

Un nceput interesant

Author's name

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Abstract

A couple of sentences on three or four lines to summarise your work.

This is a L^AT_EX template for undergraduate project reports.

Its detailed contents evolve to reflect FAQs.

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Chapter 1

Introduction

The first chapter of a well-structured report is always an introduction, setting the scene with motivation and context (as in Sec. 1.1) and then looking ahead to summarise what’s in the rest of the report (as in Sec. 1.2). It’s the bit that readers look at first — *so make sure it hooks them!*

1.1 Context and motivation

This is a template for L^AT_EX project reports in the Department of Mathematical Sciences. It shows a good overall structure for the printed document, and shows how to construct it with a master file (`report.tex`) plus subsidiary files (`chap1.tex`, ..., `app1.tex`, ..., `biblio.tex`).

At the same time, features of the current version of L^AT_EX (L^AT_EX 2_ε) are illustrated — such as mathematical expressions, numbering and cross-referencing, bibliography and citations, graphics and tables. Comparison of the source files with the printer-ready document will answer a few FAQs: ‘*How can I do ... in L^AT_EX?*’.

However, this is *not* a textbook on L^AT_EX — for that, use the ‘*Not so Short*’ notes by Oetiker *et al.* [NSS]. They are written for novices, and are a pleasure to read. They are available free on-line, and are kept up-to-date. The L^AT_EX book at *Wikipedia* [WL] includes the *Not so Short* material and is good for reference too. Access these via the L^AT_EX resources page [LAT].

For more advanced features see *eg.* ‘*The Companion*’ [MG].

Well-meant advice on L^AT_EX for report-writing and poster-making is available¹ in room CM315, where there are reference copies of both *The Companion* [MG] and *The Graphics Companion* [GRM].

Even if you are misguided enough [AC] to prepare your report in *Word*, this template at least exemplifies a good structure — and gives advice about references and help with typography.

¹From `bob.johnson@dur.ac.uk`

1.2 Contents

The main body of this report is divided as follows.

Chap. 2 has some examples of mathematics, then Chap. 3 deals with graphics and includes Sec. 3.3 about tables. The Conclusion, in Chap. 4, summarises what's been achieved, the open questions and what could be done next.

Then comes the Bibliography, listing all sources of material, data and computer programs used, *etc.* Its construction is explained in [NSS, Sec. 4.2] and there's more about it in App. A.

Otherwise appendices typically hold basic background theory, or additional or similar examples, or longer proofs (App. B) — anything you need but which would hold up the main flow of the story. You could also use an appendix for listings of any computer programs that you've written (App. C).

Here there's also brief advice on grammar and typography (App. D).

1.3 Using a PC

You may want L^AT_EX on your own computer.

A popular version of T_EX/L^AT_EX for a Windows PC is '*MikTeX*' [MKT]. *MikTeX* is free, and is available online for download [LAT] or locally on a DVD from bob.johnson@dur.ac.uk, room CM315. It's also installed on the ITS Networked PC Service under **Programs | Miscellaneous**.

To use *MikTeX* easily you need a dedicated editor or IDE². A good one is '*WinEdt*' [WDT], which runs under all recent versions of Microsoft Windows and integrates well with *MikTeX*. *WinEdt* is free for 31 days; to use it thereafter costs about \$40.

Completely free rivals include '*TeXnicCenter*' [TxC], which is provided on the *MikTeX* DVD and also set up on the ITS Networked PC Service under **Programs | Miscellaneous | MikTeX**.

Others include eg. '*WinShell*' [WSH], but are untried.

All these editors/IDEs have a familiar style of graphical user-interface with a toolbar and pull-down menus for all the common tasks involved in editing source files, running L^AT_EX and viewing the results.

²Computer scientists say 'Integrated Development Environment'.

Chapter 2

Formulas and theorems

Each main chapter or section should start with a short description of what it holds, and why. Top tip — begin the whole writing enterprise with a first draft of this little bit for each chapter. It will force you to think about overall structure.

Here we get going with mathematics and show firstly some simple equations and then some that are slightly less simple. Then there’s a theorem whose proof is relegated to an appendix, followed by some numbered results.

2.1 Plain

Here’s an inline formula: $E = mc^2$, and here’s the same thing displayed:

$$E = mc^2.$$

A matrix needs to be displayed:

$$\det \begin{pmatrix} a & b \\ c & d \end{pmatrix} = ad - bc,$$

and here’s a result that’s displayed and labelled:

$$\lim_{a \rightarrow \infty} \int_0^a \exp(-x^2) dx = \tfrac{1}{2}\sqrt{\pi}. \tag{2.1}$$

Note the punctuation in eq. (2.1) *etc*, which recognises that displayed equations are parts of sentences.

Note also that a smaller (`\textstyle`) size of numerical fraction is often useful in a displayed equation. The appropriate `\newcommand` called `\fr` is defined in the ‘*preamble*’, in file `report.tex`.

More complicated limits on `\int` (and `\sum`) need to be enclosed in braces $\{\dots\}$.

In an inline formula, avoid ugly fractions such as $v = \frac{s}{t}$ and $\frac{dy}{dx} = x + y$. It looks much better to write $v = s/t$ and $dy/dx = x + y$. That is, keep `\frac` for display:

$$\frac{dy}{dx} = x + y$$

where it belongs.

Beware of inadvertent blank lines in your `.tex` file; they often creep in immediately after a displayed equation. A blank line gives a new paragraph, usually indented, which may not be what you want. You can avoid blank lines altogether by breaking paragraphs with `\par` instead, as done here.

2.2 Fancy

Now an equation on several lines using `eqnarray`:

$$\begin{aligned} |\vec{A}|^2 &= a_1^2 + a_2^2 \\ &= \sin^2 \theta + \cos^2 \theta \\ &= 1 \end{aligned}$$

— where the star on `eqnarray*` suppresses all line-numbering¹.

Again, with just one line numbered for reference:

$$\begin{aligned} |\vec{A}|^2 &= a_1^2 + a_2^2 \\ &= \sin^2 \theta + \cos^2 \theta \\ &= 1 \end{aligned} \tag{2.2}$$

— where `\nonumber` suppresses numbering otherwise. Now you can refer to equation (2.2).

If you want to number the equations in Chapter 2 as (2.1), (2.2), etc, then² put ‘`\numberwithin`’ into *Google* or see [MG, Sec 8.2.14].

Notice that in equations you use `\lim`, `\exp`, `\sin` and `\cos` and not plain *lim*, *exp*, *sin* and *cos*. See [NSS, Sec. 3.3] for a list.

For a lot of complicated multi-line formulas it’s better to use the more sophisticated display environments provided by the package `amsmath` — see Sec. 8.2 of *The Companion* [MG]. For instance the `cases` environment is used to get

$$\theta(x) = \begin{cases} 0 & \text{if } x < 0, \\ 1 & \text{if } x > 0. \end{cases}$$

¹And re-phrase material where any displayed equation splits between pages.

²Top tip: easily find out about any L^AT_EX command by putting it *with* its backslash (and perhaps the word ‘*latex*’) into your favourite search engine.

And if you need continued fractions, instead of

$$x = \frac{1}{a_2 + \frac{1}{a_3 + \frac{1}{a_4 + \dots}}},$$

a better-looking result is

$$x = \frac{1}{a_2 + \frac{1}{a_3 + \frac{1}{a_4 + \dots}}},$$

for which `amsmath` provides the command `\cfrac` [MG, Sec. 8.4.2].

The package `amssymb` [MG, Chap. 8] extends the range of mathematical symbols (eg. \mathbb{R} , \mathbb{Z} and \mathbb{N} are available).

And its sister `amstext` provides the command `\text` to put words into a displayed equation

$$\text{like this: } E = mc^2.$$

Note that you need to put in by hand the spacing between the text and the mathematical symbols.

2.3 Theorems

This is theorem 2.3.

Theorem : The whole is greater than the sum of its parts.

Proof: See App. B, Sec. B.1.

For numbered theorems, use `\newtheorem` [NSS, Sec. 3.8].

Here's the main sequence of theorems.

Theorem 1 (my first result) *The first theorem, showing*

$$\bar{D}^n \quad \text{and} \quad \overline{D}^n$$

where the first bar is over just the 'D' and the second is over the whole expression. Also the word 'and' is inside displayed maths, using `\text` with extra space before and after.

And that's how to do left and right quotation marks, too, with `\lq` and `\rq`.

Theorem 2 *The second theorem — with `\overline` inline: \overline{D}^n .*

Theorem 3 *the third theorem*

Here's another sequence of results.

Lemma 1 (my second result) *The next result (a mere lemma) ...*

Lemma 2 *... and the next*

The Companion [MG, Sec. 3.3.3] describes how to use the packages `amsmath` and `amsthm` to state (and cross-reference) theorems, lemmas, definitions, proofs, *etc* in a more sophisticated way.

2.4 Summary

Each chapter should end with a round-up of its contents and a link with the contents of the next.

After formulas, equations and theorems, the next important topics are graphics and tables.

Chapter 3

Graphics and tables

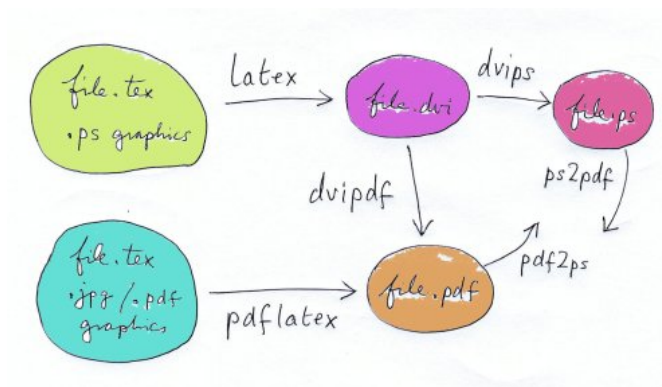
Graphics files are inserted via the package `graphicx` which is loaded in the document preamble (in file `report.tex`).

Here we deal firstly with the inclusion of a single unlabelled diagram, and then with captioned, labelled, and multiple diagrams.

After that we consider tables of information.

3.1 Plain

Here is a colour `.jpg` file, inserted in place without caption and without a number for cross-reference. It's suitable only for a simple self-explanatory diagram, used here and not again.



It shows the normal routes from a L^AT_EX source (`.tex` file) to `.ps` or `.pdf` output depending on the nature of the graphics files included¹. *Confusion over these routes is a frequent source of grief.*

This template has diagrams and graphs in `.jpg` format² and so its source is compiled to a `.pdf` file with the command or menu button `pdflatex`.

¹An IDE such as TeXnicCenter has menu buttons for each part of each route.

²File extensions must be `.jpg` and not `.JPG` or `.jpeg`.

Mathematical software such as *Maple* and *Matlab* can produce either `.ps` or `.jpg` diagrams, while cameras and scanners³ usually produce `.jpg`. If accurate detail is vital, `.ps` is best.

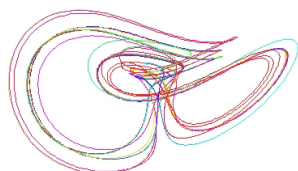
With care, you can mix some graphics formats within a document. For instance, if you compile to `.pdf` then you can use an arbitrary mix of `.jpg`, `.png` and `.pdf` graphics, but not `.ps`. And a document to be compiled to `.dvi`, including `.ps` graphics, can include other formats too if they are explicitly given ‘*bounding boxes*’. But it’s relatively tricky and you’re better-off converting everything to one format.

Note that you can’t include `.bmp` or `.gif` files at all, but conversion of graphics files — from `.bmp` to `.jpg` for example — is easily done with software like *PhotoShop* [PS] or *ImageMagick* [IM].

It’s simplest to keep your image files in the same directory as your `.tex` files. Otherwise you can explore the mysteries of `\graphicspath` [MG, Sec. 10.2.5]. In any case, use only forward slashes in a directory specification. Names of directories and of graphics files *must not* include spaces!

3.2 Fancy

It’s awkward to flow text round a picture, but it can be done with packages such as `pictinpar` or `wrapfig`, as *The Companion* explains [MG, Sec. 6.4.1].



And here’s a `.jpg` image side-by-side with some explanation, using the `minipage` environment.

Something more elaborate sometimes gives unexpected results.

That is, a picture ‘floating’ in a `figure` environment — with a caption and number as in Fig. 3.1 — might be placed by \LaTeX on a page well after the text meant to accompany it.

This happens if you have a relatively high density of graphics to text. You may be able to deal with it by re-distributing the pictures, changing the size of some of them, and the careful use of paragraph breaks. Otherwise you may resort to `\clearpage`, which forces insertion of floating objects waiting to go in.

The *Not so Short* book [NSS] has Sec. 2.12 on the issue of ‘floating bodies’ and *The Companion* has a whole chapter [MG, Chap. 6] on ‘mastering floats’.

³The figure itself is hand-drawn and scanned.



Figure 3.1: This is a caption explaining the diagram clearly and fully.

Note that inside a `figure` (or `table`) environment the `\label` must always *follow* the `\caption` — see [MG, p. 67].

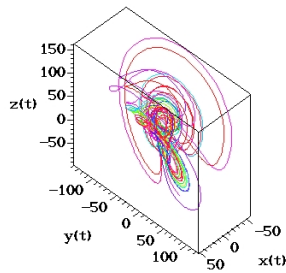


Figure 3.2: Caption to explain the diagram clearly and fully.

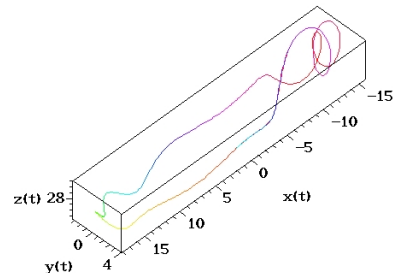


Figure 3.3: Caption to explain the diagram clearly and fully.

Fig 3.2 and Fig. 3.3 are two pictures floating side-by-side, each in a `minipage` and each with its own caption and label. This can be an economical way to insert multiple diagrams.

But don't get carried away and cram too many pictures together. Be aware of the size-reduction that's often necessary, and maintain legibility by choosing large enough font and weight for symbols, axis-labels and other text.

Figure captions should give plenty of information, because readers will first skim the Introduction and Conclusions — and then look at the pictures. If you want (really really want) to hook them, make sure that every important figure plus its caption is as self-explanatory as possible.

3.3 Tables

Besides figures you may want to include tables. Like figures, tables may be plain and simple — short and for immediate and local use only — and so put in place without a caption or label; or they may be complicated and important enough to need a reference label and an explanatory caption. Here are examples of each in turn.

First a simple table ...

row 1	it's	just	as	easy
row 2	as	this	$E = mc^2$	what
row 3	could	be	simpler	?
row 4	as	easy	as	Π

Here it is again, now floating in a `table` environment, with a caption and a label to identify it as Table 3.1. The remarks about giving full information

row 1	it's	just	as	easy
row 2	as	this	$E = mc^2$	what
row 3	could	be	simpler	?
row 4	as	easy	as	Π

Table 3.1: Floating table, with a caption to explain it clearly and fully.

in figures and their captions apply equally to tables, of course. So do the remarks about unexpected placement of floating objects.

If you need a long table, occupying more than a page, and which can't reasonably be divided, then you need to delve into *The Companion* [MG, Chap 5] to find the secret.

3.4 Summary

Graphics files are evidently straightforward to include. If you need to go beyond the basics, then refer to '*The Graphics Companion*' [GRM].

Tables are easy to use too, but don't misuse them. Lengthy data-sets can be supplied separately on CDrom. Put only summaries in the report, perhaps as an Appendix.

Chapter 4

Conclusion

The last chapter of a well-structured report reviews what's been done and mentions the main open questions. It's the part a typical reader looks at second, after the Introduction, and it should be just as appealing.

This template is provided only to help you start with L^AT_EX and to exemplify good structure. When you've got some practice, you'll want to alter it to suit your topic and your taste — and you are free to do that.

- `\documentclass[a4paper,twocolumn,10pt]{article}` gives an attractive alternative framework, for example.

Or you may prefer `\documentclass{memoir}` which has an excellent manual [MEM] that includes a general introduction to typography.

- Try to resist the temptation to make margins narrower and lines longer — it may save a sheet or two of paper but it can make the text hard to read. Indeed, typesetting professionals quote a maximum of 66 characters per line as an ideal for easy reading [NSS, Sec. 5.2.2].
- proof-read carefully — not only to get the best from L^AT_EX but also to polish grammar, spelling and punctuation [ESL]. See App. D for hints on how to avoid common pitfalls.

Good layout and use of L^AT_EX, plus fluent and grammatical writing, will together give a very good impression.

Top tip — write what you think is the final version, then put it away in a drawer and come back to it a week or so later. With fresh eyes you'll see many potential improvements. This works for anything you prepare, not just a project report. It needs forward planning of course!

Acknowledgements

Here's the place for thanks to anyone who particularly helped you. Don't go too far OTT — try to keep some dignity. This isn't the Oscars.

Bibliography

- [AC] A Cottrell, *Word Processors: Stupid and Inefficient*,
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(ISBN 1-86197-612-7).
- [GRM] M Goossens, S Rahtz and F Mittelbach,
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(ISBN 0-201-85469-4).
- [IM] *ImageMagick*, [www.dur.ac.uk/its/software/application/...](http://www.dur.ac.uk/its/software/application/...?application=ImageMagick)
[...?application=ImageMagick](http://www.dur.ac.uk/its/software/application/...?application=ImageMagick)
- [LAT] *L^AT_EX stuff*, maths.dur.ac.uk/Ug/projects/resources/latex/
- [MEM] *Memoir document class*,
www.ctan.org/tex-archive/macros/latex/contrib/memoir/
- [MG] F Mittelbach and M Goossens *et al.*, *The L^AT_EX Companion*,
Addison-Wesley, 2nd ed. 2004 (ISBN 0-201-36229-6).
- [MKT] *MikTeX Project Page*, www.miktex.org
- [NSS] T Oetiker, H Partl, I Hyna and E Schlegl,
The Not So Short Introduction to L^AT_EX 2_ε,
www.ctan.org/tex-archive/info/short
- [PS] *Photoshop*, [www.dur.ac.uk/its/software/application/...](http://www.dur.ac.uk/its/software/application/...?application=Adobe+Photoshop)
[...?application=Adobe+Photoshop](http://www.dur.ac.uk/its/software/application/...?application=Adobe+Photoshop)
- [TXC] *TeXnicCenter*, www.toolscenter.org
- [WDT] *WinEdt*, www.winedt.com
- [WL] *Wikibook on L^AT_EX*, en.wikibooks.org/wiki/Latex

[WO] *Controlling widows and orphans*,
www.tex.ac.uk/cgi-bin/texfaq2html?label=widows

[WSH] *WinShell*, www.winshell.de

Prepared in L^AT_EX 2_ε by RCJ

Appendix A

About references

Your report will be put together in your own style, mostly using your own words. Much of it will be standard material that you’ve read and digested, but you may have a fresh example, application or calculation that you’ve done yourself.

You must make clear what’s not your own work by referring suitably to your sources — books or articles or web-pages, etc. Not to do so can count as plagiarism, which is cheating.

This appendix aims to amplify the advice given in the Library’s guide [BR], which you should read.

A.1 Organisation

Follow the style of this template — that is, put an orderly list of your sources (*‘The Bibliography’*) at the end of the main text, and refer to (*‘cite’*) items on the list by suitable codes.

For your bibliography the golden rule is that each listed item must give enough detail to allow readers to follow it up themselves and find the precise part of the book, article, web-site or whatever without ambiguity or delay.

For instance it’s no use saying just *‘The Times newspaper’* unless you also give the date and page, or just *‘Wikipedia’* unless you give the complete URL of the specific page, . . . and so on.

It’s always better to give slightly too much information — e.g. you might include the ISBN of a book too. A good level of information is exemplified here and recommended in the Library guide [BR].

If you need to cite different parts of e.g. a book for different things, then list it (say AB) in the bibliography and give the different citations as [AB, page 32] and [AB, Sec. 4.7] and so on. The L^AT_EX `\cite` command allows for this.

Now you see why a bibliography list is better than lots of footnotes — it neatly allows such multiple citations. Too many footnotes make a document

into a mess.

Notice that

- this bibliography uses short letter-code keys in alphabetical order. It's one of several standard possibilities [BR] and is often preferred for economy and because the letter codes¹ can be chosen to be helpful mnemonics. Numerical codes, for instance, can't;
- long lines (with URLs usually [IM, PS]) may need to be split. The \LaTeX hack used here to manage such line-breaks may not appeal to everyone.

A.2 Doing it

What things need a reference? The answer is — anything you didn't work out or invent yourself, but took from someone or somewhere else. You may do that, so long as you say so *and also make it clear you understand it*. Don't copy blindly! Here are some examples.

- ‘*the following explanation is taken from [LH]*’ — if you've copied word-for-word from the article by Laurel & Hardy, which you list as item LH in the bibliography. Direct quotation should be used sparingly, and the text emphasised — perhaps by use of the `quotation` environment in \LaTeX .

Don't be tempted to copy from a book, or `ctrl-C/ctrl-V` from the web, *without* clearly admitting it. It's easy to detect, and it's suicide.

- ‘*the following proof is in many textbooks, eg. [LH, page 16]*’ — if it is, and you can't think of a different proof, except perhaps for notation.
- ‘*the material in this section is based on Sec. 2.6 of [CL] and Chap. 3 of [SH]*’ — if you've combined into your own words the account by Cagney & Lacey with that by Starsky & Hutch.
- ‘*the following proof is adapted from Chap. 4 of [SJ]*’ — if (say) you've filled in the gaps in Smith & Jones' proof, or perhaps changed it from the case of general n to your case $n = 2$.
- ‘*these calculations were done with Matlab [MAT] using the m-file listed in App. C*’ — where the reference MAT is to the MathWorks website.
- ‘*these calculations were done with the TISEAN package [TIS]*’ — if you've downloaded this specialised package from a web-page whose URL (and author's name, if available) is item TIS in the bibliography.

¹Note the punctuation of ‘letter-code’ and ‘letter codes’ here.

- ‘the graph is taken from Morecambe & Wise [MW, page 16]’ — if you’ve scanned the figure from their book. Similarly, if you’ve downloaded a .jpg file from a web-site, then give in the bibliography the URL and author (if known). Such citations could go either in the figure caption or in the associated text.
- ‘the data are taken from [XY]’ — where XY gives the source of the numbers you’ve analysed. This might be a journal or an online data-bank, etc. Generally the numbers themselves should be left out — a summary table or a graph or two (plotted with *R* or *Matlab* or *Maple*) is often enough. Occasionally raw data might be supplied separately — e.g. on a CDrom.

Often your supervisor or someone else gives you something — such as a set of data, or a useful *Maple* worksheet, or help with a proof — when the appropriate form of bibliography item is ‘*Dr I Newton, private communication, April 2007*’. Similarly for printed course material — ‘*Dr I Newton, lecture notes for module MATH5033, Durham University, Epiphany Term 2007*’.

Generally, don’t refer to things you haven’t read. Textbooks may well cite the Serbian-language journal where the result you want was originally published. But you are not in the business of ascribing credit for discovery. In *your* report *you* must cite the book where *you* actually got it from and not give any possibly false impression that you fluently read technical Serbian.

Likewise, you may want to quote from Euclid or Archimedes. But cite the place where you found the English words with something like ‘*Archimedes said, ‘Eureka!’ (as quoted by [AB])*’.

Summarising — tell the truth (where you got it from), the whole truth (give full details), and nothing but the truth (you don’t read Serbian).

Finally, if in doubt — ask your supervisor.

Appendix B

Long proofs

An Appendix is a good place to put lengthy proofs that must be included but would impede the flow if placed in the main text.

B.1 Proof of theorem 2.3

By inspection.

Appendix C

Computer programs

An Appendix is the place to list computer programs that you've written, using the `verbatim` environment [NSS, Sec. 2.11.4].

For example —

```
10 PRINT "HALLO SAILOR!"  
20 GO TO 10
```

Appendix D

Typography and grammar

Some errors crop up time and again, and a few of the commonest — mostly relating to use of L^AT_EX — are mentioned in the body of this template. Some others are given here, aiming to help you avoid them.

Layout errors include starting a sentence with a symbol, or leaving a single symbol that ends a sentence hanging alone on a line. Related to this are ‘widows’ and ‘orphans’ [WO]. Can you spot any in this template?

Grammar — illiteracy makes good mathematical work look like rubbish. Of course, everyone makes mistakes, but a final version with many small errors in fact signals ‘*I am ignorant and I just don’t care*’. Read, mark, learn, and inwardly digest the wisdom of the great goddess Truss [ESL].

Apart from spelling blunders, the top five usual suspects in recent project reports are (in random order) —

- ‘sentences’ with no verb;
- mis-use of apostrophes;
- mis- or non-use of hyphens;
- writing ‘*comprises of*’;
- unpunctuated displayed equations.

A tip for proof-reading — a friend or relative may spot things you’ve become blind to. And remember in practise there are a massive number of errors in grammar and style, and so fourth it’s only too easy to make that your spell checker on its own won’t find (14 in this sentence).