, and read the documentation to see what commands it gives to use the font (refer to the last paragraph of § 5.2.1 and step 2 in the procedure on p. 84).

If the font came *without* `.fd` or `.sty` files, you'll need to find someone who can make them for you (or follow the outline in § 8.3.2, step 11 in the procedure on p. 173).

8.3.1.1 Pre-generated metrics (optional)

Some METAFONT fonts come with pre-generated `.tfm` files which you can install if your system is slow at generating them itself:

1. Create a new subdirectory within `texmf-local/fonts/tfm/public/` named the same as the one you created for the `.mf` files above.
2. Copy all the `.tfm` files into this subdirectory.
3. Run your TEX indexer program (see step 4 in the procedure on p. 86).

8.3.1.2 Pre-generated bitmaps (optional)

In some rare cases, pre-generated packed bitmap fonts (`.pk` files) are also available from CTAN (normally your previewer and print driver creates these automatically, but you can use the pre-generated ones if you have a very slow system). If you really want to install these, it's a similar procedure to the `.tfm` files:

4. Create a new subdirectory within `texmf-local/fonts/pk/modeless/` named the same as the one you created for the `.mf` and `.tfm` files above.
5. Copy all the `.nnnpk` files into this subdirectory (*nnn* is a number reflecting the dot-density of the bitmap). On Microsoft systems the files may just end in `.pk` and be kept in subdirectories named after the dot-density, e.g. `dpi360`.
6. Run your TEX indexer program (see step 4 in the procedure on p. 86).

8.3.2 Installing PostScript fonts

Lots of people will tell you that PostScript fonts and PostScript output are dead and that TrueType or OpenType fonts and PDF output are the way to go. While this is true for many cases, standard LATEX does not work with TrueType fonts and does not produce PDF directly. Only *pdfLATEX* does that, and there are still many printers whose typesetters and platemakers use PostScript rather than PDF. In addition, operating system support for scalable fonts is still very poor on Unix systems (including

Linux), despite the advances in recent years, so in many cases it still makes sense to use TEX's built-in support for PostScript.

Two files are needed for each font: the `.afm`Adobe Font Metric (AFM) and the `.pfb`PostScript Font Binary (PFB) files. *You must have both for each font before you start.* If you only have the near-obsolete `.pfa`PostScript Font ASCII (PFA) files, it may be possible to generate the `.pfb` files using the *t1binary* program from the *t1utils* suite (see `http://gnuwin32.sourceforge.net/packages/t1utils.htm`) or the excellent *PFAedit* font editor (from `http://pfaedit.sourceforge.net`). There are unfortunately still some companies distributing Type 1 fonts in `.pfa` format (Mathematica is one reported recently).

> The installation method I described in earlier editions has worked perfectly for me for years, but I have updated it here to use the facilities of the *updmap* program (which comes with your TEX installation). This removes the need for one of the steps I gave before, which required editing the `psfonts.map` file, as this is now recreated by *updmap*. The procedure below is *not* the official way (that's *fontinst*), but it is the basis for a script I am working on called *Gutta-Percha*[a], which automates the whole process.
>
> [a] Yes, as in rubber.

I'll repeat this: before you start, make sure you have all the `.afm` and `.pfb` files for the typeface you want. In the example below, I'm going to use a single font from an imaginary typeface called Foo, so I have `foo.afm` and `foo.pfb` files.

1. **Put the files in your temporary directory**
   This is `/tmp` on Linux, and should be `C:\tmp` or `C:\temp` or even `C:\Windows\temp` on Microsoft Windows.

2. **Decide on the short font name to use inside LATEX.**
   This is *not* the full descriptive name (e.g. Baskerville Italic Bold Extended) but an encoded font name in the format `fnnsseec`, devised by Karl Berry, which stores the same

information in no more than eight characters for compatibility with systems which cannot handle long filenames. The letters in the format above have the following meanings (see the *fontname* documentation on your computer for more details):

Letter	Meaning	Examples
f	foundry	b=Bitstream, m=Monotype, p=Adobe
nn	typeface	ba=Baskerville, tm=Times, pl=Palatino
ss	series/shape	r=roman, bi=bold italic, etc.
ee	encoding	8a=default 8-bit ANSI, 1y=Y&Y's TEX'n'ANSI
c	[small]caps	(this is a literal 'c' character, used only if needed)

The texmf/fontname directory in your installation of LaTeX has files for several foundries giving fully-formed names like these for common fonts (e.g. ptmr8a is [Adobe] **P**ost-Script **Tim**es **R**oman in an **8**–bit **A**NSI encoding; bgsl1y is **B**itstream **G**ill **S**ans **L**ight in Y&Y's TEX'n'ANSI encoding [**LY**1]).[11] Read the documentation in *Fontname: Filenames for TEX fonts*[12] to find out how to make up your own short names if the foundry and font you want is not shown in the fontname directory.

In this example we'll call our mythical example typeface 'zork' (standing for **Z**fonts **Or**dinary Boo**k**face, because k is the letter used for Book fonts, b being already the code for bold) and we'll assume the font comes in the two files foo.afm and foo.pfb that I mentioned above.

While the *fontname* directories have ready-made lists of these names for popular collections of typefaces, making them up

[11] Confusingly, Bitstream fonts (and others from similar sources) mostly have different names from the original fonts, so what they call Humanist 521 is actually Gill Sans. Until recently, US law only allowed the *names* of typefaces to be copyrighted, not the font designs themselves, leading to widespread piracy.

[12] Berry (June 2001)

requires some knowledge of typographic terms and a careful reading of the *fontname* documentation.

3. **Decide on your encoding**
   This is what tripped me up the first few times until someone pointed me at Y&Y's[13] TEX'n'ANSI encoding which (to me) seems to be the only one that includes the glyphs I want where I want them.[14] Your mileage may vary. This encoding is referred to as `LY1` within LATEX and the encoding file is in `texmf/dvips/base/texnansi.enc`. Encoding is needed because Adobe fonts store their characters in different places to the TEX standard.

   Copy this encoding file to the temporary directory where you're doing all this stuff. If you're using the 8a or 8r encoding (or some other encoding), then copy that file instead (`8a.enc`, `8r.enc`).

4. **Convert `.afm` files to `.tfm`**
   The *afm2tfm* program is a standard utility in the `bin` directory of your TEX installation. If it's not, update your installation.

   In a command window, type:

```
afm2tfm foo.afm -v zorkly.vpl -p texnansi.enc \
rzorkly.tfm >zork.id
```

   (Here and elsewhere I have sometimes had to break the line to fit it on the printed page. It's actually all typed as one long line if you omit the backslash.)

[13] Sadly, Y&Y, Inc has ceased trading and their TEX distribution is not longer available, although there is email support at `http://lists.ucc.ie/lists/archives/yandytex.html`, and their encoding files continue to be used.

[14] The only one I still have problems with is 'ø', which for some weird reason isn't catered for in this encoding.

This creates a special 'raw' TEX Font Metric file (hence the special `r` prefix) that LATEX can use, with a list of all its properties encoded with LY1 (the `.vpl` or Virtual Property List file). Many people will tell you that virtual fonts are dead and that this is the wrong way to do it, but no-one has ever shown me an alternative that works, so I stick with it.

5. **Small caps (optional)**
   If you want a small caps variant faked up (perhaps because the typeface family doesn't have a special small-caps font), repeat the medicine like this:

```
afm2tfm foo.afm -V zorklyc.vpl -p texnansi.enc \
rzorkly.tfm >>zork.id
```

   Note the capital `V` option here. Yes, it *does* overwrite the `rzorkly.tfm` created in the first command. Let it. And those are *two* of the 'greater-than' signs before the `zork.id` filename because we want to append to it, not overwrite it.

6. **Create the virtual font**
   Turn the `.vpl` files into `.vf` and `.tfm` pairs. LATEX uses these to convert from Adobe's encoding to its own.

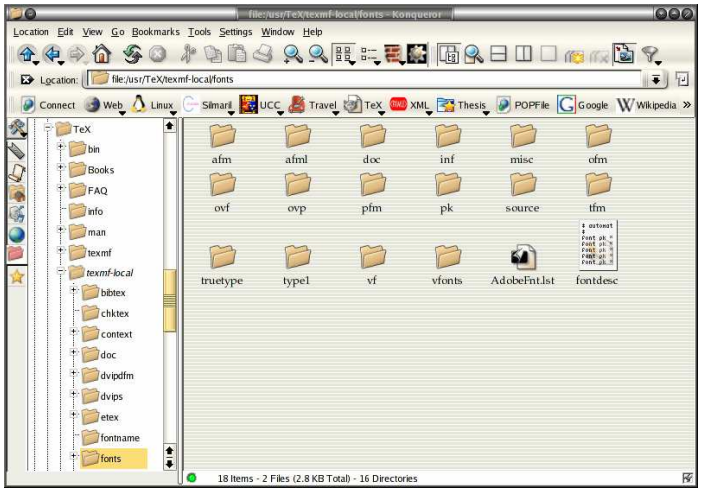
```
vptovf zorkly.vpl zorkly.vf zorkly.tfm
vptovf zorklyc.vpl zorklyc.vf zorklyc.tfm
```

   Again, the `vptovf` program is a standard part of your TEX distribution.

7. **Make directories to hold the files**

   Under your `texmf-local` directory there should be a `fonts` directory, and in there there should be `afm`, `tfm`, `type1`, and `vf` directories. Create them if they do not already exist.

Figure 8.2: Making subdirectories to hold the files



In each of these four, create a directory for the foundry, and within them create a directory for the typeface (using a human-readable typeface name, not the short Karl Berry fontname). In our example, this means:

```
cd /usr/TeX/texmf-local/fonts
mkdir -p afm/zfonts/ordinary
mkdir -p tfm/zfonts/ordinary
mkdir -p type1/zfonts/ordinary
mkdir -p vf/zfonts/ordinary
cd /tmp
```

Or if you're lazy like me:

```
(cd /usr/TeX/texmf-local/fonts;\
for d in afm tfm type1 vf;\
do mkdir -p $d/zfonts/ordinary;done)
```

For Microsoft Windows users, the path before `texmf-local` may look something like `C:\Program Files\TeXLive\`, depending on how and where you have installed your TEX system.

The `-p` is a Unix feature: it automatically creates any missing intervening subdirectories. If your directory-making command doesn't do this, you'll have to make the intervening directories by hand first.

8. **Copy the files to their rightful places**
   Copy the four groups of files to the four new directories:

```
cp *.afm /usr/TeX/texmf/fonts/afm/zfonts/ordinary/
cp *.tfm /usr/TeX/texmf/fonts/tfm/zfonts/ordinary/
cp *.pfb /usr/TeX/texmf/fonts/type1/zfonts/ordinary/
cp *.vf /usr/TeX/texmf/fonts/vf/zfonts/ordinary/
```

   You can of course do all this with a directory window and mouse if you find it easier.

9. **Create a font map**
   The font map is what tells *dvips* which PFB file to use for which font. The configuration file for *dvips* is `texmf/dvips/config/config.ps` and it gets its entries from the program *updmap* which reads map files for each typeface. The configuration file for *updmap* is `texmf-var/web2c/updmap.cfg`[15], so it needs an entry for our new font, using the three-letter font family abbreviation (the first three letters of the Berry fontname (here '`zor`'):

```
Map zor.map
```

[15] There is another one of these at `texmf/web2c/updmap.cfg`, but that contains the map references for the fonts which came with your distribution of TEX, so you should not interfere with it.

We also have to create this map file (`zor.map`) in a subdirectory of `texmf-local/dvips/config/` named after the foundry, so we need to create `texmf-local/dvips/config/zfonts` as well.

(a) Open `/usr/TeX/texmf-var/web2c/updmap.cfg` in your editor.

(b) At the bottom, add the line: `Map zor.map`

(c) Save and close the file.

The font entries in our `zor.map` will be on a *single* line each, with no line-wrapping. Each entry gives the short name of the font, the long (Adobe) name, the PostScript encoding parameters (in quotes), and then two filenames prefixed by input redirects (less-than signs): the encoding file and the PostScript outline file.

(a) First create the directory if it doesn't already exist:

```
mkdir -p /usr/TeX/texmf-local/dvips/config/zfonts
```

(b) Use your editor to open (create) the file `/usr/TeX/texmf-local/dvips/config/zfonts/zor.map`.

(c) Insert the line:

```
rzorkly  Ordinary-Blackface  "TeXnANSIEncoding  ReEncodeFont"  <texnansi.enc  <foo.pfb
```

(d) Save and close the file.

You get the full font name (here, 'Ordinary-Blackface') from the `zork.id` which was created back in step 4 in the procedure on p. 167 when we ran *afm2tfm*. You must get this exactly right, because it's the 'official' full name of the font, and PostScript files using this font need to match it.

10. **Create a style file**
LaTeX needs a style file to implement the interface to the font. Call it after the typeface or something related; in this example we'll call it `foozork.sty`. In it go some details of the name and date we did this, what version of LaTeX it needs, and any other command necessary to operate the font, like the font encoding and whether it is to supersede the current default Roman font.

    (a) Use your editor to open (create) `foozork.sty` in your `texmf-local/tex/latex/psnfss` directory.

    (b) Insert the following lines:

```
% foozork - created from foo for Zork
\def\fileversion{1.0}
\def\filedate{2002/12/03}
\def\docdate{2002/12/03}
\NeedsTeXFormat{LaTeX2e}
\ProvidesPackage{foozork}
 [\filedate\space\fileversion\space
  Zfonts Ordinary PSNFSS2e package]
\RequirePackage[LY1]{fontenc}
\renewcommand{\rmdefault}{zor}
\endinput
```

    Note the following:

    - The first argument to **`\ProvidesPackage`** *must* be the same as this style file name; and that the font family is referred to as `zor`, being the foundry letter plus the fontname abbreviation. This acts as a prefix for any/all font variants (bold, italic, etc.).
    - If you are not using Y&Y encoding, omit the line referring to LY1 font encoding.
    - If this is a typewriter font, make the renewed command **`\rmdefault`** into **`\ttdefault`**.

- If it's a sans-serif font, make it **\sfdefault** instead.
- Omit the command completely if you don't want the style file to supersede the current defaults but simply to make the font available. If you do this, you probably want to write a new command or two to use it, typically one for grouped use and one for argument use:

```
\newcommand{\zorkfamily}{\fontencoding{LY1}%
          \fontfamily{zor}\selectfont}
\newcommand{\textzork}[1]{{\zorkfamily#1}}
```

(c) Save and close the file.

11. **Create the Font Definition file**
The last file to create is the ***font definition*** (`.fd`) file. This is named following the pattern `eeefnn.fd`, using the same conventions as before, by prepending the (lowercase) encoding abbreviation to the foundry letter and fontname abbreviation, so our example would be `ly1zor.fd` for the LY1 encoding and the `zor` short font name.

(a) Use your editor to open (create) `texmf-local/tex/latex/psnfss/ly1zor.fd`

(b) Enter the following lines:

```
\ProvidesFile{ly1zor.fd}[2002/03/03 v0.1 manual
           font definitions for LY1/zor.]

\DeclareFontFamily{LY1}{zor}{}

\DeclareFontShape{LY1}{zor}{k}{n}{<-> zorkly}{}
\DeclareFontShape{LY1}{zor}{k}{sc}{<-> zorklyc}{}
```

(c) Save and close the file.

FD files typically use one **\DeclareFontFamily** command which specifies the encoding and the short font name. Then as many pairs of **\DeclareFontShape** commands as you converted fonts (assuming you did both normal and small caps for each font: see step 5 in the procedure on p. 168; if you didn't, then only one such command per font is needed here). The arguments to the **\DeclareFontShape** command to watch are the 3rd (weight/width), 4th (shape), and 5th (font outline name): the rest are static for each `.fd` file and simply identify the encoding and the font family.

The codes to use are given on pages 414–15 of the *The LaTeX Companion*[16] and should also be in your copies of `texmf/fontnames/weight.map` and `texmf/fontnames/width.map`. The rules for combining weight and width need care: RTFM for fontname. There is no `shape.map` in fontname because it's not part of font file names, it's purely a LaTeX creation, so here's what the same book says:

Character	Meaning
`n`	normal (upright)
`it`	italic
`sl`	slanted
`sc`	small caps
`ui`	upright italic
`ol`	outline

Add your own for other oddities, but be consistent: I use `cu` for cursive (scripts), for example, and `k` for blackletter faces (not to be confused with `k` as a *width* for 'book').

The default fontspec `<->` in the 5th argument in the **\DeclareFontShape** command means that all sizes are to

[16] Mittelbach et al. (2004)

come from the same font outline (remember if this was a METAFONT font with different design sizes like CM it would be much more complex).

If the face has only a few variants, you can create any other entries for bold, italic, slanted, etc. with the relevant weight and width and shape values pointing at the relevant outline file.

If you want one font to substitute for a missing one (for example italics to substitute for slanted in a typeface which has no slanted variant of its own) give the `ssub` ('silent substitution') command in the fontspec: for example to make all references to `sl` (slanted) type use an existing italic font, make the 5th argument like this:

```
{<-> ssub * zor/m/it}
```

If you find the x-height of a font too big or too small to sort well with another font you are using, you can specify an `s` ('scale') factor in this argument instead: this example will shrink the result to 80% of normal:

```
{<-> s * [0.8] zorkly}
```

12. **Update the index and the map files**
    Run your TEX indexer program (see step 4 in the procedure on p. 86) so that *updmap* can find the files it needs.

    Then run *updmap* (just type `updmap`). This updates the maps and runs the TEX indexer program again automatically.

Now you can `\usepackage{foozork}` in your LATEX file to make it the default font. To use the font incidentally instead of as the default, you can say:

```
This is {\zorkfamily ZORK} or \textzork{ZORK}
```

8.3.3 Installing the Type 1 Computer Modern fonts

Most new distributions of LaTeX use the PostScript Type 1 versions of the Computer Modern fonts. If your LaTeX installation uses the METAFONT (bitmap) versions of CM, you may want to switch to the Type 1 version, especially if you are going to be using *pdfLaTeX* instead of standard LaTeX, because Acrobat Reader makes such a hames of displaying Type3 fonts. *GSview* and *pdfview* handle them correctly.

To do this, install one of the sets of CM PostScript fonts. There are several available:

- The fonts from BlueSky Research at `http://www.ctan.org/tex-archive/fonts/cm/ps-type1/bluesky/`
- Basil K. Malyshev's 'BaKoMa' fonts at `http://www.ctan.org/tex-archive/fonts/cm/ps-type1/bakoma/`
- Vladimir Volovich's CM-Super at `http://www.ctan.org/tex-archive/fonts/ps-type1/cm-super/`
- Bogusław Jackowski's Latin Modern at `ftp://cam.ctan.org/tex-archive/fonts/ps-type1/lm.tar.gz`

The BaKoMa fonts include the American Mathematical Society (AMS) fonts for extended mathematics, but are more complex to install because they come with a special set of TFM files.

The BlueSky fonts are just PFB and AFM files, and are a drop-in replacement requiring no further changes, as they use the same TFM files as the METAFONT version. Follow the `README` file in the downloadable archive for installation instructions.

The Latin Modern and CM-Super fonts are new and I haven't tested them but they are well spoken of. Feedback on this is very welcome.

The TEX Live and TEX Collection distributions use Type 1 versions of Computer Modern by default. There are more details in the FAQ at `http://www.tex.ac.uk/cgi-bin/texfaq2html?label=uselmfonts`.

9 Programmability (macros)

We've touched several times on the ability of LaTeX to be reprogrammed. This is one of its central features, and one that still, after nearly a quarter of a century, puts it well above many other typesetting systems, even those with macro systems of their own. It's also the one that needs most foreknowledge, which is why this chapter is in this position.

LaTeX is in fact itself just a collection of macros — rather a big collection — written in TeX's internal typesetting language. These ***macros*** are little program-like sets of instructions with a name which can be used as shorthand for an operation you wish to perform more than once.

Macros can be arbitrarily complex. Many of the ones used in the standard LaTeX packages are several pages long, but as we will see, even short ones can very simply automate otherwise tedious chores and allow the author to concentrate on *writing*.

9.1 Simple replacement macros

In its simplest form, a LaTeX macro can just be a straightforward text replacement of a phrase to avoid misspelling something each time you need it, e.g.

```
\newcommand{\ef}{European Foundation for the
    Improvement of Living and Working Conditions}
```

Put this in your preamble, and you can then use **\ef** in your document and it will typeset it as the full text. Remember that after a command ending in a letter you need to leave a space to avoid the next word getting gobbled up as part of the command (see the first paragraph of § 2.4.1). And when you want to force a space to be printed, use a backslash followed by a space, e.g.

```
The \ef\ is an institution of the Commission of the
 European Union.
```

As you can see from this example, the **\newcommand** command takes two arguments: *a*) the name you want to give the new command; and *b*) the expansion to be performed when you use it, so there are always two sets of curly braces after **\newcommand**.

9.2 Macros using information gathered previously

A more complex example is the macro **\maketitle** which is used in almost every formal document to format the title block. In the basic document classes (book, report, and article) it performs small variations on the layout of a centred block with the title followed by the author followed by the date, as we saw in § 3.3.

If you inspect one of these document class files, such as `texmf/tex/latex/base/report.cls` you will see **\maketitle** defined (and several variants called **\@maketitle** for use in different circumstances). It uses the values for the title, author, and date which are assumed already to have been stored in the internal macros **\@title**, **\@author**, and **\@date** by the author using the matching **\title**, **\author**, and **\date** commands in the document.

This use of one command to store the information in another is a common way of gathering the information from the user. The use of macros containing the `@` character prevents their accidental misuse by the user: in fact to use them in your preamble we have to allow the `@` sign to become a 'letter' so it can be recognised in a command name, and remember to turn it off again afterwards (see item 1 below).

```
\makeatletter
\renewcommand{\maketitle}{%
  \begin{flushleft}%
    \sffamily
    {\Large\bfseries\color{red}\@title\par}%
    \medskip
    {\large\color{blue}\@author\par}%
    \medskip
    {\itshape\color{green}\@date\par}%
    \bigskip\hrule\vspace*{2pc}%
  \end{flushleft}%
}
\makeatother
```

Insert this in the sample file on p. 81 immediately before the `\begin{document}` and remove the `\color{...}` commands from the title, author, and date. Re-run the file through LaTeX, and you should get something like this:

Practical Typesetting
Peter Flynn
Silmaril Consultants
December 2001

In this redefinition of **\maketitle**, we've done the following:

1. Enclosed the changes in **\makeatletter** and **\makeatother** to allow us to use the @ sign in command names;[1]
2. Used **\renewcommand** and put **\maketitle** in curly braces after it;
3. Opened a pair of curly braces to hold the new definition. The closing curly brace is immediately before the **\makeatother**;
4. Inserted a **flushleft** environment so the whole title block is left-aligned;
5. Used **\sffamily** so the whole title block is in the defined sans-serif typeface;
6. For each of **\@title**, **\@author**, and **\@date**, we have used some font variation and colour, and enclosed each one in curly braces to restrict the changes just to each command. The closing **\par** makes sure that multiline title and authors and dates get typeset with the relevant line-spacing;
7. Added some flexible space between the lines, and around the **\hrule** (horizontal rule) at the end;

Note the % signs after any line ending in a curly brace, to make sure no intrusive white-space find its way into the output. These aren't needed after simple commands where there is no curly brace because excess white-space gets gobbled up there anyway.

[1] If you move all this preamble into a style file of your own, you don't need these commands: the use of @ signs in command names is allowed in style and class files.

9.3 Macros with arguments

But macros are not limited to text expansion. They can take arguments of their own, so you can define a command to do something with specific text you give it. This makes them much more powerful and generic, as you can write a macro to do something a certain way, and then use it hundreds of times with a different value each time.

We looked earlier (§ 8.2.5) at making new commands to put specific classes of words into certain fonts, such as product names into italics, keywords into bold, and so on. Here's an example for a command **\product**, which also indexes the product name and adds a trademark sign:

```
\newcommand{\product}[1]{%
      \textit{#1}\texttrademark%
      \index{#1@\textit{#1}}%
}
```

If I now type `\tmproduct{Velcro}` then I get *Velcro*™ typeset, and if you look in the index, you'll find this page referenced under '*Velcro*'. Let's examine what this does:

1. The macro is specified as having one argument (that's the `[1]` in the definition). This will be the product name you type in curly braces when you use **\product**. Macros can have up to nine arguments.

2. The expansion of the macro is contained in the second set of curly braces, spread over several lines (see item 5 for why).

3. It prints the value of the first argument (that's the `#1`) in italics, which is conventional for product names, and adds the **\texttrademark** command.

4. Finally, it creates an index entry using the same value (`#1`), making sure that it's italicised in the index (see the

list on p. 137 in § 7.5 to remind yourself of how indexing something in a different font works).

5. Typing this macro over several lines makes it easier for humans to read. I could just as easily have typed

```
\newcommand{\product}[1]{\textit{#1}\index{#1@\textit{#1}}}
```

but it wouldn't have been as clear what I was doing.

One thing to notice is that to prevent unwanted spaces creeping into the output when LaTeX reads the macro, I ended each line with a comment character (%). LaTeX normally treats newlines as spaces when formatting (remember item 2.5.1), so this stops the end of line being turned into an unwanted space when the macro is used. LaTeX always ignores spaces at the *start* of macro lines anyway, so indenting lines for readability is fine.

In (§ 2.8.2) we mentioned the problem of frequent use of unbreakable text leading to poor justification or to hyphenation problems. A solution is to make a macro which puts the argument into an **\mbox** with the appropriate font change, but precedes it all with a conditional **\linebreak** which will make it more attractive to TeX to start a new line.

```
\newcommand{\var}[1]{\linebreak[3]\mbox{\ttfamily#1}}
```

This only works effectively if you have a reasonably wide setting and paragraphs long enough for the differences in spacing elsewhere to get hidden. If you have to do this in narrow journal columns, you may have to adjust wording and spacing by hand occasionally.

9.4 Nested macros

Here's a slightly more complex example, where one macro calls another. It's common in normal text to refer to people by their forename and surname (in that order), for example Don Knuth, but to have them indexed as *surname, forename*. This pair of macros, **\person** and **\reindex**, automates that process to minimize typing and indexing.

```
\newcommand{\person}[1]{#1\reindex #1\sentinel}
\def\reindex #1 #2\sentinel{\index{#2, #1}}
```

1. The digit 1 in square brackets means that **\person** has one argument, so you put the whole name in a single set of curly braces, e.g. `\person{Don Knuth}`.

2. The first thing the macro does is output `#1`, which is the value of what you typed, just as it stands, so the whole name gets typeset exactly as you typed it.

3. But then it uses a special feature of Plain TEX macros (which use **\def** instead of LATEX's **\newcommand**[2]): they too can have multiple arguments but you can separate them with other characters (here a space) to form a pattern which TEX will recognise when reading the arguments.

   In this example (**\reindex**) it's expecting to see a string of characters (`#1`) followed by a space, followed by another string of characters (`#2`) followed by a dummy command (**\sentinel**). In effect this makes it a device for splitting a name into two halves on the space between them, so the two halves can be handled separately. The **\reindex** command can now read the two halves of the name separately.

[2] Don't try this at home alone, children! This one is safe enough, but you should strictly avoid **\def** for a couple of years. Stick to **\newcommand** for now.

4. The **\person** command invokes **\reindex** and follows it with the name you typed plus the dummy command **\sentinel** (which is just there to signal the end of the name). Because **\reindex** is expecting two arguments separated by a space and terminated by a **\sentinel**, it sees 'Don and Knuth' as two separate arguments.

   It can therefore output them using **\index** in reverse order, which is exactly what we want.

A book or report with a large number of personal names to print and index could make significant use of this to allow them to be typed as `\person{Leslie Lamport}` and printed as Leslie Lamport, but have them indexed as 'Lamport, Leslie' with virtually no effort on the author's part at all.

EXERCISE 20

Other names

Try to work out how to make this \person feature work with names like:

- **Blanca Maria Bartosova de Paul**
- **Patricia Maria Soria de Miguel**
- **Arnaud de la Villèsbrunne**
- **Prince**
- **Pope John Paul II**

Hints: the command \space produces a normal space, and one way around LaTeX's requirements on spaces after command names ending with a letter is to follow such commands with an empty set of curly braces {}.

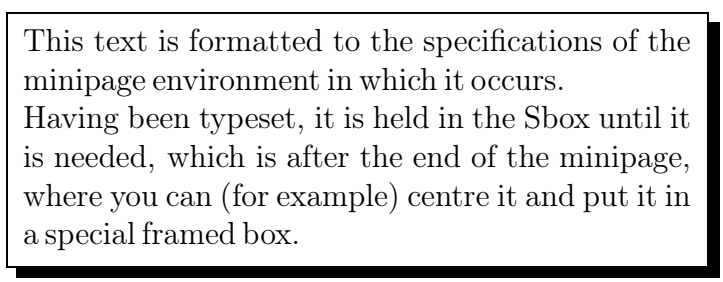
9.5 Macros and environments

As mentioned in § 6.7.3, it is possible to define macros to capture text in an environment and reuse it afterwards. This avoids

any features of the subsequent use affecting the formatting of the text.

One example of this uses the facilities of the fancybox package, which defines a variety of framed boxes to highlight your text, and a special environment **Sbox** which 'captures' your text for use in these boxes.

```
\begin{Sbox}
\begin{minipage}{3in}
This text is formatted to the specifications
of the minipage environment in which it
occurs.

Having been typeset, it is held in the Sbox
until it is needed, which is after the end
of the minipage, where you can (for example)
align it and put it in a special framed box.
\end{minipage}
\end{Sbox}
\begin{flushright}
\shadowbox{\theSbox}
\end{flushright}
```



By putting the text (here in a **minipage** environment because we want to change the width) inside the **Sbox** environment, it

is typeset into memory and stored in the macro **\theSbox**. It can then be used afterwards as the argument of the **\shadowbox** command (and in this example it has also been centred).

9.6 Reprogramming LaTeX's internals

LaTeX's internal macros can also be reprogrammed or even rewritten entirely, although doing this can require a considerable degree of expertise. Simple changes, however, are easily done.

Recall that LaTeX's default document structure for the Report document class uses Chapters as the main unit of text, whereas in reality most reports are divided into Sections, not Chapters (§ 5). The result of this is that if you start off your report with `\section{Introduction}`, it will print as

0.1 Introduction

which is not at all what you want. The zero is caused by it not being part of any chapter. But this numbering is controlled by macros, and you can redefine them. In this case it's a macro called `\thesection` which reproduces the current section number counter (see the last paragraph of § 6.2.6). It's redefined afresh in each document class file, using the command **\renewcommand** (in this case in `texmf/tex/latex/base/report.cls`):

```
\renewcommand \thesection
   {\thechapter.\@arabic\c@section}
```

You can see it invokes **\thechapter** (which is defined elsewhere to reproduce the value of the *chapter* counter), and it then prints a dot, followed by the Arabic value of the counter called *section* (that `\c@` notation is LaTeX's internal way of referring to counters). You can redefine this in your preamble to simply leave out the reference to chapters:

```
\renewcommand{\thesection}{\arabic{section}}
```

I've used the more formal method of enclosing the command being redefined in curly braces. For largely irrelevant historical reasons these braces are often omitted in LaTeX's internal code (as you may have noticed in the example earlier). And I've also used the 'public' macro **\arabic** to output the value of *section* (LaTeX's internals use a 'private' set of control sequences containing @-signs, designed to protect them against being changed accidentally).

Now the introduction to your report will start with:

1 Introduction

What's important is that you *don't ever* need to alter the original document class file `report.cls`: you just copy the command you need to change into your own document preamble, and modify that instead. It will then override the default.

9.6.1 Changing list item bullets

As mentioned earlier (§ 6.2.1), here's how to redefine a bullet for an itemized list, with a slight tweak:

```
\usepackage{bbding}
\renewcommand{\labelitemi}{%
      \raisebox{-.25ex}{\PencilRight}}
```

Here we use the bbding package which has a large selection of 'dingbats' or little icons, and we make the label for top-level itemized lists print a right-pointing pencil (the names for the icons are in the package documentation: see § 5.1.2 for how to get it).

In this case, we are using the **\raisebox** command within the redefinition because it turns out that the symbols in this font are positioned slightly too high for the typeface we're using. The **\raisebox** command takes two arguments: the first is a dimension, how much to raise the object by (and a negative value means 'lower': there is no need for a `\lowerbox` command); and

the second is the text you want to affect. Here, we are shifting the symbol down by ¼ex (see § 2.8.1 for a list of dimensions LaTeX can use).

There is a vast number of symbols available: see *A comprehensive list of symbols in TeX*[3] for a comprehensive list.

[3] Pakin (2002)

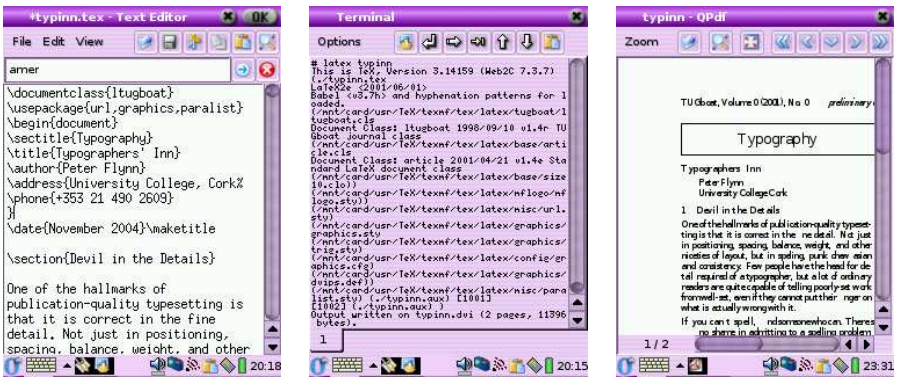
10 Compatibility with other systems

As we saw in Chapter 2, LaTeX uses plain-text files, so they can be read and written by any standard application that can open text files. This helps preserve your information over time, as the plain-text format cannot be obsoleted or hijacked by any manufacturer or sectoral interest, and it will always be readable on any computer, from your handheld (yes, LaTeX is available for some PDAs, see Figure 10.1) to the biggest supercomputer.

However, LaTeX is intended as the last stage of the editorial process: formatting for print or display. If you have a requirement to re-use the text in some other environment — a database perhaps, or on the Web or a CD-ROM or DVD, or in Braille or voice output — then it should probably be edited, stored, and maintained in something neutral like the Extensible Markup Language (XML), and only converted to LaTeX when a typeset copy is needed.

Although LaTeX has many structured-document features in common with SGML and XML, it can still only be processed by the LaTeX and *pdfLaTeX* programs. Because its macro fea-

Figure 10.1: LaTeX editing and processing on the Sharp Zaurus 5500 PDA



tures make it almost infinitely redefinable, processing it requires a program which can unravel arbitrarily complex macros, and LaTeX and its siblings are the only programs which can do that effectively. Like other typesetters and formatters (Quark *XPress*, *PageMaker*, *FrameMaker*, Microsoft *Publisher*, *3B2* etc.), LaTeX is largely a one-way street leading to typeset printing or display formatting.

Converting LaTeX to some other format therefore means you will unavoidably lose some formatting, as LaTeX has features that others systems simply don't possess, so they cannot be translated — although there are several ways to minimise this loss. Similarly, converting other formats into LaTeX often means editing back the stuff the other formats omit because they only store appearances, not structure.

However, there are at least two excellent systems for converting LaTeX directly to HyperText Markup Language (HTML) so you can publish it on the web, as we shall see in § 10.2.

10.1 Converting into LaTeX

There are several systems which will save their text in LaTeX format. The best known is probably the LyX editor (see Figure 2.2), which is a wordprocessor-like interface to LaTeX for Windows and Unix. Both the *AbiWord* and *Kword* wordprocessors on Linux systems have a very good **Save As**...LaTeX output, so they can be used to open Microsoft *Word* documents and convert to LaTeX. Several maths packages like the *EuroMath* editor, and the *Mathematica* and *Maple* analysis packages, can also save material in LaTeX format.

In general, most other wordprocessors and DTP systems either don't have the level of internal markup sophistication needed to create a LaTeX file, or they lack a suitable filter to enable them to output what they do have. Often they are incapable of outputting any kind of structured document, because they only store what the text looks like, not why it's there or what role it fulfills. There are two ways out of this:

- Use the File Save As... menu item to save the wordprocessor file as HTML, rationalise the HTML using Dave Raggett's *HTML Tidy*[1], and convert the resulting Extensible HyperText Markup Language (XHTML) to LaTeX with any of the standard XML tools (see below).

- Use a specialist conversion tool like EBT's *DynaTag* (supposedly available from Enigma, if you can persuade them they have a copy to sell you; or you may still be able to get it from Red Bridge Interactive[2] in Providence, RI). It's expensive and they don't advertise it, but for bulk conversion of consistently-marked *Word* files into XML it beats everything else hands down. The *Word* files *must* be consistent, though, and must use named styles from a stylesheet, otherwise no system on earth is going to be able to guess what it means.

[1] `http://tidy.sourceforge.net/`
[2] `http://www.rbii.com/`

There is of course a third way, suitable for large volumes only: send it off to the Pacific Rim to be retyped into XML or LaTeX. There are hundreds of companies from India to Polynesia who do this at high speed and low cost with very high accuracy. It sounds crazy when the document is already in electronic form, but it's a good example of the problem of low quality of wordprocessor markup that this solution exists at all.

You will have noticed that most of the solutions lead to one place: SGML[3] or XML. As explained above and elsewhere, these formats are the only ones devised so far capable of storing sufficient information in machine-processable, publicly-accessible form to enable your document to be recreated in multiple output formats. Once your document is in XML, there is a large range of software available to turn it into other formats, including LaTeX. Processors in any of the common SGML/XML processing languages like the Document Style Semantics and Specification Language (DSSSL), the Extensible Stylesheet Language [Transformations] (XSLT), *Omnimark*, *Metamorphosis*, *Balise*, etc. can easily be written to output LaTeX, and this approach is extremely common.

Much of this will be simplified when wordprocessors support native, arbitrary XML/XSLT as a standard feature, because LaTeX output will become much simpler to produce.

- Sun's *Star Office* and its Open Source sister, *OpenOffice*, have used XML as their native file format for several years, and there is a project at the Organisation for the Advancement of Structured Information Systems (OASIS) for developing a common XML office file format based on those used by these two packages, which has been proposed to the International Organization for Standardization (ISO) in Geneva as a candidate for an International Standard.

[3]The Standard Generalized Markup Language (SGML) itself is little used now for new projects, as the software support for its daughter XML is far greater, but there are still hundreds of large document repositories in SGML still growing their collection by adding documents.

- *WordPerfect* has also had a native SGML (and now XML) editor for many years, which will work with any Document Type Definition (DTD) (but not a Schema; and at the time of writing (2005) it still used a proprietary stylesheet format).

- Microsoft has had a half-hearted 'Save As…XML' for a while, using an internal and formerly largely undocumented Schema (recently published at last). The 'Professional' versions of *Word* and *Excel* in *Office 11* (Office 2003 for XP) now have full support for arbitrary Schemas and a real XML editor, albeit with a rather primitive interface, but there is no conversion to or from *Word*'s `.doc` format.[4]

  However, help comes in the shape of Ruggero Dambra's *WordML2LaTeX*, which is an XSLT stylesheet to transform an XML document in this internal Schema (WordML) into LaTeX 2ε format. Download it from any CTAN server in `/support/WordML2LaTeX`.

- Among the conversion programs on CTAN is Ujwal Sathyam's *rtf2latex2e*, which converts Rich Text Format (RTF) files (output by many wordprocessors) to LaTeX 2ε. The package description says it has support for figures and tables, equations are read as figures, and it can the handle the latest RTF versions from Microsoft Word 97/98/2000, StarOffice, and other wordprocessors. It runs on Macs, Linux, other Unix systems, and Windows.

When these efforts coalesce into generalised support for arbitrary DTDs and Schemas, it will mean a wider choice of editing interfaces, and when they achieve the ability to run XSLT conversion into LaTeX from within these editors, such as is done at the moment with *Emacs* or *XML Spy*, we will have full convertability.

[4] Which is silly, given that Microsoft used to make one of the best *Word*-to-SGML converters ever, which was bi-directional (yes, it could round-trip *Word* to SGML and back to *Word* and back into SGML). But they dropped it on the floor when XML arrived.

10.1.1 Getting LaTeX out of XML

Assuming you can get your document out of its wordprocessor format into XML by some method, here is a very brief example of how to turn it into LaTeX.

You can of course buy and install a fully-fledged commercial XML editor with XSLT support, and run this application within it. However, this is beyond the reach of many users, so to do this unaided you just need to install three pieces of software: *Java*[5], *Saxon*[6] and the DocBook 4.2 DTD[7] (URIs are correct at the time of writing). None of these has a visual interface: they are run from the command-line in the same way as is possible with LaTeX.

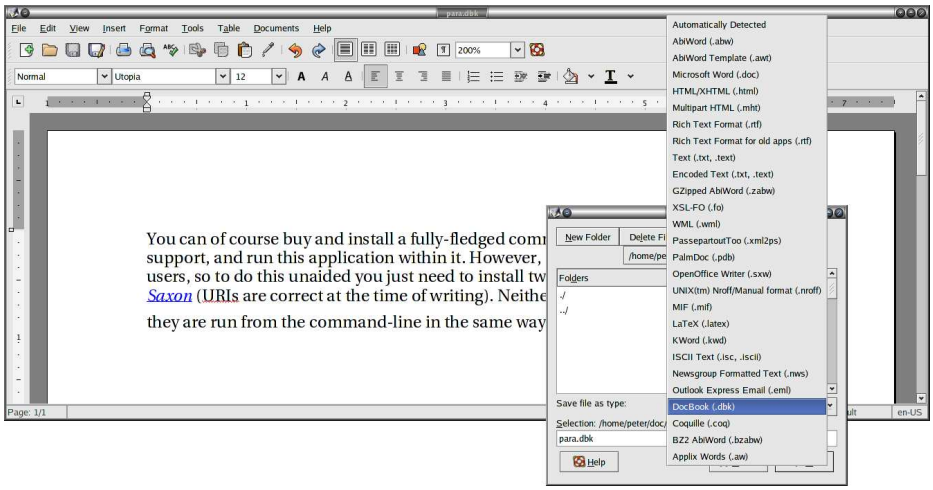
As an example, let's take the above paragraph, as typed or imported into *AbiWord* (see Figure 10.2). This is stored as a single paragraph with highlighting on the product names (italics), and the names are also links to their Internet sources, just as they are in this document. This is a convenient way to store two pieces of information in the same place.

AbiWord can export in DocBook format, which is an XML vocabulary for describing technical (computer) documents–it's what I use for this book. *AbiWord* can also export LaTeX, but we're going make our own version, working from the XML (Brownie points for the reader who can guess why I'm not just accepting the LaTeX conversion output).

Although *AbiWord*'s default is to output an XML `book` document type, we'll convert it to a LaTeX article document class. Notice that *AbiWord* has correctly output the expected section and title markup empty, even though it's not used. Here's the XML output (I've changed the linebreaks to keep it within the bounds of this page size):

[5] `http://java.sun.com/j2se/1.4.2/download.html`
[6] `http://saxon.sourceforge.net/`
[7] `http://www.docbook.org/xml/4.2/index.html`

Figure 10.2: Sample paragraph in *AbiWord* converted to XML




```
<!DOCTYPE book PUBLIC "-//OASIS//DTD DocBook XML V4.2//EN"
          "http://www.oasis-open.org/docbook/xml/4.2/docbookx.dtd">
<book>
<!-- ============================================================= -->
<!-- This DocBook file was created by AbiWord.                     -->
<!-- AbiWord is a free, Open Source word processor.                -->
<!-- You may obtain more information about AbiWord at www.abisource.com -->
<!-- ============================================================= -->
   <chapter>
      <title></title>
      <section role="unnumbered">
         <title></title>
         <para>You can of course buy and install a fully-fledged commercial XML
editor with XSLT support, and run this application within it. However, this
is beyond the reach of many users, so to do this unaided you just need to
install three pieces of software: <ulink
url="http://java.sun.com/j2se/1.4.2/download.html"><emphasis>Java</emphasis></ulink>,
<ulink
url="http://saxon.sourceforge.net"><emphasis>Saxon</emphasis></ulink>, and
the <ulink url="http://www.docbook.org/xml/4.2/index.html">DocBook 4.2 DTD</ulink>
(URIs are correct at the time of writing). None of these has a visual
interface: they are run from the command-line in the same way as is possible
with L<superscript>A</superscript>T<subscript>E</subscript>X.</para>
      </section>
   </chapter>
</book>
```

The XSLT language lets us create templates for each type of element in an XML document. In our example, there are only three which need handling, as we did not create chapter or section

titles (DocBook requires them to be present, but they don't have to be used).

- `para`, for the paragraph[s];
- `ulink`, for the URIs;
- `emphasis`, for the italicisation.

I'm going to cheat over the superscripting and subscripting of the letters in the LaTeX logo, and use my editor to replace the whole thing with the **\LaTeX** command. In the other three cases, we already know how LaTeX deals with these, so we can write our templates (see Figure 10.3).

If you run this through *Saxon*, which is an XSLT processor, you can output a LaTeX file which you can process and view (see Figure 10.4).

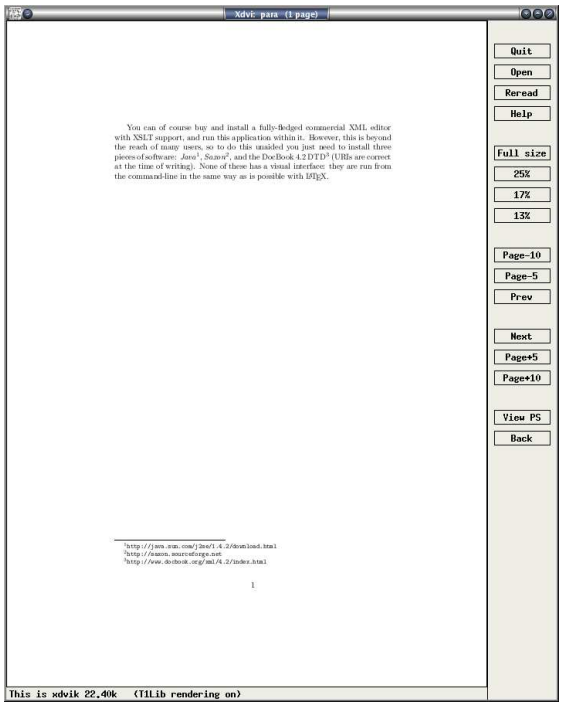
```
$ java -jar /usr/local/saxonb8-0/saxon8.jar -o para.ltx \
para.dbk para.xsl
$ latex para.ltx
This is TeX, Version 3.14159 (Web2C 7.3.7x)
(./para.ltx
LaTeX2e <2001/06/01>
Loading CZ hyphenation patterns: Pavel Sevecek, v3, 1995
Loading SK hyphenation patterns: Jana Chlebikova, 1992
Babel <v3.7h> and hyphenation patterns for english,
dumylang, nohyphenation, czech, slovak, german, ngerman,
danish, spanish, catalan, finnish, french, ukenglish, greek,
croatian, hungarian, italian, latin, mongolian, dutch,
norwegian, polish, portuguese, russian, ukrainian,
serbocroat, swedish, loaded.
(/usr/TeX/texmf/tex/latex/base/article.cls
Document Class: article 2001/04/21 v1.4e Standard LaTeX
document class (/usr/TeX/texmf/tex/latex/base/size10.clo))
(/usr/TeX/texmf/tex/latex/ltxmisc/url.sty) (./para.aux)
[1] (./para.aux) )
Output written on para.dvi (1 page, 1252 bytes).
Transcript written on para.log.
$ xdvi para &
```

Writing XSLT is not hard, but requires a little learning. The output method here is `text`, which is LaTeX's file format (XSLT can also output HTML and other formats of XML).

Figure 10.3: XSLT script to convert the paragraph

```
<?xml version="1.0" encoding="utf-8"?>
<xsl:stylesheet
 xmlns:xsl="http://www.w3.org/1999/XSL/Transform"
 version="1.0">
  <xsl:output method="text"/>

  <xsl:template match="/">
    <xsl:text>\documentclass{article}
\usepackage{url}</xsl:text>
    <xsl:apply-templates/>
  </xsl:template>

  <xsl:template match="book">
    <xsl:text>\begin{document}</xsl:text>
    <xsl:apply-templates/>
    <xsl:text>\end{document}</xsl:text>
  </xsl:template>

  <xsl:template match="para">
    <xsl:apply-templates/>
    <xsl:text>&#x000A;</xsl:text>
  </xsl:template>

  <xsl:template match="ulink">
    <xsl:apply-templates/>
    <xsl:text>\footnote{\url{</xsl:text>
    <xsl:value-of select="@url"/>
    <xsl:text>}}</xsl:text>
  </xsl:template>

  <xsl:template match="emphasis">
    <xsl:text>\emph{</xsl:text>
    <xsl:apply-templates/>
    <xsl:text>}</xsl:text>
  </xsl:template>

</xsl:stylesheet>
```

Figure 10.4: Displaying the typeset paragraph




```
\documentclass{article}\usepackage{url}\begin{document}

      You can of course buy and install a fully-fledged commercial
XML editor with XSLT support, and run this application within it.
However, this is beyond the reach of many users, so to do this
unaided you just need to install three pieces of software:
\emph{Java}\footnote{\url{http://java.sun.com/j2se/1.4.2/download.html}},
\emph{Saxon}\footnote{\url{http://saxon.sourceforge.net}}, and the
DocBook 4.2 DTD\footnote{\url{http://www.docbook.org/xml/4.2/index.html}}
(URIs are correct at the time of writing). None of these has a visual
interface: they are run from the command-line in the same way as is
possible with \LaTeX.

\end{document}
```

1. The first template matches '/', which is the document root (before the `book` start-tag). At this stage we output the text `\documentclass{article}` and `\usepackage{url}`. The '`apply-templates`' instructions tells the processor to carry on processing, looking for more matches. XML comments get ignored, and any elements which don't match a template simply have their contents passed through until the next match occurs.

2. The `book` template outputs the `\begin{document}` and the `\end{document}` commands, and between them to carry on processing.

3. The `para` template just outputs its content, but follows it with a linebreak (using the hexadecimal character code `x000A` (see the ASCII chart in Table C.1).

4. The `ulink` template outputs its content but follows it with a footnote using the **`\url`** command to output the value of the `url` attribute.

5. The `emphasis` template surrounds its content with `\emph{` and `}`.

This is a relatively trivial example, but it serves to show that it's not hard to output LaTeX from XML. In fact there is a set of templates already written to produce LaTeX from a DocBook file at `http://www.dpawson.co.uk/docbook/tools.html#d4e2905`

10.2 Converting out of LaTeX

This is much harder to do comprehensively. As noted earlier, the LaTeX file format really requires the LaTeX program itself in order to process all the packages and macros, because there is no telling what complexities authors have added themselves (what a lot of this book is about!).

Many authors and editors rely on custom-designed or home-brew converters, often written in the standard shell scripting languages (Unix shells, Perl, Python, Tcl, etc). Although some of the packages presented here are also written in the same languages, they have some advantages and restrictions compared with private conversions:

- Conversion done with the standard utilities (eg awk, tr, sed, grep, detex, etc) can be faster for *ad hoc* translations, but it is easier to obtain consistency and a more sophisticated final product using LaTeX2HTML or TeX4ht — or one of the other systems available.
- Embedding additional non-standard control sequences in LaTeX source code may make it harder to edit and maintain, and will definitely make it harder to port to another system.
- Both the above methods (and others) provide a fast and reasonable reliable way to get documents authored in LaTeX onto the Web in an acceptable — if not optimal — format.
- LaTeX2HTML was written to solve the problem of getting LaTeX-with-mathematics onto the Web, in the days before MathML and math-capable browsers. TeX4ht was written to turn LaTeX documents into Web hypertext — mathematics or not.

10.2.1 Conversion to *Word*

There are several programs on CTAN to do LaTeX-to-*Word* and similar conversions, but they do not all handles everything LaTeX can throw at them, and some only handle a subset of the built-in commands of default LaTeX. Two in particular, however, have a good reputation, although I haven't used either of them (I stay as far away from *Word* as possible):

- *latex2rtf* by Wilfried Hennings, Fernando Dorner, and Andreas Granzer translates LaTeX into RTF — the opposite

of the *rtf2latex2e* mentioned in item 10.1the list on p. 195. RTF can be read by most wordprocessors, and this program preserves layout and formatting for most LaTeX documents using standard built-in commands.

- Kirill Chikrii's *TeX2Word* for Microsoft Windows is a converter plug-in for *Word* to let it open TeX and LaTeX documents. The author's company claims that 'virtually any existing TeX/LaTeX package can be supported by *TeX2Word*' because it is customisable.

One easy route into wordprocessing, however, is the reverse of the procedures suggested in the preceding section: convert LaTeX to HTML, which many wordprocessors read easily. The following sections cover two packages for this.

10.2.2 *LaTeX2HTML*

As its name suggests, LaTeX2HTML is a system to convert LaTeX structured documents to HTML. Its main task is to reproduce the document structure as a set of interconnected HTML files. Despite using Perl, LaTeX2HTML relies very heavily on standard Unix facilities like the *NetPBM* graphics package and the pipe syntax. Microsoft Windows is not well suited to this kind of composite processing, although all the required facilities are available for download in various forms and should in theory allow the package to run — but reports of problems are common.

- The sectional structure is preserved, and navigational links are generated for the standard Next, Previous, and Up directions.
- Links are also used for the cross-references, citations, footnotes, ToC, and lists of figures and tables.
- Conversion is direct for common elements like lists, quotes, paragraph-breaks, type-styles, etc, where there is an obvious HTML equivalent.

- Heavily formatted objects such as math and diagrams are converted to images.
- There is no support for homebrew macros.

There is, however, support for arbitrary hypertext links, symbolic cross-references between 'evolving remote documents', conditional text, and the inclusion of raw HTML. These are extensions to LaTeX, implemented as new commands and environments.

LaTeX2HTML outputs a directory named after the input filename, and all the output files are put in that directory, so the output is self-contained and can be uploaded to a server as it stands.

10.2.3 *TeX4ht*

TeX4ht operates differently from LaTeX2HTML: it uses the TeX program to process the file, and handles conversion in a set of postprocessors for the common LaTeX packages. It can also output to XML, including Text Encoding Initiative (TEI) and DocBook, and the OpenOffice and WordXML formats, and it can create TeXinfo format manuals.

By default, documents retain the single-file structure implied by the original, but there is again a set of additional configuration directives to make use of the features of hypertext and navigation, and to split files for ease of use.

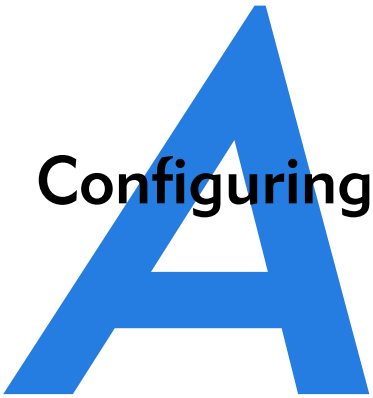
10.2.4 Extraction from PS and PDF

If you have the full version of Adobe *Acrobat*, you can open a PDF file created by *pdfLaTeX*, select and copy all the text, and paste it into *Word* and some other wordprocessors, and retain some common formatting of headings, paragraphs, and lists. Both solutions still require the wordprocessor text to be edited into shape, but they preserve enough of the formatting to make it worthwhile for short documents. Otherwise, use the

pdftotext program to extract everything from the PDF file as plain (paragraph-formatted) text.

10.2.5 Last resort: strip the markup

At worst, the *detex* program on CTAN will strip a LaTeX file of all markup and leave just the raw unformatted text, which can then be re-edited. There are also programs to extract the raw text from DVI and PostScript (PS) files.



Configuring TEX search paths

TEX systems run on a huge variety of platforms, and are typically made up of a large number of rather small files. Some computer operating systems have problems with packages like this, as their built-in methods for searching for a file when needed are poor.

To get around this, TEX uses a technique borrowed from the Unix world, based on a simple hash index for each directory they need to look in. This is known as the ls-R database, from the Unix command (`ls -R`) which creates it. The program which does this for TEX is actually called after this command: *mktexlsr*, although it may be renamed *texhash* or something else on your system. This is the program referred to in step 4 in the procedure on p. 86.

However, to know where to make these indexes, and thus where to search, TEX needs to be told about them. In a standard TEX installation this information is in `texmf/web2c/texmf.cnf`. The file is similar to a Unix shell script, but the only lines of significance for the search paths are the following (this is how they appear in the default Unix installation, omitting the comments):

```
TEXMFMAIN = /usr/TeX/texmf
TEXMFLOCAL = /usr/TeX/texmf-local
HOMETEXMF = $HOME/texmf
TEXMF = {$HOMETEXMF,!!$TEXMFLOCAL,!!$TEXMFMAIN}
SYSTEXMF = $TEXMF
VARTEXFONTS = /var/lib/texmf
TEXMFDBS = $TEXMF;$VARTEXFONTS
```

As you can see, this defines where the main TEX/METAFONT directory is, where the local one is, and where the user's personal (home) one is. It then defines the order in which they are searched, and makes this the system-wide list. A temporary directory for bitmap fonts is set up, and added to the list, defining the places in which *texhash* or *mktexlsr* creates its databases.

In some installations, the local directory is set up in `/usr/local/share/texmf` or `/usr/share/texmf.local` or similar variations, so you would substitute this name for `/usr/TeX/texmf-local`. Under Microsoft Windows, the names will be full paths such as `C:\ProgramFiles\TeXLive\texmf`. On an Apple Mac, it might be `HardDisk:TeX:texmf`.

If you edit plain-text configuration files with anything other than a plain-text editor (e.g. a wordprocessor), or if you edit them with a plain-text editor which has been set to word-wrap long lines, make sure you turn line-wrapping *off* so that any long lines are preserved in their correct format.

B TEX Users Group membership

The TEX Users Group (TUG) was founded in 1980 for educational and scientific purposes: to provide an organization for those who have an interest in typography and font design, and are users of the TEX typesetting system invented by Donald Knuth. TUG is run by and for its members and represents the interests of TEX users worldwide.

TUG membership benefits

Members of TUG help to support and promote the use of TEX, METAFONT, and related systems worldwide. All members receive *TUGboat*[1], the journal of the TEX Users Group, the TEX Live software distribution (a runnable TEX system), and the CTAN software distribution (containing most of the CTAN archive).

In addition, TUG members vote in TUG elections, and receive discounts on annual meeting fees, store purchases, and TUG-sponsored courses. TUG membership (less benefits) is tax-

[1] Beeton (Since 1980)

deductible, at least in the USA. See the TUG Web site for details.

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Please see the forms and information at `http://www.tug.org/join.html`. You can join online, or by filling out a paper form. The NTG (Dutch) and UKTUG (United Kingdom) TEX user groups have joint membership agreements with TUG whereby you can receive a discount for joining both user groups. To do this, please join via `http://www.ntg.nl/newmember.html` (the NTG membership page) or `http://uk.tug.org/Membership/` (the UKTUG page), respectively, and select the option for joint membership.

Each year's membership entitles you to the software and TUGboat produced for that year (even if it is produced in a subsequent calendar year, as is currently the case with TUGboat). You can order older issues of TUGboat and TEX memorabilia through the TUG store (`http://www.tug.org/store`).

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C The ASCII character set

The American Standard Code for Information Interchange was invented in 1963, and after some redevelopment settled down in 1984 as standard X3.4 of American National Standards Institute (ANSI). It represents the 95 basic codes for the unaccented printable characters and punctuation of the Latin alphabet, plus 33 internal 'control characters' originally intended for the control of computers, programs, and external devices like printers and screens.

Many other character sets (strictly speaking, 'character repertoires') have been standardised for accented Latin characters and for all other non-Latin writing systems, but these are intended for representing the symbols people use when writing text on computers. Most programs and computers use ASCII internally for all their coding, the exceptions being XML-based languages like XSLT, which are inherently designed to be usable with any writing system, and a few specialist systems like APL.

Although the TEX and LATEX file formats can easily be used with many other encoding systems (see the discussion of the inputenc in §2.7), they are based on ASCII. It is therefore important to

Table C.1: The ASCII characters

Oct	0	1	2	3	4	5	6	7	Hex
′00 ↑	NUL	SOH	STX	ETX	EOT	ENQ	ACK	BEL	″0 ↑
′01 ↑	BS	HT	LF	VT	FF	CR	SO	SI	″0 ↓
′02 ↑	DLE	DC1	DC2	DC3	DC4	NAK	SYN	ETB	″1 ↑
′03 ↑	CAN	EM	SUB	ESC	FS	GS	RS	US	″1 ↓
′04 ↑		!	"	#	$	%	&	'	″2 ↑
′05 ↑	(	)	*	+	,	-	.	/	″2 ↓
′06 ↑	0	1	2	3	4	5	6	7	″3 ↑
′07 ↑	8	9	:	;	<	=	>	?	″3 ↓
′10 ↑	@	A	B	C	D	E	F	G	″4 ↑
′11 ↑	H	I	J	K	L	M	N	O	″4 ↓
′12 ↑	P	Q	R	S	T	U	V	W	″5 ↑
′13 ↑	X	Y	Z	[	\	]	^	_	″5 ↓
′14 ↑	`	a	b	c	d	e	f	g	″6 ↑
′15 ↑	h	i	j	k	l	m	n	o	″6 ↓
′16 ↑	p	q	r	s	t	u	v	w	″7 ↑
′17 ↑	x	y	z	{	|	}	~	DEL	″7 ↓
	8	**9**	**A**	**B**	**C**	**D**	**E**	**F**	

know where to find *all* 95 of the printable characters, as some of them are not often used in other text-formatting systems. The following table shows all 128 characters, with their decimal, octal (base-8), and hexadecimal (base-16) code numbers.

The index numbers in the first and last columns are for finding the octal (base-8) and hexadecimal (base-16) values respectively. Replace the arrow with the number or letter from the top of the column (if the arrow points up) from the bottom of the column(if the arrow points down).

Example: The Escape character (ESC) is octal '033 (03 for the row, 3 for the number at the top of the column because the arrow points up) or hexadecimal "1B (1 for the row, B for the letter at the bottom of the column because the arrow points down).

For the decimal value, multiply the Octal row number by eight and add the column number from the top line (that makes ESC 27).

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The same fonts are used here as in the text of the book (see the Introduction on p. xvi) to distinguish between different meanings:

Notation	Meaning
CTAN	Acronyms (small caps in some typefaces)
`\command`	LaTeX control sequences (monospace font)
term	Defining instance of a specialist term (bold italics)
product	program or product name (italics)
environment	LaTeX environment (sans-serif bold)
package	LaTeX package (sans-serif; all available from CTAN)
options	Options to environments (sans-serif oblique)
variables	Variables (monospace oblique)

In the online version, the entries below are all hyperlinked to their source, with subsequent multiple occurrences giving the section number or name. Page or section numbers in **bold type** indicate a defining instance.

Special characters

A

B

C

D

E

F

G

H

I

J

K

L

M

N

O

P

Q

R

S

T

U

V

W

X

Y

Z