Handbook of Typography for the Mathematical Sciences

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To Johann Gutenberg (née Gensfleisch) and Donald E. Knuth.

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PREFACE

Ellen Swanson's book *Mathematics into Type* is a unique and important contribution to the literature of technical typesetting. It set a standard for how mathematics should be translated from a handwritten manuscript to a printed book or document. While Swanson's book was intended primarily as a resource for technical typesetters, it was also important to mathematical and other technical authors who wanted to take an active role in ensuring that their work reached print in an attractive and accurate form.

The landscape has now changed considerably. With the advent and wide availability of TEX,[1] most mathematicians can take a more active role in producing typeset versions of their work. Indeed, many mathematicians currently use TEX to write preliminary versions of their work that are very similar (in many respects) to what will ultimately appear in print.

While the output from TEX has a more typeset appearance than that from most word processors, the TEX product is not automatically (without human intervention) "ready to go to press." There are still "post-processing" typesetting issues that must be addressed before a work actually appears in print. The style and format of running heads, section headings and other titles, the formatting of theorems and other enunciations, the text at the bottom of the page, page break issues, and the fonts and spacing used in all of these go under the name of "page design". These are often customized for a particular book or journal. The index and table of contents must be designed and typeset. Graphics, and sometimes new fonts, must be integrated. Additional questions of style in the formatting of equations and superscripts and subscripts can also arise. Most TEX users *do not know* how to handle the questions just listed, which is why most publishers currently send TEX documents for books or journal articles to a third-party TEX consultant. The purpose of the present work is to serve as a touchstone for those who want to learn to make typesetting decisions themselves.

[1] TEX is a markup language for doing mathematical typesetting. We will talk about TEX in more detail as the book develops.

Let us set out once and for all what this book is *not*. It is not a text for learning TEX. Indeed, *A TEX Primer for Scientists* by Sawyer and Krantz provides a venue for the rapid assimilation and mastery of TEX basics. There is no need to repeat the lessons of *A TEX Primer* here. Instead, the present volume is (in part) a book on how to *use* TEX. But the typesetting principles enunciated here will apply equally well for those whose work is being typeset by a different method. The user of Microsoft `Word`,® for example, will not himself implement (as would a TEX user) the kerning and formatting and page design commands which we discuss in Chapters 2 and 3, but he will communicate with the typesetter about those commands. He will not be able to format equations with the level of precision and detail that we describe, but he will (after reading this book) be equipped with the vocabulary and skills to tell the typesetter what he wants. He will not be importing an encapsulated PostScript® figure into his document in just the manner that we lay out, but he will learn the process and thus be able to ensure that his book or tract comes out in the form desired.

There is no point to mince words. We believe strongly, and we are certainly not alone in this belief, that the medium of choice for producing a mathematical document today is TEX. Most mathematicians use TEX, most publishers use TEX, and most Web sites are set up either to handle TEX documents or to handle files produced from TEX code. TEX code is more portable than the files from any word processor, and its output is of vastly higher quality than the output from any other system available. With suitable plug-ins, TEX can handle graphics beautifully. There is no formatting problem that TEX cannot handle.[2] If you send your work to a journal or a publisher in any electronic format other than TEX (or one of the variants of TEX), then you are only inviting trouble and, in some cases, derision. We hope that this book will serve to convince you of the correctness of all these assertions.

Prerequisites for reading this book are a knowledge of the elements of mathematical writing (for which see, among other sources, *A Primer of Mathematical Writing* by this author) and an interest in mathematical typesetting and graphics issues. We certainly *do not* assume that the reader is an active user of TEX. We include a brief description of TEX and its most basic commands, just because TEX is so much a part of mathematical life today; and also because it is easier to describe some

[2]Consider this typesetting problem: You have an expression that consists of a 3×3 matrix divided by an integral, and you want to typeset it in displayed fashion as a fraction. TEX can perform this task beautifully and easily, with simple and sure commands. Your word processor cannot, nor can any other document preparation system that is available as of this writing. A similar remark applies to commutative diagrams, to tables, and to many other high-level typesetting tasks.

of the typesetting procedures that are essential to mathematics if one can make reference to TEX. In Appendices III and VII we include a compendium of all the TEX commands that are most commonly used in mathematical writing. Appendix VIII contains a sample of TEX code together with the compiled output. The reader who spends some time with the present book will certainly come away with considerable motivation for learning more about TEX.

Likewise, we do not assume that the reader is conversant with the tools for providing his book or manuscript with graphics—such as PostScript or bitmap (`*.bmp`) files or `*.jpg` files or `*.gif` or `*.pdf` files or PICTEX. Instead, we hope to acquaint the reader with these and some of the other graphics options that are available to the mathematical author.

The tools that are now available for creating the index, the table of contents, the list of figures, the bibliography, tables, diagrams, and other writing elements are both powerful and marvelous. We wish to compile here a resource for the author who wants to take control of these portions of the creation of a book or document.

Finally, many a book author today will want his book to contain a computer diskette, or a reference to software that is available on the World Wide Web, or source code for software. We will discuss issues attendant to this part of mathematical writing, and offer some solutions as well.

The reader who becomes acquainted with the present work will be a well-informed author who is equipped to deal with publishers, compositors, editors and typesetters, with TEX consultants, with copy editors, and with graphics designers of every sort. He may not be tempted to perform the various typesetting and formatting and graphical tasks himself, but he will be prepared to communicate with those who do. It is our hope that the result will be an author who has a better understanding of the publishing process, and one who will want to and be able to create better mathematics books.

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Over the years, my friend and collaborator Stanley Sawyer has taught me a great deal about TEX and about typesetting. He was also good enough to read many drafts of the manuscript for this book, and to offer innumerable suggestions. For all of his help and suggestions I am grateful.

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CRC Press has engaged several reviewers to help me hone this book into the precise and accurate tool that it should be. To all of them I express my indebtedness.

My editor, Bob Stern, has been encouraging and helpful in every aspect of the production of this book. He helped me interpret the reviewers' remarks and keep this book on track. As always, thanks.

chapter 1

Basic Principles

1.1 An Overview

The ability to write well is not a gift from the heavens. It is a craft that is honed and developed over time. This assertion is as true for technical writing as it is for prose and poetry. A large part of the craft is the ability to harness one's thoughts and to organize them into sentences, paragraphs, and chapters. Today's technical writer is also involved in the physical process of putting the words on the page. Word processing systems like Microsoft `Word` and computer typesetting systems like TeX put the writer in charge of the composition of the page, the choice of fonts, the layout of section and chapter titles, the design of running heads, and of many other aspects of the book or document as it will finally appear.

Thus the creation of a document in the modern writing environment involves not only the traditional process of organizing one's thoughts, but also planning the form of the document. There are some easy choices that can be made. LaTeX (a dialect of TeX invented by Leslie Lamport)[1] allows you to choose one of several different pre-formatted document styles (in LaTeX 2.09) or document classes (in LaTeX2$_\varepsilon$). As an example, you can choose the `book` document style or document class by entering `\documentstyle{book}` or `\documentclass{book}` as the first line of your TeX source code file. See the sample code in Appendix VIII. Once you have made this choice, many typesetting and page design decisions are automatically made for you. Your sections, subsections, theorems, propositions, definitions, examples, equations, and so forth are all numbered automatically. Every reference to an equation or theorem or other enunciation will be *linked* to that theorem or equation, so that all of your

[1]See Chapter 2 for more information about TeX and LaTeX. Among dialects of TeX, LaTeX is often preferred by publishers because it gives authors fewer choices, and because it is a *structured* language.

references will always be accurate. You will be able to refer to equations and theorems and other items by nickname, and LaTeX will number them automatically; should you move one of these items to a different part of the document, LaTeX will still get the numbering right.

LaTeX2$_\varepsilon$ further allows you to customize your stylistic choice with the `\usepackage` command. Some of the packages that may be invoked are `babel.sty`, `multicol.sty`, `\epic.sty`, and `varioref.sty`. As their titles suggest,

- `babel.sty` gives the choice of several languages in which the document may be typeset.
- `multicol.sty` enables several different multi-column formats. It is much more powerful than the multi-column format of LaTeX 2.09.
- `epic.sty` provides a high-level user interface to the LaTeX picture environment.
- `varioref.sty` provides powerful cross-referencing capabilities.

There are many other packages provided with LaTeX2$_\varepsilon$, and more that you can download from the Web (see Appendix VI).

Please note that non-customized (out-of-the-box) LaTeX styles look grey and dull to many experienced editors, technical writers, and typesetters. Few publishers will publish a manuscript in that form, if for no other reason than that each publisher wants his or her books to have a distinctive look.

In addition, few publishers will simply accept what the author sends in. A copy editor will go through the manuscript and analyze line breaks, page breaks, kerning, spacing, displays, running heads, graphics, choice of fonts, and many other aspects of the manuscript that you might have thought was a finished product. He will think about your syntax, your use of language, your use of specialized terms and jargon, and the precision of your English. If you want to interact on an informed and intelligent level with that copy editor, and if you want your book to come out the way that *you* want it, then it behooves you to learn about these and many other features of the typesetting process.

In many cases, the publisher will send you a TeX or LaTeX style file that will determine the style of the finished product. Suppose, for definiteness, that you are using LaTeX2$_\varepsilon$ and that the style file is called `publstyle.sty`. This file will be "called" at the top[2] of your document

[2] The "top" of your LaTeX source code file—the part that occurs after the `\documentstyle` or `\documentclass` command and before the line `\begin{document}`—is called the "preamble". Various special LaTeX commands *must be placed in the preamble*. Others must occur *after* the preamble.

source or root file (or the first line of each source file if you have different chapters in different self-contained files). In LaTeX2ε, the first two lines will be

```
\documentclass{book}
\usepackage{publstyle}
```

Roughly speaking, the `book.cls` file invoked in the first line makes broad stylistic choices that will apply to most any book. The `publstyle.sty` file invoked in the second line will introduce refined stylistic features. In LaTeX 2.09, the `\input` command may be used in a style analogous to `\usepackage` in LaTeX2ε, but it is considerably less powerful.

Typically, the publisher's style files will specify the size of the print block on the page, fix the margins, fix the formatting of chapter and section and subsection titles, and select fonts for all these features. It will format enunciations (theorems, definitions, etc.), displayed equations, and other features in your writing. It will sometimes add graphical elements like horizontal lines to set off titles. Where suitable, it will also format the bibliography, index, and table of contents. A well-designed page is a delight to behold (and by no means an easy thing to create). Unless you want to spend a great many hours mastering the principles of page design, I urge you to let your publisher design the pages of your book or paper. Even if you think you know how to do it, it is quite likely that your publisher will modify or veto whatever page style you may create.

1.2 Choice of Notation

An important part of planning a document, and one that is special to the writing of mathematics, is choosing your notation. Even the unseasoned mathematical writer will know that notation should be consistent throughout a given work. One should not use the symbol E to stand for a group in Section 2 and for a topological space in Section 7 (unless, of course, the group and the topological space are one and the same entity). But, from the point of view of typography and clarity, there are other issues at play.

Strive for simplicity and elegance in your notation. This dictum sometimes runs counter to the way that a mathematician thinks. For example, it is very natural for a mathematician to use

$$E_{j_1,j_2,\ldots,j_k}$$

to denote an entity (namely, E) that depends on indices $j_1, j_2, \ldots, j_k$. But it is simpler to typeset, and certainly easier to read, the expression

$$E(j_1, j_2, \ldots, j_k).$$

The meaning is unchanged, but the conveyor of the information is simpler. A more extreme, and perhaps more convincing, example is to use the notation

$$E(i_1, i_2, \ldots, i_m; j_1, j_2, \ldots, j_k)$$

in preference to

$$E^{i_1,i_2,\ldots,i_m}_{j_1,j_2,\ldots,j_k} .$$

It is best to avoid stacked accents. They are difficult to typeset, difficult to center properly, and need not be used. They can cause trouble with between-line spacing. For example, in Fourier analysis the embellishment $\widehat{\ }$ is used to denote the Fourier transform. And, if f is a function on $\mathbb{R}$, then the symbol $\widetilde{f}$ is defined by

$$\tilde{f}(x) = f(-x).$$

If one wishes to compose these two operations (as in the standard proof of Plancherel's theorem—see [KRA2]), then one might be tempted to typeset (this is the default in TEX):

$$\tilde{\widehat{f}} .$$

You can see that the tilde is not properly centered over the $\widehat{f}$. And, if you wish, you can blame the software TEX for this clumsiness. But there it is, and adjusting the TEX code to obtain the desired result

$$\tilde{\widehat{f}}$$

is a tedious business. It is simpler, and more attractive, to introduce the notation $\mathcal{I}f(x) = f(-x)$ and then to write $\mathcal{I}(\widehat{f})$ for the composition. One can go further and introduce $\mathcal{F}f$ to stand for $\widehat{f}$. Then the composition becomes $\mathcal{I}\mathcal{F}f$. Some of the stacked accent problems have been fixed in LATEX2$_\varepsilon$.

In a related vein, it is not always convenient, nor aesthetically pleasing, to use $\widehat{f}$ to denote the Fourier transform—especially if the argument is a large expression. Rather than typeset

$$A + \widehat{B + C} + D$$

(note that the $\widehat{\ }$ is far too short) one can typeset

$$\bigl(A + B + C + D\bigr)\widehat{\ }$$

(LATEX2$_\varepsilon$ has special commands for handling this formatting situation). Perhaps even better, you could typeset

$$\mathcal{F}\Bigl(A + B + C + D\Bigr) .$$

The experienced TeX user will know that the Fourier transform's hat and also the tilde come in two forms: there is $\hat{f}$ and $\widehat{f}$, as well as $\tilde{f}$ and $\widetilde{f}$. These are given by the TeX command pairs `\hat{f}`, `\widehat{f}` and `\tilde{f}`, `\widetilde{f}`. It should be noted that, unlike the overbar (given by `\overline`), the Fourier hat and the tilde are not infinitely extendable. There are serious typesetting problems connected with both the shape of and the positioning of hats and tildes. A similar comment applies to the so-called "inverse Fourier transform", or "bird" (the symbol $\check{}$, given by `\check`). The user who needs a wide hat, tilde, or bird will either need to learn METAFONT (in order to manufacture his own) or may be able to find a third-party font which includes these.

Sometimes we do things on the computer just because we can. It is fun to enter the code

```
e^{{a \over b} + {c \over d}}
```

and then to see the compiled outcome

$$e^{\frac{a}{b}+\frac{c}{d}} .$$

But it is much clearer, and less prone to error, to typeset

$$e^{(a/b)+(c/d)}$$

with the fractions typeset in shilling form. Better still is

$$\exp\bigl[(a/b) + (c/d)\bigr]$$

(note the use of parentheses () to help parse the fractions) or

$$\exp\left(\frac{a}{b} + \frac{c}{d}\right) .$$

It is critical when you set a fraction in shilling form to use sufficient parentheses so that the meaning is unambiguous. An expression like $A/B+C$ has two distinct possible meanings. You want either $A/(B+C)$ or $(A/B)+C$.

All notation should strive for simplicity, elegance, and clarity. If F is a function of the matrix argument

$$\begin{pmatrix} a & b \\ c & d \end{pmatrix}$$

then one might be tempted to typeset

$$F\begin{pmatrix} a & b \\ c & d \end{pmatrix} .$$

But it is much clearer to write

> Let
> $$A = \begin{pmatrix} a & b \\ c & d \end{pmatrix}$$
> and consider
> $$F(A) .$$

A final example to round out the message being promulgated here: It may be natural to typeset an expression like

$$\sqrt{\frac{a+b^2}{c+\sin d}}\,\frac{2ab}{a^2+b^2} .$$

In some displayed equations, this format will probably serve; and it is great fun to see the huge square root sign make its appearance. But in many contexts it is clearer, and less intrusive on the neighboring material, to render the formula as

$$\left[\frac{a+b^2}{c+\sin d}\right]^{1/2} \cdot \frac{2ab}{a^2+b^2}$$

or even

$$\left[\frac{a+b^2}{c+\sin d}\right]^{1/2} \cdot \left[\frac{2ab}{a^2+b^2}\right] .$$

See Appendix V for a treatment of various typesetting choices.

This may be the moment to note that you should *never* begin a sentence or a phrase (following a comma, for instance) with notation. For example, never write

> $f(x)$ is a positive function on the interval $[a, b]$.

or

> G is a group of finite order.

Such usage will cause the reader to do a double-take; it will only serve to obfuscate your prose. Better is

> Let f be a positive function on the interval $[a, b]$.

or

> The function f is positive and has domain the interval $[a, b]$.

For the second example, it is preferable to say

We use the notation G to denote a group of finite order.

or perhaps

The group G has finite order.

Observe that, in the first example, we have corrected another common error along the way. The character f is the *name* of the function and $f(x)$ is the *value* of that function. In the present context, it is correct to use "f" rather than "$f(x)$".

1.3 Displaying Mathematics

An important decision, which the mathematical author must make frequently and effectively, is whether to display a mathematical expression or leave it inline (i.e., in text).[3] If the expression is more than one fourth of a line long, then you should usually display it. If it is not complex and if it occurs near the beginning of a paragraph (so that you do not have to worry about line breaks), then you may leave it inline. If it involves more than a few subscripts or superscripts, or if these embellishments are compounded, then you should display it so that it does not interfere with the lines above and below. If it involves integrals which are not completely elementary, or any kind of matrices, then you should display it. It is always better to err on the side of clarity, and therefore better to have too many displays rather than too few. But try to avoid having so many displays that the mathematical exposition becomes harder to follow.

Mathematical writing expert N. J. Higham [HIG] tells us that we should display a mathematical expression when

- it needs to be numbered;
- it would be hard to read if placed inline;
- it merits special attention (perhaps because it contains the first occurrence of an important mathematical entity).

These are excellent guidelines for deciding when to display an item. In the end these decisions must be made by the author—based on meaning,

[3]Here a piece of mathematics is said to be "displayed" if it occurs by itself, separated vertically from the text before and after, and is centered left-to-right. Often, but not always, displayed text will be larger—or at least *appear* larger—than text in the main body of text. If mathematics is not displayed, then it is typeset "inline", which means that it is part of the regular flow of text.

context, and appearance. Refer also to Section 2.5, where more subtle issues of displaying mathematics are discussed.[4]

1.4 Consistency

In fact the planning to which we alluded in the first and second sections can lead to some attractive, and very desirable, consistency. As we will explain in Chapters 2 and 3, the natural way to *execute* the planning of the form of a book or document (at least when you are using TeX) is to write some macros. The creation of a macro is simply the assigning of a name to a collection of commands. The aggregate of commands is then executed by simply invoking the macro name. Thus one creates macros for section heads, subsection heads, chapter headings, running heads, formatting of theorems, formatting of displayed equations, etc. It also makes sense to create macros for complicated mathematical expressions that will be used repeatedly. (See [SAK] for the full picture of macro creation. Here we merely give a couple of simple examples.) As an instance, the line of TeX code[5]

```
\def\smsqr#1#2{\sqrt{{#1}^2 + {#2}^2}
       + \frac{1}{{#1}^2 + {#2}^2}}
```

creates a new TeX command called `\smsqr`. This command accepts two arguments (designated by `#1` and `#2`). The way of TeX is to replace every occurrence of `\smsqr` with the code

```
\sqrt{{#1}^2 + {#2}^2} + \frac{1}{{#1}^2 + {#2}^2}.
```

With this macro definition at the top of your TeX file, entering the line `\smsqr{x}{y}` will result in the typeset expression

$$\sqrt{x^2 + y^2} + \frac{1}{x^2 + y^2} .$$

A second example is a macro for theorems:

```
\def\theorem#1{{\sc Theorem} \ #1: }
```

This is a macro with a single argument (designated by `#1`), which will usually be the number of the theorem. If you place this line of code at the top of your TeX document, then you can invoke the macro with the code

---

[4]It might be mentioned that the command `\displaystyle` allows you to format mathematics in display *size and format* while you are in inline mode; the similar command `\textstyle` allows inline math formatting in display mode.

[5]Refer to Appendix VII for the meanings of the different TeX commands.

```
\theorem{3.5}  Let $\epsilon > 0$.  Let $[a,b]
\subseteq \RR$ be an interval.  There is a function
$f$ such that \dots
```

The result will be the typeset text

> THEOREM 3.5: Let $\epsilon > 0$. Let $[a, b] \subseteq \mathbb{R}$ be an interval. There is a function f such that ...

The nice thing about this macro is that now all your "theorem" declarations will be set in the same font and will have the colon included; you need not remember, nor perform, a check for consistency.

The practice of using macros not only saves time and eliminates aggravation, but it also serves to promote accuracy. By using macros, you will guarantee that size, spacing, indentation, and other features of your composition are maintained uniformly throughout the document.

There are other aspects of consistency about which many authors are blissfully unaware: spacing above and below a displayed equation, spacing above and below a theorem,[6] space after a proof, the mark at the end of a proof (QED, or the Halmos "tombstone" $\square$, for example). Again, a good macro can be invaluable in addressing these issues; but awareness of the problem is also a great asset.

1.5 Overall Design

Proper page design requires an artistic sense and experience that most mathematicians and other technical writers may not have. For this reason, page design is best left to professionals, or at least should only be done with input from professionals. If the publisher provides a set of style macros that you can include at the top of your TeX file (see Section 1.1), then many of the design decisions will already have been made.

Even if you are using style macros provided by the publisher, there are issues of which you should be aware. TeX will not align the bottom lines of facing pages in a book unless the style macros do this explicitly.[7] TeX can be told to prohibit orphans and widows,[8] but this is sometimes

[6]Here, and throughout this book, we use the word "theorem" to denote any displayed body of text, including proposition or lemma or sublemma or definition or remark or any number of other similar constructions. It is common among typesetters to call these "enunciations", and we will use that terminology as well.

[7]The two pages of production notes in the classic [GMS] discuss the rather clever and technical means by which these three very skilled authors had to hand-correct decisions made by LaTeX. Almost all of these corrections concerned page breaks.

[8]Here an orphan is a brief phrase—less than a full line—that occurs at the bottom of a page and that begins a new paragraph. A widow is a brief phrase—less than a full line—that occurs at the top of a page and that ends the preceding paragraph.

not done because it can cause problems elsewhere. A chapter should not end on a page with fewer than four lines from that chapter. A section heading should be followed by at least two lines of text of the new section *on the same page*. At some stage it will be necessary for someone to go through the manuscript by hand and correct problems of this kind. (With many publishers, this "someone" will be the author.)

Likewise, TeX can be clumsy with line breaks. If TeX gets jammed up trying to fit just the right number of words into a line, or if it encounters an unfamiliar word that it cannot figure out how to hyphenate, then it may break a line in an inauspicious place—in fact, TeX may leave too much space between words or not enough. Worse, it may run part of a word or formula out into the margin.[9] TeX treats certain formulae in math mode as unbreakable units; it is easy to see that such a rigid chunk of typeset text can also be run out into a margin—resulting in an unsightly paragraph and page. It is best if the author is the one to deal with a problem such as this, because it is sometimes necessary to rephrase or rewrite a sentence or paragraph to make things come out as they should. You certainly do not want someone else rewriting your material just to make the typesetting come out right![10]

As we have suggested, things become a bit easier once you have a publisher. The publisher will then provide a TeX style file or (the old-fashioned approach) a hard-copy style manual. If you do not yet have a publisher, then you should avoid the temptation to be seduced by TeX (or whatever document preparation system you are using) into writing an overly complex source file. You should either use the simplest choices in a standard TeX dialect (like Plain TeX, LaTeX, AMS-TeX, or AMS-LaTeX), or else make sure that your style macros are well-designed and very well-documented. Otherwise, your eventual publishers may accuse you of "freestyling", which suggests a TeX file with rigid or non-uniform stylistic choices and TeX source that is incomprehensible except perhaps to you. If you are guilty of freestyling, then it can be extremely difficult for either the publisher or yourself to translate your work into publishable form.

At the risk of belaboring this last point, let us mention a few examples. Some authors go to great pains to have each chapter, or each section, begin with a dropped gothic capital letter. Or they format pages in two or three columns. Or they equip the left-hand pages with a running

[9]The habit of TeX is to place a black box in the margin next to a line that has not been typeset according to TeX's standards. You can adjust or weaken the standards, and thereby eliminate some of the black boxes. Usually it is better to eliminate the boxes by learning to be a better TeXnical typesetter.

[10]George Bernard Shaw tells of rewriting sentences or passages in his plays in order to satisfy the typesetter, and then the typesetter getting things wrong anyway.

head and the right-hand pages with a running foot. Or they use very exotic fonts. Or they may place the page numbers (the folios) in strange places, set in peculiar fonts. All very charming, but no publisher will want to preserve and to propagate these whimsies. You make everyone's life easier if you eschew the eccentric and stick to the most basic constructions. This advice is valid for the Plain TEX user, for the LATEX user, for the Microsoft Word user, and for every other user of electronic tools.

chapter 2

Typesetting Mathematics

2.0 Introductory Remarks

When mathematical formatting works well, we are hardly aware of it. What we see is what we expect to see: there is a smooth transition from what is printed on the page to what the eye sees to the cognitive processes of the brain.

When one is creating typeset mathematics, one must be aware of the components of good typesetting, so as best to effect the attractive process just described. In particular, one must be aware of the issues of spacing and positioning that control the clarity and meaning of mathematical expressions.

In this chapter, we discuss such issues. While we will often invoke TEX in this chapter, such invocations are generally self-contained. As you read along, you will want to refer to Appendices III, VII, and VIII, which are designed to speed along your acquaintance with TEX. Certainly this book will tell you enough about TEX so that you will find everything that we discuss comprehensible, and so that it will travel well to whatever document preparation system you are using.

2.1 What is TEX?

TEX is a computer package for producing document output of typeset quality. TEX is a computer typesetting language—a high-level computer programming language. It is used by individuals to write letters and articles with a personal printer as well as by technical publishers to typeset mathematics books on a Varityper 6000 or a Linotronic 630 or other electronic typesetting device. TEX is particularly powerful and useful for preparing manuscripts with mathematical formulas and tables. Since being invented and introduced by Donald Knuth in the early 1980s, it is now almost universally used by mathematicians to typeset mathematics, and is also widely used in areas of science and engineering that emphasize mathematics.[1]

Part of the reason for TeX's long life and wide use is that it implements a "markup language" instead of creating output on a computer screen as you enter it. The computer file that you write for a manuscript is a text or ASCII file that contains commands that describe in more-or-less plain English terms how you want the pages formatted and what mathematical symbols you want to use. Viewing output as it might be printed is a separate step. This has the advantage that your computer source file is independent of improvements to your computer hardware. Currently laser printers have around 1200 dots per inch or around 10,200 horizontal dots per page, while most current computer monitors go up to at most 1200 or 1600 horizontal dots per screen. So you can see that, from the outset, screens display material to a different tolerance than the printer will print it. With the help of its markup commands, TeX positions elements on the printed page to within 10^{-6} of an inch. In effect, the TeX code mandates *exactly* how you want the document to look. The screen provides an approximation to this truth, usually suitable for accuracy checking. Depending on the quality of your printing device, the printer will give a hard-copy rendition of the ideal document dictated by the TeX code. The superb degree of accuracy of which TeX is capable should protect TeX from obsolescence for many decades to come.

Fortunately, you do not have to decide yourself how to position each character on the printed page to within a millionth of an inch. TeX makes most of these decisions itself. You can use TeX commands to customize these decisions, but this is usually not advisable unless you have a considerable amount of experience with either typesetting or TeX. However, as we described in Chapter 1, there are a number of situations where human intervention is necessary for highest-quality output. One of the main purposes of this book is to explain what those situations are and how to deal with them, or else how to communicate with a copy editor and/or typesetter so that he or she can deal with them.

Like many languages that have been around for some time, TeX has a number of dialects. The most common dialects are LaTeX, Plain TeX, AMS-TeX, and AMS-LaTeX. These are roughly as close as American English and English English, with Plain TeX being slightly more divergent. Computer installations that support one of these dialects will generally support all four.

[1] In fact, TeX has been used by law offices and even by the periodical *TV Guide*. The portability—in the large and in the small—of TeX make it a powerful and versatile tool.

A note about pronunciation: TeX is pronounced as in "technical," not as in "Texas". Many purists pronounce the final "X" like the "ch" sound in German or Scottish, but a simple "k" sound is more than sufficient. The most common pronunciation of LaTeX is `lay′-tek`, presumably in analogy with the word "latex" in "latex gloves". Some people, however, enjoy saying `lah′-tek`.

A command or special symbol in TeX is typically an alphanumeric word preceded by the symbol \ (the "backslash"). Some examples are[2]

```
\alpha , \parindent , \vskip.35cm , \bigtriangleup ,
\matrix , \biggl , \kern-.2in
```

A more complete list of TeX commands appears in Appendix VII; see also Appendices III and VIII. Ordinary words are entered as text, just as they would be with a typewriter or a word processor. In the remainder of this chapter we shall provide a more detailed picture of TeX.

2.2 *Methods of Typesetting Mathematics*

In today's world, there are basically five types of mathematical typesetting:

(1) *Cold type typesetting:* This is the most traditional form of the art, used for centuries. Characters, diphthongs, accents, and spaces are actualized in pieces of lead. These lead slugs are positioned in a rack, and that rack serves as the initial printing plate.

(2) *Photoelectric typesetting:* The typesetter works from a keyboard, and his output is actualized on film. From that piece of film, an image is produced on a copper or zinc plate. The plate is etched, and becomes the printing plate.

(3) *Paper tape typesetting:* This is a variant of **(2)**, in which the output is on a stream of paper tape (known in the industry as "idiot tape"). The tape is then used—as in a Turing machine—to operate either a phototypesetting or metal typesetting machine.

(4) *Camera-ready copy:* The manuscript is produced by typewriter, word processor, calligraphy, or other means. It is photographed,

[2]The first command typesets the Greek letter α, the second is for paragraph indentation, the third is a vertical space of size .35 centimeters, and the fourth is a large triangular symbol ($\bigtriangleup$) like the Laplace operator. On the second line, the first command is for forming a matrix, the second controls the size of a left delimiter, and the third moves the point of typesetting 0.2 inches to the left.

and then the photographic image reproduced on a copper or zinc plate. The plate is then etched, and becomes the printing plate.

(5) *TEX:* The work is produced in TEX computer code. The source file is compiled and a `*.dvi` file produced. The `*.dvi` file is translated to PostScript. The PostScript file is used to make an image of each page on film. The film is then used to produce an image on a copper or zinc plate. The plate is etched and becomes the printing plate.

Of these five techniques for mathematical typesetting, **(5)** is becoming the most prevalent. This book will concentrate on ideas and techniques connected to **(5)**.

2.3 A Lightning Tour of TEX

When you create a document with a word processor, you enter text and perhaps mathematical formulas (using suitable syntax) from a computer keyboard; the code then appears on a CRT or computer screen. The word processor formats your text as entered, perhaps with right justification (i.e., alignment at the right margin) if desired.

Most word processors have poor capabilities for typesetting mathematics. On the positive side, most word processors are essentially WYSIWYG ("What you see is what you get."). Whatever you see on the screen is more-or-less what is printed, although individual text characters or graphics may be printed at a higher pixel resolution.

TEX is more sophisticated. It gives you microscopic control over formatting. With TEX, as in other high-level word processors, you can print your page in multiple columns, flow text around a graphic or chart, and import multiple fonts and typeset them in a bewildering array of sizes and positions. TEX will give you more control over positioning and sizing than will any other document preparation system. TEX has more fonts and (with METAFONT) the ability to create fonts without limit. But, most important for the mathematician, you can integrate mathematics[3] into your work and have complete control over the outcome. You also can integrate and manipulate graphics in TEX in a variety of useful and convenient formats.

From the point of view of portability, TEX has a decided advantage over word processors. First of all, TEX is virtually platform-independent.

[3]You can download utilities from the Web to tackle a variety of very complex diagrams (mathematical commutative diagrams and others), as well as chemical charts, Feynman diagrams, tables, graphs, bar charts, histograms, chess problems, musical scores, and many other challenging typesetting tasks. See Chapter 7 and Appendix VI for details on Web resources.

$$\texttt{myfile.tex} \;\rightarrow\; \texttt{myfile.dvi} \;\rightarrow\; \begin{cases} \text{directly to printer} \\ \text{directly to computer screen} \\ \texttt{myfile.hp} \text{ or other file that can} \\ \quad \text{be understood by your printer} \\ \texttt{myfile.ps} \text{ (a PostScript file for} \\ \quad \text{various output devices)} \\ \texttt{myfile.pdf} \text{ (Acrobat}^{®} \text{ file)} \end{cases}$$

Figure 2.1

You can enter your TeX code (into an ASCII file called `myfile.tex`, for example) on a PDP-11, compile it on a Macintosh,® and preview it on a Pentium machine. But it is portable in another important sense: if you set up a complicated display in TeX, then you can copy or transfer that piece of TeX code to another part of your document or to another document altogether and the result (in the compiled output) will be unchanged. This sort of "translation-invariance" does not obtain with word processors. Because a word processor has hidden formatting commands, cutting and pasting often corrupts the formatting of text, and you must waste time fiddling around and re-formatting. That will never happen with TeX.

An effective TeX user must learn to read many TeX commands and TeX code contexts and understand what they say and what effect they have on the printed output. He must also learn the concepts that underpin the basic logic by which TeX operates, and the fundamental commands that select a typesetting operation and then implement it.

We begin by diagraming the logic of creating a TeX document. Suppose that you are creating a business report. You might entitle the source code file `myfile.tex`. Although it is not mandatory, you will usually find it more convenient to give your source code file the three letter extension `.tex` in its name. Here `myfile.tex` is the file that you write in a text editor or word processor.[4]

The file `myfile.tex` is called the TeX source file, and contains TeX commands and unformatted text as you have entered it. A software engineer might view `myfile.tex` as analogous to the source code file for

[4]This file should be a straight text or ASCII file. In Microsoft `Word`, the file should be saved as either "Text Only" or "Text Only with Line Breaks". Other word processors might require "non-document mode" or "ASCII with carriage returns and line feeds." If you are using a text editor that is part of an integrated TeX package, then it will write plain ASCII output files by design and you need not worry. Many dedicated TeX users use one of the standard programmer's editors: `emacs` or `vi` on a UNIX system, or `epsilon` or `crisp` on a PC.

a FORTRAN or C or Java computer program. Unlike a word processor, TEX does not *emulate* the ultimate page of output; instead, TEX issues formatting commands that specify where and how the page elements will appear.

Refer to Figure 2.1. The first arrow in the diagram represents the "compile" operation, which converts the source code file to a `*.dvi` file (this latter is the binary file that carries all the machine-coded information about your document). The binary codes in this file resemble codes that might be sent to a printer or computer screen, but are in a language that is independent of any specific printer or computer. In this sense, the compiled file is "device independent" (hence the name `myfile.dvi`), and is usually called a `*.dvi` file for short. The information in the `*.dvi` file specifies positions on the printed page within 10^{-6} of an inch (in particular, it thinks of each character or typesetting element as occupying a box, and records the dimensions and position of each such box), and also has information that determines line breaks, page breaks, between-line and between-paragraph spacing, what fonts should be used, and other formatting specifications.

Software is available for most all modern (personal) computers to interpret TEX `*.dvi` files. In particular, you can create `myfile.dvi` on a Macintosh or UNIX computer, display it on a DEC Alpha, and then print it on an Intel Pentium machine. This platform universality is a second reason for the long life of TEX. If you buy a new computer or upgrade your computer hardware, you merely must make sure that you have a text editor, that the TEX program (that converts `myfile.tex` to `myfile.dvi`) works on your new computer, and that you have screen and printer programs that can display `*.dvi` files.[5] These steps taken together are generally easier than porting an entire integrated word-processing package to a new machine. Such a word processor will certainly be platform-dependent, and its data files will not travel well.

The second arrow in Figure 2.1 represents some of the things that you can do with a `*.dvi` file. (Printing or screen display refers to the typeset output, not the literal TEX commands and text in `myfile.tex`.) Current printers generally have much finer resolution than current display devices (see Section 2.1). Most screen preview programs have magnification features to make it easier to see fine detail. Some TEX preview programs display smaller characters more coarsely to make them easier to read. This is sometimes called "hinting," and is not used if that part of the

[5]If you are a real hacker, then you can actually obtain the C and Pascal source code for TEX and compile it on any machine you like. Most of us will instead obtain a suitable version of TEX, for whatever machine we may wish to use, from a commercial vendor or from the Web. Appendix VI discusses Web sites that offer public domain versions of TEX for a variety of platforms.

screen output is sufficiently magnified. Other preview programs do not use hinting. This makes the output more attractive and closer to what would be printed, but also makes smaller characters harder to read.

There are some TeX programs that write output files directly in Adobe PDF® format instead of `*.dvi` format. There are also widely-used computer programs that convert `*.dvi` files to either Adobe PostScript or PDF format. One advantage of PDF and PostScript files is that they generally contain complete font information, while `*.dvi` files do not (the `*.dvi` file only records a sequence of boxes). This has the advantage that screen display and printer programs do not need access to font information in auxiliary files. However, displayed or printed PDF or PostScript files can be noticeably cruder if they are displayed or printed at a different resolution than that of their embedded font information (unless the user is smart enough to use scalable fonts).[6]

2.4 *The Guts of TeX*

In this section, we discuss some of the types of commands and text that can go into a typical TeX source file. This is meant as part of a brief overview of what can go into a `*.tex` file. See references such as [SAK], [KNU], [LAM], or [GMS] for more detail. Also refer to Appendices III, VII, and VIII.

Text: Literal text that you want to appear in your printed output. This is entered directly into the source file, just as with typewriter or traditional word processor. For example, if you enter the text

```
The cat with a bat saw a rat take a hat off the mat.
```

then the sentence

The cat with a bat saw a rat take a hat off the mat.

will appear in your output—either on screen or on the printed page.

You begin a new paragraph by leaving a blank line in your source code. TeX will understand that all the material appearing in an aggregate clump—without vertical spacing—is a paragraph. No matter how you type it, with any number of words on a line and any number of spaces between words, TeX will collapse an positive number of spaces into a single space and will calculate the correct number of words to put on a line. It will format the text into paragraphs in a highly professional way, and will also hyphenate words if need be.

[6] Refer to Appendix VI for some URLs where PostScript resources can be obtained.

Fonts: A font is a style of type. According to [GMS], a font has five attributes:

- monospaced or proportionately spaced
- serif or sans serif
- shape
- weight
- width

Perhaps a word of explanation is in order.

On a traditional typewriter, the font is "monospaced." This means in effect that each character occupies the same amount of horizontal space. If you think about how a typewriter mechanism works then monospacing makes a lot of sense: after you strike each key, the carriage moves by a pre-determined amount of space. So of course each character (from "i" to "m" to "w") must have the same width. But genuine typesetting is not monospaced; it is *kerned*. This means that the way space is set around a given character depends both on that character and on what characters are its neighbors. Certainly one of the characteristic features of TEX is that it is *not* monospaced; TEX is a full-featured typesetting system and each character comes equipped with complete information as to how it should be typeset against every other character.

A serif on a character is a small embellishment (a perpendicular cross) at the end of one of the main strokes that composes the character. The roman character "I" has two serifs: one at the top and one at the bottom. The roman character "R" has three serifs.[7]

The attributes "shape" and "width" are self-explanatory.

The "weight" of a character describes the thickness of the strokes that make up the character. For example, a boldface **b** is composed of thicker strokes (i.e., has more weight) than a roman b.

The size of a font is generally specified in points (where a typesetter's "point" is about $\frac{1}{72}$ of an inch), but other units are sometimes used. The Glossary defines a number of different typesetter's units of measure.

In TEX, and in other typesetting situations, the word "font" can also refer to the size of the type (measured in points). Some of the standard fonts are roman, **boldface**, and *italic*. These are normally from the Computer Modern font family in TEX, but some TEX implementations

[7] A useful font for some applications is the "sans serif" style of font. As the name suggests, the characters in such a font have no serifs. The phrase This is a sans serif font is set in sans serif. We sometimes use sans serif for abstracts, headings, and displayed statements. Some people like to use sans serif in business correspondence.

use Times Roman or Lucida or other popular fonts. Other common TEX fonts are BIG CAP-SMALL CAP, *slanted roman*, and `typewriter-like`. Today there are many hundreds of fonts available for TEX. These include bitmap fonts, outline fonts, PostScript fonts, METAFONT fonts, and other types of fonts. The books [SAK] and [GMS] contain a thorough discussion of fonts.

The default font in TEX is (Computer Modern) roman. (The basic Computer Modern fonts were created by D. Knuth at the time that he created TEX.) Most of the words in this paragraph are typeset in roman. This is the font that TEX uses in text unless you enter TEX commands that mandate otherwise. In LATEX 2.09, to typeset a phrase in (for example) boldface, isolate the phrase with braces and put the command `\bf` just after the opening brace. Thus the TEX code

```
As you can see, {\bf this is boldface} text.
```

produces the output

As you can see, **this is boldface** text.

Similarly, you can use the commands `\it`, `\sc`, `\sl`, and `\tt` (inside matched braces) to typeset (respectively) text in italics, big cap-small cap, slanted roman, and typewriter-like fonts.

LATEX2ε has a more sophisticated protocol for invoking fonts other than the default roman. Although LATEX2ε will recognize the LATEX 2.09 commands, there are advantages to using the new command (to obtain boldface, for example)

```
As you can see, \textbf{this is boldface} text.
```

The output is of course the same. In order to keep the logic straight, you must keep in mind that (among other things), LATEX2ε is a superset of $\mathcal{AMS}$-TEX, and $\mathcal{AMS}$-TEX now has distinct commands for boldface in text mode and boldface in math mode. The new `\textbf` command works in both text and math modes, and in all versions of TEX. It has other sophisticated capabilities which are best learned by reading [GMS]. Of course there are analogous commands for italic (instead of the LATEX 2.09 command `\it` one uses the LATEX2ε command `\textit`), and the more sophisticated LATEX2ε command even takes into account the special spacing requirements that the built-in slant of italic characters requires. The even more sophisticated LATEX2ε command `\bfseries` calls in not just one font but a whole series of fonts. We again refer the reader to [GMS] for the details of these subtle and powerful commands.

A curiosity in TEX is that it offers “old style” numerals for specialized applications. These are contained in the font `cmmi10`. A sample of such numerals is $\oldstyle{1234567890}$.

Formatting Mathematics: In TEX, learning the commands for different mathematical symbols is easy. It is the formatting that is difficult. We will treat only the most elementary formatting questions here.

Although you may never have explicitly noted the fact before, spacing in text is done differently from spacing in mathematics. Thus TEX has two environments: the text environment and the mathematics environment. The text environment is the default: just start entering ASCII code, with no special commands, and you are in the text environment. There are two slightly different mathematics environments: *inline* and *display*. To enter the inline mathematics environment, type `$` and then begin your mathematics. Type a terminal `$` when you are done. To enter the display mathematics environment, type `$$` and then begin your mathematics. Type a terminal `$$` when you are done. For instance, the TEX code

```
Let $y = x^2 + 2 + \int_1^x t\sin t\,dt$.   That says it.
```

produces the typeset output

Let $y = x^2 + 2 + \int_1^x t \sin t\,dt$. That says it.

In contrast, the TEX code

```
Let $$y = x^2 + 2 + \int_1^x t\sin t\,dt.$$  That says it.
```

produces output with the formula in display math mode:

Let

$$y = x^2 + 2 + \int_1^x t \sin t\,dt.$$

That says it.

Since TEX has more room (vertical and horizontal space) in display mode, it uses a larger integral sign in the integral and a less-cramped style for upper and lower limits on the integral.

To keep your source file from getting too cramped, it is better to enter code for display math as

```
Let
$$
y = x^2 + 2 + \int_1^x t\sin t\,dt .
$$
That says it.
```

The effect to TEX is the same, but the source file will be much easier to read.

Many TeX gurus recommend an alternative method for designating math mode. For inline math mode, the usage (instead of `$   $`) is `\(f(x) = x^2 + 3\)` and for displayed math mode, the usage (instead of `$$   $$`) is `\[f(x) = x^2 + 3\]`. One advantage of these notations is that they are *oriented*: the user can tell the left delimiter from the right; this fact will presumably help to reduce errors, and help to find them when they occur.

Mathematical Symbols: Many different technical symbols are used in mathematics. See also Appendices III, VII, and VIII. The TeX commands for these symbols are mostly straightforward to learn. The following chart will get you well on your way to typesetting mathematics.

TeX Code	Typeset Result
`\alpha`	α
`\beta`	β
...	...
`\omega`	ω
`\Gamma`	Γ
`\Delta`	Δ
...	...
`\Omega`	Ω
`\int_a^b f(x) \, dx`	$\displaystyle\int_a^b f(x)\, dx$
`{d \over dx}`	$\displaystyle\frac{d}{dx}$
`A_j^m`	A_j^m
`\sum_{j=1}^\infty a_j/b_j^2`	$\sum_{j=1}^\infty a_j/b_j^2$
`\pmatrix{ a & b \\ c & d}`	$\begin{pmatrix} a & b \\ c & d \end{pmatrix}$
`{a+b \over c} \leq {E^x \over s^y}`	$\displaystyle\frac{a+b}{c} \leq \frac{E^x}{s^y}$
`\overline{\partial} u = \nabla g`	$\overline{\partial} u = \nabla g$

Observe that `&` is used as TeX's alignment character. If you need the actual symbol &, then enter the TeX code `\&`.

Aligned Equations: Equations that are aligned at an equality or inequality sign are common in mathematical writing. The TEX commands for typesetting aligned equations vary slightly with the TEX dialect. In LATEX, the code

```
\begin{eqnarray*}
    y &=& (x+2)(x+5) - (x+1)(x+6) \\
      &=& x^2 + 7x + 10 - (x^2 + 7x +6) \\
      &=& 4 .
\end{eqnarray*}
```

produces the output

$$\begin{aligned} y &= (x+2)(x+5) - (x+1)(x+6) \\ &= x^2 + 7x + 10 - (x^2 + 7x + 6) \\ &= 4. \end{aligned}$$

LATEX, by default, generates equation numbers for all equations in an array. The `*` in `\begin{eqnarray*}` and `\end{eqnarray*}` suppresses the equation numbers. If you enter instead

```
\begin{eqnarray}
    y &=& (x+2)(x+5) - (x+1)(x+6) \\
      &=& x^2 + 7x + 10 - (x^2 + 7x +6) \nonumber \\
      &=& 4 .
\end{eqnarray}
```

then the output becomes

$$\begin{aligned} y &= (x+2)(x+5) - (x+1)(x+6) \qquad (2.1) \\ &= x^2 + 7x + 10 - (x^2 + 7x + 6) \\ &= 4. \qquad (2.2) \end{aligned}$$

In Plain TEX or $\mathcal{AMS}$-TEX, the code

```
$$
\eqalign {
    y &= x^2 + 2x + 17 \cr
      &\le w^3 + 4 w^{A \otimes B} \cr
      &\equiv z\times w \cr }
$$
```

is typeset as

$$\begin{aligned} y &= x^2 + 2x + 17 \\ &\le w^3 + 4w^{A\otimes B} \\ &\equiv z \times w. \end{aligned}$$

For equation numbers, enter

```
$$
\eqalignno {
     y &= x^2 + 2x + 17    &(17)\cr
       &\le w^3 + 4 w^{A \otimes B} \cr
       &\equiv z\times w .  &(18)\cr }
$$
```

The output is

$$
\begin{aligned}
y &= x^2 + 2x + 17 && (17)\\
&\le w^3 + 4w^{A\otimes B}\\
&\equiv z\times w. && (18)
\end{aligned}
$$

To put the equation numbers on the left, replace `\eqalignno` by `\leqalignno`.

Many people like to put their equation numbers on the left. Others like to put them on the right. The wisdom among typesetters is that the equation number is less important than the equation itself. As a result, the recommendation is that the label come *after* the equation (i.e., on the right).

Finally, choose a system for numbering your equations that is transparent, and makes it easy to find equations. The reference [KRW] discusses this matter in greater detail.

2.5 Modes of Typesetting Mathematics

There are two standard formats for mathematics on the typeset page: inline mathematics and displayed mathematics. Inline mathematics is part of the body of text; displayed mathematics is set off from the text. In broad strokes, they are very much the same—except that the displayed math is sometimes larger overall. Let us now discuss, in some detail, their similarities and differences.

Similarities: The default in TEX (for example) is to put (essentially) no spaces between characters in either of the math modes. This point must be clarified. If you enter the code `$The cat sat in the hat.$`—putting an English sentence in math mode—then the typeset output will be

$$The cat sat in the hat.$$

Not only is the font incorrect, but the standard between-word spacing is gone. TEX is actually very smart at finding the correct spaces to put between symbols in math formulas (for example the spaces around a $+$ sign, or the space just to the right of an integral $\int$ sign). But some spaces (for example just before the dx in an integral) must be hand-inserted by the user or typesetter. And, by default, the characters are set in a font called *math italic*. If you look in any mathematics monograph, you will confirm instantly that the font in mathematical formulas is different from the roman font used for text.

Differences: Displayed math will be generally larger than inline math. That is, certain components, such as integral signs and summation signs will be larger. The result is that an expression in displayed math mode will appear altogether larger than that same expression in inline math mode. The text itself in a math display will be the same size as ordinary text.

A more interesting difference is in the way that sums and integrals and other mathematical artifacts with labels above and below are typeset. Consider the following examples:

	Inline Mode		**Display Mode**
(1)	$\textstyle\sum_{j=1}^{10} a_j$	vs.	$\displaystyle\sum_{j=1}^{10} a_j \quad .$
(2)	$\textstyle\int_a^b f(x)\,dx$	vs.	$\displaystyle\int_a^b f(x)\,dx \quad .$
(3)	$\textstyle\cup_{j\in\mathcal{A}} S_j$	vs.	$\displaystyle\bigcup_{j\in\mathcal{A}} S_j \quad .$

In each instance, the displayed version is more attractive in its layout, and easier to read. But it is also clear that such a user-friendly display would not work in inline mode, because the limits above and below would interfere with the text in the adjacent lines. That is why the inline mathematics mode has such labels *adjacent* to the carrier rather than above and below it.

2.6 Line Breaks in Displayed Mathematics

It is often the case that a displayed mathematical formula, or string of inequalities, cannot fit comfortably on one line. Compare the display

$$(x+3)^4 = x^4+12x^3+54x^2+108x+81 = x\Big[108+x\big[54+x(12+x)\big]\Big]+81$$

with the much more readable display

$$\begin{aligned}(x+3)^4 &= x^4+12x^3+54x^2+108x+81 \\ &= x\Big[108+x\big[54+x(12+x)\big]\Big]+81.\end{aligned}$$

In practice, it is best to disabuse oneself of the idea that a displayed equation belongs on one line, and instead to think in terms of displaying mathematics in multi-line chunks. In TeX, this means to think in terms of the command `\eqalign{    }` and in LaTeX it means to think in terms of `\eqnarray{    }` rather than the displayed math command `$$ ... $$`.

In substantive mathematical discourse, very long and complicated equations are quite common. The issue therefore arises of how to break a long equation across a line.

The first choice is to break at a "verb" connective. Our last example showed breaks at $=$ signs, and breaks at $\leq$ or $\geq$ or similar connectives are very natural and easy to read. But it is sometimes necessary to break at connectives like a $+$ or $-$ sign, or perhaps in the middle of a product of two large expressions. We now discuss, by way of some examples, how best to do this.

EXAMPLE I: The break

$$\begin{aligned}(x+2y)^6 = x^6 &+ 12x^5y+60x^4y^2+160x^3y^3 \\ &\qquad +240x^2y^4+192xy^5+64y^6\end{aligned}$$

is more attractive than either

$$\begin{aligned}(x+2y)^6 = &\ x^6+12x^5y+60x^4y^2+160x^3y^3 \\ &+240x^2y^4+192xy^5+64y^6\end{aligned}$$

or

$$\begin{aligned}(x+2y)^6 = &\ x^6+12x^5y+60x^4y^2+160x^3y^3+ \\ &240x^2y^4+192xy^5+64y^6.\end{aligned}$$

First of all, it is a good idea to indent the second line, so that the reader's eye is signaled of a continuation. Second, it is recommended to place the plus sign on the second line so that the reader knows that the line is a continuation.

$$A^3 + \frac{xy^2 + e^x + 7\log B}{-4xy^3 + zw^2} = \left(\frac{\operatorname{erf}(s+t) - \cosh t^3 p}{s + \frac{a+b}{c}}\right)$$
$$\times \left(x^2 - 4y \cdot \frac{x + w - \tan\theta}{\ln(3t) + 2w\cos\psi + \arg(\tau)}\right)$$

is more attractive than either

$$A^3 + \frac{xy^2 + e^x + 7\log B}{-4xy^3 + zw^2} = \left(\frac{\operatorname{erf}(s+t) - \cosh t^3 p}{s + \frac{a+b}{c}}\right)$$
$$\times \left(x^2 - 4y \cdot \frac{x + w - \tan\theta}{\ln(3t) + 2w\cos\psi + \arg(\tau)}\right)$$

or

$$A^3 + \frac{xy^2 + e^x + 7\log B}{-4xy^3 + zw^2} = \left(\frac{\operatorname{erf}(s+t) - \cosh t^3 p}{s + \frac{a+b}{c}}\right)$$
$$\cdot \left(x^2 - 4y \cdot \frac{x + w - \tan\theta}{\ln(3t) + 2w\cos\psi + \arg(\tau)}\right)$$

or

$$A^3 + \frac{xy^2 + e^x + 7\log B}{-4xy^3 + zw^2} = \left(\frac{\operatorname{erf}(s+t) - \cosh t^3 p}{s + \frac{a+b}{c}}\right)$$
$$\left(x^2 - 4y \cdot \frac{x + w - \tan\theta}{\ln(3t) + 2w\cos\psi + \arg(\tau)}\right).$$

First of all, it is a good idea to indent the second line, so that the reader's eye is signaled of a continuation. Second, it is best to include the initial $\times$ on the second line so that the reader knows that the line is a continuation. Third, the multiplicative $\cdot$ is hard to read and too easily misinterpreted. Last, while juxtaposition of two expressions is commonly interpreted in mathematics to mean multiplication, that meaning is lost when the two expressions occur on different lines.

As mathematicians, we have the ability to use notation as a weapon. This device is exploited with insufficient frequency. For instance, in the last example one could write

Let

$$\alpha = \frac{\operatorname{erf}(s+t) - \cosh t^3 p}{s + \frac{a+b}{c}},$$

$$\beta = x^2 - 4y \cdot \frac{x + w - \tan\theta}{\ln(3t) + 2w\cos\psi + \arg(\tau)},$$

and

$$\gamma = \frac{xy^2 + e^x + 7\log B}{-4xy^3 + zw^2}\,.$$

Then

$$A^3 + \gamma = \alpha \cdot \beta\,.$$

EXAMPLE III: If the material in your display is grouped with parentheses ( ), or braces { }, or brackets [ ], then it is best to keep matching pairs on the same line. But if the expression between delimiters is quite long and complicated, then it may be necessary to break it. Doing so, you want to be certain that the left and right delimiters match (in both size and shape), and that they are easily and quickly paired up in the reader's eye. Thus it is best to make them a bit larger than is perhaps necessary. For example, the displayed expression

$$\begin{aligned} y + x^2 = \biggl\{ & \frac{x-y}{x+2y} - \frac{a-b}{a+2b} \cdot \frac{m+n}{m-n} \\ & + \frac{s+t}{s-4t} \biggr\} \cdot 16w^4 \end{aligned}$$

is much easier to read than

$$\begin{aligned} y + x^2 = \{ & \frac{x-y}{x+2y} - \frac{a-b}{a+2b} \cdot \frac{m+n}{m-n} \\ & + \frac{s+t}{s-4t} \} \cdot 16w^4 \end{aligned}$$

or

$$\begin{aligned} y + x^2 = \bigl(& [x-y]/[x+2y] - \{[a-b]/[a+2b]\} \cdot \{[m+n]/[m-n]\} \\ & + [s+t]/[s-4t] \bigr) \cdot 16w^4. \end{aligned}$$

It is helpful to have the material on the second line shorter than the material on the first—so that the second line looks like an appendage (which is the effect that you *want*).

EXAMPLE IV: If a displayed expression is *very long*, then it will have to be broken into several lines (not just two). In such a case, alignment and judicious use of indentation can be of great assistance to clarity. For example,

$$
\begin{aligned}
y + \frac{a+b+c}{a-b+2c} &= \frac{a-b-c}{a+b-2c} + \frac{d+b-c}{a-d+2c} \\
&\qquad\qquad + \frac{a+f+c}{a-b+2g} - \frac{h+b+k}{a-k+2\ell} \\
&\qquad\qquad - \frac{\ell+f+m}{a-n+2z} - \frac{r+b+q}{a-k+2p} \\
&\leq x^2 + 3y + 7
\end{aligned}
$$

is much clearer than

$$
\begin{aligned}
y + \frac{a+b+c}{a-b+2c} &= \frac{a-b-c}{a+b-2c} + \frac{d+b-c}{a-d+2c} \\
&\qquad + \frac{a+f+c}{a-b+2g} - \frac{h+b+k}{a-k+2\ell} \\
&\qquad - \frac{\ell+f+m}{a-n+2z} - \frac{r+b+q}{a-k+2p} \\
&\leq x^2 + 3y + 7
\end{aligned}
$$

or

$$
\begin{aligned}
y + \frac{a+b+c}{a-b+2c} &= \frac{a-b-c}{a+b-2c} + \frac{d+b-c}{a-d+2c} \\
&\qquad + \frac{a+f+c}{a-b+2g} - \frac{h+b+k}{a-k+2\ell} \\
&\qquad\qquad - \frac{\ell+f+m}{a-n+2z} - \frac{r+b+q}{a-k+2p} \\
&\leq x^2 + 3y + 7 \,.
\end{aligned}
$$

EXAMPLE V: If the first line of a multi-line expression is *very long*, then the verb connective ($=$ or $\leq$ or something similar) and the right-hand side of the first relation will have to go on a succeeding line. In this circumstance, the second and subsequent lines should be aligned with a two-em quad indent from the left:

$$
\begin{aligned}
&z^3 - xyz^2 + \frac{a+b-c}{d-e^2+f} + \sin[x^3y - zy^2 + xyzw] \\
&\qquad = z^x y_w m^{qr} st + a \cdot b \cdot c^{de} \cdot f \cdot g - h^i j_k l^m n_o p \\
&\qquad \leq 23 - 45 + 17 + 333 - 4769.
\end{aligned}
$$

2.7 *Types of Space*

TeX is very good at the spacing that is needed for a well-formatted mathematics formula. It knows how much space to put after an integral sign, how to space out a matrix, and how to typeset an arrow. But the default in TEX mathematics mode is to put *no space* between objects. Thus, for example, the TEX code

```
$x  y   z^2     w$
```

is typeset as xyz^2w. In situations like this, all spacing that occurs is imposed by the user. So one must have positive cognizance of spacing.

Some of the most standard horizontal spaces in typesetting are these

- *The thin space:* This is a horizontal space with thickness approximately 0.023 in. Some standard instances in mathematics where the thin space occurs are

    1. Before and after a connective that can be read as a "verb": These include

    $$= \qquad \cong \qquad \to \qquad \subset \qquad \supset \qquad \equiv \qquad \doteq \qquad \in \qquad \pm$$

    Examples are $x = y$, $A \supset B$, and $a \in A$. TEX supplies the space automatically as part of the "glue" that comes with each of the connectives.

    2. In an integral:

    $$\int_a^b f(x)\,dx.$$

    There is a thin space both before and after the $f(x)$. (In TEX, the first of these is automatic and the second not.)

    3. After a coefficient:

    $$\alpha\sum_{j=1}^{\infty} x_j \qquad \beta\int_a^b f(x)\,dx.$$

    4. Before and after a connective that can be read as a "conjunction". These include

    $$+ \qquad - \qquad \div \qquad \cap \qquad \vee \qquad \oplus$$

    Examples include $x + y$, $S \cap T$, and $V \oplus W$.

    5. Before, but not after, certain binary connectives when they are used as adjectives:

    $${} + 3 \qquad {} - 4 \qquad {} \pm 8$$

    6. After function names that are set in roman type:

    $$\sin x \qquad \log 3 \qquad \deg\alpha \qquad \dim T \qquad \exp 4z$$

7. After commas in a list or sequence:

$$\{1,2,3\} \qquad (1,2) \qquad a,b,c,\ldots$$

8. Before and after a single vertical bar or a colon used as a mathematical symbol:

$$A \mid B \qquad \{x\colon x^2>0\}$$

9. Before a "back subscript" or "back superscript":

$$x\,{}^3_1H \qquad a\,{}_2M$$

- *The thick space:* This is a horizontal space of thickness equal to two thin spaces. Some standard instances in mathematics where the thick space occurs are:

1. In congruences (before the parentheses):

$$9 = 3 \pmod 6$$

2. In conditional statements (before the parentheses) in text:

$$x_n > n\;(n=1,2,\ldots)$$

- *The em quad:* This space is so named because, traditionally, it was the width of the letter capital "M" in the font being used. Nowadays the definition is variable, and depends on the font and on other parameters as well. Some standard instances in mathematics where the em quad occurs are:

1. Between mathematical expressions and verbal statements:

$$a_n > 0 \quad \text{for most values of } n$$

or

$$a \neq b \quad \text{by Theorem 1.3.8.}$$

2. Around conjunctions (or other connectives):

$$x > 0 \quad \text{or} \quad y < 5$$

or

$$a_n > 0 \quad \text{if} \quad n \geq 5.$$

- *The two-em quad:* The space is so named because it is twice the thickness of an em quad. Some standard instances in mathematics where the two-em quad occurs are:

1. Between two equations:

$$x^2 - y^3 = 9, \qquad x^4 + y^5 = 3\,.$$

2. To separate an equation from an accompanying condition in display:

$$a_n > 0 \qquad (n = 0, 1, \ldots)$$

or

$$b_n < 0 \qquad (n \text{ odd}).$$

- *Negative space:* The most commonly used negative space command in TEX is `\!` . It denotes a *negative thin space*; that is to say, an amount of space equal to a thin space is *removed* at the place where the command occurs.

  Here is a common use of `\!`. If you wish to typeset two integrals in a row, such as

  $$\int\!\!\!\int f(x, y)\, dxdy,$$

  then it will not do to typeset

  ```
  \int \int f(x,y) \, dx dy.
  ```

  In fact, every character or expression in TEX comes equipped with "glue", which is a certain amount of spacing that is formed around it. When two integrals are juxtaposed, their built-in spacing superimposes, and the result is too great a space between the two integral signs. Using the TEX code `\int \int f(x,y) \, dx dy`, one obtains

  $$\int \int f(x, y)\, dxdy.$$

  The improved TEX code `\int \! \! \! \int f(x,y) \, dx dy` produces the more desirable

  $$\int\!\!\!\int f(x, y)\, dxdy.$$

  Note that LATEX2ε has the command `\iint` which is, in effect, a macro for the formatting protocol that we have just defined. The analogous commands `\iiint` and `\iiiint` produce triple and quadruple integrals.

- *Forced horizontal space:* In TEX, one can mandate a horizontal space of any size with the command `\hskip#`, where `#` denotes a linear measure. For instance, the code

```
Bob \hskip.3in and Sally or Sally \hskip-.2in and Bob
```

yields the compiled output

Bob   and Sally or Sally and Bob

- *Kerning:* To kern is to move the position at which the typesetting is taking place—either left-right or up-down. Thus if one enters the TeX code

  ```
  book \kern-.1in binder and book \kern.1in binder
  ```

  then one obtains the output

  bookbinder and book   binder

  This is an extreme example, just to illustrate what kerning does. But one can plainly see that negative kerning will have the same effect as a negative space, and positive kerning will have the same effect as a positive space (except that the horizontal space command `\hskip` has a certain amount of flexible latitude, or "glue", associated with it while `\kern` does not).

2.8 Technical Issues

Here we list and discuss some technical matters that come up frequently in mathematical typesetting. We recommend the book [SWA] for the mathematical typesetting details and [SAK] for technicalities of TeX. Here we concentrate on just a few issues. We will frequently filter these topics through the sensibilities of TeX.

Abbreviations in Mathematics: Certain words, such as "sine", "cosine", "angle", and "exponential", are commonly abbreviated in mathematical formulas. Thus we see, in equations, expressions like

$$\sin x + \cos\theta - \exp t = 0\,.$$

What you should observe about these expressions is that **(i)** the abbreviated word is in roman (*not* italic) and **(ii)** there is a thin space after the abbreviated word and before the argument (unless the argument is in parentheses or brackets or braces, in which case there is no space).

TeX supplies macros for the most commonly used math abbreviations. For example, `\sin` in math mode gives the sine function in roman followed by a thin space. If you fail to use the built-in TeX command for sine, and instead enter the code `$sin x$`, then you will get the unsightly result $sinx$. (Is this an eccentric rendition of the word "sinx" or the product of s, i, n, x or something else?)

For some functions, TeX will not have the name built in and you will have to define your own macro. As an instance, you can enter `\def\sgn{\mathop{\rm sgn}}` to define a TeX command `\sgn` as an abbreviation for the signum function.

Blackboard Bold Characters: Because it is difficult to write boldface characters with a piece of chalk at the blackboard, the font *blackboard bold was invented*. Over time, people became accustomed to blackboard bold and it was used in print as well. When this author published [KRA1], the publisher declined to use blackboard bold for the complex numbers because the font needed to be imported from Japan and was considered to be too expensive. Nowadays, however, it is a commonplace. It is standard in printed mathematics to denote the integers, rationals, reals, and complex numbers as $\mathbb{Z}, \mathbb{Q}, \mathbb{R}$, and $\mathbb{C}$. Donald Knuth does not like the blackboard bold font (see [KNU] to learn why), hence blackboard bold characters are not a standard part of TeX or LaTeX.

The American Mathematical Society (AMS), however, has come to the rescue. The AMS font `msbm` has these characters, but you need to learn how to call the font. You should include the lines[8]

```
\newfam\msbfam
\font\tenmsb=msbm10  \textfont\msbfam=\tenmsb
\font\sevenmsb=msbm7 \scriptfont\msbfam=\sevenmsb
\font\fivemsb=msbm5  \scriptscriptfont\msbfam=\fivemsb
\def\Bbb{\fam\msbfam \tenmsb}

\def\ZZ{{\Bbb Z}}
\def\QQ{{\Bbb Q}}
\def\RR{{\Bbb R}}
\def\CC{{\Bbb C}}
```

at the top of your `*.tex` file. Then typeset the characters with `$\ZZ, \QQ, \RR, \CC$`. The result is $\mathbb{Z}, \mathbb{Q}, \mathbb{R}, \mathbb{C}$.

Delimiters, Size of: A delimiter is a bracketing device such as a parenthesis or a brace or a bracket. The book [SAK] contains a discursive discussion of delimiters—their names, their meaning, their use, and their limitations. Delimiters parse information, group information, and organize information. It is essential, for maximum clarity in mathematical

[8]Calling a text font involves a simple one-line command—see Section 3.6. Calling a math font involves calling an entire family and is a bit complicated. See [SAK] for a thorough and cogent discussion of these matters.

writing, to use delimiters of the correct size, shape, and position. A passage like

$$y = x + (z + \int_0^1 f(t)\, dt - \frac{a}{b})$$

(typeset with the TEX code

```
$$
y = x + (z+\int_0^1 f(t) \, dt-\frac{a}{b} )
$$
```

is hard to read just because the parentheses are too small. TEX will size the delimiters for you if you simply modify your code in this way:

```
$$
y = x + \left ( z+\int_0^1 f(t) \, dt-\frac{a}{b} \right ) .
$$
```

With this change, the compiled output is

$$y = x + \left(z + \int_0^1 f(t)\, dt - \frac{a}{b} \right) .$$

The commands `\left` and `\right` generally do a good job at suiting delimiters to the text that comes between them. TEX measures the heights of the intervening boxes and adapts the delimiters to those boxes. But sometimes you must intervene when TEX makes a poor choice. For example, in the expression

$$\left(\sum_{k=1}^{n+1} \frac{k}{k^2 + 1} \right)^2 ,$$

typeset with the code

```
$$
\left ( \sum_{k=1}^{n+1} \frac{k}{k^2 + 1} \right )^2
$$
```

the parentheses are a bit too large. Since the limits $k = 1$ and $n+1$ are not seen by the human eye as an integral part of the summation, they can (and should) be allowed to extrude slightly beyond the upper and lower limits of the parentheses. In circumstances such as these, we use *explicitly sized delimiters.* The commands for explicit sizing are

```
\bigl    \bigm    \bigr    \big
\Bigl    \Bigm    \Bigr    \Big
\biggl   \biggm   \biggr   \bigg
\Biggl   \Biggm   \Biggr   \Bigg
```

Thus we would typeset

```
$$
\biggl ( \sum_{k=1}^{n+1} \frac{k}{k^2 + 1} \biggr )^2
$$
```

to obtain the somewhat more desirable output

$$\biggl(\sum_{k=1}^{n+1} \frac{k}{k^2 + 1} \biggr)^2 .$$

Complete details may be found in [SAK]. We sometimes also use explicitly sized delimiters when the left and right units occur on different lines. LaTeX has alternative tools for handling that situation (see [LAM] or [GMS]).

Ellipses: An ellipsis is a sequence of three dots used either to indicate a break in text or the trailing end of a thought. For instance

> Consider the sequences $a_1, a_2, \dots, a_N$ and $b_1, \dots, b_M$ of real numbers. Define $A = a_1 \cdot a_2 \cdots a_N$, $B = b_1 + \cdots + b_M$, and $C = b_1 \times \cdots \times b_M$. Now we ponder these numbers . . . .

The displayed text exhibits six ellipses: one on the baseline in the list of the a_j's, one on the baseline in the list of the b_j's, one in the definition of the product, one in the sum, one in the definition of C, and one at the end of the passage. If the "missing material" is bracketed by binary operators, then usually a raised (or vertically centered) ellipsis is used. Otherwise a baseline ellipsis is appropriate. In almost all applications in mathematics, an ellipsis is surrounded either by operators or commas. If the ellipsis occurs at the end of a sentence, then you must include a fourth dot (the period) to denote the end of the sentence—unless, of course, you mean to indicate that the sentence is incomplete.

In TeX, it is *incorrect* to form an ellipsis simply by concatenating three periods (for a baseline ellipsis) or by concatenating three `\cdot` commands to adjoin three centered dots. The reason is that the period . and the centered dot $\cdot$ each come with glue, and they do not perform well under concatenation. TeX provides us with `\dots` for a baseline ellipsis and `\cdots` for a raised (or vertically centered) ellipsis. Please use them.

Embellishments, Accents, and Diacritical Marks: Twenty-six alphabetical letters, both upper- and lower- case, are generally insufficient matérial to express our mathematical thoughts. Therefore we frequently use embellishments over single letters. Examples are

$$\hat{f}\ ,\ \check{c}\ ,\ \dot{a}\ , \breve{e}\ ,\ \vec{v}\ .$$

It is best not to over-use embellished symbols, as they are harder to read (and to remember) than un-embellished ones. An equation such as

$$\frac{\breve{a} \cdot \grave{c} + \grave{e}}{\acute{m}/\hat{f} - \bar{w} \cdot \tilde{n}} = h'' + \dot{a} + \breve{z}$$

is a nightmare to read and to comprehend.

As noted in Section 1.2, compound embellishments are best avoided, because they are difficult to typeset and may interfere with the line above. Embellishments *under* letters are generally a bad idea, as they can interfere with letters (like g) that hang below the baseline.

If you are tempted to flout the suggestions in the previous paragraph, consider instead using a boldface character, or a character from another alphabet.

Hard vs. Soft Spaces: If you enter plain text in a `*.tex` source file, then TEX will decide where to put line breaks. The first choice for a line break is between words (it obviously only requires a trivial filter for TEX to find these), and the second choice is at the inter-syllable hyphenation of a word. In fact TEX comes equipped with a rather remarkable algorithm for hyphenating words, and usually gets these breaks right. But there are some places in your text where you definitely do not want a line break, and other places where not having a break is definitely preferred. As an instance of the first of these, you do not want a break in "Section 5" between the word "Section" and the number "5". As an instance of the second of these, you probably do not want a break in "Mr. Smith" between the title "Mr." and the name "Smith". In either of these circumstances, or in situations like them, you use the TEX code `Section~5` or `Mr.~Smith` to tell TEX that you want a space, but the space cannot be broken at the end of a line. The books [KNU] and [HIG] provide more information on the use of the so-called hard space `~` .

One-symbol Formulas: In a passage like

> Let x be a real variable. The function f is assumed to operate on x in the following way:

it is essential that the one-symbol formulas x and f be formulated in math italic. If not, the sentence would be difficult to read. This observation simply means that you must enter math mode (using either `$` signs or `\(` and `\)`) to typeset the x and the f. Thus the correct code is

```
Let $x$ be a real variable.  The function $f$ is assumed
to operate on $x$ in the following way:
```

By contrast, the incorrect code

```
Let x be a real variable.  The function f is assumed
to operate on x in the following way:
```

produces the less desirable output

> Let x be a real variable. The function f is assumed to operate on x in the following way:

Page Breaks: TEX usually has pretty good judgement about where to break pages, and probably you do too. But here are a few breaks to avoid:

1. In the middle of a displayed equation or sequence of equations that run more than one line;
2. In a series of equations that are numbered as a group;
3. After the first line of a new section (i.e., a new section title should be followed by at least two lines of that section on the same page);
4. So as to leave a widow (see Section 1.4);
5. So as to leave an orphan (see Section 1.4);
6. So as to isolate the last three lines of a chapter.

If there is a sequence of equations separated by commas, then it is all right to put a page break in the middle of the sequence (the logic being that such a sequence does not make up a single assertion). An acceptable place to break a page is *before* a short phrase, not the end of a sentence, that precedes a displayed equation.

Punctuation and Formulas, Interaction of: The final word about punctuation in formulas has not yet been enunciated, and it will not be enunciated here. In particular, there is considerable disagreement concerning whether punctuation should appear at the end of a displayed formula. That is, should it be

> Substituting the values for x, y, and z results in the formula
>
> $$A = B^2 + CD\,.$$

or

> Substituting the values for x, y, and z results in the formula
>
> $$A = B^2 + CD$$

One argument for the second protocol in favor of the first is that if the formula was replaced by a figure or photograph, then you certainly would not put a period at its lower right. An argument in favor of the first protocol over the second is that, if you read the sentence aloud, then the formula translates to words and demands a period.

Many scientific style manuals militate against punctuation at the end of a displayed formula. Most mathematics books and journals *do* include the punctuation. After all, if the formula was typeset in inline mode, then you most certainly would include the punctuation. So why not do the same with a displayed formula? On the other hand, the vertical space after a displayed formula provides the necessary logical pause; with that thought in mind, punctuation is redundant.

Clearly the question does not have a clear answer. In your own writing, you should choose a paradigm for punctuating formulas and then be consistent. Some publishers will have a preferred style, and you should learn it and adhere to it.

Struts, Use of: Struts are a technical device that allows TeX to provide a "roof" on which to rest certain symbols. For example, the TeX code

```
$$
\sqrt{a} = \sqrt{X} + \sqrt{y}
$$
```

typesets rather badly as

$$\sqrt{a} = \sqrt{X} + \sqrt{y}$$

with square root signs of different heights. The situation may be remedied by the use of the `\mathstrut` command:

```
$$
\sqrt{\mathstrut a}=\sqrt{\mathstrut X}+\sqrt{\mathstrut y}
$$
```

The `\mathstrut` provides an invisible strut of zero width atop which the square root rests. The output now is

$$\sqrt{\mathstrut a}=\sqrt{\mathstrut X}+\sqrt{\mathstrut y}$$

and all the square roots have the same height.

There is also a `\strut` command for use in text mode, but we shall say nothing about it here. Complete details are in [SAK].

2.9 Including Graphics in a TeX Document

The original design of TeX made no provision for the inclusion of graphics stored in external graphics files. The number of popular graphics formats was growing then and is probably continuing to grow as you read this book, and any assumptions about graphics formats of external files would have rapidly made those parts of TEX obsolete.

Today there are two principal types of graphics: bitmap graphics and vector graphics. The Web site

http://www.rcc.ryerson.ca/rta/brd038/nsr/ptenk/bitvec1.htm

has a lovely discussion of the merits of these two graphic protocols. Briefly, a bitmap graphic stores the image pixel by pixel while a vector graphic uses a mathematical language to describe lines and curves. Vector graphic files tend to be smaller than bitmap files. Vector images have the advantage of being easily scalable, while bitmap images are better at providing the detail needed in high quality (photographic, for example) images. New technologies are being developed that combine the best features of both formats. In what follows, we discuss both vector graphic formats such as PostScript or Acrobat (actually both of these are much more than vector graphics systems) and also bitmap graphic formats, such as `*.gif` and `*.bmp`.

TEX does have the capacity for producing graphics internally by positioning text characters at arbitrary positions within an open box. The PICTEX package for TEX and the LATEX `picture` environment are based on this approach. The TEX companion program METAFONT can also be used to produce graphics. METAFONT is used to design fonts for TEX, and uses a script language to specify the shapes of characters (so it is, in effect, a vector graphics language). This script language can be used to produce line drawings. The result would appear to the user as a new font with a single character that might be of arbitrary size. But these packages do not have the power and flexibility of general-purpose computer packages for producing bitmapped graphics or line/vector graphics. In particular, scaling and rotation of graphics is generally awkward in the METAFONT environment.

One significant advantage of the "internal" graphics packages just described is that they travel well. If you re-position material in your document, add or change labels to figures, scale figures, etc., then everything works as it should—just like any other part of the TEX document. Third party graphics packages pose real problems with scaling, and especially with labeling (move a figure and the labels may stay where the figure used to be). `PSTricks` is one of many packages that addresses this problem with captions and labels. This point will be discussed in more detail below.

Even though out-of-the-box TEX has no provision for graphics, the door was left open for extensions. The TEX command `\special{...}` allows the user to send whatever information he or she wants directly to the printer or screen display program. The printer or screen display program can then do whatever it likes with this information. The most common use of `\special` commands is to send to the printer information about external graphics files and about how the information in these files should be positioned and scaled.

In recent years, PostScript has become widely used for the production and manipulation of graphics. TEX printer and screen display programs that can read and display PostScript graphics files are widely available. The book [GRM] is devoted to this topic. We cannot include all of that information here.[9] However, please note that you can use any good Web browser—such as Netscape®— to view a PostScript file. In the Windows® environment, simply click on <File> and then <Open Page> and enter the path of the `*.ps` file. Another useful utility for this purpose is `ghostview`, which can be downloaded from the Web.

Traditional (non-electronic) methods for the inclusion of graphics in a book or paper are more laborious. The author creates line drawings, photographs, and/or halftones on separate pieces of paper. The figures are submitted along with the finished manuscript to the publisher, who handles the technical details from that point. Specifically, specialists in the production department at the publishing house will either redraw each figure from scratch or will scan each figure into `MacDraw`® or `CorelDRAW`® or some other powerful graphics software and render it as a cleanly and professionally drawn figure. This "traditional" method is still used, and most current publishers will perform this service for an author.[10]

There are advantages and disadvantages to handling graphics yourself, as an integral part of the electronic document, as opposed to submitting graphics to the publisher on separate pieces of paper. Among these are:

Advantage: You have complete control over the form and the formatting of your document. You will be certain that each of your graphics is exactly what you want, positioned as you want, and scaled as you want, in just the form that you want.[11]

[9]Refer to Appendix VI for some URLs where Acrobat and PostScript resources can be obtained.

[10]There may, however, be a cost. The publisher may offer a lower royalty rate if his production department must do the figures. I have heard experienced editors yearn for the "good old days when the publishing house did everything." But the modern business reality is that the house wants to outsource to the author.
On the other hand, the publisher may *pay* the author if he is willing to handle the graphics himself.

[11]If you have never before published a document with graphics, then you may have no idea what a struggle it is to communicate your desires to a technical artist who is probably a few thousand miles away and who has no idea what you are trying to depict. The publisher himself can complicate matters by complaining that the production of your graphics is becoming too convoluted and too costly.

Disadvantage: The method you choose for incorporating graphics may depend on the system you are using and the software you are using.

Disadvantage: You must be sure that you are able to generate output that your publisher can use. This means not simply that you end up with satisfactory figures in your printed output, but also that you end up with a computer file that the publisher can read and manipulate. This might be a TeX or LaTeX file that has PostScript input commands and an accompanying PostScript file for each figure. Or it might be a PostScript file for each chapter, which includes all the text and all the graphics for that chapter. Most publishers can handle PostScript files. Many (but not all) publishers can process a TeX file with suitable "include" commands for PostScript graphics files. However, the method for inclusion may be system-dependent.

Disadvantage: If the publisher wants you to provide "camera-ready" output in hard copy, then you must have access to a 1200 dpi or higher resolution printer, and you must be able to obtain the sort of RC (resin-coated) paper that is required for camera-ready output. If your publisher is able to transfer your data directly from a computer disk or computer file to film,[12] then this step will not be necessary.

Disadvantage: You must determine how to position each graphic on the page, and decide how to attach labels to each figure. If you typeset the labels in TeX, it may be possible that, each time you revise your document, all the labels will be disturbed. You may find it more convenient to make the labels for each graphic a part of that graphic (i.e., to draw the labels in the fonts provided with your graphics package, or to use `PSTricks` or another package that makes the labels portable).

Disadvantage: If you want to include color graphics, then you may need to learn additional procedures for color filtering. Traditionally, a "screen" or "benday" was used to sort a color picture into its yellow, magenta, cyan, and black source. Then four separate printing plates were generated, and the page was run through the printer four times.[13] With modern technology, many of these steps

[12] Here the film is used to print a photographic image on a (usually copper or zinc) lithography plate. The plate is then etched and used as the printing master in the press.
[13] These two sentences explain why color graphics traditionally drove up the price of a book or document.

may be eliminated. But screening, and keeping track of the primary colors, is still an important part of the process, and is the responsibility of the person who is in charge of the graphics.

Disadvantage: If you are creating graphics with `CorelDRAW` or `xfig` or another standard graphics package, then you will have no trouble generating a PostScript file for inclusion in your document. But there are different versions of PostScript (encapsulated, non-encapsulated, compressed, and others), and these are not all compatible. The heading of the PostScript file must contain crucial data in just the right form or else you will not be able to use it. If you are so foolish as to introduce a blank line at the top of your PostScript file then some systems will not read it.

Disadvantage: You can use graphics packages that are internal to TEX and LATEX. These include PICTEX, LATEX's native `picture` environment, `PSTricks`, `Gnuplot`, METAFONT, and others. Such an internal graphics package has the advantage of portability—its source code becomes part of the TEX source and is as portable as the `*.dvi` files that TEX produces. Also the labels and captions become, in effect, part of the figure; when the figure moves or re-sizes, then so do these ancillaries. However, many of these packages are limited in the types of graphics they can produce, and some are quite tedious to use.

Thus, if you are writing a book or article that has graphics, then you are either going to have to **(i)** become your own system manager, and configure your computer and printer to produce the types of files and hard-copy output that you require, or **(ii)** consult closely with the system manager at your place of work to find out what tools are available on your system for doing the tasks that you need to perform.

In the following, we will describe two or three common methods for including graphics in your TEX document. All of these exploit commonly used and readily available software. However, there is no guarantee that precisely these resources will be available on your system. And our description here is by no means exhaustive. The real hacker will have other means at his disposal; he can use a preprocessor to decompose a graphic into a number of fonts, each containing a small piece of the the graphic as a pixel pattern. Alternatively, graphics can also be made up of raw printer commands, proprietary to your particular printer, that you send to the printer using the TEX `\special` command. We shall not treat any of these more advanced methods here.

2.9.1 *Handling Graphics in the Computer Environment*

Powerful commercial packages are available today for rendering graphic images for almost any application. `CorelDRAW`, `Adobe Illustrator`,® `Harvard Graphics`,® and `FreeHand`® are some of these. These products are obtainable both for the Windows and the Macintosh platforms. A UNIX installation will probably include `xfig` or `idraw`. The mathematics/computer algebra packages `Mathematica`,® and `Maple`,® and `MatLab`® will generate beautiful graphs and other graphics;[14] they cannot, however, be used as full-feature graphics packages. For example, if you needed to draw a figure for a Euclidean geometry text, you would find it quite difficult to use `Mathematica`. But a full-featured graphics package like `CorelDRAW` would make the job easy. Most commerical graphics packages have the feature that their output can be saved in PostScript files.

Many of these products have their own proprietary (vector) graphics language in which figures are encoded. In addition, most graphics packages nowadays allow you to export your graphic to any of dozens of different graphics formats, including PostScript and a variety of bitmapped and line graphic formats; these include formats that at one time were considered proprietary to Microsoft DOS,® UNIX, or Macintosh® systems. The PostScript format has the advantage of creating an ASCII or text file, and is one for which the interface with TEX is highly developed. For the purposes of the present discussion, we will assume that you have converted your graphic to a PostScript file.[15]

2.9.2 *The Inclusion of a PostScript® Graphic*

Suppose that your graphic is called Figure 1, and that the name of your corresponding PostScript file is `fig1.ps`.[16] Now your source code file (in LATEX 2.09) should include the line `\input{epsf}` (in LATEX2$_\varepsilon$ it would

[14]It is actually possible to produce an entire document using `Maple` or `Mathematica`. The graphics will be rendered in PostScript and the text will be rendered in LATEX. But the TEX capabilities are limited. The software `Scientific Workplace`® is a document-creation utility that gives LATEX output for text and has a `Maple` kernel for calculations. One can actually do calculations on the fly as one is writing in `Scientific Workplace`.

[15]Virtually every UNIX installation, and many personal computer systems too, has a system utility called `dvips`. Many versions of this utility can also be downloaded from the Internet. Using a simple syntax, `dvips` will convert your `*.dvi` file to a PostScript file. It will either send that file to the printer or will store the PostScript file to disc. The utility `dvips` can also input external PostScript graphics files and format them as part of your document.

[16]Observe that `*.ps` is the default extension for a PostScript file name. Also `*.eps` is the default extension for an encapsulated PostScript file name.

be `include graphics` and in Plain TEX it would be `\input epsf`) in its preamble; this calls in the package for handling PostScript files. At the point of impact—where the figure should actually appear—there should be the lines

```
\epsfysize=3in
\centerline{\epsfbox{fig1.ps}}
```

In point of fact, after you compile and view a file containing the code just described, you may be unsatisfied with the results. Indeed, you may be unable to find the figure on the page! In practice, the positioning of graphics is one of the most difficult features of the entire process. You can, however, cut through much of the complexity by using LATEX's built-in `figure` environment. Instead use the code

```
\begin{figure}
\epsfysize=3in
\centerline{\epsfbox{fig1.ps}}
\caption{This is a picture of whatever it is a picture of.}
\end{figure}
```

Let us explain what each piece of this code signifies.

LATEX's `figure` environment turns the object inside it into a "float". A float is an object—this could be a graphic or a table or even a body of text—into a displayed object that does not have a pre-assigned position in the document. In fact, LATEX will solve an optimization problem to determine where best to place the float, so that it causes the least difficulty with page and line breaks.[17] Combined with `\centerline`,[18] the `figure` environment will usually do a nice job of positioning and centering the figure, of positioning and centering the caption, and also of making peace with the text that surrounds the figure.

The `\epsfysize` command scales or sizes the figure. A smaller number yields a smaller figure and a larger number yields a larger figure. There is not necessarily any direct correlation between the numerical value of size that you mandate (in our example, this is "three inches"or `3in`) and the actual physical size of the figure that you will obtain in the output. This is, in part, because that size will depend on the size of the figure with which you began, and on the overall magnification of the TEX document. TEX will not be sizing the collection of lines and objects that make up your figure, but rather the "minipage" on which it

[17]It is not difficult to imagine that a poorly placed figure could cause a great deal of blank space to occur on a page, or a section title that is separated from its section.
[18]As you might suppose, this TEX command simply centers—from left to right—the object inside it.

lives. So you will have to learn through trial-and-error how to size your figures.

The `\caption` command provides a suitably typeset caption for the figure, and numbers it automatically (in just the same way that LaTeX numbers chapters and sections and equations). Later, you can use LaTeX utilities to collect all the caption names and numbers and pages and produce (without human intervention) a List of Figures to go in the front of your book or document.

In all, you will find that the simple five lines of code offered above will nicely dispatch almost any PostScript graphic that you want to include in your LaTeX document. If you are using Plain TeX instead of LaTeX, then you will need to use the float commands `\midinsert` and `\endinsert` instead of the `figure` environment. And you will have to label your figures manually. The other basic ideas are the same.

In both TeX and LaTeX, it is quite common to use the alternative utility (which is actually a TeX package or macro) `\psfig` for the inclusion of PostScript graphics. The command `\psfig{psfile=fig1.ps}` will create the appropriate amount of vertical space for the figure and, assuming the macro has been suitably customized, will insert a TeX `\special` command into the `*.dvi` file that will cause the figure to be included. There are various options that will enable you to scale the figure.

2.9.3 Graphics and the LaTeX2$_\varepsilon$ Environment

LaTeX2$_\varepsilon$, the latest implementation of LaTeX, has considerably enhanced graphics capabilities (over LaTeX 2.09, the preceding release). It has both the `graphics` and the more advanced `graphicx` packages. To use the first of these packages on a PC, one enters

```
\usepackage[dvips]{graphics}
```

and then

```
\includegraphics*[llx, lly][urx, ury]{filename}
```

to call in a particular graphic file.[19] The use of `graphicx` is similar.

On many Macintosh installations, the command for implementing `graphics` will be

```
\usepackage[textures]{graphics}
```

This change has to do with the nature of the TeX implementation on a Mac. Everything else about `graphics` is the same as for a PC.

[19]Here (llx, lly) are the coordinates of the lower left corner of the image and (urx, ury) are the coordinates of the upper right corner of the image.

LaTeX2ε has the delightful feature of a uniform syntax for the inclusion of every kind of graphics file that can be handled by the drivers. In many respects, it is much easier to use than earlier versions of LaTeX.

2.9.4 The Use of PCTeX®

Just to illustrate another method for handling graphics in a TeX environment—perhaps on a home computer—we will now discuss PCTeX. In fact PCTeX offers[20] several methods for including graphics. In its current implementation, PostScript graphics may be included, viewed, and printed out. PCTeX can also handle `*.wmf`, `*.jpg`, and other graphics formats. It has a full implementation of `dvips`.

Previous releases did not allow screen viewing of PostScript graphics; the current implementation does, but it is buggy. Since we have already discussed PostScript graphics in the preceding subsection anyway, we shall instead now treat bitmap (or `*.bmp`) graphics for PCTeX.

PCTeX will allow you both to preview your TeX file with the `*.bmp` graphics displayed, and also to print out the results. The commands needed to carry out this procedure are analogous to those for PostScript graphics that we described in the last subsection, but have modified syntax in order to handle bitmaps. Specifically, in the preamble to the document, include the line `\input setbmp`. Then, at the point of impact (where the figure is to appear), include the line

```
\setbmp{dim1}{dim2}{dim3}{fig1.bmp}
```

A few words of explanation are in order. In fact, `\setbmp` is a macro for the more discursive TeX command

```
\def\setbmp#1#2#3#4{\vskip#3\relax\noindent\hskip#1\relax
 \special{bmp:#4 x=#2, y=#3}}
```

Even those not well-versed in TeX will see that the first argument (that is, `#1`) corresponds to horizontal spacing, the second (`#2`) is width, the third (`#3`) is vertical spacing, and the fourth (`#4`) is the name of the file. Embedded inside the definition of `\setbmp` is a `\special` command, which is the basic tool for inputting printer commands and graphic machine codes.

A complete example of a typesetting command in the PCTeX environment for Figure 1 (with file name `fig1.bmp`) is

[20]For specificity, we will discuss PCTeX 32,® version 4.0. That was the latest release at the time of this writing.

```
\setbmp{-2.55in}{1.88in}{1.8in}{fig1.bmp}
\begin{center}
Figure 1.  A picture of everything.
\end{center}
```

As in previous discussions, the dimension parameters given here do not correspond literally to anything that you will actually see in the printed output. In particular, the way to get the figure positioned properly is to fiddle. You will have to learn by trial and error what these numbers signify. The centered material following the figure call is, of course, the caption.

2.9.5 Freeware that Will Handle Graphics

The TEX implementation known as BCTEX (for the PC), available for free from the World Wide Web, has powerful graphics capabilities. An implementation of BCTEX may be downloaded from

http://199.26.180.160/winnt/misc/page2.html

There are certainly more modern freeware versions of TEX that are available as downloads (such as MikTEX—see below). But BCTEX is tried and true and readily available; and its graphic interface is particularly easy to describe.

To import a bitmap graphic (i.e., a `*.bmp` file) using BCTEX, the command is

```
\special{isoscale fig1.bmp, 1.5in 1.7in}
```

You can see the explicit role of the `\special` command in this example. The command `isoscale` is one of several choices in BCTEX, indicating the scaling method (isotropic or non-isotropic) that one wishes to use. The dimensions `1.5in` and `1.7in` denote the horizontal and vertical sizes of the figure. The usual remarks about positioning the figure on the page still apply.

Today, the software MikTEX (for the PC) is one of the most popular, and most powerful, freeware implementations of TEX that can be downloaded for free from the Web.[21] MikTEX has a useful `dvips` utility, flexible tools for handling graphics, and many other helpful add-ons. It may be downloaded from the `ftp` site

```
ftp://ctan.tug.org/tex-archive/systems/win32
   /miktex/1.20/index.html
```

[21] OzTEX is a package available online for Macs. Created by Andrew Trevorrow, it comes both in freeware and shareware versions. See http://www.trevorrow.com/oztex/ozfaq.html for more information.

More information about MikTEX (and downloads) can be obtained from any of the Web sites:

http://members.tripod.com/~upem/miktex.html

http://www.miktex.de

http://wuarchive.wustl.edu/packages/TeX/systems
/win32/miktex/1.20/

(This last is a site at the author's university.) Incidentally, the CTAN (Comprehensive TEX Archive Network) site is, in general, a great place to get TEX fonts, utilities, articles, and other materials related to TEX. See also Appendix VI for other TEX Web sites.

The TEX Users Group makes available the TEX package TEXLive4 (for the PC). This is a large installation (about 170 Mb), but it contains useful packages such as Xy-pic (for commutative diagrams). However, this package is available only for purchase or by joining the TEX Users Group.

For the Macintosh, OzTEX is the standard freeware package. Another is called CMacTEX. A Mac TEX Web site is

http://www.esm.psu.edu/mac-tex/versions.html

It contains fonts, add-ons, and other useful information about TEX for the Mac user. See Appendix VI for other Internet sites that will be of interest to the TEX user.

chapter 3

TeX and the Typesetting of Text

Although TeX was designed specifically for its prowess with mathematics, it is also a powerful tool in the typesetting of English prose.

Straight prose, in paragraph format, is child's play with TeX. You simply type away, as on a traditional typewriter or word processor. You need not worry about line breaks or page breaks; TeX can calculate those, and take care of right justification as well. To begin a new paragraph, just leave a blank line. TeX will automatically indent the new paragraph and provide the right amount of vertical space between paragraphs.

What is tricky in the typesetting of English text is handling various advanced formatting issues. Certainly the possibilities are limitless: TeX can format a page in two (or more!) columns, can display an indented block of text, can flow text around a graphic or figure, and can perform other standard and exotic typesetting tasks. Fortunately for you, these issues rarely come up in the writing of a mathematical paper or book. For those who need these powerful but complicated TeX functions, the book [SAK] provides all necessary details. For most of us, the information in this chapter will suffice.

3.1 Other Word Processors and Typesetting Systems

Before TeX, there were word processors. Compared to the old-fashioned typewriter, a word processor is a marvel. Using one, you can type as fast as you like, never fearing for errors. Making changes, corrections, and revisions is trivial. Most importantly, you can move around large blocks of text; and you can *try things*. Word processors have changed the way people write; and many of the changes are for the good.

The word processor shows on the screen *just what you will be getting on the printed page*. A printer driver is built right into the word processor, thus guaranteeing complete compatibility between screen output and hard-copy output. Of course you can store your documents for future use, and call them up and modify them at will.

But the convenience of a word processor is also the source of its limitations. The best Super VGA screens are only about 1200 pixels[1] across. A high quality laser printer has a resolution of 1200 dots *per inch*. Thus the accuracy, and level of detail, that the printer can achieve is an order of magnitude higher than what is possible on the computer screen.

Much more powerful is a *markup language*, such as TEX. TEX is a computer *typesetting system*—not a word processor. In other words, TEX is a high-level computer language, and it allows you to issue commands that declare exactly what will appear on your page and how it will be formatted.

Of greatest interest for readers of this book is that a word processor is generally quite limited in its ability to handle mathematics. Microsoft `Word`, Corel `WordPerfect`,® and other popular word processors can, in fact, format equations. Commercial patches are available which enhance the mathematical capabilities of these products. But, even so, a word processor cannot handle the variety of fonts and font sizes, and especially the formatting and positioning issues, that are essential to the quality typesetting of mathematics. Try creating a fraction whose numerator is an integral and whose denominator is the determinant of a matrix. With TEX the matter is a triviality; with your word processor or other system, good luck.

If you send your work to a publisher and it is created in TEX, then the publisher will tinker with it and then publish it in TEX (or in PostScript, which is easily produced from the output `*.dvi` file). But if you send your work to the publisher in `WordPerfect` then it will have to be typeset,[2] almost as if you had sent in a typed manuscript.[3]

As of this writing, TEX is virtually the only complete software system for *typesetting* both mathematics and English. It is used universally, and around the world. It is available in Russian, Japanese, and other

[1]A pixel is a screen dot.

[2]Not quite. Many publishers can utilize the ASCII code in your word processed document. But all the mathematics will have to be typeset from scratch.

[3]It is worth noting explicitly that it is impossible to create a without-human-intervention translator to mediate between a word processor and TEX. That is because a word processor and TEX are conceptually different: the word processor is a device of convenience, for putting words on the page in a workable form; TEX, which is a typesetting system, is much more exacting, and specifies page format to a much higher degree of accuracy than is possible on any word processor.

languages. It is infinitely portable, and it is stable. Every young (and old) mathematician should learn to use TEX.

3.2 Modes of Typesetting Text

The typeset page has margins mandated, and these usually are fixed once and for all throughout the entire manuscript. In TEX, the default margins are $1''$ on all sides. For a full-sized $8.5'' \times 11''$ page and 10 point type, such margins are too small. You need to select margins that are suitable for the size of the page, the size of the type, and the purpose of the document. A medical reference work will have large pages, possibly two columns, very small type, and narrow margins. A children's book will have even larger pages, but also large type and large margins. Most documents will have specifications somewhere in between.

In a mathematical document—either an article or a report or a book—most text will be in paragraph mode. Usually paragraphs are indented, and there is customarily a bit of extra vertical space between paragraphs (i.e., more space than between successive lines in the same paragraph). We now spend some time discussing various standard typesetting situations that deviate from the standard paragraph layout.

Bibliographic References: A great deal might be said about how to typeset bibliographic references. Consult [HIG], [SWA], and especially [SKI] for the complete chapter and verse. Our simple advice is that you should pick a standard format and stick to it. If you use $\mathcal{AMS}$-TEX or BIBTEX, for example, then the package will choose a format for you. This software has special ways of formatting references to books, articles, theses, preprints, and other forms of scholarly work. If you use other typesetting environments, then you will have to exert some control over the situation.

One standard format for a reference to a paper is

> S. Schlobodkin, An incorrect proof of the Riemann hypothesis, *Journal of Unpublishable Results* 43(1997), 23–59.

Here 43 is the volume number of the journal, 1997 is the year, and 23–59 is the range of pages.

For a book, the information required and the format are slightly different:

> Dewyew Luffmea, *The Complete Index of Hypothetical Theorems*, Voracious Vanity Press, Vancouver, 1943.

For a thesis, an acceptable format is

> A. Lincoln, The slaves should be freed, Thesis, University of Albemarle, Albemarle, 1994.

For a preprint, use

J. Davis, I'm not so sure, but we lost the war, preprint.

Of course there are occasionally other types of sources to which you will refer. One is the "private communication"—indicating that someone has told you something but that it has not been published anywhere. This could have been a personal letter, or a conversation, or perhaps an e-mail message. The custom in this circumstance is to write

J. P. Jones, private communication.

Displayed Quotations: A quotation of length greater than one sentence, or fifteen words, should be displayed. This means that it is set off from the main body of text, with extra space above and below and wider margins than the default. Sometimes—especially for long quotations—the text is set in a smaller font. When a quotation is displayed then quotation marks are not used. An example is

> A rare delicacy in Korea is a gruel made of mosquito eyeballs. There is a certain bat that eats the mosquitos, and that bat can digest all parts of the mosquito except the eyeball. Thus the eyeballs are harvested by processing the leavings of the bats.

Footnotes: A footnote is designated by a special mark in the text—sometimes a number or a dagger † or another special symbol—at the point of impact. Then the text of the footnote appears at the bottom of the page. This text is generally in a smaller font than the main text body, and is often separated from the main text by a horizontal line.[4] The footnote at the bottom of this page was typeset with the code `\footnote{This is an example of a typeset footnote.}`.

Many publishers of mathematics discourage footnotes. This is an interesting historical development. In the nineteenth century and early twentieth century, bibliographic references in a mathematical work were generally set in footnotes. Now such references are usually collected in a list at the end of the document. In more modern times, publishers objected to footnotes because they were extra work for the typesetter. Also, the footnote labels could be misconstrued as superscripts. With the advent of electronic typesetting systems—such as TEX—this objection has grown moot. But the custom is still to minimize the use of footnotes.

[4]This is an example of a typeset footnote.

Marginalia: Sometimes, in a reference work, it is useful to have topic headings or sometimes even notes to the reader in the margin. In a textbook, one sometimes has exercise numbers hang-indented into the margin. But, generally speaking, works of mathematics contain no material in the margin. Again, part of the reason for this custom is that it is extra work for the typesetter to typeset such material. Even with electronic typesetting systems, it is time-consuming and tedious to set up marginalia. Marginalia are best avoided.

Even so, there are situations where a "hang indent" format is desirable. When you are presenting a list of problems (as in the exercise section of a textbook), it is common to hang the problem numbers in the margin. This can be done with the TEX code

```
\medbreak\noindent\llap{{\bf 1.}\enskip}\ignorespaces
Consider a deck of 53 cards.  Drop it on the floor and
step on the cards with flamenco shoes \dots
\medbreak\noindent\llap{{\bf 2.}\enskip}\ignorespaces
Three men have \$47 dollars among them.  Each man hands
\$3.50 to the man on his right, taking back a quarter
when the other man isn't looking \dots
```

The result is

1. Consider a deck of 53 cards. Drop it on the floor and step on the cards with flamenco shoes ...

2. Three men have $47 dollars among them. Each man hands $3.50 to the man on his right, taking back a quarter when the other man isn't looking ...

The key command here is `\llap`, and the others are of secondary importance. We refer the reader to [SAK, p. 152] for a detailed discussion of all the TEX commands used in this last example.

Sometimes a "hangindent" can make for an attractive display. This typesetting concept entails having one or more initial lines flush against the left margin, and the subsequent lines uniformly indented. An example is obtained from the TEX code

```
\medbreak \hangindent=.3in \noindent S. G. Krantz,
{\it Function Theory of Several Complex Variables},
Second Edition, Wadsworth Publishing, Belmont,
California, 1992.  {\sf This is a fine text, written
```

```
in the classical style.  The author, while young,
seems to know what he is talking about.}
```

which typesets as

S. G. Krantz, *Function Theory of Several Complex Variables*, Second Edition, Wadsworth Publishing, Belmont, California, 1992. This is a fine text, written in the classical style. The author, while young, seems to know what he is talking about.

The key command here is `\hangindent`, and the others are of secondary importance. We refer the reader to [SAK, p. 186] for a detailed discussion of all the TEX commands used in this last example.

Tables or Charts: Of course a table or chart cannot appear inline; it must be displayed—with extra space above and below and on both sides. A table will often use multiple fonts, perhaps bold for headings and italic for subheadings. LATEX has special macros, notably the `tabular` environment, for typesetting tables and the like. See also the macros provided in [SAK]. The creation of a table (unaided) is remarkably difficult in Plain TEX.

Theorems, Definitions, and Other Displayed Material: It is customary in mathematics to organize material into blocks of text, or enunciations; theorems, definitions, examples, remarks, and other devices are common organizational tools. Usually there is a small amount of extra vertical space above and below each of these displayed items.

There are many different paradigms for typesetting these units. You should pick one and use it consistently. Many times, the word "Theorem" or "Definition" or "Remark" or "Example", together with its number or other designation, is set in boldface. Some authors choose to set the word "theorem" (or other sobriquet) in all caps, or big cap-small cap, or some other special form; the main thing is to choose a format and be consistent. The text of the enunciation is generally typeset in roman. However, many authors find it useful to put the text of an enunciation in *slanted roman*, just so that it will stand out.

LATEX includes a utility called `\newtheorem` for typesetting enunciations. For example, if you want to specify in advance how a proposition and a lemma will look, then (in your preamble) you include the code

```
\newtheorem{proposition}{PROPOSITION}
\newtheorem{lemma}{Lemma}
```

Now when you want to typeset a lemma followed by a theorem then you use the code

```
\begin{lemma}
Let $\epsilon > 0$.  For every continuous function $f \dots$
\end{lemma}

\begin{proposition}
Let $\zeta$ be Riemann's zeta function.  Let $P$ be a zero
of $\zeta$ that lies in the critical strip \dots
\end{proposition}
```

The typeset result is

LEMMA 3.1
Let $\epsilon > 0$. For every continuous function $f \dots$

PROPOSITION 3.1
Let ζ be Riemann's zeta function. Let P be a zero of ζ that lies in the critical strip ...

As you can see, it is the default in LaTeX to typeset these displayed units in *italic*. This author finds such a typesetting decision to be in error; italics were invented to slow down the eye, and should be used only for single words or short phrases. A lengthy enunciation should not be typeset in italics. Many typesetters would agree that slanted roman is preferable to italic in this instance. You can either invoke the alternative font by setting `\sl` by hand or else (in LaTeX2ε) you can use the command `\theorembodyfont`.

3.3 Hyphens and Dashes

English typesetting commonly uses three types of hyphens or dashes: the hyphen (-), the en-dash (–), and the em-dash (—). Each of these three punctuation marks has a distinct and well-defined use.

The Hyphen: The hyphen is used in standard hyphenation of words: well-defined, semi-retired, ultra-modern. Although infrequently invoked by mathematicians, numbers between twenty and one hundred, written out in words, are hyphenated: forty-two and eight-seven. It is common in mathematics to refer to the Cauchy-Kowalewski theorem or the Heine-Borel theorem. Do not put spaces on either side of the hyphen.

The En-Dash: The en-dash is longer than the hyphen but shorter than the em-dash. It is customarily the length of an en, which is the width of the letter "N" in the current font. The en-dash is used to designate a range of numbers or years: pages 3–42 or the reign of King Henry (1833–1841). Do not put spaces on either side of the en-dash.

An interesting artifact of modern life is that some publishers (and authors) consider Cauchy-Kowalewski and Heine-Borel to be politically incorrect, because the use of the hyphen might suggest that Cauchy and Kowalewski or Heine and Borel were married (and had therefore hyphenated their names). Thus the publisher will typeset Cauchy–Kowalewski and Heine–Borel (with an en-dash).

The Em-Dash: The em-dash is the longest of the commonly used dashes. It is customarily the length of an em, which is the width of the letter "M" in the current font. The em-dash is used for a pause or break in a sentence:

> Bob began systematically to move Mary's possessions out of the apartment—he was really the best man to do it.

There is general agreement that you should *not* put spaces on either side of the em-dash.[5]

3.4 Alignment

Alignment is a useful tool for organizing material. When making a list, or creating a table, or designating a correspondence, you will use alignment to make your ideas clear.

Name	**Rank**	**Number**
Jones	sergeant	37-99405
Smith	major	43-89427
Larson	lieutenant	11-48950
Masters	colonel	53-48045

An example of alignment.

You mark items in a manuscript for alignment by running a vertical (sinuous) line through the initial letters of the leading words and writing "align" in the margin.

[5]But customs in other countries may vary.

Making a good table—in which the information is clear and easy to retrieve—is a skill that must be honed over time. The book [HIG] has a detailed and informative discussion of how to form clear and easy-to-read tables. Other fine references for table-making are [CHI] and [TUR]. The book [TUF] is an authoritative source on the display of quantitative information.

3.5 Typesetting Material in Two Columns

We sometimes encounter two-column typesetting in encyclopedias (for example the *Encyclopaedia Britannica*), in medical reference books, and in insurance contracts. It is rarely appropriate to use the two-column format in a serious mathematical work. The presence of complex, often long, equations is directly in conflict with the narrowness of columns. On the other hand, the two-column format is sometimes used in statistical writing. Consult the Author Guidelines for any publication you are considering before you think about setting your text in two columns.

Certainly LaTeX has macros which make the two-column format a breeze to invoke. But, using them, you will find yourself doing a lot of handwork to correct line over-runs and awkward line and page breaks. LaTeX2$_\varepsilon$ is more versatile in this regard than is LaTeX 2.09.

3.6 Some Technical Textual Issues

The formatting of text has a great many technical questions attached to it. Fortunately, most of them will not apply to mathematical writing. We focus here on only a few of the most common topics.

Font Calls: The lore of fonts is vast and varied. It is discussed rather thoroughly in [SAK] and [GMS]. We give just a quick idea here of how a text font call is done. The font `cmss10` is a sans serif font. The basic logic of a font call is that the name that you use for a font in a TeX call cannot contain any digits. But we keep track of fonts by their name and their size. So a font is typically *stored* on your hard drive with a name that uses *both* characters and digits—such as `cmss10`. So you must assign a nickname to the font; let us use the nickname `sanser`. Thus, at the top of your file, you would include the code

```
\font\sanser=cmss10
```

This statement assigns the "working nickname" `sanser` to the font `cmss10`.

Then if you want to set the phrase "Quoth the raven, 'Nevermore'. " in sans serif you enter the TeX code

```
{\sanser Quoth the raven, ‘Nevermore’.}
```

The compiled output is then

Quoth the raven, ‘Nevermore’.

Periods, Spaces After: One of the ingenious features of TEX is that most every character comes equipped with “glue”. In a nutshell, a character’s glue tells TEX how much space that character wants on either side of it. This is not a trivial issue. For example, a left parenthesis wants more space to the left than to the right. A + sign wants an equal amount of space, of a certain size, on both sides; an = (equal sign) will want a slightly different amount of space. And, in order to effect attractive line breaks, TEX must build a certain amount of flexibility into its spacing mandates.

A period “ . ” is often used as a device for ending a sentence. As such, it wants no space on the left and a double space on the right. In fact, that is the default space that TEX gives to the humble period. But if instead you are typesetting “Mr. Smith” then you definitely do not want a double space after the period. In that case you must either typeset `Mr.\ Smith`, where the `\ ` is a manual single space, or else typeset `Mr.~Smith`, where we have used the hard space discussed in Section 2.8.

If the period follows a capital letter, then TEX assumes that the letter is an initial (as in P. G. Wodehouse) and puts a single space after the period. You may want to use the hard space anyway (typeset as `P.~G.~Wodehouse`) to guarantee that there will not be an awkward line or page break between or after the initials.

Quotation Marks, Usage of: There is reason to be grateful that this issue does not come up very frequently in mathematical writing. Logic dictates that one should write

Euclid called it “one of those Pythagorean things”. $(*)$

The thought here is that Euclid’s statement is a proper subset of the full sentence, therefore the closing double quotation mark should come before the full stop (i.e., the period). Unfortunately, typesetting convention runs contrary to logic. The correct mode is

Euclid called it “one of those Pythagorean things.” $(**)$

Matters are actually more complicated than the previous paragraph might indicate. Rules of grammar and syntax, and rules of typesetting as well, are in a constant state of genesis and flux. The convention we have described above is very much in force—simply go and consult a popular novel to verify this claim for yourself. But the inertia in current mathematics is to follow the logical rather than the popular; that is to say, more and more mathematical manuscripts adhere to the first custom $(*)$ rather than the second custom $(**)$.

The notion that the punctuation mark should precede the closing quotation marks applies both to commas and to periods. For colons and semi-colons the rule is just the opposite: the punctuation mark should follow the quotations marks. But the rules are different in Britain.

Whatever paradigm you may choose to follow, do be consistent. This author has advocated (in the book [KRW]) that the standard rule should be broken when the quotation marks surround a short phrase without a verb. For example, the sentence

> Bob's favorite words were "apple", "ludicrous", "apostle", and "perquisite".

is arguably clearer and less clumsy than

> Bob's favorite words were "apple," "ludicrous," "apostle," and "perquisite."

Professional typesetters have told us that this view is probably correct and sensible, but it ought not to be uttered in public. Judge for yourself. See also the following discussion of smart quotes vs. straight quotes.

Quotes, Smart vs. Straight: The method in TEX for specifying quotation marks is to use pairs of single quotation marks. For example, the code `George said, ‘‘Hello Bob.’’` produces the output George said, “Hello Bob.” The clear advantage of using pairs of single quotation marks is that it allows us to specify left quotes and right quotes explicitly, so that they are typeset correctly as left curly quotes and right curly quotes. If you instead use straight quotation marks in your TEX code, i.e., `George said, "Hello Bob."` then you will get the incorrect result George said, ”Hello Bob.”

It is easy enough to get used to TEX's method for handling quotations. But in some systems there is now a system of "smart quotes". For example, the latest release of Microsoft `Word` allows you to enter straight quotes both on the left and the right, and it correctly converts them to left curly quotes and right curly quotes. The `Smart Quotes`® software of Sam Kington will automatically convert straight quotes to (correctly chosen) curly quotes in any desktop situation. `Smart Quotes` is freeware. You can become better acquainted with `Smart Quotes` at the Web site `http://www.illuminated.co.uk/acorn/smartquote/`.

Spell Checkers: Whether you use TEX or a word processor, do develop the habit of using a spell checker. You may be the world's greatest speller—winner of every spelling bee from London to Newcastle—but when typing rapidly you could set `teh` instead of `the` or `enromous` instead of `enormous`. You could, in your haste, double a consonant that should not be doubled or put an "i" before an "e" when it should be the other way around. The spell checker will help you to catch such errors. Please note that the spell checker will *not* catch mistakes like typing `homeomorphism` for `homomorphism` or `conversation` for `conservation` because these are all legitimate words. In point of fact, your spell checker may flag both "homeomorphism" and "homomorphism" as errors because they are not part of the standard English lexicon. But you can, and should, add words to your spell checker's dictionary so that the jargon you usually use in your work does not get flagged.

If you are a TeX user, then your spell checker will flag `\parindent` and `\eqnarray` and other standard TeX and LaTeX commands. But some popular spell checkers (such as MicroSpell®) have either a TeX mode that will ignore TeX commands or a TeX filter that will sort out the TeX commands and just check the text.

chapter 4

Front Matter and Back Matter

4.1 The Beginning

The front matter for a book comprises the front and back title pages, the Table of Contents or TOC, the Preface, the Foreword (optional), the List of Figures (optional), the Acknowledgements (optional), the Dedication (optional), and like material. The back matter consists of Appendices (optional), the Bibliography or References, the Glossary, tables and other resources (optional), and the Index.

LaTeX and other standard sets of TeX macros enable the automatic generation of the TOC, List of Figures, the Glossary, the Bibliography, and the Index. A few words of explanation are relevant in this regard.

In the LaTeX book style, one begins a chapter, a section, and a subsection thusly:

```
\chapter{All about Everything}
\section{Specific Comments about Everything}
\subsection{General Comments about Very Little}
```

In order to create a Table of Contents, you need to enter the line `\tableofcontents` in your source code file *after* you enter the all-important line `\begin{document}`. LaTeX is what computer scientists call a two-pass system.[1] The first time that you run `latex` on a source file (call it `mybook.tex`), it creates an auxiliary file called `mybook.toc`. The `*.toc` file contains information about the names and the page numbers of the various chapters, sections, and subsections. When you then run `latex` on the file a second time, it builds a Table of Contents, typeset in TeX. Of course all the titles and page numbers are literal copies of what

[1]For some packages (such as BibTeX), even more than two passes may be required.

actually appears in the text. This is a wonderful labor-saving device, and guarantees perfect accuracy.

The creation of the List of Figures is just the same. You insert the command `\listoffigures` after the `\begin{document}` line. When you run `latex` on your file `mybook.tex`, then the file `mybook.lof` is created. It contains information about the caption, the number, and the page number for each figure. When you run LaTeX a second time, a typeset List of Figures is generated. A List of Tables may be produced in an identical manner. The interested reader may consult [GMS], and the various TeX Web sites (such as the TeX Users Group, whose URL is `http://www.tug.org`) will contain additional macros for specialized applications. See also Appendix VI.

4.2 The End

The back matter for a book consists of the references or bibliography, the index, perhaps some appendices, and other auxiliary material of the author's choosing.

In a mathematics book (as opposed to, say, a romance novel), the Index is of vital importance. A mathematics book is thick and dense, and the author should do his utmost to help the reader navigate his way around. The Index is an important tool in that quest.

In the old days, the author would painstakingly plod through the page proofs; he would note each word to be indexed, and its page number, on a $3'' \times 5''$ card. At the end of this process, the author would have a stack of said cards, and would then alphabetize them. Then he would type out the index; in the process, he would eliminate redundancies, amalgamate cognate terms, classify words either as principal entries or subentries (see the display below for a sample of a finished Index, with entries and subentries clearly exhibited), and so forth. The entire procedure could easily take a week of hard work.

A sample passage from an Index might look like this:

homology 37
    class 38
    group 40
homotopy 29
    deformation 31
    equivalence 30

In this sample, "homology" and "homotopy" are principal entries and "class", "group", "deformation", and "equivalence" are subentries.

With TeX, the entire process just described has been automated. The author puts the command `\makeindex` in the TeX source code file *before* the `\begin{document}` command (i.e., in the preamble to the electronic file). Then he inserts *tagged* words in the file wherever they are to be indexed. In out-of-the-box LaTeX, if the word “homotopy” occurs in the TeX file in line 1227, then the author adds `\index{homotopy}` to that line adjacent to the original occurrence of that word. In LaTeX2$_\varepsilon$, one can also use an index tag of the form `\index{homotopy!stable}` to indicate that “homotopy” is a principal index entry and “stable” is a subentry. When the TeX file (call it `myfile.tex`) is compiled, an auxiliary file `myfile.idx` is created. It contains each word that was tagged, together with the number of the page on which the word occurs. Now here is data, ready to be manipulated.

Simple operating system commands can now be used to alphabetize the `myfile.idx` file. And it is straightforward, using a good text editor, to eliminate redundancies and to sort entries as either principal entries or subentries. When the final manipulation is complete, the `myfile.idx` file is incorporated into `myfile.tex`, and it compiles as a finished Index. Usually, the entire task can be handled in an evening.

Incidentally, with the use of auxiliary TeX packages (such as the utility `makeindex`) that are available on many systems, much of the editing described in the last paragraph can be done by machine, without any human intervention. You simply enter the command

```
makeindex myfile.idx
```

and the file `myfile.ind` will be produced. This new file alphabetizes the index, removes redundancies, and sorts out index entries and index subentries. The reference [GMS] gives a more detailed treatment of the use of the `makeindex` command.

Many of the public domain TeX archives, such as CTAN (see Appendix VI), contain utilities for performing the sort of sorting and filtering described in the last paragraph. See also the indexing macros that are provided with the book [SAK].

A glossary may be created using exactly the same procedures as we have described for creating an index. Words are tagged with the TeX syntax `\glossary{ }`. The glossary is compiled and formatted in just the same way.

The creation of bibliographies is a world of its own. Different versions of TeX each have their own macros for formatting the bibliography. In LaTeX, for example, each style macro (`book`, `article`, `report`, etc.) has its own paradigm for formatting the references. There is also BibTeX, which gives the user the power to create a bibliographical database with a filename `*.bib`. BibTeX is premised on the notion that we tend to use the same references repeatedly in our work. So why not have them all in a single database, and add to that database as new references come along? Each entry in the database—be it book, or article, or thesis, or other item—has a nickname, and any new document being created can invoke an item in the database simply by using its nickname. All very slick, and you can read the details in [GMS].

As with any good piece of software, BibTeX will cause you to re-think the process of doing bibliographical work. BibTeX will

1. allow you to re-format the entire bibliography of a paper or book simply by selecting a different bibliography style file;

2. allow you to keep the reference lists of all your works up-to-date (i.e., which preprints have appeared, which book manuscripts have been published by which publisher, which "private communications" have actually become papers) simply by keeping your master `*.bib` file up-to-date;

3. allow you to share your bibliographic database (by putting it on the Web, for instance) and to access the bibliographic databases of others.[2]

Here are some sample entries from a file called `mybooks.bib`, a typical database for BibTeX:

```
@ARTICLE{whole-journal,
   key = "GAJ",
   journal = {\mbox{G-Animal's} Journal},
   year = 1986,
   volume = 41,
   number = 7,
   month = jul,
   note = {The entire issue is devoted to gnats
           and gnus (this entry is a cross-referenced
           ARTICLE (journal))},
}

@INBOOK{inbook-full,
   author = "Donald E. Knuth",
   title = "Fundamental Algorithms",
   volume = 1,
   series = "The Art of Computer Programming",
   publisher = "Addison-Wesley",
   address = "Reading, Massachusetts",
   edition = "Second",
   month = "10~" # jan,
```

[2]Many subject areas have rather complete, publicly accessible, bibliographic databases posted on the Web. These are updated regularly.

```
   year = "{\noopsort{1973b}}1973",
   type = "Section",
   chapter = "1.2",
   pages = "10--119",
   note = "This is a full INBOOK entry",
}

@BOOK{book-full,
   author = "Donald E. Knuth",
   title = "Seminumerical Algorithms",
   volume = 2,
   series = "The Art of Computer Programming",
   publisher = "Addison-Wesley",
   address = "Reading, Massachusetts",
   edition = "Second",
   month = "10~" # jan,
   year = "{\noopsort{1973c}}1981",
   note = "This is a full BOOK entry",
}

@INPROCEEDINGS{inproceedings-crossref,
   crossref = "whole-proceedings",
   author = "Alfred V. Oaho and Jeffrey D. Ullman
        and Mihalis Yannakakis",
   title = "On Notions of Information Transfer in
       {VLSI} Circuits",
   organization = "",
   pages = "133--139",
   note = "This is a cross-referencing INPROCEEDINGS
       entry",
}

@PHDTHESIS{phdthesis-minimal,
   author = "F. Phidias Phony-Baloney",
   title = "Fighting Fire with Fire: Festooning
       {F}rench Phrases",
   school = "Fanstord University",
   year = 1988,
}

@TECHREPORT{techreport-full,
   author = "Tom T{\'{e}}rrific",
   title = "An {$O(n \log n / \! \log\log n)$}
       Sorting Algorithm",
```

```
   institution = "Fanstord University",
   type = "Wishful Research Result",
   number = "7",
   address = "Computer Science Department,
       Fanstord, California",
   month = oct,
   year = 1988,
   note = "This is a full TECHREPORT entry",
}

@UNPUBLISHED{unpublished-full,
   author = "Ulrich {\"{U}}nderwood and Ned {\~N}et
       and Paul {\={P}}ot",
   title = "Lower Bounds for Wishful Research Results",
   month = nov # ", " # dec,
   year = 1988,
   note = "Talk at Fanstord University (this is a
       full UNPUBLISHED entry)",
}
```

Your TEX source file `myfile.tex` might have this form:

```
\documentclass{article}
\begin{document}

\section{This is the First of Many Sections}

Now is the time for all good men to come.  Come, men,
come.  An appropriate reference for these ideas is
\cite{whole-journal}.  Further developments appear in
\cite{techreport-full}.  And if that doesn't float your
boat,\index{{\sc Bib}\TeX, sample of use}
then look in \cite{phdthesis-minimal}.

\bibliographystyle{plain}
\bibliography{mybooks}

\end{document}
```

Compiling this TEX ASCII source file will result in a document with a full bibliography at the end and appropriate citations to the bibliographic entries appearing in the text.

4.3 Concluding Remarks

The front matter of a book will include the Preface, Table of Contents, Acknowledgements, the front and back title pages,[3] and perhaps a Foreword and a brief Biography of the author. The back matter will include the Bibliography and Index and may also include Appendices, Tables (of notation, for example), a Glossary, and other auxiliary material. LaTeX has dedicated macros for creating most of these book components. We urge you to consult [GMS] or [LAM] for all the details.

[3]The back title page is where the Copyright and ISBN number, and like information, appears.

chapter 5

Copy Editing

5.1 Traditional Methods of Copy Editing

Traditionally, even as recently as twenty years ago, the copy editor worked with the hard-copy manuscript submitted by the author. He first made a pass through the manuscript in order to make notes on stylistic issues: formatting of section and chapter heads, use of remarks and examples and other enunciations, numbering of theorems, use of unusual spellings or constructions, syntax, grammar, usage, specialized words or jargon, and so forth. Then the copy editor would go through the manuscript again, correcting each page and bringing it into a consistent form that adheres to the usual customs and paradigms of the publishing business. All of the copy editor's marks would be made by hand, usually with red or blue pencil, in the margins of the manuscript. The usual collection of copy editor's marks (see Appendix I and Appendix II) would be exploited. The copy editor would also write queries to the author in the margins. Appendix I, Plate 4 shows how this is done. Then the author would be given a chance to respond to the copy editor's ministrations. As an author, you should learn the copy editor's marks (Appendix I). They will facilitate your communications with the copy editor.

5.2 Communicating with Your Copy Editor

The copy editing process is described in detail later in the book. Your primary method for communicating with your copy editor is by way of his markings and your markings on the manuscript. Learn to use the standard proofreader's marks (see Appendix I); they are as sure and accurate a way of communicating with your copy editor as learning French is a sure way of communicating with a resident of Paris. A complete list of those proofreader's/copy editor's marks that are most useful to the technical writer may be found in Plates 1–4 of Appendix

I. See also Appendix II for instances of the actual usage of these marks. The sources [SKI, p. 71] and [SWA, pp. 13, 85] contain further details about these marks, plus examples of their use. The reference [HIG] contains some useful exercises.[1]

You can also communicate with your copy editor using English prose, but the chance of a misunderstanding or inaccuracy will be higher. The fact that you are both native speakers is no guarantee that you will understand each other.

When communications with the copy editor become bogged down or too complex—and this will happen occasionally, despite the best intentions of all parties—then you will find yourself talking to the copy editor on the telephone. Our own experience is that this happens most frequently in trying to understand graphics, and what they are meant to represent. We wish to stress that this is *not* a confrontational transaction. Your copy editor wants nothing more than to make your book or paper come out right. You do too.

Electronic mail and FAXes are also an effective means for communicating with the copy editor. When a substantial (or surprising) change is necessary, we have sometimes found it useful to re-typeset a passage (in TEX, of course), compile and print it, and then FAX the result to the copy editor. Alternatively, one could e-mail (or `ftp`) the TEX code or the `*.dvi` file.

5.3 Communicating with Your Typesetter

Generally speaking, you will not communicate directly with the typesetter. In many instances *you* will be the typesetter, so the issue is moot. But even when the publisher outsources to a third-party typesetter, the copy editor or production editor will serve as a mouthpiece—both to you and to the typesetter. This is prudent, for most authors do not have the experience and the vocabulary to communicate directly with the typesetter. The copy editor can interpret the author's wishes for the typesetter and vice versa. The editor is the unique person in the transaction who is equipped to see that the page comes out as it should.

[1]Note that it will virtually never happen that you and the copy editor are sending (modified) electronic TEX files back and forth. In such a scenario, it would be too difficult to locate the passages which have been changed, and to compare the old and the new. There is too much chance for error, and for misunderstanding. The advantage of a hand-marked hard copy is that you have both the existing text and the proposed change before your eyes, and you always know what is meant.

5.4 Communicating with Your Editor

Here we speak of your developmental editor, or your acquisitions editor, or your production editor (not your copy editor). Much communication with the editor will be by telephone. In the best of circumstances, the editor will interpret your wishes as expressed in proofreader's marks (see also the discussion in Section 5.2). If your attempts to communicate how a graphic should appear have failed, then a telephone conversation can often clear things up. When misunderstanding occurs, then a phone call, or FAX, or e-mail, or even a FedEx may be necessary. Generally speaking, your relationship with your editor will develop into a salubrious, friendly, and productive one.

5.5 Modern Methods of Copy Editing

Today the process just described is frequently streamlined. First, the copy editor is likely working with a printout of the author's electronic file—either TeX, or LaTeX, or Microsoft `Word`, or some other piece of document-preparation software. The copy editor would *never* work directly with the author's electronic file; doing so would create too much potential for confusion (in part because one could not distinguish the original material from the corrected material), and increase the likelihood of miscommunication with the author.

Some things remain the same: the copy editor will still use the traditional copy editing marks (Appendix I), and will still place them in the margins of the manuscript, using red or blue pencil. He will write queries to the author, by hand, in the margins. As before, these will be recognizable because each begins with "Au:" or "Qu:" or "Qy:".

Usually the publisher will send this edited manuscript back to the author, thus giving the author a chance to respond. Then the publisher will generate page proofs, and the author will have another look. Other publishers will have the copy editor work with an already edited version of the author's work, rendered in page proofs, and this will be the author's one and only chance to review corrections.

Whether you have a publisher that adheres to the traditional methodology or the modern one, take heart. You will have at least one last chance to review your beloved book before it goes to press.

5.6 More on Interacting with Your Copy Editor

A copy editor is a trained technician, with considerable knowledge of the English language and syntax. He is not a mathematician. Such a person will have a good sense of English sentence structure and, because he does not get lost in the *meaning* of the sentences he is reading, can be a good judge of proper phraseology and overall writing. You should take the suggestions and corrections of the copy editor seriously, and reply to each one with care.

But, because of lack of knowledge of mathematics, the copy editor will make blunders. This author once had the experience of a copy editor intervening in a discussion of the Riemann zeta function and changing every occurrence of "critical strip" to "critical ship". On another occasion, a copy editor changed the name "Riemann mapping theorem" to "Riemannian mapping theorem" because the name "Riemannian metric" had occurred elsewhere in the manuscript. You will sometimes find the copy editor recommending a certain construction just because it seems to be correct English; but it will be incorrect mathematics. Indeed, what the copy editor is proposing may be just the opposite of what you want to say. What is one to do?

It is natural for one to become outraged. How dare the copy editor overstep his role and try to change your carefully chosen prose? If he is proposing this particular outrage, then what other travesties has he committed on your beloved manuscript elsewhere?

Be of stout heart. The copy editor is a serious professional, and he is aware of his limitations. In each instance where the copy editor has made an inapposite proposal, you merely need to write in the margin "This may be unfamiliar English, but it is standard mathematical jargon. Please leave as set." The standard editing argot, whose use will endear you to the copy editor, is *STET* (see the description of this acronym in Appendix I). Just write *STET* after your comment and your message will be clear. And you will get no further argument.

As indicated elsewhere, the discussion of figures and other artwork in the manuscript is going to be trickier. You may have submitted a sketch that was perfectly clear to you. That clarity stems in part, no doubt, from the fact that you yourself understand the mathematics behind the picture. The artist does not. So it is agonizingly likely that the publisher's first drafts of some of your figures will not at all represent what you had intended. Often, in a geometric figure, certain intersections or tangencies or containments must be depicted just so; the artist will not know that, and will render the picture rather differently. Somehow you must react calmly to what you've been sent, and communicate your true feelings so that the next draft will be more accurate.

There are several difficulties with this process. First of all, in many instances you will be communicating with the copy editor rather than directly with the commercial artist. Second, it is difficult to articulate in words what you want the picture to show; that is perhaps why you were using a picture in the first place. Thus there really is a lot to be said for either **(i)** submitting a professionally hand-drawn figure (drawn locally under your direct supervision!) to the publisher or **(ii)** learning to use software to generate the figures for your work, or at least to generate a figure accurate enough to communicate to the publisher's artist what you want.

If you choose to go the first route, and if you are unable to generate the hand-drawn figure yourself, then at least you can hire someone to do it for you, and you can stand right next to him and tell him what you want. The cost at a university of getting a skilled technician to generate your graphics is on the order of $30–$40 per figure (in the year 2000). This is money well spent if you want your book to come out right; and you may be able to convince your publisher to help to defray the costs.

5.7 Manuscript Proofs, Galley Proofs, and Page Proofs

In other parts of this book we have made reference to different types of proofs of your work. To recapitulate, the standard drafts of a work in progress that you may see are

(1) *The Manuscript.* This is the original hard-copy draft that you submit to the publisher. Today, this will generally be the printout from some electronic document preparation system such as TEX, or Microsoft `Word`, or some analogous piece of software. Most publishers will still accept typewritten copy; but working from such copy will add to the cost of producing the book or paper.

(2) *The Galley Proofs.* This is the typeset draft of the work, prepared from the submitted manuscript, but now correct for formatting, spacing, line breaks, numbering, and English usage and syntax. *It is not correct for page breaks.* The galley proofs will *not* be spaced for figures, tables, and other displayed matter.

(3) *The Page Proofs.* This is a representation of how the work will ultimately appear in print. It preserves all of the format and syntax formalities that were present in the galley proofs, but is now correct for page breaks as well. In particular, the page proofs will exhibit where all figures, tables, and other displays will appear. They will be correct for size, shape, and position. This is the moment when "what you see is what you get." It is your last opportunity to review your work before it goes to the printer.

Today, many publishers eliminate the galley proof stage; or else they meld the galley proof and page proof stages into a single stage. Because of electronic media, it is trivial to reformat page breaks and reposition figures. Today the publisher is not significantly inconvenienced if, even at the page proof stage, you need to move or to alter a figure (in the old days this would have been a major calamity). Therefore a lot of time and expense in the production process can be saved, and steps can be skipped.

5.8 *The End of the Process*

After you have reviewed your page proofs, you will send them into the publisher, usually by express mail. That is the end of the editorial process. Are there any more steps, from the point of view of the author?

There are a few. First, you may be asked to sign a statement proclaiming that you accept the manuscript in its current form, you give permission for it to go to press, and you will offer no further corrections. If you have been doing your homework all along, then this declaration should be easy for you.

Now let us assume that you are publishing a book (rather than an article). If your publisher is being particularly upfront and solicitous (professional societies are particularly good about this), then you will be asked/allowed to review the format and content of the cover. Part of this process is for you to evaluate the artistic and design qualities of the cover. The other part is for you to review the words on the cover. Of course make sure that the title is correct and the author's name spelled accurately; but also check the text on the back cover and on the flyleaves. Feel free to offer suggestions, corrections, and emendations. More people will read this material than will actually read the book, so you want it to make a good impression. In fact, many decisions on whether to buy the book will be based on the impression that this material makes. So be sure that it reflects well on you.

Less certain, but definitely desirable from your point of view, is to review the advertising copy for your book. Many marketing departments are rather territorial, and will not let even the editor see what they are creating. Let us hope that the marketing crew at your publisher's is not like that. You should be allowed to see the advertising copy, and you should be allowed to criticize it just as you did with your copy edited manuscript. Your editor should act as your broker/attorney, and make sure that your wishes are met. You certainly do not want the advertising copy to be inaccurate or embarrassing.

These last two transactions—the cover and the advertising copy—take place while the book is going into production. By the time you have approved the advertising copy, your book will be high in the queue at the printer's. In today's market, advertisements for your book will appear before the book has actually hit the street. Check out the Web sites:

http://www.amazon.com

or

http://www.barnesandnoble.com

or the pages of the *Notices* of the AMS to begin to develop an appreciation for your pear-shaped tones. In a short while, a box of books will be arriving on your doorstep.

chapter 6

The Production Process

6.1 Production of a Paper

These days, mathematical authors frequently operate under the delusion that they themselves will typeset their paper or book in TEX or some other markup language, send the disc into the publisher, and that is the end of it: The author's diskette is popped into one end of a big machine and a box of books or reprints comes out the other end. Not true. For a first line journal or book, that subscribes to quality typesetting practices, there is a lot more to the process.

Many authors will begin by writing the manuscript out longhand. This is so because, when you are writing out complicated mathematical expressions or ideas, it is easiest to maintain control with a pen or pencil. Then either the author or his typist renders the document in a "typed up" form. Today, it is really best if this can be done on a computer. If you submit a paper to a journal and do not have an ASCII file on a diskette, then the journal will incur extra expense and aggravation getting your work typeset. Many journals will give a paper not prepared in electronic form a low priority; some journals have an explicitly stated policy to this effect. Other journals simply will not consider papers unless they are typeset in TEX. If you are not yourself a TEX user, or if your department does not have a TEX typist, you may actually find yourself hiring someone to do your TEXing for you.

It is the case now, and always has been, that a journal will expect you to produce your own artwork. That is to say, when you submit the final draft of your paper to the journal, then you should submit repro-quality printouts of your graphics as well. The journal may in turn decide to render those graphics as bitmaps, or in PostScript, or in some other graphic format. Generally speaking, however, you cannot expect the journal to draw your pictures for you.

Let us suppose that you are preparing a paper with the intention of publishing it in a journal. After the "typed up" document is prepared, the manuscript is then submitted—usually in duplicate or triplicate—to a journal. Unless the journal explicitly encourages electronic submission, you should submit your work in hard-copy form, accompanied by the customary cover letter to the editor.[1] Do *not* submit your diskette at this time, because there will probably be modifications to the paper—initiated either by you or by the referee—before the paper is in final, accepted form.

After the paper is refereed and, presumably, accepted, there may be some revisions required. When you submit the final draft of the paper, again send two or three hard copies (marked as revisions and dated), the diskette with a TEX or other suitable electronic file, and the standard cover letter.

In due course, the author will receive page proofs for the article. This will not simply be a printout from the disc that the author submitted. Most mainstream mathematics journals outsource to a TEX consultant who painstakingly works over each paper for the journal, rendering it in the journal's style and seeing to it that formulas, and theorems, and the other parts of each paper are all typeset to an exacting—and to the *same*—standard. In an effort to achieve uniformity, some journals will change the author's numbering system. Many journals will modify the author's method of formatting the references, and particularly his method of labeling the books and papers listed in the references. Certainly all of the page breaks, and even some of the line breaks, will be different from those in the preprint.

Note that, twenty years ago or more, it was common for the author to receive galley proofs—not broken into pages. These galley proofs would not have shown placement of figures, tables, and other displayed matter. Today, because of electronic typesetting, what the author receives really is a representation of how the article will finally appear. These proofs will be accompanied by instructions on how to proofread the manuscript, how to mark corrections, and there may be author queries noted in the margins. Do follow whatever instructions may be provided by the publisher for that particular journal; if the publisher provides no instructions, then instead follow the guidelines provided in this book. The page proofs will be accompanied by copyright transfer forms and order forms for reprints and other clerical materials. It is generally requested that proofs be returned within forty-eight hours. Do endeavor to handle your proofs efficiently, accurately, and with dispatch. Also be careful to mail your proofs to the correct address—often it will be an address *different* from the one to which you originally submitted your

[1] The book [KRW] contains a discursive discussion of how to deal with journal editors and referee's reports, and we shall not repeat that advice here.

paper.

That is the end of the story. After you mail your page proofs back to the publisher, the next you will hear of your work will be on receipt of a packet of reprints and on your library's receipt of the appropriate issue of the journal.

6.2 Production of a Book

The steps in the production of a book are similar to those in the production of an article, but there are more of them. We give here a sketch of the process.

Many authors will begin by writing the book manuscript out longhand. This is so because, when you are writing out complicated mathematical expressions or ideas, it is easiest to maintain control with a pen or pencil. Then either the author or his typist renders the document in a "typed up" form. Today, it is really best if this can be done on a computer. Many publishers provide authors with a "manuscript preparation grant" ($2000 or so) to help defray the cost of getting the book TeXed. Alternatively, the publisher will offer to pay the author to do the TeXing. A warning is in order here. In many instances, if you sign a contract agreeing to produce the TeXed version of the document, then you may very well be agreeing to produce the final version that meets all the requirements of the copy and production editors. Thus you have agreed to engage in a process that goes way beyond just keying in the mathematics. You will have to wrestle with line and page breaks, spacing, running heads, and other formatting issues. In other words, you will have to master all the ideas in this book! Some authors will choose to simply forego the extra cash and let the publisher worry about these technicalities.

After the "typed up" document is prepared, the manuscript is then submitted to a book publisher.[2] (Of course if you are already under contract to a publisher and/or if a publisher has helped you to to prepare the document, then you are already committed and this step is automatic.) You should definitely submit your work in hard-copy form *only* at this time. One copy will suffice, and it should be printed on just one side of the page, with ample margins (so that editors and reviewers can make notes in the margins). Do not submit a disc yet, as there will certainly be changes later on. Although it may seem obvious to observe, this really needs to be said: Your book manuscript should be as polished and complete at the time of submission as a mathematics paper

[2]A journal article can only be submitted to one journal at a time. By contrast, a book manuscript can be sent to several different publishers simultaneously.

that you would submit to a journal. You would never send an article into the *Annals of Mathematics* that said

> **Theorem:** The zeros of the Riemann zeta function in the critical strip all lie on the critical line.
>
> **Proof:** George—include a plausible argument here. Enough details to be convincing. Add some figures for pizzazz.

But in fact people submit book manuscripts in this form—incomplete, with notes that the author has written to himself—all the time.

Your book manuscript should be as polished and complete as you can make it: include the Table of Contents, Preface or Prospectus, List of Figures, all text, all illustrations and tables and figures, all Appendices, the Glossary, the Bibliography, and the Index. You should include a detailed cover letter explaining just what this manuscript is, and for what audience it is intended. You should tell the publisher just who *you* are. Include your *Curriculum Vitae*, plus all current information about your address, phone number, e-mail address, FAX number, and so forth. The book [KRW] contains detailed information about dealing with a publisher over a book manuscript; we shall not repeat that advice here.

In an effort to evaluate your project, the publisher will send your manuscript out to various editorial advisors and reviewers. After a time, he will evaluate the reviewer reports and will render a decision about whether to pursue publication of your manuscript. It is rare that a publisher will say, "This is great and we will rush it to press." Most likely, you will be asked to consider some revisions. Eventually, you will produce a finished product, complete with all the elements described above, and be ready to submit this final draft to the publisher. In fact, there are several ways to do so.

You certainly will want to send the publisher a final hard copy. This hard copy represents what *you think the book is supposed to look like.* If an editor has any trouble with any of your electronic code, or is not sure what a certain formula or passage is supposed to say, then he will use *your hard copy* as a reference.[3] Of course the publisher will also want your electronic files. If the book is not too long, then a couple of 3.5″ diskettes is a perfectly acceptable medium on which to submit your book. However, if you are submitting PostScript files or graphics in electronic format, then your files are liable to be quite large. Therefore you may wish to use a Zip disc (which holds 100 megabytes, as opposed to the paltry 1.44 megabytes that a 3.5″ high density diskette holds).[4] It is also

[3]If that fails, then the editor will simply phone you up and ask you.

[4]Iomega Zip drives and discs have become a standard in the publishing industry.

possible, with some publishers, to submit your files over the Internet by `ftp` (file transfer protocol). A common procedure is to `tar` your files together so that you are manipulating just one big file, compress it with `gzip` or some other standard compression utility, and then `ftp` the file to a Web site that the publisher has set up for this purpose.

If your files are in a pre-agreed upon format that the publisher can use (say TeX and PostScript), then the technicians at the publishing house will have no trouble decompressing, un-`tar`ing, and printing or viewing your files.

At this point one or more copy editors will go to work on your book. Their task is both laborious and painstaking. The copy-editing procedure for a 400 page book could take several weeks. The editor will go over each page for style, formatting, consistency, (and possibly) grammar, syntax, and usage. You will then be sent the marked-up manuscript. Read the publisher's instructions carefully. If you are doing the typesetting, then you will respond to the copy-editing by incorporating the editor's instructions into the TeX source code. If the publisher is doing the typesetting, then it is up to you to read all of the copy editor's marks and either to accept them or to change them (by putting your own marks on the pages) or to challenge them (this latter option will be the exception). At the end of this process, you will either

(i) [*If you are doing the typesetting*] Print out a new hard copy and send it, along with your elecronic files, into the publisher.

(ii) [*If the publisher is doing the typesetting*] Send the newly marked-up manuscript back to the publisher.

The publishing industry is almost always in a "hurry up and wait" mode. Thus it is considered *de rigueur* to send things in using express mail (Federal Express or DHL or another service).

The copy editors will now go back to work. Depending on which publishing house is handling your book, you may now engage in some give-and-take with the editors, fine tuning the manuscript to a mutually agreeable finale. Or you may in fact receive a (putatively) final set of *page proofs* for your approval.

As with a journal article, the page proofs are your very last opportunity to see how everything will appear—including positioning of figures, all page breaks, formatting of special sections and materials, and front and back matter. Take a few days and spend some time with your book before it goes off to press. This is how it is going to look to your public!

6.3 *What Happens at the Printer's*

The reference [SKI, pp. 511–532] gives a detailed and authoritative description of all the activities that take place in a print shop. It is a long, complicated, and charming story—fraught with much history and tradition. In particular, page 518 of that book tells all the steps involved in the production of a book by the traditional methods (that were used almost universally up until 20 years ago). It would take us far afield to describe all this history, and most of it is not relevant today. We cannot take time to tell the whole story here. But we shall give a sketch.

In the old days, here is what would happen once your book was ready to go into production. The publisher would print out "repro copy" on special, high quality paper called *RC paper*. Then a technician would "shoot" the book: take a photograph of each page. Now each page of the book was a photographic negative. That negative would then be photographically printed on an emulsion-coated copper or zinc printing plate.[5] And that plate would then be engraved, and become the master printing or lithography plate for the given page.

Today, the process just described has been streamlined. Now there is hardware and software that will go directly from the `*.dvi` file to film; more precisely, the `dvi file` is converted to a PostScript file and then `ghostview`, or `ghostscript`, or another[6] utility will then transfer the image to film. The film is then used to produce the image on the plate, the plate is engraved, and (as before) it is mounted on the printing press.

A modern printing plant is quite a technological operation. No longer is it the case that the printer performs individual steps of printing sixteen pages to a sheet, folding the sheets into signatures, binding the sheets together, and compiling them between flyleafs and covers. In fact, a machine performs all the steps—without human intervention. At the output end of the great, rumbling behemoth, a stack of books is ejected. That is the good news.

The bad news is that such high-tech printing operations are few in number, and are in great demand. Often the queue at the printer is the great unknown in the publishing process. All the editing described above can take two or three months. Then waiting to get the book printed can take another two or three months (the actual printing itself might take only an hour or so!!).

Certainly even a well-informed and high-tech author need not know the details of how the printing process works. But if something goes

[5] Depending on the quality of hard-copy output that is desired, the printer will sometimes use plastic or compressed fiber plates.

[6] Refer to Appendix VI for some URLs where `ghostview`, `ghostscript`, and related tools may be found.

wrong, it is helpful if you can speak to your editor knowledgeably about a reprint, or a tip-and-tear (see the Glossary), or paper weight, or types of ink. Again, see [SKI] for the chapter and verse on these matters. The one certain fact—and this is in large part why the present book was written—is that you do not want to find yourself unable to communicate your needs or concerns to your editor, and you also do not want to find yourself unable to understand what he is telling you. You need to learn the language!

chapter 7

Publishing on the Web

7.1 Introductory Remarks

The Internet is a vast network of interlinked computers. Thanks to the World Wide Web, material posted on many of these computers can be easily accessed from any of the others with a simple, intuitive graphics interface.

It has become desirable, for many reasons, to publish scientific material on the Web. The World Wide Web provides an essentially cost-free, instantaneous vehicle for universal dissemination of your ideas. Write up a new theorem tonight, post it on the Web tomorrow, and your colleagues in Uzbekistan can be reading it right away. No longer are we dependent on the vagaries of the publisher, the printer, the postal service, the university library, or other distribution systems.

There are disadvantages to Web publishing from the point of view of archiving. As of this writing, there does not exist any permanent and reliable protocol for archiving electronic media. The traditional method of archiving a book is to print a thousand hard copies of the volume and to distribute them to libraries (both public and private) around the world. Since each of those "mirror copies" is stable, we can be reasonably sure that a fire or a rodent attack at one location will not affect copies at another location. By contrast, sun spots or cosmic rays could simultaneously damage *all* electronic mirror images everywhere.

We encourage you to archive your work in the time-tested hard-copy format. But, for rapid communication and dissemination, you had better learn to use the Web.

7.2 How to Get on the Web

If you are on a UNIX system, then in a subdirectory with a name something like `~/public_html` you will create a file with the name `index.html`. That file is the basis of your Web page. It may (ultimately) contain hyperlinks to other files, but `index.html` is where it all begins. If you are posting straight text, then you will use the universal Web language HTML (Hypertext Markup Language). HTML is an extremely straightforward, high-level computing language which allows you to issue standard text formatting commands for size, font, spacing, and so forth. Here is a typical bit of code for an HTML file, taken from the book [GOR]:

```
<TITLE>The simplest HTML example</TITLE>
<H1>A level one heading</H1>
<P>Welcome to the world of HTML!
<P>Let's have a second paragraph.
```

This will appear on the screen roughly as

> **A level one heading**
>
> Welcome to the world of HTML!
>
> Let's have a second paragraph.

The title “The Simplest HTML example” will appear in the title bar of the browser. Of course what the end user actually sees will depend on what browser he is using; so this “sample” should be taken only as a suggestion of how HTML code is translated into typeset text.

As you can see, HTML uses *tags* to tell the Web browser how to format text. Some tags, such as `<TITLE>`, have a beginning tag and an ending tag; these are differentiated by the presence of a forward slash `/` in the latter. The `<H1>` tag indicates a level one heading, which is a large, bold font. Smaller, lower priority, headings are denoted with `<H2>`, etc. The `<P>` tag indicates a new paragraph. Other tags are similar.

A surfer on the World Wide Web would locate your Web page by typing in your URL (Uniform Resource Locator), or Web address. The Web address of Steven G. Krantz is typical:

http://www.math.wustl.edu/~sk

You can see that the address consists of the node in our mathematics department followed by an identifier for the individual person. Very simple.

Private Internet providers will have their own protocol for creating a Web page. If you are an America Online user, or a Compuserve user, or an EarthLink user, then you will have to learn their particular paradigm for creating a Web page. But it will be similar to what we have described for UNIX.[1]

[1]There is quite a lot of software available for creating Web pages. America Online and other ISPs have their own utilities. Third-party products—such as Micrografx's

7.3 Web Resources

The World Wide Web is growing rapidly as a source of information about many topics. Thanks to the efforts of many mathematicians, publishers, and computer scientists, the information on the Web about mathematematical publishing is growing apace. It would be impossible here to give anything but a hint of some of the Web resources available to the mathematical author. We mention just a few favorites.

arXiv Available from `www.arXiv.org`, this is a preprint server for the sciences. Initiated by Paul Ginsparg at Los Alamos, the `arXiv` has become something of a national resource, and a model for how preprint servers should be run. New preprints are posted without human intervention (apart from the actions of the author to post his work), and can be downloaded in `*.pdf`, `*.dvi`, `*.ps`, source code, and other formats.

AucTEX AucTEX is an add-on to the UNIX editor GNU `emacs`. It is an extensible package that supports writing and formatting TEX files, particularly those created in LATEX and AMS-TEX. A 60+ page manual is included in the distribution of AucTEX. There is also a link to an on-line version of the manual.

You can download AucTEX from the Web site

`http://www.math.auc.dk/~dethlef/Tips/auc.html`

That site also contains links to sources for `emacs`, MiKTEX, `ghostview`, `Ispell`, and `Lacheck`. (Some of these are discussed below.)

Bibweb This is a utility for automatically retrieving bibliographical information from the American Mathematical Society's `MathSciNet` program. Requires the use of BIBTEX. Available from the Web page

`http://www.math.washington.edu/~palmieri/Bibweb/`

comp.text.tex This is an electronic newsgroup on electronic document preparation. Their FAQ (list of "Frequently asked Questions"), called `tex-faq`, is a terrific source of information about `troff`, PostScript, TEX, and other typesetting ideas. The useful newsgroup also contains the utility `TeX-index`, which is an archive of all public domain TEX macros.

Webtricity, Sierra Home's *Complete Web Studio*, IBM's *Top Page*, and SoftQuad's *HotMetal Pro 6.0*—may be purchased at any computer store. This software provides an interface, very much like a word processor, between the user and HTML.

Front Greg Kuperberg's contribution to the quality of mathematical life, `Front` is a very user-friendly front end for `arXiv`. You can try out `Front` for free at `http://front.math.ucdavis.edu`.

Ispell Also available from the Web site

`http://www.math.auc.dk/~dethlef/Tips/auc.html`

`Ispell` is a spell-checker for all types of documents. You can also download `Cygwin` from the Web site; it is needed for running `Ispell`.

JSTOR The Mellon Foundation's ambitious project to provide electronic archiving for major scholarly journals. There are now about 130 journals archived on JSTOR, 11 of these in mathematics. New journals are continually being added. Other fields covered range from Afro-American Studies to Economics, Philosophy, and Sociology. If a university subscribes to JSTOR, then there is no limit to the number of its people who can read the same article at the same time. Articles may be downloaded and printed. Learn more about JSTOR at `http://www.jstor.org`.

Lacheck This is a utility for checking cosmetic errors (at a rather recondite technical level) in a TEX source code file. Downloadable from the Web site `http://www.math.auc.dk/~dethlef/Tips/auc.html`.

MathSciNet Created by the American Mathematical Society, in this author's opinion `MathSciNet` is the most important new mathematics resource to come along in many a year. Type in the name of an author and in a few seconds `MathSciNet` will return complete bibliographical references for *all* his papers. Type in a full or partial title and `MathSciNet` will return all papers with that text in the title. Type in key words and `MathSciNet` will return a list of all papers with those words in the title, or in the *Math Reviews* review. `MathSciNet` is also a great tool for seeing what that "special someone" has been up to in the past few years.

`MathSciNet` is *not* free. In fact, the American Math Society requires that you subscribe to the hard-copy *Math Reviews* before you can subscribe to `MathSciNet` (for an additional fee). But it is worth it. Learn more about `MathSciNet` at `http://www.ams.org/mathscinet`.

MR Lookup This is a new utility for accessing the MathSciNet database to verify and create references that can link to reviews and original sources. If you input basic reference data into MR Lookup, then it returns electronic publication-ready references with live links to reviews in MathSciNet and to original articles. Available from the AMS Web site http://www.ams.org/mrlookup.

7.4 Mathematics and the Web

The interesting issue about Web publishing from the point of view of the mathematician is that HTML cannot handle mathematics. There does not even exist universally readable HTML code for the Greek letter π.[2] The mathematician seeking to post his ideas on the Web is best advised to use another medium.[3]

Many, if not most, mathematicians will create their documents in some form of TeX. Most publishers prefer LaTeX, just because it gives the author fewer choices and because it emphasizes logical markup over visual markup.[4] So let us assume, for the sake of this brief discussion, that you have created a mathematics document—perhaps a research paper, or a chapter of a book, or an article for the *Notices* of the American Mathematical Society—in LaTeX. Now you want to put it on the Web. What do you do?

The simple answer is that your document needs to be rendered in `*.pdf` format. Adobe Acrobat is designed to read and manipulate `*.pdf` files.[5] An Acrobat file can be recognized by the extension `*.pdf` (where `pdf` stands for "portable document format"). The utility `pdftex` will, in fact, turn your TeX file directly into `*.pdf` code. You can use the utility `dvipdf` to turn your `*.dvi` file into a `*.pdf` file. Alternatively, either Adobe Acrobat `distiller` or `ghostview` will turn a PostScript file into `*.pdf`. Then anyone with an Acrobat reader will be able to read your document, with formatting and resolution quality comparable to that of TeX.

You can, if you wish, use the utility `latex2html` to translate your LaTeX file directly into HTML. If your system is so equipped, it will turn

[2] It should be noted that Greek letters are now part of the ISO 10646 standard, and they are implemented in the HTML specification. Not every Web browser supports the code, however. As of this writing, HTML does not have an international standard (like the ANSI Standard in C), and SGML is still under development.

[3] Everything about publishing, and especially about publishing mathematics, on the Web is in flux. It is constantly developing, and at a rapid rate. So whatever we say about it here should be understood in that context.

[4] Any description of "what publishers think" is going to depend on the particular publishing house, on the particular individual expressing the opinion, and on what that individual's position is. Most editors are not fluently conversant with TeX, and view it as a black box. They see TeX in terms of what end product it will produce, and how easily. A member of the publisher's production department will take a more technical and empirical view of TeX.

[5] Refer to Appendix VI for some URLs where Acrobat-related tools may be found.

your mathematics characters and formulas into bitmaps. The result is a display that is difficult to read, and files that are not very portable.

If your document includes graphics, then you must be sure that these are in the proper format. The `pdftex` utility can handle `*.png`, `*.jpg`, and `*.pdf` graphics files. Whereas—earlier—we touted encapsulated PostScript as the way to go for incorporating graphics in a TeX document, we now must tell you to translate (using `ghostview` or Adobe Acrobat `distiller`, for example) those `*.eps` files to `*.pdf`. The utility `pdftex` is included in the TeX implementations MikTeX and fpTeX, both of which may be downloaded free from the Web.

One big issue that impacts—philosophically, practically, and perhaps legalistically—on the person publishing on the Web is this: What the end user sees is highly dependent on the particular Web browser that he is using; it does *not* depend in any essential way on the browser that the promulgator is using. It is quite possible that the end user's browser will format things differently than the author intended, or it could make font substitutions. For casual reading these differences may not be important. But for scientific data, or for a table of vital information, or for a mathematical formula, or a business document, a small slip may entirely change the intended meaning. If a Web browser encounters a piece of code that it does not understand, then it will simply pass over that piece of code. There will be no error message! In that case, the end user will see a document with the meaning drastically changed. Use of Acrobat tends to minimize these differences, and to offer some guarantee of coherence and integrity in the transmission of information.[6]

Another set of legal issues concerns copyright infringements. Many of these questions are still being argued in the courts. Let us note, for example, that if you are writing a book for a commercial publisher then at some point you may sign the rights over to that publisher. The publisher will probably be happy to have you post your book on the Web up until the time the book appears in (hard copy) print. At that moment, however, the publisher will tell you in no uncertain terms to take it down. The situation with research papers is similar. Everyone wants to have their work posted on the Web. But as soon as the publisher has the rights to the paper or book then he can exercise control over where, and in what form, the paper can appear. So you must be careful.

These days there are a great many utilities available for putting your TeX or LaTeX document on the Web. Space limitations prevent us from discussing any of these in detail. Suffice it to say that they all have their strengths, and they all have limitations. Some are accurate but very slow. Some do not handle fonts well. Some cannot handle scaling. Some

[6]Refer to Appendix VI for some URLs where Acrobat-related tools may be found.

have trouble with graphics. Some do not interact well with certain Web browsers. The monograph [GOR] gives the full picture of many of the most popular of these tools. We briefly will mention just a few.

The IBM product `techexplorer` allows you to, in effect, manipulate a TEX or LATEX file as though it were an HTML document. Note that `techexplorer` does not treat the `*.dvi` file; instead it directly treats the `*.tex` file. With `techexplorer` you will manipulate your document in MathML.[7] Therefore much of the "attribute customization" that can be performed on an HTML document can also be performed on a TEX or LATEX document. The utility `techexplorer` does not support style files, is touchy about user-made macros, and requires that you enter your markup commands in a certain order. It may skip over markup commands that occur in a place where it does not expect them.

The utility `TeX4ht` creates configurable hypertext versions of LATEX documents. With `TeX4ht`, you manipulate the `*.dvi` file rather than the `*.tex` file. It requires multiple passes to make everything come out right, and often post-processing of loose-end tasks is required. Generally speaking, it is troublesome to handle graphics with `TeX4ht`.

The utility `WebEQ` is a popular Java applet for rendering mathematics in a browser. It includes tools for dispalying math. With `WebEQ`, you store documents in the Mathematical Markup Language MathML.

The language `WebTeX` is not quite TEX and not quite LATEX. In fact, it is a version of these languages adapted for the Internet. It retains many features of TEX and LATEX but discards others. If you are going to use `WebTeX`, then you will have to do some retooling.

The book [GOR] gives detailed tutorials in the uses, attributes, and limitations of all the utilities described here. It treats several others as well, and furthermore describes the differences and relationships among the markup languages HTML, SGML, XML, and MathML. We recommend it highly to the stalwart reader who really wants to understand how all these utilities work.

7.5 *Software to Go with your Book or Article; Web Sites*

These days, it is becoming more and more common to have software that is connected in some way to a hard-copy book or article. Some of the ways that this connection is implemented are as follows:

[7] Here MathML is a markup language to be used with XML, and XML is an extensible markup language that improves on HTML in many ways.

- The author has a number of specialized references, or arcane and lengthy examples, or other ancillary material that would not be attractive to include in the hard-copy material. He instead puts them on a publicly accessible Web site. The URL is provided with the hard-copy material.

- The author has written a textbook, and may want to put worked problem solutions, or additional examples, or review material, or color figures, or animated graphics, on a Web site.

- The author has created executable software, either in `C`, or `Fortran`, or `C++`, or `Java`, or some other standard programming language (for which most readers will have a compiler, or at least access to one), that he wants the reader to be able to download and use. He puts the `*.exe` file, or perhaps the source code, together with suitable documentation, on a publicly accessible Web site.

In any of these instances, the author may wish to place the TEX code, or perhaps the `*.dvi` or `*.ps` files for the entire text of the document, on the Web site as well. There may, however, be copyright or legal or fiduciary considerations that need to be worked out before doing so. Consult with your publisher before you put your entire book or MS on the Web.

This is not the place to describe in detail just how to put software on a Web site. Suffice it to say that you will put it somewhere in your `public_html` directory, and you will create a button on your home page that will lead users to it. Along the tree that leads to your software, you will offer options including **(i)** documentation, **(ii)** examples, **(iii)** additional information, **(iv)** FAQs (Frequently Asked Questions), **(v)** other references and Web sites, and **(vi)** hyperlinks to related material.

You will be doing your readers a great favor by making your Web site as user-friendly as possible. Many Web sites consist of little more than a list of hyperlinks, each of which leads to a download. It is up to the user to figure out what is what, and how to download. With a little extra effort, you can give your site an attractive and readily understandable graphic interface and you can also provide some text that will lead the user to the particular choice that will satisfy his needs.

If you are writing a book, you may wish to include a diskette with the book. (For example, [SAK] has such a diskette; it contains TEX macros that are discussed in the book.) In that instance, you must decide whether to render the files in Windows format, or Macintosh format, or some other format. Whatever choice you make will of course exclude some readers. The really classy thing to do is to put your files on a CD-ROM, which has plenty of storage space, and then provide the files in several formats.

It is a nice touch to include a few pages in the book which explain how to use the provided disc or how to access the Web site, as the case may be. Many people are still quite naive and inexperienced at using a computer. If you provide them with nothing but a disc then they may just assume that it is a self-booting disc that will run all by itself. Likely as not, that is untrue; there may be a `readme` file or an executable or a batch file. The experienced hacker will know just what to do, but the neophyte will not. Providing a little help is your job. If the reader cannot figure out what to do with your disc then he will become frustrated and may set your book aside. That is not the effect that you want. After all the hours that you will invest *making* the disc, invest a few more making it easy for people to *use* the disc.

A final note: Sometimes it is attractive to include written-out computer code in the book you are writing. If it is a book about dynamical systems, then you may want to include the code for generating the Mandelbrot set. If it is a book on numerical methods, then you may want to include the code for Euler's method or for Runge-Kutta. It is now quite standard to use the "typewriter-like font" for computer code. For instance, here is a fragment of code that this author wrote (many years ago) for a utility for the pharmaceutical industry to calculate volumes and surface areas of pills (tablets):

```
1573 FOR J = 0 TO 16:PRESET (550+J,35):NEXT J
1577 LINE (383,44)-(398,44)
1580 INPUT "THICKNESS OF BELLY BAND (FIG DIM BB)";BB
1590 IF BB < 0 THEN GOTO 2130
1593 FOR J = 0 TO 16:PRESET (383+J,44):NEXT J
1597 LINE (394,12)- (401,12)
1600 INPUT "LAND (FIG DIM L)                        ";INC
1610 IF INC < 0 THEN GOTO 2130
1615 FOR J=0 TO 8:PRESET (394+J,12):NEXT J
1617 LINE (428,12)-(458,12)
1618 INPUT "MINOR RADIUS (FIG DIM MINR)             ";MINR
1620 IF MINR < CD THEN GOTO 2130
1623 IF 2*MINR*CD - CD^2 < 0 THEN GOTO 2130
1624 G = SQR(ABS(2*MINR*CD - CD^2))
1625 FOR J = 0 TO 31:PRESET (428+J,12):NEXT J
1635 S2 = (PI*(MI^2)*.25 + (MA - MI)*MI)*BB
```

The more fundamental question is what syntax to use. The code that we just exhibited is Turbo BASIC, which most people would consider to be Neantderthal. Should your code instead be in `C`, or in `Fortran`, or in

`APL`, or should it be in *pseudocode*?[8] Speaking from my own experience, I find true code, coming from a specific language, to be much clearer than pseudocode. Since pseudocode does not have a generally accepted syntax, I often do not know what the writer's pseudocode means. In any event, `C` is a nearly universal scientific programming language these days. So is `Java`. I would recommend that you use one of these. In my own work, I have found that attempting to understand an author's provided language-specific code gave me just the motivation I needed to learn more about `C`. Perhaps it will work in the same way for you.

[8] Here the jargon "pseudocode" denotes a generic, made-up code that comes from no particular language. It will tell, by paradigm, the well-informed reader how to write code in the language of his choice.

Appendix I: Copy Editor's/Proofreader's Marks

	Delete
	Close up
^	Insert
#	Insert space
⊓	Raise
⊔	Lower
[	Move left
]	Move right
‖	Straighten type line at side of page
//	Straighten lines
¶	Paragraph
center	Put in middle of page or line

∼	Transpose
Tr	Transpose
	Turn inverted letter right side up
X	Change broken letter
Stet	Let stand as set
. . . . .	Let stand as set
w.f.	Wrong font, size, or style
l.c.	Lower case, not caps
rom.	Use roman letters
bf.	Use bold letters
$\odot$	Period
$\wedge$,	Comma
$\vee$ '	Apostrophe

2	Superscript
2	Subscript
=/	Hyphen
sc.	Use small capitals
caps	Use capitals
ital.	Use italics
$\square$	em quad
	Two-em quad
] [	Center the expression between markings
$\frac{(x+1)}{a}$	Set as $(x+1)/a$
a	Roman caps
a	Italic caps
a	Italic

1/m	Insert hyphen
burgondy ?	Query, verify
Qu	Query to author
Au	Query to author

Appendix II: Use of Copy Editor's Marks[9]

Tr Osberve that the j^{th} element of the sequence is a_j+1. We say +1
that the sequene converges if there is a number ℓ such that c
$\mathscr{9}$ | ε for each ~~epsilon~~ > 0 there is a $N \geq 1$ such that $|a_j - \ell| < \epsilon$ n
holds whenever it that $j > N$. We sometimeds write $a_j \to \ell$.
s We fee that if $a_j \to \ell$ and $b_j \to m$ then $a_j \cdot b_j \to \ell o m$.
\+ Furthermore $a_j + b_j \to \ell \ominus m$. If F is a continuous function l.c.
e | cap than $f(a_j) \to f(\ell)$. notice that property may also be for- this
a multted in terms of $f-1$. -1

cap rom. THEOREM 3.6: Let $\mathcal{A} = \{a_j\}$ and $\mathcal{B} = \{b_j$ be conver- }
l.c. genT sequences of real numbers. If $\lambda_1, \lambda_2 \ldots$ are scalars then ,
$\lambda_j a_j + b_j$ is a sequence that may or may not converge.

Section 12.6: A Discussion of Series

rom. | rom.

\# A series $S = \sum_{j=1}^{\infty} c_j$ isa formal expression , where each
l.c. c_j is a real or Complex number. Consider the partial sums

$$S_N = \sum_{j=1}^{N} c_j \qquad (12.5)$$

6.1

rom. We say that the series S converges if there is a number ℓ such that $S_N \to \ell$ as $N \to \infty$.

We have tried to strongly emphasize that the convergence Tr
s | Tr of a eries is equivalent to the convergence the of sequence of its partial sumz. s

[9] We have used marks from our tables as well as some new marks that should be clear from context. A typical copy-edited manuscript will contain both.

Appendix III: Specialized Mathematics Symbols

We present here, in table form, the standard mathematics symbols that make up most mathematical manuscripts that you will see. These are typeset using the computer typesetting system $\TeX$. We begin with the Greek alphabet.

Lower-Case Greek Letters

α	`\alpha`	λ	`\lambda`	ϕ	`\phi`
β	`\beta`	μ	`\mu`	χ	`\chi`
γ	`\gamma`	ν	`\nu`	ψ	`\psi`
δ	`\delta`	ξ	`\xi`	ω	`\omega`
ϵ	`\epsilon`	o	`o`	ε	`\varepsilon`
ζ	`\zeta`	π	`\pi`	ϑ	`\vartheta`
η	`\eta`	ρ	`\rho`	ϖ	`\varpi`
θ	`\theta`	σ	`\sigma`	ϱ	`\varrho`
ι	`\iota`	τ	`\tau`	ς	`\varsigma`
κ	`\kappa`	υ	`\upsilon`	φ	`\varphi`

Observe that the Greek letter "omicron" is just the same as the lower-case roman "o". The characters $\varepsilon, \vartheta, \varpi, \varrho, \varsigma, \varphi$ are, in effect, script versions of the lower-case Greek letters $\epsilon, \theta, \pi, \rho, \sigma, \phi$.

Capital Greek Letters

A	`A`	Λ	`\Lambda`	Φ	`\Phi`
B	`B`	M	`M`	X	`X`
Γ	`\Gamma`	N	`N`	Ψ	`\Psi`
Δ	`\Delta`	Ξ	`\Xi`	Ω	`\Omega`
E	`E`	O	`O`		
Z	`Z`	Π	`\Pi`		
H	`H`	P	`P`		
Θ	`\Theta`	Σ	`\Sigma`		
I	`I`	T	`T`		
K	`K`	Υ	`\Upsilon`		

One can typeset slanted upper-case Greek letters by using the command `\mit`. For example, the code `$\mit\Phi=\Psi(\Delta,\Gamma)$` will compile to $\mit\Phi = \Psi(\Delta, \Gamma)$. Boldface capital Greek may be typeset in an obvious way: the code `$\bf \Gamma + \Delta$` typesets to $\mathbf{\Gamma} + \mathbf{\Delta}$.

The characters

$$\mathcal{A}\,\mathcal{B}\,\mathcal{C}\,\mathcal{D}\,\mathcal{E}\,\mathcal{F}\,\mathcal{G}\,\mathcal{H}\,\mathcal{I}\,\mathcal{J}\,\mathcal{K}\,\mathcal{L}\,\mathcal{M}\,\mathcal{N}\,\mathcal{O}\,\mathcal{P}\,\mathcal{Q}\,\mathcal{R}\,\mathcal{S}\,\mathcal{T}\,\mathcal{U}\,\mathcal{V}\,\mathcal{W}\,\mathcal{X}\,\mathcal{Y}\,\mathcal{Z}$$

are typeset by using the command `\cal` inside the TEX math environment to invoke the calligraphic alphabet.

A standard $\mathcal{AMS}$-TEX implementation will contain certain commonly used fonts for mathematicians. These include Euler fraktur, which is invoked by the font call `\frak` and has the form **Euler fraktur**, and blackboard bold, which is invoked by the font call `\Bbb` and has the form $\mathbb{BLACKBOARD}$ $\mathbb{BOLD}$.

It is convenient, from the point of view of TEX, to group characters according to their “spacing type”. With that paradigm in mind, here are the characters of class Ord:

Characters of Class Ord

$\aleph$	`\aleph`	$\prime$	`\prime`	$\neg$	`\neg`
$\hbar$	`\hbar`	$\emptyset$	`\emptyset`	$\Vert$	`|`
$\imath$	`\imath`	∇	`\nabla`	$\backslash$	`\backslash`
$\jmath$	`\jmath`	$\surd$	`\surd`	$\flat$	`\flat`
ℓ	`\ell`	$\top$	`\top`	$\natural$	`\natural`
$\wp$	`\wp`	$\bot$	`\bot`	$\sharp$	`\sharp`
$\Re$	`\Re`	$\angle$	`\angle`	$\clubsuit$	`\clubsuit`
$\Im$	`\Im`	$\triangle$	`\triangle`	$\diamondsuit$	`\diamondsuit`
∂	`\partial`	$\forall$	`\forall`	$\heartsuit$	`\heartsuit`
∞	`\infty`	$\exists$	`\exists`	$\spadesuit$	`\spadesuit`

Large Operators of Class Op

$\coprod$	`\coprod`	$\bigcup$	`\bigcup`	$\bigoplus$	`\bigoplus`
$\bigvee$	`\bigvee`	$\int$	`\int`	$\bigodot$	`\bigodot`
$\bigwedge$	`\bigwedge`	$\prod$	`\prod`	$\oint$	`\oint`
$\biguplus$	`\biguplus`	$\sum$	`\sum`	$\bigsqcup$	`\bigsqcup`
$\bigcap$	`\bigcap`	$\bigotimes$	`\bigotimes`	$\smallint$	`\smallint`

Symbols for Footnotes

$*$	`*`	$\dagger$	`\dag`	$\ddagger$	`\ddag`
$\S$	`\S`	$\|$	`|`	¶	`\P`

Binary Operations

$\times$	`\times`	$\cap$	`\cap`	$\triangleleft$	`\triangleleft`
$\div$	`\div`	$\cup$	`\cup`	$\triangleright$	`\triangleright`
$\mp$	`\mp`	$\sqcap$	`\sqcap`	$\bigtriangleup$	`\bigtriangleup`
$\pm$	`\pm`	$\sqcup$	`\sqcup`	$\bigtriangledown$	`\bigtriangledown`
$\wedge$	`\wedge`	$\uplus$	`\uplus`	$\circ$	`\circ`
$\vee$	`\vee`	$\bullet$	`\bullet`	$\bigcirc$	`\bigcirc`
$\ddagger$	`\ddagger`	$\odot$	`\odot`	$\setminus$	`\setminus`
$\dagger$	`\dagger`	$\oslash$	`\oslash`	$\cdot$	`\cdot`
$\amalg$	`\amalg`	$\otimes$	`\otimes`	$\ast$	`\ast`
$\diamond$	`\diamond`	$\ominus$	`\ominus`	$\star$	`\star`
$\wr$	`\wr`	$\oplus$	`\oplus`		

Relations

$\propto$	`\propto`	$\approx$	`\approx`	$\to$	`\to`
$\sqsubseteq$	`\sqsubseteq`	$\sim$	`\sim`	$\leftarrow$	`\leftarrow`
$\sqsupseteq$	`\sqsupseteq`	$\simeq$	`\simeq`	$\uparrow$	`\uparrow`
$\parallel$	`\parallel`	$\cong$	`\cong`	$\downarrow$	`\downarrow`
$\mid$	`\mid`	$\succeq$	`\succeq`	$\perp$	`\perp`
$\dashv$	`\dashv`	$\preceq$	`\preceq`	$\equiv$	`\equiv`
$\vdash$	`\vdash`	$\supset$	`\supset`	$\asymp$	`\asymp`
$\ne$	`\ne`	$\subset$	`\subset`	$\doteq$	`\doteq`
$\notin$	`\notin`	$\supseteq$	`\supseteq`	$\smile$	`\smile`
$/$	`\not`	$\subseteq$	`\subseteq`	$\frown$	`\frown`
$\le$	`\le`	$\in$	`\in`	$\bowtie$	`\bowtie`
$\ge$	`\ge`	$\ni$	`\ni`	$\models$	`\models`
$\succ$	`\succ`	$\gg$	`\gg`	$\rightleftharpoons$	`\rightleftharpoons`
$\prec$	`\prec`	$\ll$	`\ll`	$\iff$	`\iff`

Punctuation Marks and Ellipses

$.$	`\ldotp`	$\vdots$	`\vdots`	$\ddots$	`\ddots`
$\cdotp$	`\cdotp`	$\ldots$	`\ldots`	$\cdots$	`\cdots`
$:$	`\colon`	$\dots$	`\dots`		

Arrows

$\nearrow$	`\nearrow`	$\Leftrightarrow$	`\Leftrightarrow`	$\longleftrightarrow$	`\longleftrightarrow`
$\searrow$	`\searrow`	$\leftrightarrow$	`\leftrightarrow`	$\Longleftrightarrow$	`\Longleftrightarrow`
$\nwarrow$	`\nwarrow`	$\Longrightarrow$	`\Longrightarrow`	$\hookrightarrow$	`\hookrightarrow`
$\swarrow$	`\swarrow`	$\longrightarrow$	`\longrightarrow`	$\hookleftarrow$	`\hookleftarrow`
$\mapsto$	`\mapsto`	$\longleftarrow$	`\longleftarrow`	$\leftharpoonup$	`\leftharpoonup`
$\Leftarrow$	`\Leftarrow`	$\Longleftarrow$	`\Longleftarrow`	$\leftharpoondown$	`\leftharpoondown`
$\Rightarrow$	`\Rightarrow`	$\longmapsto$	`\longmapsto`	$\rightharpoonup$	`\rightharpoonup`
$\iff$	`\iff`	$\to$	`\to`	$\rightharpoondown$	`\rightharpoondown`
$\leftarrow$	`\leftarrow`	$\uparrow$	`\uparrow`	$\downarrow$	`\downarrow`

Delimiters

<table>
<tr><td>$($</td><td><code>(</code></td><td>$\langle$</td><td><code>\langle</code></td><td>$\uparrow$</td><td><code>\uparrow</code></td></tr>
<tr><td>$[$</td><td><code>[</code></td><td>$\backslash$</td><td><code>\backslash</code></td><td>$\downarrow$</td><td><code>\downarrow</code></td></tr>
<tr><td>$\{$</td><td><code>\{</code></td><td>$\lfloor$</td><td><code>\lfloor</code></td><td>$\Uparrow$</td><td><code>\Uparrow</code></td></tr>
<tr><td>$|$</td><td><code>|</code></td><td>$\lceil$</td><td><code>\lceil</code></td><td>$\Downarrow$</td><td><code>\Downarrow</code></td></tr>
<tr><td>$\|$</td><td><code>\|</code></td><td>$\lgroup$</td><td><code>\lgroup</code></td><td>$\Updownarrow$</td><td><code>\Updownarrow</code></td></tr>
<tr><td>$/$</td><td><code>/</code></td><td>$\lmoustache$</td><td><code>\lmoustache</code></td><td></td><td></td></tr>
</table>

Next is a display of the two most standard AMS-TEX symbol fonts:

AMS Symbol Font MSAM10

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	
0.	$\boxdot$	$\boxplus$	$\boxtimes$	$\square$	$\blacksquare$	$\centerdot$	$\lozenge$	$\blacklozenge$	$\circlearrowright$	$\circlearrowleft$	$\rightleftharpoons$	$\leftrightharpoons$	$\boxminus$	$\Vdash$	$\Vvdash$	$\vDash$	**0.**
10.	$\twoheadrightarrow$	$\twoheadleftarrow$	$\leftleftarrows$	$\rightrightarrows$	$\upuparrows$	$\downdownarrows$	$\upharpoonright$	$\downharpoonright$	$\upharpoonleft$	$\downharpoonleft$	$\rightarrowtail$	$\leftarrowtail$	$\leftrightarrows$	$\rightleftarrows$	$\Lsh$	$\Rsh$	**10.**
20.	$\rightsquigarrow$	$\leftrightsquigarrow$	$\looparrowleft$	$\looparrowright$	$\circeq$	$\succsim$	$\gtrsim$	$\gtrapprox$	$\multimap$	$\therefore$	$\because$	$\doteqdot$	$\triangleq$	$\precsim$	$\lesssim$	$\lessapprox$	**20.**
30.	$\eqslantless$	$\eqslantgtr$	$\curlyeqprec$	$\curlyeqsucc$	$\preccurlyeq$	$\leqq$	$\leqslant$	$\lessgtr$	$\backprime$	$-$	$\risingdotseq$	$\fallingdotseq$	$\succcurlyeq$	$\geqq$	$\geqslant$	$\gtrless$	**30.**
40.	$\sqsubset$	$\sqsupset$	$\vartriangleright$	$\vartriangleleft$	$\trianglerighteq$	$\trianglelefteq$	$\bigstar$	$\between$	$\blacktriangledown$	$\blacktriangleright$	$\blacktriangleleft$	$\dashrightarrow$	$\dashleftarrow$	$\blacktriangleleft$	$\blacktriangle$	$\triangledown$	**40.**
50.	$\eqcirc$	$\lesseqgtr$	$\gtreqless$	$\lesseqqgtr$	$\gtreqqless$	$\yen$	$\Rrightarrow$	$\Lleftarrow$	$\checkmark$	$\veebar$	$\barwedge$	$\doublebarwedge$	$\angle$	$\measuredangle$	$\sphericalangle$	$\varpropto$	**50.**
60.	$\smallsmile$	$\smallfrown$	$\Subset$	$\Supset$	$\Cup$	$\Cap$	$\curlywedge$	$\curlyvee$	$\leftthreetimes$	$\rightthreetimes$	$\subseteqq$	$\supseteqq$	$\bumpeq$	$\Bumpeq$	$\lll$	$\ggg$	**60.**
70.	$\ulcorner$	$\urcorner$	$\circledR$	$\circledS$	$\pitchfork$	$\dotplus$	$\backsim$	$\backsimeq$	$\llcorner$	$\lrcorner$	$\maltese$	$\complement$	$\intercal$	$\circledcirc$	$\circledast$	$\circleddash$	**70.**

AMS Symbol Font MSBM10

	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**A**	**B**	**C**	**D**	**E**	**F**	
0.	$\lvertneqq$	$\gvertneqq$	$\nleq$	$\ngeq$	$\nless$	$\ngtr$	$\nprec$	$\nsucc$	$\lneqq$	$\gneqq$	$\nleqslant$	$\ngeqslant$	$\lneq$	$\gneq$	$\npreceq$	$\nsucceq$	**0.**
10.	$\precnsim$	$\succnsim$	$\lnsim$	$\gnsim$	$\nleqq$	$\ngeqq$	$\precneqq$	$\succneqq$	$\precnapprox$	$\succnapprox$	$\lnapprox$	$\gnapprox$	$\nsim$	$\ncong$	$\diagup$	$\diagdown$	**10.**
20.	$\varsubsetneq$	$\varsupsetneq$	$\nsubseteqq$	$\nsupseteqq$	$\subsetneqq$	$\supsetneqq$	$\varsubsetneqq$	$\varsupsetneqq$	$\subsetneq$	$\supsetneq$	$\nsubseteq$	$\nsupseteq$	$\nparallel$	$\nmid$	$\nshortmid$	$\nshortparallel$	**20.**
30.	$\nvdash$	$\nVdash$	$\nvDash$	$\nVDash$	$\ntrianglerighteq$	$\ntrianglelefteq$	$\ntriangleleft$	$\ntriangleright$	$\nleftarrow$	$\nrightarrow$	$\nLeftarrow$	$\nRightarrow$	$\nLeftrightarrow$	$\nleftrightarrow$	$\divideontimes$	$\varnothing$	**30.**
40.	$\nexists$	$\mathbb{A}$	$\mathbb{B}$	$\mathbb{C}$	$\mathbb{D}$	$\mathbb{E}$	$\mathbb{F}$	$\mathbb{G}$	$\mathbb{H}$	$\mathbb{I}$	$\mathbb{J}$	$\mathbb{K}$	$\mathbb{L}$	$\mathbb{J}$	$\mathbb{N}$	$\mathbb{O}$	**40.**
50.	$\mathbb{P}$	$\mathbb{Q}$	$\mathbb{R}$	$\mathbb{S}$	$\mathbb{T}$	$\mathbb{U}$	$\mathbb{V}$	$\mathbb{W}$	$\mathbb{X}$	$\mathbb{Y}$	$\mathbb{Z}$	$\widehat{\ }$	$\widehat{\quad}$	$\widetilde{\ }$	$\widetilde{\quad}$		**50.**
60.	$\Finv$	$\Game$					$\mho$	$\eth$	$\eqsim$	$\beth$	$\gimel$	$\daleth$	$\lessdot$	$\gtrdot$	$\ltimes$	$\rtimes$	**60.**
70.	$\shortmid$	$\shortparallel$	$\smallsetminus$	$\thicksim$	$\thickapprox$	$\approxeq$	$\succapprox$	$\precapprox$	$\curvearrowleft$	$\curvearrowright$	$\digamma$	$\varkappa$	$\Bbbk$	$\hslash$	$\hbar$	$\backepsilon$	**70.**

We conclude with the commands for the math abbreviations (or function names) included in TEX.

Math Abbreviations

`\arccos`	`\cos`	`\csc`	`\exp`	`\ker`	`\limsup`	`\min`	`\sinh`
`\arcsin`	`\cosh`	`\deg`	`\gcd`	`\lg`	`\ln`	`\Pr`	`\sup`
`\arctan`	`\cot`	`\det`	`\hom`	`\lim`	`\log`	`\sec`	`\tan`
`\arg`	`\coth`	`\dim`	`\inf`	`\liminf`	`\max`	`\sin`	`\tanh`

Appendix IV: Standard Alphabets

We now exhibit some of the most standard fonts that are used in modern typesetting. These are rendered using TEX.

Upper Case Alphabets

roman	boldface	italic	slanted roman	calligraphic	fraktur
A	**A**	*A*	*A*	$\mathcal{A}$	**A**
B	**B**	*B*	*B*	$\mathcal{B}$	**B**
C	**C**	*C*	*C*	$\mathcal{C}$	**C**
D	**D**	*D*	*D*	$\mathcal{D}$	**D**
E	**E**	*E*	*E*	$\mathcal{E}$	**E**
F	**F**	*F*	*F*	$\mathcal{F}$	**F**
G	**G**	*G*	*G*	$\mathcal{G}$	**G**
H	**H**	*H*	*H*	$\mathcal{H}$	**H**
I	**I**	*I*	*I*	$\mathcal{I}$	**I**
J	**J**	*J*	*J*	$\mathcal{J}$	**J**
K	**K**	*K*	*K*	$\mathcal{K}$	**K**
L	**L**	*L*	*L*	$\mathcal{L}$	**L**
M	**M**	*M*	*M*	$\mathcal{M}$	**M**
N	**N**	*N*	*N*	$\mathcal{N}$	**N**
O	**O**	*O*	*O*	$\mathcal{O}$	**O**
P	**P**	*P*	*P*	$\mathcal{P}$	**P**
Q	**Q**	*Q*	*Q*	$\mathcal{Q}$	**Q**
R	**R**	*R*	*R*	$\mathcal{R}$	**R**
S	**S**	*S*	*S*	$\mathcal{S}$	**S**
T	**T**	*T*	*T*	$\mathcal{T}$	**T**
U	**U**	*U*	*U*	$\mathcal{U}$	**U**
V	**V**	*V*	*V*	$\mathcal{V}$	**V**
W	**W**	*W*	*W*	$\mathcal{W}$	**W**
X	**X**	*X*	*X*	$\mathcal{X}$	**X**
Y	**Y**	*Y*	*Y*	$\mathcal{Y}$	**Y**
Z	**Z**	*Z*	*Z*	$\mathcal{Z}$	**Z**

Lower Case Alphabets

roman	boldface	italic	slanted roman	calligraphic	fraktur
a	**a**	*a*	*a*		**a**
b	**b**	*b*	*b*		**b**
c	**c**	*c*	*c*		**c**
d	**d**	*d*	*d*		**d**
e	**e**	*e*	*e*		**e**
f	**f**	*f*	*f*		**f**
g	**g**	*g*	*g*		**g**
h	**h**	*h*	*h*		**h**
i	**i**	*i*	*i*		**i**
j	**j**	*j*	*j*		**j**
k	**k**	*k*	*k*		**k**
l	**l**	*l*	*l*		**l**
m	**m**	*m*	*m*		**m**
n	**n**	*n*	*n*		**n**
o	**o**	*o*	*o*		**o**
p	**p**	*p*	*p*		**p**
q	**q**	*q*	*q*		**q**
r	**r**	*r*	*r*		**r**
s	**s**	*s*	*s*		**s**
t	**t**	*t*	*t*		**t**
u	**u**	*u*	*u*		**u**
v	**v**	*v*	*v*		**v**
w	**w**	*w*	*w*		**w**
x	**x**	*x*	*x*		**x**
y	**y**	*y*	*y*		**y**
z	**z**	*z*	*z*		**z**

Observe that there are no lower case calligraphic letters in TEX.

Appendix V: Alternative Mathematical Notations

Here we present various typesetting situations together with some choices in how to address them.

Option 1	**Option 2**	**Remarks**
$\overline{\lim}\,,\ \underline{\lim}$	$\limsup\,,\ \liminf$	Option 2 more common
$e^{\frac{x^3-y^2}{xy+2}}$	$\exp\big((x^3-y^2)/(xy+2)\big)$	Option 2 better in text
$\sqrt{x^n+y^m}$	$(x^n+y^m)^{1/2}$	Option 1 better in text
$\frac{x+2y}{3}$, $\frac{4}{3}$	$(x+2y)/3$, $4/3$	Option 2 better in text
$\sum_{j=1}^{n}\,,\ \prod_{\ell=0}^{k}$	$\displaystyle\sum_{j=1}^{n}\,,\ \prod_{\ell=0}^{k}$	Option 1 better in text Option 2 better for display
$a_{j_1,\ldots,j_m}$	$a(j_1,j_2,\ldots,j_m)$	Option 2 easier to read
$a_{j_1,\ldots,j_m}^{k_1,\ldots,k_p}$	$a(j_1,\ldots,j_m;k_1,\ldots,k_p)$	Option 2 easier to read
$\binom{e}{f}$	$C_{e,f}$	Option 2 better in text
$C \xrightarrow{f} D$	$f : C \to D$	Option 2 easier to read
$\overline{X \cup Y}$	$\mathrm{Cl}(X \cup Y)$	Option 2 better in text
$\vec{v}$	$\mathbf{v}$	Option 2 better in text
$\dot{A}\,,\ \ddot{A}\,,\ \tilde{w}\,,\ \widehat{f}\,,\ \bar{x}$	$A'\,,\ A''\,,\ w^*\,,\ \mathcal{F}(f)\,,\ x^{\#}$	Option 2 better in text
$\dfrac{\log\frac{2}{y}}{\sqrt[5]{c-\frac{b}{z}}}$	$\dfrac{\log(2/y)}{[c-b/z]^{1/5}}$	Option 2 easier to read
$f\begin{pmatrix} x & y \\ z & w \end{pmatrix}$	$f(A)\,,\ A = \begin{pmatrix} x & y \\ z & w \end{pmatrix}$	Option 2 preferable

Appendix VI: TEX, PostScript, Acrobat, and Related Internet Sites

There are a number of Internet sites that archive TEX fonts, macros, and other utilities that will be of interest to the TEX user. We record some of the `ftp` addresses and Web sites here.

Always bear in mind that Web sites are transient. They are constantly in flux, they change form, they move, and (sadly) sometimes they disappear. As of this writing, all the given sites are operational.

As an alternative to logging on to one of the given sites, you can use one of the utilities `archie`, `gopher`, or `wais` to search for the package you are looking for. Or else use the `altavista`, or `yahoo`, or `google` Web search engines to conduct a search.

Sites from which to `ftp` TEX Packages

`ftp.math.utah.edu` `/pub/tex/tex-index`

This is Nelson Beebe's server, and it is particularly strong in information about BIBTEX. It also contains a concordance of all articles in *TUGboat*, the publication of the TEX Users Group.

`labrea.stanford.edu`

This is the "official" Stanford University repository for TEX, METAFONT, `dvips`, and related files.

`http://www.tug.org`

This is the site maintained by the TEX Users Group. It is a source for `emTeX`, `publicTeX`, `publicMF`, and many other fonts and macros and TEX utilities.

`e-math.ams.org`

This is the `ftp` site of the American Mathematical Society (AMS). The login and password are both `e-math`. The Society is the creator and promulgator of AMS-TEX, and the site makes both AMS-TEX and AMS-LATEX available for downloading. Once you are logged on, use your <Up>-<Down> keys to highlight <Sitemap> and then press <Enter>. Again use your <Up>-<Down> keys to scroll to <TeX Resources> and again press <Enter>. Now you are in the AMS's world of TEX. There are numerous fonts, macros, style files, author packages, manuals and other TEX resources available at the `e-math` site.

`ftp.dante.de` `/pub/tex/help/TeX-index`

is a source of the "Mainz" packages of Mittelbach and Schöpf (these resources include `multicol`, `verbatim`, `theorem`, `NFSS`, `ftnright`, and `array`). It is a mirror site of `ftp.tex.ac.uk`, and has the Web address `http://www.dante.de`.

`ftp.tex.ac.uk` `/pub/archive/help/TeX-index`

This is a CTAN site (a mirror of `ftp.dante.de`), and also the home of the UKTeX newsletter. The corresponding Web address is `http://www.tex.ac.uk`.

Other URLs for TEX Goodies

`http://199.26.180.160/winnt/misc/page2.html`

An implementation of BCTEX may be downloaded from this site.

`ftp://ctan.tug.org/tex-archive/systems`
`/win32/miktex/1.20/`

MikTEX may be downloaded from this site.

`http://www.esm.psu.edu/mac-tex/versions.html`

This is a TEX Web site for Macintosh users.

`http://www.tug.org`

This is the Web site of the TEX Users Group. It has pointers to several different CTAN sites.

`http://www.cs.wisc.edu/~ghost/`

This site is a source for the utility `ghostscript`, for manipulating PostScript.

`http://www.adobe.com`

Adobe's home page. Adobe is the the company that created Acrobat and PostScript.

`http://www.math.uakron.edu/~dpstory/acrotex.html`

A repository for PDF-based math tutorials. Makes great and extensive use of Acrobat forms.

http://www.tug.org/applications/pdftex/

A resource of pdfTEX examples.

http://www.pdfzone.com/

The PDF Zone.

http://www.adobe.com/prodindex/postscript/main.html

Information about PostScript at Adobe.

ftp://ctan.tug.org/tex-archive//support/latex2html/sources/

Sources for LATEX2HTML on the CTAN site.

http://www.5-d.com/niknak.htm

This is a commercial PostScript®-to-PDF converter.

http://www.wargaming.net/Programming

Adobe PostScript resources.

http://math.berkeley.edu/~vojta/xdvi.html

This is Paul Vojta's (he is a math professor at U. C. Berkeley) X-Windows TEX previewer.

http://www.yandy.com/

The home page of Y&Y TEX.

http://www.cs.wisc.edu/~ghost/

Source for Ghostview, Ghostscript, GSview.

http://godel.ph.utexas.edu/Members/timg/gs/gs.html/

Source for Atari Ghostscript.

For those not entirely conversant with the process of conducting an ftp transaction, we now provide a little guidance. On a UNIX system, log on and get to a system prompt. On a Macintosh machine, go to the ftp icon. Instructions for America Online are given below.

To go to the first `ftp` site given in this Appendix, `ftp` now to the `ftp` site `ftp.math.utah.edu`. (On a UNIX system, this step is performed by typing

```
ftp ftp.math.utah.edu
```

at your system prompt. On other systems, or with a browser, this will be done by typing `ftp.math.utah.edu` in a suitable window and clicking on <Go> or a similar icon.) Perform the logon by entering "anonymous" and using your e-mail address as a password. Type `cd pub` followed by <`Enter`>. Then type `cd tex` followed by <`Enter`>. Now you will be at Nelson Beebe's famous TeX site. Enjoy!

Of course you can always use your Web browser to `ftp`. With America Online, click on <Keyword>, type `ftp` in the keyword window, and then click on <Go>. With Netscape, type `ftp://ftp.math.utah.edu` in the URL search window and press <Enter>. Other Web browsers have similar protocols.

Appendix VII: Basic TeX Commands

We provide here a concordance of the most basic commands in TeX. This list will supplement, and in some instances duplicate, what appears in the tables in Appendix III. While those tables emphasized mathematics symbols, the present list also contains formatting and text commands.

Our wish is that this will serve as a quick-and-dirty reference for the beginner, and also a quick review for the more experienced TeX user.

Command	Meaning or Purpose
"\ "	hard single space
`\,`	thin space
`\!`	negative thin space
`\'`	acute accent (or egout) in text (e.g., á)
`` \` ``	accent grave in text (e.g., ò)
`\~`	tilde in text (e.g., ẽ)
`\"`	dieresis or umlaut in text (e.g., ä)
`\^`	circumflex in text (e.g., $\hat{\text{f}}$)
`\.`	dot accent in text (e.g., ȯ)
`\=`	macron in text (e.g., ē)
`` !` ``	¡
`` ?` ``	¿
`$ $`	inline math mode
`\( \)`	inline math mode
`$$ $$`	display math mode
`\[ \]`	display math mode
`\b`	bar-under accent in text (e.g., e̱)
`\c`	cedilla (e.g., ç)
`\d`	dot-under accent in text (e.g., ọ)
`\H`	long Hungarian umlaut in text (e.g., ő)
`\t`	tie-after accent in text (e.g., o͡o)
`\u`	breve in text (e.g., ŏ)
`\v`	háček or check in text (e.g., ǎ)
`\AA`	Å
`\aa`	å
`A^b`	superscript A^c
`A_c`	subscript A_c
`\AE`	Æ
`\angle`	angle ($\angle$)
`\acute`	acute accent in math mode (e.g., $\acute{a}$)
`\AmSTeX`	logo for $\mathcal{AMS}$-TeX
`\AmSLaTeX`	logo for $\mathcal{AMS}$-LaTeX
`\approx`	approximately equal to ($\approx$)
`\backslash`	backslash ($\backslash$)

`\bar`	macron in math mode (e.g., $\bar{u}$)
`\Bbb`	blackboard bold font ($\mathbb{C}, \mathbb{N}, \mathbb{R}$)
`\bf`	boldface font (**a, b, c, d**)
`\biggl`	left delimiter enlargement size $\biggl($
`\Biggl`	left delimiter enlargement size $\Biggl($
`\biggm`	middle delimiter enlargement size $\biggm\vert$
`\Biggm`	middle delimiter enlargement size $\Biggm\vert$
`\biggr`	right delimiter enlargement size $\biggr)$
`\Biggr`	right delimiter enlargement size $\Biggr)$
`\bigl`	left delimiter enlargement size $\bigl($
`\Bigl`	left delimiter enlargement size $\Bigl($
`\bigm`	middle delimiter enlargement size $\bigm\vert$
`\Bigm`	middle delimiter enlargement size $\Bigm\vert$
`\bigr`	right delimiter enlargement size $\bigr)$
`\Bigr`	right delimiter enlargement size $\Bigr)$
`\bigtriangleup`	large triangle, like Laplacian ($\bigtriangleup$)
`\bigskip`	large vertical space
`\Box`	the "Halmos tombstone" ($\Box$)
`\breve`	breve in math mode (e.g., $\breve{a}$)
`\bullet`	typesetter's bullet ($\bullet$)
`\bye`	command for ending a TeX document
`\cal`	the math mode calligraphic font ($\mathcal{A}, \mathcal{B}, \mathcal{C}$)
`\cap`	intersection sign ($\cap$)
`\cases`	formats a function defined by cases
`\cdot`	small, centered dot ($\cdot$)
`\cdots`	three small, centered dots (an ellipsis $\cdots$)
`\centerline`	command for centering a line of text
`\check`	a "check" accent in math mode ($\check{f}$)
`\choose`	binomial expression (${a \choose b}$)
`\circ`	small, centered circle ($f \circ g$)
`\cos`	cosine
`\cup`	union sign ($\cup$)

`\dagger`	typesetter's dagger (†)
`\ddagger`	typesetter's double dagger (‡)
`\ddot`	double dot math accent or dieresis ($\ddot{x}$)
`\def`	macro definer
`\div`	division sign ($\div$)
`\dot`	dot accent in math mode (e.g., $\dot{a}$)
`\dots`	three small, baseline dots (an ellipsis $\dots$)
`\ell`	script, lower-case script ell (ℓ)
`\emptyset`	empty set ($\emptyset$)
`\eqalign`	utility for aligned displays
`\eqalignno`	`\eqalign` with numbering
`\eqno`	equation label at right margin
`\equiv`	is defined to be ($\equiv$)
`\exists`	there exists ($\exists$)
`\folio`	page number, as in a footline
`\footline`	command for creating a running foot
`\footnote`	creates a footnote
`\forall`	for all ($\forall$)
`\frak`	the Euler fraktur font ($\mathbf{f}, g, h$)
`\ge` or `\geq`	greater than or equal to ($\geq$)
`\gg`	double greater than ($\gg$)
`\grave`	accent grave in math mode (e.g., $\grave{a}$)
`\hangindent`	command for creating hangindents
`\hat`	a caret "hat" accent ($\hat{f}$)
`\hbox`	an environment for placing text into math
`\headline`	command for creating a running head
`\hfil`	command for filling out a line with space
`\hfill`	command for filling out a line with space
`\hrule`	a solid black box ($\blacksquare$)
`\hskip`	horizontal skip
`\int` , `\int_a^b`	integral ($\int_a^b$)
`\Im`	imaginary part of ($\Im$)
`\imath`	the dotless "i", for use in mathematics
`\in`	is an element of ($\in$)
`\indent`	paragraph indentation
`\infty`	infinity (∞)
`\input`	command for including macros
`\it`	italic font (*a, b, c, d*)
`\item`	delineates an element of a list
`\itemitem`	delineates a sub-element of a list
`\itemitemitem`	delineates a sub-sub-element of a list
`\jmath`	the dotless "j", for use in mathematics
`\jot`	vertical space
`\kern`	horizontal re-positioning
`\l`	ł

`\langle`	left inner product delimiter ($\langle$)
`\LaTeX`	logo for LaTeX
`\le` or `\leq`	less than or equal to ($\leq$)
`\left`	controls size of left delimiter
`\leftarrow`	leftward pointing arrow ($\leftarrow$)
`\Leftarrow`	leftward pointing double arrow ($\Leftarrow$)
`\leqno`	equation number at left margin
`\ll`	double less than ($\ll$)
`\llap`	command for hang indenting
`\magnification`	controls size of font, spacing in document
`\magstep`	specifies magnification size
`\mapsto`	maps to ($x \mapsto y$)
`\mathop`	defines a new "math operator" expression
`\mathstrut`	an invisible box used for spacing
`\matrix`	matrix
`\medskip`	medium vertical space
`\mid`	a vertical bar for use in setbuilder notation ($\mid$)
`\narrower`	formats text with wider margins for display
`\ne` or `\neq`	not equal to ($\neq$)
`\nabla`	nabla (∇)
`\nearrow`	arrow point northeast ($\nearrow$)
`\nwarrow`	arrow point southwest ($\nwarrow$)
`\ni`	has as an element ($\ni$)
`\noindent`	prevents indentation
`\nopagenumbers`	creates a document with no page numbers
`\not`	puts a slash ($/$) through the next symbol
`\O`	Ø
`\o`	ø
`\OE`	Œ
`\oe`	œ
`\oint`	complex line integral ($\oint$)
`\ominus`	a minus sign in a circle ($\ominus$)
`\oplus`	a plus sign in a circle ($\oplus$)
`\otimes`	a times sign in a circle ($\otimes$)
`\over`	used in making fractions
`\overbrace`	a brace *over* text ($\overbrace{x+y}$)
`\overline`	a line *over* text ($\overline{x+y}$)
`\parindent`	paragraph indentation
`\partial`	a partial differentiation sign (∂f)
`\perp`	perpendicular sign ($\perp$)
`\pm`	plus or minus ($\pm$)
`\pmatrix`	matrix with parentheses
`\qquad`	a double em quad
`\quad`	an em quad

`\rangle`	right inner product delimiter ($\rangle$)
`\Re`	real part of ($\Re$)
`\right`	controls size of right delimiter
`\rightarrow`	rightward pointing arrow ($\rightarrow$)
`\Rightarrow`	rightward pointing double arrow ($\Rightarrow$)
`\rm`	roman font
`\sc`	BIG CAP-SMALL CAP font
`\searrow`	arrow point southeast ($\searrow$)
`\setminus`	sign for set-theoretic difference ($A \setminus B$)
`\sim`	similar to ($a \sim b$)
`\simeq`	variant of `\sim` ($a \simeq b$)
`\sqrt`	square root ($\sqrt{x+A}$)
`\ss`	ß
`\supset`	is a (proper) superset of ($A \supset B$)
`\supseteq`	is a superset of ($A \supseteq B$)
`\swarrow`	arrow point southwest ($\swarrow$)
`\sin`	sine
`\sl`	*slanted roman* font
`\smallskip`	small vertical space
`\subset`	is a (proper) subset of ($\subset$)
`\subseteq`	subset of ($\subseteq$)
`\tan`	tangent
`\TeX`	macro for TeX ($\TeX$)
`\tilde`	tilde ($\tilde{A}$)
`\times`	a times or multiplication sign ($\times$)
`\tt`	typewriter-like font
`\underbrace`	a brace *under* text ($\underbrace{x+y}$)
`\underline`	a line *under* text ($\underline{a+b}$)
`\vbox`	a typesetting device for isolating text
`\vec`	the vector accent ($\vec{a}$)
`\vee`	a vee ($S \vee T$)
`\vrule`	a solid black box (▮)
`\vskip`	vertical skip
`\wedge`	a wedge, as in an exterior product ($v \wedge w$)
`\widehat`	wide caret or "hat" in math mode (e.g., $\widehat{f}$)
`\widetilde`	wide tilde in math mode (e.g., $\widetilde{h}$)

Appendix VIII: A Sample of $\LaTeX$

We now present a sample of $\LaTeX$ code and then show its compiled output. You will be able to do a fair amount of $\LaTeX$ typesetting just by imitating what you see here. For convenience, we present the code both in $\LaTeX$ 2.09 form and $\LaTeX2_\varepsilon$ form.

The LaTeX 2.09 Code

```
\documentstyle{article}

\newfam\msbfam
\font\tenmsb=msbm10    \textfont\msbfam=\tenmsb
\font\sevenmsb=msbm7   \scriptfont\msbfam=\sevenmsb
\font\fivemsb=msbm5    \scriptscriptfont\msbfam=\fivemsb
\def\Bbb{\fam\msbfam \tenmsb}

\def\RR{{\Bbb R}}

\def\HollowBox #1#2{{\dimen0=#1 \advance\dimen0 by -#2
   \dimen1=#1 \advance\dimen1 by #2
   \vrule height #1 depth #2 width #2
   \vrule height 0pt depth #2 width #1
   \llap{\vrule height #1 depth -\dimen0 width \dimen1}%
   \hskip -#2
   \vrule height #1 depth #2 width #2}}
\def\BoxOpTwo{\mathord{\HollowBox{6pt}{.4pt}}\;}

\begin{document}

\begin{center}
\large \bf The Fundamental Theorem of Calculus
\end{center}

Let $f$ be a continuous function on an open interval
$I \subseteq \RR$.  Fix a point $a \in I$.
For any point $x \in I$, we define
$$
F(x) = \int_a^x f(t) \, dt .  \eqno (\dagger)
$$
The substance of the Fundamental Theorem of Calculus is
to claim that $F$ is an anti-derivative for $f$.
More precisely, we have
\smallskip \\

\noindent {\sc Theorem 1:}  The function $F$ defined above
is differentiable, and
$$
\frac{d}{dx} F(x) = f(x)
$$
for every $x \in I$.
```

```
\smallskip \\

\noindent {\bf Proof:}  We endeavor to calculate the
derivative of $F$ by forming the difference or Newton
quotient for $h \ne 0$:
\setcounter{chapter}{0}
\begin{eqnarray}
\underbrace{\frac{F(x + h) - F(x)}{h}}_{\hbox{Newton quotient}}
                  & = & \frac{\int_a^{x+h} f(t) \, dt
                      - \int_a^x f(t) \, dt}{h} \nonumber \\
                  & = & \frac{\int_x^{x+h} f(t) \, dt}{h} .
\end{eqnarray}

Now fix a point $x_0 \in I$.  Let $\epsilon > 0$.  Choose
$\delta > 0$ such that $|t - x_0| < \delta$ implies that
$|f(t) - f(x_0)| < \epsilon$.  Now we may rewrite (1) as
\begin{eqnarray*}
\frac{\int_x^{x+h} f(t) \, dt}{h} & = &
                    \frac{\int_x^{x+h} f(x) \, dt}{h}
                  + \frac{\int_x^{x+h} [f(t) - f(x)] \, dt}{h} \\
    & = &  f(x) + \frac{\int_x^{x+h} [f(t) - f(x)] \, dt}{h} . \\
\end{eqnarray*}
If $|h| < \delta$ then we may estimate the last fraction as
$$
\left | \frac{\int_x^{x+h} [f(t) - f(x)] \, dt}{h} \right | \leq
     \frac{\int_x^{x+h} |f(t) - f(x)| \, dt}{h} \leq \epsilon .
$$
Thus, in summary, we have
$$
\frac{F(x + h) - F(x)}{h} = f(x) + \hbox{error} ,
$$
where the error is not greater than $\epsilon$.  In conclusion,
$$
\lim_{h \rightarrow 0} {F(x+h) - f(x)}{h} = f(x) .  \eqno \BoxOpTwo
$$

\end{document}
```

The $\LaTeX 2_\varepsilon$ Code

```
\documentclass{article}

\newfam\msbfam
\font\tenmsb=msbm10    \textfont\msbfam=\tenmsb
\font\sevenmsb=msbm7   \scriptfont\msbfam=\sevenmsb
\font\fivemsb=msbm5    \scriptscriptfont\msbfam=\fivemsb
\def\Bbb{\fam\msbfam \tenmsb}

\def\RR{{\Bbb R}}


 \def\HollowBox #1#2{{\dimen0=#1 \advance\dimen0 by -#2
    \dimen1=#1 \advance\dimen1 by #2
    \vrule height #1 depth #2 width #2
    \vrule height 0pt depth #2 width #1
    \llap{\vrule height #1 depth -\dimen0 width \dimen1}%
    \hskip -#2
    \vrule height #1 depth #2 width #2}}
 \def\BoxOpTwo{\mathord{\HollowBox{6pt}{.4pt}}\;}

\begin{document}

\begin{center}
\textbf{\large The Fundamental Theorem of Calculus}
\end{center}

Let $f$ be a continuous function on an open interval
$I \subseteq \RR$.  Fix a point $a \in I$.
For any point $x \in I$, we define
$$
F(x) = \int_a^x f(t) \, dt .  \eqno (\dagger)
$$
The substance of the Fundamental Theorem of Calculus is
to claim that $F$ is an anti-derivative for $f$.
More precisely, we have
\smallskip \\

\noindent \textsc{Theorem 1:}  The function $F$ defined above
is differentiable, and
$$
\frac{d}{dx} F(x) = f(x)
$$
```

```
for every $x \in I$.
\smallskip \\

\noindent \textbf{Proof:}  We endeavor to calculate the
derivative of $F$ by forming the difference or Newton
quotient for $h \ne 0$:
\setcounter{chapter}{0}
\begin{eqnarray}
\underbrace{\frac{F(x + h) - F(x)}{h}}_{\hbox{Newton quotient}}
                     & = & \frac{\int_a^{x+h} f(t) \, dt
                   - \int_a^x f(t) \, dt}{h} \nonumber \\
                    & = & \frac{\int_x^{x+h} f(t) \, dt}{h} .
\end{eqnarray}

Now fix a point $x_0 \in I$.  Let $\epsilon > 0$.  Choose
$\delta > 0$ such that $|t - x_0| < \delta$ implies that
$|f(t) - f(x_0)| < \epsilon$.  Now we may rewrite (1) as
\begin{eqnarray*}
\frac{\int_x^{x+h} f(t) \, dt}{h} & = &
                    \frac{\int_x^{x+h} f(x) \, dt}{h}
                  + \frac{\int_x^{x+h} [f(t) - f(x)] \, dt}{h} \\
     & = &  f(x) + \frac{\int_x^{x+h} [f(t) - f(x)] \, dt}{h} . \\
\end{eqnarray*}
If $|h| < \delta$ then we may estimate the last fraction as
$$
\left | \frac{\int_x^{x+h} [f(t) - f(x)] \, dt}{h} \right | \leq
     \frac{\int_x^{x+h} |f(t) - f(x)| \, dt}{h} \leq \epsilon .
$$
Thus, in summary, we have
$$
\frac{F(x + h) - F(x)}{h} = f(x) + \hbox{error} ,
$$
where the error is not greater than $\epsilon$.  In conclusion,
$$
\lim_{h \rightarrow 0} {F(x+h) - f(x)}{h} = f(x) .
     \eqno \BoxOpTwo
$$

\end{document}
```

[The Compiled Output]

The Fundamental Theorem of Calculus

Let f be a continuous function on an open interval $I \subseteq \mathbb{R}$. Fix a point $a \in I$. For any point $x \in I$, we define

$$F(x) = \int_a^x f(t)\,dt. \tag{\dagger}$$

The substance of the Fundamental Theorem of Calculus is to claim that F is an anti-derivative for f. More precisely, we have

THEOREM 1: The function F defined above is differentiable, and

$$\frac{d}{dx}F(x) = f(x)$$

for every $x \in I$.

Proof: We endeavor to calculate the derivative of F by forming the difference or Newton quotient for $h \neq 0$:

$$\begin{aligned}\underbrace{\frac{F(x+h)-F(x)}{h}}_{\text{Newton quotient}} &= \frac{\int_a^{x+h} f(t)\,dt - \int_a^x f(t)\,dt}{h} \\ &= \frac{\int_x^{x+h} f(t)\,dt}{h}. \qquad (1)\end{aligned}$$

Now fix a point $x_0 \in I$. Let $\epsilon > 0$. Choose $\delta > 0$ such that $|t - x_0| < \delta$ implies that $|f(t) - f(x_0)| < \epsilon$. Now we may rewrite (1) as

$$\begin{aligned}\frac{\int_x^{x+h} f(t)\,dt}{h} &= \frac{\int_x^{x+h} f(x)\,dt}{h} + \frac{\int_x^{x+h} [f(t)-f(x)]\,dt}{h} \\ &= f(x) + \frac{\int_x^{x+h} [f(t)-f(x)]\,dt}{h}.\end{aligned}$$

If $|h| < \delta$ then we may estimate the last fraction as

$$\left|\frac{\int_x^{x+h} [f(t)-f(x)]\,dt}{h}\right| \le \frac{\int_x^{x+h} |f(t)-f(x)|\,dt}{h} \le \epsilon.$$

Thus, in summary, we have

$$\frac{F(x+h)-F(x)}{h} = f(x) + \text{error},$$

where the error is not greater than ϵ. In conclusion,

$$\lim_{h\to 0} F(x+h) - f(x)h = f(x).$$

Glossary

The definitions included here have been drawn from a variety of books and articles listed in the References, but especially from the Web page of Budgett and Johnstone.

A4 paper size The international standard size for business paper: 297mm $\times$ 210mm. See *international paper sizes* and *ISO*.

AA's (author's alterations) Changes to the copy made by author after the manuscript has been typeset. A publisher may charge the author for AA's that exceed 15%.

accent A mark on a character, usually a letter, indicating stress. Common accents are named acute (é), grave (è), circumflex (â), cedilla (ç), tilde (ñ).

accent grave The accent (used in French, Spanish, and other European languages) that has the form à and is given by the TEX code `` \` ``.

acquisitions editor The editor who evaluates a new manuscript from an author, gets it reviewed, and determines whether it is to be published.

acute accent The accent (used in French, Spanish, and other European languages) that has the form á and is given by the TEX code `\'`. Also called "accent egout".

Adobe Acrobat A reader for the `pdf` computer graphics and page design language. Particularly well-suited for use on the Internet.

agate An old unit of measure in typesetting equal to slightly less than 5.5 points. For years the agate was the standard for measuring advertisements. In England this unit was called the ruby.

AMS American Mathematical Society.

AMS-LATEX A version of TEX that incorporates many of the best features of LATEX and of AMS-TEX.

AMS-TEX A macro package for TEX that has been created by the American Mathematical Society (specifically, by Michael Spivak) in order to facilitate the creation of mathematics documents. AMS-TEX contains special style macros for the Society's journals, special fonts, and also macros for creating commutative diagrams and for other mathematical displays.

archive A collection of software located at a particular Web address that can be accessed through anonymous `ftp`. Also: a single file that contains a collection of other files, for manipulation with the `tar` command.

ascender The portion of a lower-case letter that extends above the main body of the letter. Compare *descender*.

ASCII code The American Standard Code for Information Interchange. An enumeration of all characters, both alphanumeric and symbolic, that can be typed in on a computer keyboard.

back matter Material that follows the main body of text. This may include appendices, glossaries, tables, references, indexes, and like material. See *front matter*.

bar-under accent The accent having the form c̲ and given by the TEX code `\b`.

baseline An imaginary line that passes through the bottoms, or bases, of the capital letters.

bed The base on which the forme is held when printing by letterpress. Newspapers speak of "sending an issue to bed."

benday The screen used to create a halftone. See also *halftone*.

BIBTEX A macro for LATEX that is designed for the preparation of bibliographies. Bibliographic data is archived in `*.bib` files in a special BIBTEX format.

big cap-small cap font A font in which lower-case letters are replaced by small capital letters. THIS SENTENCE IS SET IN BIG CAP-SMALL CAP.

binary code The machine code that is read and understood by a computer.

binding A method (of which there are many) for securing loose leaves or sections into a book. Among these methods are perfect and saddle-stitched.

bitmap A machine language graphic format. See also `*.bmp` *file*.

blanket cylinder The cylinder by way of which the inked lithography plate transfers the image to the paper. Usually the cylinder is covered with a rubber sheet which prevents wear from the plate coming into contact with the paper.

bleed Illustrations that extend to the edge of the page, and are trimmed off at the time of binding, are said to bleed.

block in The process of sketching in the main parts of an image prior to making the more formal design.

block quotation An excerpt or quotation set in reduced type. Such a quotation is often displayed. Also called an *extract*.

blow up An enlargement of a graphic image or a photograph.

***.bmp file** A graphics file that is stored in the bitmap format.

body size The height of a type font, measured in points, as measured from the top of the tallest ascender to the bottom of the lowest descender.

boldface A font consisting of heavy, dark, thick letters. In some fonts boldface is available in either upright **A, B, C** or slanted ***A, B, C*** form.

bond A sized, finished writing paper of 50 grams per square meter or heavier. Such paper can also be printed upon.

braces The delimiters $\{\ \}$.

brackets The delimiters $[\ ]$.

breve The accent that has the form $\breve{a}$ and is given by the TEX code `$\breve{a}$`.

broadsheet See *broadside.*

broadside See *landscape.*

browser A piece of software used for reading material on the World Wide Web. See also *search engine.*

bullet A large dot placed before text to add emphasis. Invoked in LATEX with the command `\begin{itemize}`.

camera copy or camera-ready copy Proof sheets that are ready to go to the printer. Usually printed on RC (resin-coated) paper. Also known as "mechanicals". See also *repro copy.*

cap line An imaginary line drawn through the tops of all capital letters.

caps Capital letters.

cap size The distance from the cap line to the baseline.

caption The heading or title of a figure, table, illustration, or of a chapter or article. As distinct from a *legend.*

caret The symbol $\wedge$, used in proofreading to indicate an insertion. Similar to, but generally larger than, the circumflex.

case bound A hardbound book made with stiff outer covers. The case is often covered with cloth, leather, or vinyl.

cast off To estimate the number of typeset pages that will be made from a manuscript. Alternatively, to estimate the number of pages of text that will be made from a set of galleys. Also used as a noun: to make a castoff.

catchline A temporary heading—provided for identification purposes—at the top of a galley proof.

cedilla The accent (used in French and other European languages) that has the form ç and is given by the TEX code `\c`.

chalking If the ink fails to dry satisfactorily after printing, then a resulting powdering effect on the surface is called chalking.

character count The number of characters (i.e., letters, numerals, signs, spaces, symbols, etc.) in a piece of copy or a line or a paragraph. Used as the first step in a cast off.

chase A metal frame in which (cold) metal type and blocks (i.e., engravings) are locked into position in order to make up a page.

check The accent that has the form ǎ and is given in text by the TEX code `\v{a}` and in math mode by the TEX code `$\check{a}$`.

circumflex The "hat" accent that is used to denote the Fourier transform, and also occurs in foreign languages such as French.

close up A proof correction mark (copy editor's mark) that is used to indicate reduction of the amount of space between characters or words.

cold type composition The traditional technology used for typesetting. Each character or ligature is engraved on a piece of lead. Words, sentences, and paragraphs are composed by juxtaposing the pieces of lead in a rack.

collate To assemble the separate pages or section of a book into the proper order for binding. See *gathering*.

collective sign A mathematical symbol, such as a sum, product, union, or integral, that signifies some aggregation.

colophon The publisher's logo or trade emblem, usually appearing on the title page of a book. The term also refers to a passage at the end of a book describing the type and how the book was produced.

color separation The division of a four-color or multi-colored original into the primary process colors of yellow, magenta, cyan, and black. See also *benday*, *screen*, *halftone*.

column inch In a newspaper or magazine, a portion of the type body that is one column wide and one inch deep. The measure is used to calculate the cost of display advertising.

commercial "at" The symbol @, commonly used in e-mail addresses.

composition The process of setting a manuscript into type. The same as *typesetting*.

compositor In traditional typesetting, the person who typesets text.

consonantal digraph A combination of two consonants to express a single sound. See also *diphthong*.

copy editing The process by which a manuscript is read and evaluated—by a trained expert—with a view to correcting both the use of language, grammar, spelling, syntax, style, consistency, and the formatting of the page.

copy editor The person who performs copy editing functions.

copy editor's marks See *proofreader's marks*.

copyholder A person who reads manuscript aloud to the proofreader.

copyright The legal entity that gives protection to the creator of material to prevent use without express permission or acknowledgement of that creator.

corner marks The angle marks printed on a sheet to denote the trim or register marks.

cover The outside binding material of a book or journal. Usually made of heavier material than the actual pages. The outside front cover, inside front cover, inside back cover, and outside back cover are often designated covers 1, 2, 3, and 4 respectively.

CPU Central processing unit. The chip that is the "brains" of the computer.

cropping The editing away of portions of a photograph or other original graphic that are not desired in the printing. Usually cropping is done in order to allow the other parts of the graphic to be enlarged to fill the indicated space.

CRT Cathode ray tube. The computer's monitor. Nowadays some of the new "thin" monitors use digital technology, not cathode ray tubes.

CTAN (Comprehensive TEX Archive Network) A Web site, with many mirror images, that holds TEX macros, fonts, implementations of TEX and LATEX, and many other TEX resources. See Appendix VI for more information about CTAN sites.

cursive A typeface that resembles written script.

cut flush A method of trimming a book after the cover has been attached.

cutout A halftone in which the background has been cropped out in order to produce a silhouette.

dagger In typesetting, the symbol † that is used to mark equations, displays, or footnotes.

daisy wheel printer An impact printer which prints from a wheel that has many different engraved print images. This method of printing is slow, and has been replaced by ink-jet, laser, and other printing technologies.

ddagger In typesetting, the symbol ‡ that is used to mark equations, displays, or footnotes.

dash A short horizontal rule used for punctuation. This could be an *em-dash* or an *en-dash*.

delimiter See *fence*.

descender That portion of a lower-case letter that extends below the baseline.

developmental editor This is the editor that oversees the writing and genesis of the book—from early draft to final form that will be sent into production. The developmental editor will get reviews, from peers of the author and from others, and will help the author to interpret those reviews. The developmental editor will help the author to render his graphics, will guide the author through writing problems, and will help him to assemble the final book. The role of the developmental editor is most decisive, and pervasive, in the writing of elementary textbooks.

die A hardened steel engraved block used to print an inked image. Used, for example, in the production of high quality letter headings.

dieresis The accent that has the form ä and is given in text by the TEX code `\"{a}` and in math mode by the TEX code `$\ddot{a}$`.

digraph A combination of two letters to express a sound. See *diphthong.*

diphthong A digraph composed of two vowels. Common diphtongs are ae and oe . The pairing is called a "diphthong", but the resulting compressed symbol (e.g., æ or œ) is called a *ligature.* See also *logotype.*

discretionary hyphen See *soft hyphen.*

displayed mathematics Mathematics that is typeset in a size larger than the regular text and is set off, with space above and below, from the text body.

display type Large type, usually at least 18 point and set in bold, that is used in a heading.

DOS The disc operating system. The one in most prevalent use today was created by Microsoft in the early 1980s and is denoted MS-DOS. This computer operating system for PC computers has now been superceded by the Windows products: Windows95,® Windows98,® WindowsNT,®and Windows2000.®

dot accent The accent that has the form ä and is given in text by the TEX code `\.{a}` and in math mode by the TEX code `$\dot{a}$`.

dot matrix printer A printer that forms each character from a matrix of dots. Such a printer could be an impact system (in which a wire is fired at a ribbon), or thermal, or electro-erosion. The dot matrix printer has now been superceded by laser, ink-jet, and other printer modern technologies.

dot-under accent The accent that has the form ạ and is given in text by the TEX code `\d{a}`.

double spread Two facing pages in printed copy. Also called "double page spread".

DPI (dots per inch) The measurement of resolution for page printers, phototypesetting machines, and graphics screens. The image is divided into dots and the number of dots per linear inch is the DPI. Modern laser printers are 1200 DPI or more.

drawn on The method of binding a paper cover to a book by drawing on the cover and gluing it to the back of the book.

drop cap A large initial letter at the beginning of text that drops below the baseline and into several of the lines of text below. Often typeset in gothic.

drop folio A page number placed at the bottom of the page (as opposed to top left or right).

dry transfer Characters, images, drawings, etc., that can be transferred to the work by rubbing on the back of a plastic transfer sheet. Often known as Letraset.

dunhill A popular typeface that features tall, elongated letters. This is Dunhill.

***.dvi file** A device independent file, created when a TEX source code file is compiled.

dye transfer A photographic color print methodology that uses special coated paper to produce a full-color image.

editor The publishing process involves several different types of editors. The *acquisitions editor* is one who accepts manuscripts for review and who ultimately decides which of these will go into publication. Once a manuscript has been accepted, the *production editor* oversees the production process. The *copy editor* performs a technical review of the manuscript, correcting for formatting, usage, spelling, and syntax. See also *text editor*.

elided A page range is elided if it is written in the form 465–83 rather than 465–483.

ellipsis Three periods or dots, as $\ldots$ or $\cdots$; used to denote an omission.

em See *em quad*.

emacs A popular text editor for the UNIX operating system. Also known as GNU emacs.

embellished letter A letter that has been augmented with an accent, bar, cedilla, dot, tilde, umlaut, or other diacritical mark.

em-dash A long dash that used for a pause or break in a sentence.

em quad A space named because, traditionally, it was the width of the capital letter "M" in the font being used. Nowadays the definition is variable, and depends on the font and on other parameters as well. Also called an *em*.

en See *en quad*.

encapsulated PostScript® A form of PostScript that is especially designed for inclusion in other documents, such as a TEX document. Such files have the form `*.eps`. See *PostScript*.

en-dash A dash of medium length, used to indicate a range of pages or numbers, and in similar contexts. Also called an *en*.

endpaper A folded sheet of paper, different in texture and perhaps in color from the main pages of a book. It is pasted in the front of a book (half to the front cover) and in the back of a book (half to the back cover). Compare *flyleaf*.

en quad A space named because, traditionally, it was the width of the capital letter "N" in the font being used. Nowadays the definition is variable, and depends on the font and on other parameters as well. Also called an *en*.

enunciation A displayed mathematical statement such as a theorem, lemma, corollary, definition, remark, or example.

***.eps** Encapsulated PostScript format. See also *PostScript*.

Epson emulation or standard The industry standard control codes for dot matrix printers, developed by Epson Corporation.

even pages See *verso pages*.

extract See *block quotation*.

face An abbreviation for "typeface". Refers to a given font family in a given style.

FAQ On a Web site, the "Frequently Asked Questions" button.

fence A delimiting mark, usually used in pairs, such as a parenthesis, brace, or bracket. See also *delimiter*.

final proof Proof which has gone through the editing and correction process (i.e., the galley and page proof stages) and is now in final form.

first order index A superscript or subscript that directly augments a character on the baseline. In the expression A_1^2, both the 1 and the 2 are first order indices. See *second order index*.

first proof See *galley proof*.

flexography A rotary or letterpress technology consisting of printing from a rubber or other flexible plate and using fast-drying ink.

flush left Alignment of copy along the left margin.

flush right Alignment of copy along the right margin.

flyleaf A blank leaf or page bound into the front or back of a book. Compare *endpaper*.

folio The page number. Also a sheet of a manuscript.

font A style and size of type. A font includes all upper- and lowercase letters, all numerals, and all punctuation. Most fonts will have a boldface variant and a slanted or italic variant.

forme Type and blocks assembled in pages and placed in a metal chase ready for printing.

four-color press A press that can print four colors simultaneously (usually yellow, magenta, cyan, and black), to produce all possible colors on one pass through the printer.

freeware Software that is available (often on the World Wide Web) without any payment or quid pro quo.

front matter Material that precedes the main body of text. This may include the title page, foreword, preface, acknowledgements, dedication, table of contents, the list of figures, and like material. See *back matter*.

ftp The acronym for "file transfer protocol". This is both the protocol and the software for transferring files between different computers on the Internet.

galley proof The typeset manuscript of a book or paper, formatted according to customary typesetting standards but not broken for pages. The galley proof will not show space for figures, tables, and other displayed material.

galleys Printing term for the long metal trays used to hold type after it had been set and before the press run.

gathering The process of placing the pages, sections, or signatures of a book in the proper order for binding. See *collate*.

***.gif file** A graphics file that is in the Graphics Image Interchange format.

glue In TEX, the information about spacing and adjoining to other characters that comes "packaged" with each TEX character.

graphics artist A technically trained artist who can render graphics for a book or article for the purposes (and to the standards of) publication.

gravure A printing process in which the image is etched onto a metal plate attached to a cylinder. Also called "rotogravure" or *photogravure*.

grey scale A range of luminance values for evaluating shading from white to black. Used in evaluation of scanner images. The term is sometimes applied to certain types of CRTs or computer monitors.

gutter The inner margins of a page, which are over-sized because they will be bound.

háček The accent that has the form ǎ and is given in text by the TEX code `\v{a}` and in math mode by the TEX code `$\check{a}$`.

hairline rule The thinnest rule (line) that can be printed.

hairlines The thinnest of the strokes in a typeface. See *hairline rule*.

half title A (possibly abbreviated) title which appears by itself on a page preceding the more formal title page.

halftone A process by which a black-and-white photograph is filtered through a screen so that various shades are represented by different densities of dots. See also *benday*.

halftone screen A glass plate or film, carrying a network of parallel lines, that is placed between an original photograph and the film to be exposed. The number of lines per inch controls the coarseness of the final dot configuration in the resulting halftone.

handwork Composition that requires manipulation by an artist rather than just keyboarding.

hang indent A paragraph typeset so that the first line is flush left and subsequent lines uniformly indentd.

hanging punctuation Punctuation that is allowed to fall outside the print margins.

hardback A case bound book with a separate stiff board cover. A book that is not paperback.

hard copy A version of a document that is printed out on a (paper) page; as opposed to the electronic (or "soft") version of the document.

head The margin at the top of a page.

header Computer code at the beginning of a (TEX) document, giving format and style specifications.

head margin The blank space occupying the region from the top edge of the page to the topmost element of the print body. See also *sinkage*.

heads Words or phrases used to differentiate different portions of the text (chapters, sections, etc.). Often set in boldface, or big cap-small cap, or some other special type.

helvetica A popular sans serif typeface.

house style A publisher's or publication's preferred style of spelling, punctuation, hyphenation, indentation, and display.

HTML (Hypertext Markup Language) The code that is used to prepare Web pages and text for electronic documents on the Internet. Especially useful for hyperlinks. See *MathML*, *SGML*, *XML*.

hypertext The language used to format material for the Internet.

hyphen The shortest type of dash. Used to hyphenate words.

icon A pictorial image on screen that designates a utility function, a file, a folder, or an application. In the Windows or Macintosh environment, the icon is activated by clicking with a mouse or other pointing device.

impression cylinder The cylinder of a printing machine that brings the paper into contact with the printing plate.

imprint The name and address of a publisher, usually appearing on the title page of a book. Sometimes this material will appear with the *colophon* (or publisher's logo) and the date of publication.

index These are subscripts and superscripts which augment a character on the baseline. Also the alphabetized list of topics at the end of a book or manuscript. See *first order index* and *second order index.*

ink-jet printer A printing technology in which particles or droplets of electrically charged ink are sprayed from a matrix of tiny ink jets.

inline mathematics A mathematical expression that occurs in the flow of text, and is the same size as the regular text. As opposed to *displayed mathematics.*

insert An instruction to the printer for the inclusion of additional copy.

international paper sizes The International Standards Organization (ISO) system of paper sizes is based on a series of three sizes: **A**, **B**, and **C**. Business-size paper, in many industrial countries, is size A4. North American countries do not subscribe to the ISO standard. The American $8.5'' \times 11''$ business paper is not an ISO paper size, nor is the American legal $8.5'' \times 14''$ size.

Internet The union of millions of computers, linked by modem and ethernet, around the world. Each such computer is accessible from any other.

ISBN (International Standard Book number) Similar to the *SBN* number.

ISO The International Standards Organization for paper size. See *international paper sizes.*

ISP Internet service provider.

italic A slanted version of a font, used to slow down the eye when emphasis is desired. *This sentence is typeset in italic.* Mathematical expressions are generally typeset in a form of italic called *math italic:* $x^2 - 2yz = w$. Some expressions in mathematical logic are *not* typeset in italic.

***.jpg file** A graphics file that is in the Joint Photographic Experts Group format.

justified lines A line typeset flush against one or both margins. See *left justified line* and *right justified line.*

kern To move the point of typesetting either left-right or up-down.

keyline An outline drawn on artwork to show the size and position of an illustration.

laid In the production of high-quality stationery, the paper with a watermark pattern showing the wire marks used in the paper-making process.

laminate A thin, transparent plastic coating on paper or board to provide protection and a glossy finish.

landscape Presentation of material on an $11'' \times 8.5''$ page. In other words, the page is held sideways instead of up-and-down. Contrast with *portrait.*

laser printer A high-quality printing technology—in wide use today—in which a laser beam is used to produce an image on a photosensitive drum. The image is then transferred to paper by a process similar to xerography.

lateral reversal An image (positive or negative) transposed from left to right as in a mirror reflection.

$\LaTeX$ A $\TeX$ macro package, originally designed by Leslie Lamport, which provides style files for articles, reports, books, and other standard types of documents. Also called $\LaTeX$ 2.09.

$\LaTeX2_\varepsilon$ A newer release of $\LaTeX$ that incorporates powerful, new macros and graphics features. $\LaTeX$3 is under preparation at the time of this writing.

layout A sketch of a page, in preparation for printing, which shows positioning of text and illustrations and gives overall instructions.

leading A vertical space used in typesetting. Traditionally, the space was effected with a blank piece of lead type. It is common to put 2 points of space between lines of text, hence the phrase "2 point leading". A 6 point leading is sometimes used between sections, and before and after displayed material (i.e., mathematical formulas or enunciations).

left justified line A line of text which is typeset flush against the left margin.

legend The explanatory material that accompanies an illustration, figure, table, or chart. Compare *caption.*

Letraset See *dry transfer.*

letterpress The type of printing in which ink is applied directly to the metal type and then transferred to the paper by the application of pressure. Compare *lithography* or *offset printing.*

letterset A printing process that combines offset printing with a letterpress relief printing plate.

letterspacing The addition of space between the letters in a word in order to increase line length, thereby improving the appearance of a line of text.

ligature A symbol resulting from the juxtaposition of two letters—for instance æ or œ. See also *diphthong* and *logotype.*

line copy/line drawing (Graphic) copy that is produced with pen strokes, without using a screen. Compare *halftone.*

line cut An engraving in which there are no tonal gradations. The graphic effect is produced with lines rather than halftones.

line gauge A metal rule used by printers, often marked with pica measurements.

linen tester The magnifying glass designed for checking dot images in a halftone.

lineup table A backlighted glass table used for preparing and checking the alignment of page layouts and paste-ups.

line weight The thickness of a line or stroke used in a line drawing.

lining figures Numerals that are aligned at the baseline and at the top.

linotype A typesetting machine that sets solid lines of slugs of metal type. This was the standard method of typesetting for the first half of the twentieth century.

lithography The process of printing in which ink is applied to the metal type, then transferred to a rubber pad by way of pressure, and then finally transferred to the paper by way of direct contact with the rubber pad. Most modern printing is done with lithography.

logotype A single piece of type bearing two or more usually separate elements. See also *diphthong* and *ligature*. Often the word "logotype" is used to refer to the piece of cold type that bears the diphthong or ligature. Abbreviated "logo".

long Hungarian accent or umlaut The accent that has the form a̋ and is given by the TEX code `\H{a}`.

loose leaf A method of binding which allows for insertion and removal of pages, for continuous updating. Binding in a three-ring binder of ACCO folder.

lower-case Denotes those letters which are not capitalized. Compare *upper-case*.

macro A collection of computer commands that may be invoked by using a nickname that has been assigned to them.

macron An overbar in text. The accent that has the form ā and is given by the TEX code `\={a}`.

majuscule An upper-case letter.

makeready The process by which a letterpress plate is adjusted or aligned to compensate for irregularities in the plate.

make-up The assembling of all elements in order to form the printed image.

managing editor The person who oversees all the other editorial staff in the production of a book—the developmental editor, the production editor, and the copy editor.

manuscript The hard-copy draft of a document that you submit to the publisher.

Maple A high-level computer language, created by the mathematicians of Waterloo, for doing mathematics by way of symbol manipulation.

margins The non-printing areas of a page. The blank space on the edges of a printed page.

mark up Copy prepared for a compositor setting out all the typesetting instructions.

markup language A high-level computer language that is used to describe the content and formatting of a page of textual material. TEX is a markup language.

mask Opaque material, often masking tape, that is used to block off an area of artwork.

masthead Detailed information about publisher, editors, and editorial staff that are usually printed on the contents page of a periodical.

Mathematica A high-level computer language, created by Wolfram Research, Inc., for doing mathematics by way of symbol manipulation.

math italic The italic font that TEX uses to typeset mathematics.

MathML Mathematical Markup Language. A markup language to be used with XML. Especially good for mathematical and scientific content. See *HTML*, *SGML*, *XML*.

mechanical binding A method of binding that consists of securing pre-trimmed pages by the insertion of wire or plastic spirals through holes drilled in the binding edge.

mechanicals See *camera copy* or *repro copy*.

METAFONT Donald Knuth's language for creating fonts. Part of the TEX family.

miniscule A lower-case letter.

mock up The rough visual dummy of a publication or design of a work.

moire A checkered effect that is achieved by superimposing halftone screens at the wrong angle.

monospace The attribute of a font of having each character occupy the same amount of horizontal space.

monotype A particular sort of typesetting machine. Material is keyboarded, and a paper tape produced. Also used to refer to a typesetting style in which all characters have the same width.

montage A single image formed from the assemblage of several images.

mounting board A heavy board used for mounting and assembling artwork.

MS See *manuscript.*

mutt The *em quad.*

negative A photographic image in which colors are reversed, or black and white are reversed. See *positive.*

nipping The compression of air after sheets of a book are sewn together.

oblique strok See *shilling* or *solidus* or *virgule.*

OCR See *optical character recognition.*

odd pages See *recto pages.*

offprint See *reprint.*

offset printing See *lithography.*

oldstyle type A typeface that is characterized by stressed strokes and triangular serifs. An example of an oldstyle typeface is Garamond.

old style numerals (0123456789) A style in which most numerals ascend or descend from the x-height of the other characters in the typeface.

opacity The degree to which paper will show print through.

optical character recognition The technology by which a machine, by way of scanning, can recognize characters on a page and convert them to ASCII code. As opposed to bitmapping.

orphan A brief phrase—less than a full line—from the start of a paragraph that occurs at the bottom of a page.

outline font A typeface in which characters are formed with only their outline specified (rather than solid strokes). Outline fonts will scale well.

overlay A transparent sheet that shows the color breakdown—used in the preparation of multi-color artwork.

overprinting Printing a second time over an area already printed. The method may be used to emphasize changes or alterations.

overs Additional paper used to compensate for that which is spoiled in the printing process. Can also refer to extra copies above the number initially ordered.

overstrike A method used in word processing, and also with a traditional typewriter, to produce a character not in the given typeface by superimposing two given characters. For example, a mathematician will produce a blackboard boldface C by superimposing an I and a C.

ozalid A patented method for producing page proofs from paper or film.

page description language (PDL) A programming language that enables both text and graphics to be described in a series of mathematical statements. A page description language allows the applications software to be independent of the physical printing device. PostScript® is an important PDL.

page printer A non-impact printer which produces a complete page in one action. Some examples of page printers are laser, LED, LCD shutter xerographic, ion deposition, electro-erosion, and electro-photographic.

page proof Similar to the galley proof, but broken for pages, and with space set for figures, tables, and other displays. This is the typeset text in its final form.

pagination The numbering of pages in a book. There are dry transfer pagination sheets to help with pagination.

pantone A patented name for an ink color matching system. Used, for example, by CorelDRAW.

paperback A book with a perfect binding whose covers are made of heavy paper.

paper plate An offset printing plate for a short print run on which matter can be typed directly.

paragraph mark A typesetting symbol (¶) used to denote the start of a paragraph. Can also be used to mark a footnote.

paste up The elements of a layout mounted in position—often on a mounting board—to form camera-ready artwork.

PDF format A file format (Portable Document File format) due to Adobe that is similar to PostScript (q.v.). Files in this format generally have extension `.pdf`, as in `myfile.pdf`. Now a standard file format for electronic document printing and distribution. The Adobe Acrobat reader is designed to read `pdf` files.

PDL See *page description language*.

perfect binding A style of bookbinding in which the backs of the signatures are cut off, the edges roughened, and the pages then glued together with adhesive. Compare *signature*.

perfector A printing press which can print both sides of the paper at one pass.

PE's (printer's errors) Changes or errors made in the typeset text that are the responsibility of the typesetter or copy editor. These alterations are not charged to the author.

photogravure See *gravure*.

phototypesetting A process of typesetting onto film.

pica A unit of distance in typesetting, equal to 12 points.

pica ruler The metal rule most commonly used by a typesetter in page design.

pi fonts Characters not typical of a font, but added specially. These might include mathematical symbols and timetable symbols.

pixel A screen dot on a computer monitor or CRT. A typical SVGA monitor is about 1200 pixels across and 1000 pixels high.

plant costs Fixed costs of the book production process that are not connected with any one book or by the size of the edition. These include composition, plates, electricity, staff salaries, overhead, and equipment.

point A unit of length equal to 0.013837 inches. There are about 72 points to an inch.

portrait Presentation of material on an $8.5'' \times 11''$ page. In other words, the page is held up-and-down instead of sideways. Contrast with *landscape*.

positive The true photographic image of the original made on paper or film. See *negative*.

PostScript A page design language created by Adobe. This is a high-level computer language that allows the formatting of both graphics and text.

preamble That part of a LaTeX source code file that occurs before the line `\begin{document}`.

preface The part of the front matter of a book that introduces the subject and that particular presentation of it. See also *prospectus*.

preprint A copy of the manuscript or original hard copy of an article, chapter, or book manuscript.

press run The number of copies (of a book or article) to be printed.

primary colors These are cyan, magenta, and yellow. When mixed together in suitable proportions with black these will produce all other colors.

print block The entire body of text on a page.

print body The totality of print on a page, measured from the bottom of the top margin to the top of the bottom margin, and from the right edge of the left margin to the left edge of the right margin.

print-on-demand The digital technology that allows the printing of a small number of copies of a document, at the moment of demand. In traditional typesetting, the cost of setting up the printer made it too impractical and costly to do small print runs. With digital technology this is now feasible and affordable.

production editor The editor who oversees the process of bringing a book from final manuscript form to final, printed copy. The production editor oversees the copy editor, graphics artists, and the TeX specialists to whom the MS is outsourced.

progressive proofs A series of plates, each produced in one of the four basic colors (yellow, magenta, cyan, and black). These are superimposed progressively and used to check color quality and alignment.

proof Copy obtained from inked type, plate, block, or screen for the purpose of checking quality and accuracy.

proof correction marks See *copy editor's marks*, *proofreader's marks*.

proofreader The person who reads proof copy for errors.

proofreader's marks A universally accepted collection of symbols and markings that are used to annotate proof copy. See the plates in Appendix I. See *copy editor's marks*.

proofreading The process of reading proofs to check them for errors—usually by comparing those proofs with the original copy. The process of proofreading involves marking any errors with standard proofreader's or copy editor's marks.

proofs Typeset text that is ready for checking (proofreading) and correction. See *page proof* and *galley proof*.

proportional spacing A method of spacing in typesetting whereby each character is spaced according to the varying widths of the elements of the font. The method uses *kerning*. See also *monospace*.

prospectus Similar to a preface, but also includes information about the market and about other books on the same subject. See *preface*.

public domain A term used to describe software that has not been copyrighted.

quad Same as an *em quad*.

quadding Additional space to fill out a line of type, using em quads or en quads.

quire One twentieth of a ream (25 sheets) of paper.

ragged Lines of set type that do not begin or end at the same horizontal position.

ragged left Describes a body of text with an unjustified left margin.

ragged right Describes a body of text with an unjustified right margin.

rag paper High quality paper for stationery that is manufactured from cotton rags.

Raster image processor (RIP) A hardware engine which calculates the bitmapped image of both text and graphics from a series of mathematical instructions. This process may be effected using a *page description language*.

RC paper Resin-coated paper, used for camera-ready copy. If printing plates are to be prepared in the traditional manner, then proof sheets are first printed on RC paper and then “shot” (photographed) for reproduction on a copper or zinc plate.

ream A package of 500 sheets of paper.

recto pages The odd-numbered pages of a book. See also *odd pages.*

recto-verso printing Two-sided printing (as in a book).

reference mark A symbol used in text to direct the reader to a footnote. This could include †, ‡, ¶, (∗).

register The printing of each impression, for each primary color, in the correct position relative to other impressions. This to check alignment.

register marks Marks used in color printing to position the paper correctly. These marks are usually crosses or small circles.

reprint A separate reproduction of an article or book chapter; printing of part of a larger work. See *offprint.* The author of a journal article is usually given fifty reprints free of charge. These are produced by printing fifty unbound copies of the journal.

repro copy See *camera copy.*

resolution Measurement used in typesetting to determine quality of output. The units are “dots per inch” or *DPI.*

rest in proportion (RIP) An instruction, when sizing artwork, that other parts of the artwork are to be sized proportionately.

retouching A method for altering or correcting artwork or color separations.

reverse out To reproduce as a white image out of a solid background.

revise The stage at which corrections have been incorporated from previous proofs and new, corrected proofs submitted. For example, first revise, second revise, etc.

right justified line A line of text which is typeset flush against the right margin.

roman The default typeface in TEX. This definition is typeset in computer modern roman.

rotary press A web- or reel-fed printing press which uses a curved printing plate mounted on a cylinder.

rough A preliminary sketch of a proposed design.

royal Printing paper of size $20'' \times 25''$.

rule A line, usually horizontal, for separating bodies of text. Also a line used for decorative purposes.

runarounds Text set in short lines so that they run around a fixed object, such as an illustration or photograph.

run in To merge two paragraphs or bodies of text into a continuously flowing body.

running foot The abbreviated section title, or chapter title, or author identification that appears across the bottom of the page, below the body of type.

running head The abbreviated section title, or chapter title, or author identification that appears across the top of the page, above the body of type.

sans serif A typeface or font that is plain, without serifs.

SBN number (Standard Book Number) A nine-digit number, assigned in a unique fashion to each published book. The first part identifies the publisher; the second part identifies the particular edition or title; the third part is a parity check. See also *ISBN*.

scale The ability of a program to reduce or to enlarge the amount of space that an image will occupy.

scaling A means of determining the amount of enlargement or reduction required to fit a photograph or graphic to an alloted space.

scamp A sketch of a design that shows the basic concept. See also *rough*.

screen A traditional technique for transforming a solid block of color, or a continuous-tone image, into a pattern of dots. The size and density of dots determines the intensity and darkness of the color. The resulting image is called a *halftone*.
script A typeface or font that resembles handwritten letters: $\mathcal{A}$, $\mathcal{F}$ are examples of script.

search engine A piece of software used for conducting searches on the World Wide Web. Some popular search engines are Netscape, Microsoft Internet Explorer,® Excite,® Yahoo,® Google,® and Dogpile.® See also *browser*.

second order index A superscript or subscript that augments a first order index. In the expression A_{f^3}, the 3 is a second order index. See *first order index*.

section mark A character (§) used at the beginning of a new section.

serif A small decoration or embellishment—a crossed line at the end of the main strokes—that appears as part of letters on a font. The letter R has three serifs and the letter A has two serifs.

set off The accidental transfer of the printed image from the front of one sheet (where the ink has been applied) to the back of another.

set size The width of the type body at a given point size.

set solid Type set without line spacing (leading) between the lines.

SGML Standard Generalized Markup Language. This is an International Standard that describes a generalized markup scheme for representing the logical structure of documents in a system-independent and platform-independent manner.

shareware Software that can be distributed for free, but for which a modest payment is requested from satisfied users.

sheet fed A printing press which handles single sheets of paper instead of rolls or reels of paper.

sheetwise A method of printing a section by which half the pages are imposed and printed and then the remaining half of the pages are printed on the other side.

shilling The forward slash / used in the *shilling form of a fraction*. See also *solidus* or *virgule*.

shilling form of a fraction The format of a fraction that is a/b rather than $\frac{a}{b}$ (the *stacked fraction* format). See also *solidus*.

shooting a page In traditional typesetting, the process of photographing each page of the repro copy of a book or manuscript that has been test-printed on RC paper.

sidebar A vertical bar positioned on the side of the screen—usually on the right.

side heading A subheading that is typeset flush into the text at the left edge.

signature A large sheet of paper, folded and cut to produce a certain number of pages (usually a power of 2, and often 16 or 32). Classically, books were bound in signatures. Compare *perfect binding*.

sinkage The vertical distance between the very top of a printed page and the top of the body of text (or text block).

slanted roman A variant of the roman typeface in which *the letters are slanted*.

slug A 6-point or 12-point piece of lead that is used for vertical spacing in the cold type typesetting process.

slurring A smearing of the printed image caused by slippage of the paper during the printing process.

softback See *paperback*.

soft cover See *softback* or *paperback*.

soft hyphen A specially coded hyphen that only displays when the potentially hyphenated word occurs at the end of a line.

solidus The slanted line used between the parts of a fraction written in *shilling form*. See also *shilling* or *virgule*.

source code In a high-level computing language, this is the file consisting of the commands pertaining to that language.

spell check A software device for checking the spelling in a document. Modern spell-scheckers have an extensible dictionary so that the checker may be adapted to the specialized needs of the user.

spine The back of a book; that part which joins the front and back covers. Also called the backbone or shelfback.

spiral binding A type of binding in which a spiral of plastic or metal is wound through holes in the pages.

s/s (same size) Instruction to reproduce to the same size as the original.

stacked fraction The form of a fraction in which the numerator is placed directly above the denominator, with a horizontal line in between, for example $\frac{a}{b}$. Contrast with the *shilling form* of a fraction.

stem The main vertical stroke making up a character in a type font.

STET Sign used in proof correction work to cancel a previous correction. From the Latin "*let it stand*".

strap A subheading used above the primary headline in a newspaper article.

style file A collection of commands, or a macro, that specifies page style for a particular document or publisher. See also *header*.

style sheet A collection of tags that specify page layout style, paragraph settings, type specifications. The style sheet can be defined by the user and saved for other documents. The `*.sty` files in LaTeX serve as style sheets. See *house style*.

subheads Headings, subordinate to chapter heads, that mark divisions in a chapter. These might include section heads, subsection heads, and so forth.

subscript A symbol, smaller than those on the baseline, that appears slightly below the baseline and is an embellishment to a baseline character—for example j is a subscript in the expression x_j.

superior numeral A small numeral, printed above the x-height of the font, used to denote a reference mark.

superscript A symbol, smaller than those on the baseline, that appears slightly above the baseline and is an embellishment to a baseline character—for example j is a superscript in the expression a^j.

surprint Printing over a previously printed area. See *overprinting*.

swash letters Italic characters with extra flourishes. These are sometimes used at the beginnings of chapters.

tabloid A page half the size of a broadsheet or broadside.

tabular setting Text set in columns.

tags The many different formats which make up a style sheet—automatic section numbering, margin and column settings, page layouts, paragraph settings, hyphenation and justification, widow and orphan control.

technical report A document published by a scientific organization or company for external circulation. Usually such a report is part of a series, and appears with a special cover bearing a logo.

template The prototype or paradigm for a standard page layout, including basic details of the page dimensions.

TeX A high-level computing language created by Donald Knuth in the 1970s for the purpose of typesetting—especially the typesetting of technical material.

text editor A piece of software for entering ASCII code and line breaks/carriage returns. Unlike a word processor, a text editor does not have (hidden) formatting information.

text type The typeface(s) used for the main text of material in a given article or book.

text wrap See *runarounds*.

thick space A horizontal space of thickness equal to two thin spaces.

thin space A horizontal space of thickness about 0.023″.

tie-after accent The accent in text that has the form o͡o and is given by the TeX code `\t{oo}`.

tied letters See *ligature*.

***.tif file** A graphics file that is in the Tag Image File format.

tilde The accent that has the form ã and is given in text by the TeX code `\~{a}` and in math mode by the TeX code `$\tilde{a}$`.

tip and tear To remove a page from a bound book (perhaps one with an error on it) and to tip in a corrected page.

tip in To paste an extra sheet into a bound book.

TLA Three-letter acronym.

tone line process The method of producing line art from a continuous tone original.

transparency A full color, photographically produced image on transparent film.

trash can The icon for the deleting of files or other (computer) objects. See particularly the Windows desktop.

trim Cutting of the finished, printed product to the correct size.

trim marks See *register marks*.

trim size The final size of the entire page of a book or journal, after trimming.

troff An early computer typesetting system and text formatting utility; a precursor of TEX. Still in use on UNIX systems as part of the Documenter's WorkBench (DWB) system.

***.ttf** The True Type Font format.

two-em quad A space in typesetting that is equal to two standard em quads.

typeface The raised or engraved surface carrying the image of a character in metal. Also used to refer to a complete set of characters of a given family or style.

typescript A typed manuscript.

typesetting See *composition*.

type (text) page The total area of the print block on a page.

typewriter-like font A font that `simulates the characters that are produced by a typewriter`.

typo Abbreviation for typographical error. An error in the typeset copy or proof copy.

typographer A specialist in the design of printed matter, page design, and the art of typography.

typography The design and planning of printed material using type.

UCC (Universal Copyright Convention) Gives protection to authors, editors, and originators of text, photographs, or illustration; prevents use without permission or acknowledgement. See *copyright*.

umlaut The accent that has the form ä and is given in text by the TEX code `\"{a}` and in math mode by the TEX code `$\ddot{a}$`. See also *dieresis*.

UNIX A computer operating system developed at AT&T Laboratories and at the University of California at Berkeley. This operating system is public domain, and is widely used on work stations and super computers.

upper-case Denotes capital letters.

URL Universal Resource Locator. This is the address of a particular page on a particular computer on the Internet.

vellum The chemically treated skin of a calf used as a writing material. Also used to describe any thick, creamy book paper.

verso pages The even-numbered pages of a book. See also *even pages*.

vertical justification The adjusting of interline spacing (leading) and manipulation of text in fine increments to make columns and (facing) pages end at the same place.

vi The primary text editor of the UNIX operating system.

vignette A small illustration in a book that is not enclosed in a border.

virgule See *shilling* or *solidus*.

watermark An impression or image incorporated in the process of papermaking which shows the name of the paper or a company logo.

Web browser A piece of software designed for accessing locations on the World Wide Web.

weight The degree of thickness or boldness of a character or a font.

wf Abbreviation for "wrong font". Used as a copy editor's mark to indicate that a character is set in the wrong font.

widow A brief phrase—less than a full line—from the end of a paragraph that occurs at the top of a page.

Windows The operating system created by Microsoft. Windows comes in four flavors: Windows95, Windows98, WindowsNT, and Windows2000.

word break The division of a word—usually between syllables, and designated by a hyphen—at the end of a line.

word processor A piece of software for creating documents. Contains (hidden) formatting information, and displays on the screen (in a WYSIWYG manner) what will be printed on the page.

word wrap In a word-processing environment, the automatic right-justification of lines and adjustment of the number of words on a line.

work and tumble A method of printing where pages are imposed together. The sheet is printed on one side and then turned or tumbled from front to rear to print the opposite side.

work and turn A technique of printing whereby pages are imposed in one forme or assembled on one film. One side is printed and then the sheet turned over and printed from the other edge using the same forme.

World Wide Web A subset of the Internet consisting of locations that can be accessed with a standard Web browser.

WYSIWYG "What you see is what you get".

xerography A photocopying or printing process in which the image is formed using the electrostatic charge principle. In this process, ink is replaced by tone.

***x*-height** The height of lower-case characters, such as the x in a font.

XML Extensible Markup Language. An extensible markup language that improves on HTML in many ways. A subset of SGML. See *HTML*, *MathML*, *SGML*.

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