

Guide to Report Writing

for the Engineering Tripos and the Manufacturing Engineering Tripos

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Summary

This Guide provides practical advice on all aspects of technical report writing throughout the Engineering / Manufacturing Engineering Tripos (MET). Report writing is a key transferable skill that needs to be learnt and practised during the course. It is central to life as a practising engineer (and in most professions) to write reports, papers, or technical memoranda. Well-written reports are read, enjoyed, remembered, cited, and are potentially career-advancing; poorly written reports are not.

Report Writing is introduced in Part IA Exposition in the first term, and evolves through laboratory reports, project reports, and coursework and examination essays, until the Part IIB Final Project Reports. Reports will therefore range from a few pages written to a prescribed format, through to a 10,000 word final project report, designed and written entirely by you. But most principles of good technical writing are common to all that you write – so this Guide serves as a single resource for the whole course. The modular structure and indexed Web format are designed to enable the Guide to be accessed repeatedly during the course, as your writing tasks become progressively more advanced.

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Acknowledgements

This Guide to Report Writing draws on several different sources that have evolved in the Department of Engineering over many years, edited by the following: D A Cardwell (2007), R S Cant (2001), J P Longley (2000), R J Richards (1998), J D Lewins (1993), J A Williams (1993).

The Guide also draws on the excellent and closely related document *How to Write a Paper*, by Mike Ashby (Cambridge University and Granta Design). The July 2011 version is available on the Web in modular form or as a complete PDF:

http://www.eng.cam.ac.uk/teaching/teachoff/study_skills/Ashby_How_to_write/index.html

Permission to use material from these sources is gratefully acknowledged.

1 Report writing in the Engineering Tripos

The Table below summarises the main technical writing activities in the Engineering Tripos. MET has its own program in Part IIA and IIB – for more details see the MET Website.

Specific instructions on each task may be found in the relevant handouts and by following the hyperlinks.

PART IA		
Activity	Term	Writing Task
Exposition	Michaelmas	Report on Statics experiment
Engineer in Society	Christmas vacation	Report (see CamTools)
Structural Design Course	Michaelmas or Lent	Report (see SDC Handout)
Integrated Electrical Project	Lent	Report (see IEP Handout)
Laboratory Experiments	Lent and Easter	Long Lab Reports (+ see Lab Handouts)
PART IB		
Activity	Term	Writing Task
Integrated Design Project (IDP)	Michaelmas or Lent	IDP final report
Integrated Coursework	Michaelmas or Lent	4 page report (extended exercise)
Laboratory Experiments	Michaelmas and Lent	Long Lab Reports (+ see Lab Handouts)
PART IIA		
Activity	Term	Writing Task
Module experiments	Michaelmas and Lent	1 x laboratory report per module
Module experiments (FTR)	Michaelmas and Lent	1 x "Full Technical Report" per term
3Ex module coursework	Michaelmas and Lent	1 x coursework essay per module
IIA Projects (x 2)	Easter	Interim and Final Reports
PART IIB		
Activity	Term	Writing Task
Module coursework	Michaelmas and Lent	1 or more reports per module
IIB Project: Interim Report	Christmas vacation	Technical Milestone Report
IIB Project: Final Report	Easter	Final Project Report

2 Introduction to technical writing

Purpose of technical writing

The purpose of writing any report is to convey information clearly and to persuade your reader of your arguments. No matter how hard you have worked in preparing the material, lack of effort in presenting the work will diminish its impact. Whenever you set out to write a report, whatever its length, there are two key things to do first: (a) think who the readers are and what you want them to learn from the report; (b) plan the structure and contents, before you write anything.

Know your audience

Technical reports could be read by several people with different levels of knowledge of the subject, and different pressures on their time. For example, an industrial project report may be read by your immediate supervisor, who is familiar with the problem, and who expects you to display detailed knowledge of the report material. It could also be read by a new colleague, and your report is needed to bring them up to speed quickly. On the other hand, it may be read by a senior manager, who has little time to study the detail, and is only concerned with your summary, conclusions and recommendations. Managing the length, structure and style depend directly on a sound assessment of the intended readers. For example, a common device is to use appendices to record details that will be of interest only to a very specific reader, such as someone who perhaps is going to repeat your work. But equally, no reader wants irrelevant content – details of how standard equipment works, or basic theory that all intended readers can be assumed to know. Much can be absorbed from your own reading of other people's writing – if you found a report to be a good, clear read, think about their structure and style: why was it effective? Or if it was a dreadful experience: what would you have done differently?

The writing process

The writing process resembles the design process – it breaks down into stages (planning, drafting, and revising), with iterations between these stages as the report is filled out and refined. Remember the golden rule in design: time spent in the early stages pays dividends later. A short report may be written in one complete draft, but will still benefit from some advance planning, and a read-through. For long reports, planning and iteration are essential. This takes time – you will be a much more effective critic of your own writing if you come back to it after a break of at least one day, preferably longer.

The message then is to *start early*, allowing time for critical self-editing (and proof-reading by friends or colleagues), while hitting your deadline. The plan itself is somewhat fluid, as sometimes it is only by writing a few sections that you realise that things are not in the right

order, and that there are omissions or unnecessary content. Allowing time will also help you to develop good style. Reading through and improving a draft of one section of a report will enable the lessons learnt to be applied in the remainder of the report. You can also re-visit sections of this (and other) writing guides, at the time when they are directly relevant to you.

Planning, drafting and good style are addressed in later sections. First though, all writers must understand the importance of these concepts: integrity, record-keeping, plagiarism and referencing.

Integrity, record-keeping, plagiarism and referencing

Integrity

Professional engineering requires integrity in conducting and reporting all technical work. The physical records of the work are therefore central to maintaining, and being able to prove, your integrity. The records include the notes and results taken during the work itself, which nobody else might read at the time, and the subsequent distilled reports and papers written for the benefit of others. Engineers must therefore maintain detailed, honest, laboratory notebooks (or the electronic equivalent in software documentation), and this takes practice to become a routine habit. Technical reports and dissertations do not provide the full historical record of how some new concept was developed, though they may make some reference to ideas that were explored and proved unsuccessful. Journal and conference papers are even more compact, and are written to summarise an investigation with the author's best current interpretation of the results. This brings us to the second aspect of maintaining professional integrity: recognising that all of your technical work builds on the work of others. The confidence which a reader has in a technical report or paper is based on trusting the authors. Part of building that trust is through the authors demonstrating how they have built on the work of others and given full credit for previous contributions. Note that this does not only mean work that you read about in the literature or on the Web – it applies just as much to the contribution of others to work conducted in collaboration or as a team. In both instances it is essential when writing up your work to acknowledge and to reference the contributions of others. Any attempt to pass off the work of other people as your own is plagiarism.

Record-keeping: Laboratory Notebooks and Software Documentation

In Part I, you will be provided with Laboratory Notebooks; in Part II you mostly provide your own. But the aim of having them is the same: you use them in the laboratory, and afterwards when working on the analysis and report, to record *everything*: your measurements, hand calculations, draft graphs, sketches of equipment, draft designs etc. For ongoing research or design work (e.g. Part IB IDP, or Part II and MET projects) it can also serve to record notes from meetings with supervisors, industrial sponsors, or members

of your group in a team project – it is then a good idea to date every entry: meeting notes, experimental records, notes from phone calls etc.

Developing best practice in keeping records is an important part of the laboratory and project work in the Engineering and Manufacturing Engineering Tripos. It is required professional practice in all research and development laboratories. Your work may be inspected and signed off at regular intervals by a supervisor, but even more importantly your lab notebook can form the essential evidence of originality and intellectual property when making a patent application. Your creative imagination is what your employers are paying you for and so it is only reasonable that they expect you to provide the evidence on which the company can survive commercially. In the Department we expect bound notebooks, with any additional pages fastened in – loose pieces of paper are easily damaged or lost.

Similar principles apply to the development of software, though in this case the records may be primarily electronic. An electronic logbook follows the same pattern as a hard copy logbook, but software provides two additional challenges: version control, and commenting code. Keeping track of different versions of evolving code requires rigour in recording and dating (in hard copy or your electronic log) how each version differs in its functionality, with careful choice of systematic file names and directories for archiving. Commenting within the code itself is essential best practice in software development – one of those slightly dull tasks that nearly everyone is tempted to shortcut, but which pays dividends in the long run (either when you need to go back over your own code, or when you pass it on to someone else to develop and run). For most code it pays to write a “user guide” as you go along, even for your own exclusive use – it is safe to assume that you will forget small but important details about data format, or sequence, or software compatibilities.

Plagiarism

Collaboration is central to professional practice: modern engineering is frequently complex and multi-disciplinary, so collaboration and teamwork make sense in terms of splitting up large, difficult tasks into smaller parts. It can also be an efficient and enjoyable method of generating and implementing new projects. Learning how to manage and work within a collaborating team therefore forms an important part of your training as an engineer, including writing reports. In professional reports and papers that describe collaborative work, the input of all the contributors is recognised by including them as co-authors. In undergraduate work submitted individually for assessment and examination credit, it is important to identify unambiguously the parts of any collaborative work which are the student's own, original contribution.

Whether your reports are based on collaborative work or your own individual effort, the key point is that integrity is maintained: at no point should you attempt to present the work of others as your own. This deception is known as *plagiarism*, defined as *"the action or practice of taking and using as one's own the thoughts, writings or inventions of another"*

(Shorter Oxford English Dictionary, 1964). Forms of plagiarism include copying someone else's language and/or ideas as if they are your own by, for example, quoting verbatim, paraphrasing, cutting and pasting from the internet, and applies to *all* types of sources and media, whether published or not. Plagiarism is both poor scholarship and a breach of academic and professional integrity. Resorting to unfair means is taken very seriously within the Department, and more generally in all University academic matters. Such behaviour is a form of cheating, and any incident in work assessed for examination credit will be reported to the relevant Chair of Examiners, who may refer to the University Proctors.

So remember, the guiding principle is that the Examiners and others who may read your work must be in no doubt as to which parts of your work are your own original work and which parts are the work of others, or have been produced by you in collaboration with others.

Referencing

The mechanism for maintaining the integrity of your technical writing is *referencing*, to give recognition to other people's work (published or otherwise). Wherever you use sources of information or data such as books, journal articles, internal company sources, personal interviews, web-sites or other internet resources you should ensure that they are fully referenced, so that the reader can locate the source and if necessary make an independent judgement of the quality of the information. You should include text which you have not generated yourself only if it is clearly marked as a quotation (e.g. by placing it in quotation marks with a full reference to its source). In some instances, standard facts and ideas are so well-known that no reference appears necessary. But if in any doubt about whether the reader might misinterpret the extent of your own contribution, it does no harm to refer explicitly to sources of previous work (which may be textbooks for well-established material). A subsidiary benefit of referencing is that it also provides a historical 'audit trail' for how the current cumulative state of knowledge has been reached, allowing the entire track record of a particular topic to be re-visited and re-interpreted as techniques and understanding evolve.

For examples of the approved ways to reference sources of material, see *References* in the section *Guidance on Technical Writing*.

Further guidance can be found in the statement of the University's Policy on Plagiarism at www.admin.cam.ac.uk/univ/plagiarism. If you are ever uncertain about plagiarism or the interpretation of these guidelines, seek advice from the appropriate coursework leader and supervisors will be glad to provide advice.

3 Planning a technical report

Introduction: planning, drafting and revising

Planning

Before you start any report you need to gather your information and plan the form of your document. Even the shortest lab report will benefit from some preliminary jottings; a 50 page final year project report requires correspondingly more planning. Before committing time to actual writing, planning allows you to:

- check any requirements for layout/presentation style. Are there specific instructions to observe (font size, line spacing, page limits, required house-style used by your employer etc?). If the report is going to be published: camera-ready, or type-set by a publisher? What are their presentation rules and requirements?
- check that you have included everything that you consider relevant, and have the relevant data and results prepared (or in hand, if computations or experiments are continuing in parallel to the writing).
- check you're not including unnecessary stuff – e.g. have you read the lab handout, which may give specific guidance on what is not expected, or should be included as an Appendix?
- play around with the sequence: for larger reports, it is not necessarily self-evident in which order some things should appear, and you might change your mind as you write – but it is helpful to have thought about it, and at least to have a plan in place for the first draft.

Planning needs something to be mapped out and written down, for you to refer back to and revise as you go along. Thinking about what to write often throws up bits and pieces that you decide are important, and don't want to forget to incorporate. Having a written outline also allows you to 'braindump' notes to yourself: key references to remember for the introduction, a particular figure or two that you produced earlier and capture the key results, an inspired idea you had to plot two sets of data in a novel, revealing way, and so on.

There are various formats for a written plan, and it is largely a matter of personal preference. Two are discussed in later sections: a concept sheet, and an extended Table of Contents.

Drafting

In the drafting stage, the main goal is to get the bulk of the report written down, without worrying too much about style and artistic impression. In the final report, appearance *is* important, but much of the tidying up can wait until the content is done (good layout, clear headings, breaks in sensible places etc). Clearly the better the style and use of English in the first draft, the better for you in the long run, but this comes with practice and you can

only give this your full attention once the content has been committed to paper. Reports don't have to be drafted sequentially – do it in any order you wish. Your overall plan will keep you on track, and will remind you what will have been said by this point, even if you haven't said it yet! In fact it is often easier to write introductory material when you've already written about the content towards which it is heading. The Abstract or Summary should wait until last – just leave a suitable space. For now, get the scientific facts and technical ideas down, graphs and figures planned and drawn, calculations developed, reference lists assembled. If good ways of expressing particular ideas occur to you now, write them down and work out how they fit later.

One thing worth developing in near-final form from the outset is figure style. Figure clarity is particularly important and should not be left until the end. Figures are usually plotted electronically from a template, which is copied and edited repeatedly. Developing the template on one or two early figures allows this to be propagated through the whole report, saving endless repeated revisions later. So experiment with the graph aspect ratio, the size and line weight for the axes, background grid (if used), symbols, and curves, and choose a suitable font and size for the axis labels. For work to be published for a conference or journal, or for internal use in a company, there are often required styles in both text layout and figures – make sure you adopt the right templates at the outset.

Revising

Finally comes the crafting, iterating (like a good designer) to improve the clarity, balance, and readability. Read the report through, both to correct the more obvious mistakes of spelling and grammar, but also to improve your style – anything that helps to make the meaning clearer. The section *Guidance on Technical Writing* deals with good English and good style.

Ideally, a final draft should be left for a week and then be re-read. It is amazing how many omissions and errors are then obvious, but are not noticed if you try and proof-read your own writing after only one day. For Part II reports, get a friend to read your draft and make helpful comments – though this must not go as far as copying from your peers (remind yourself of the expectations concerning integrity and plagiarism).

Planning I: concept sheet

to come.....

Planning II: draft table of contents

to come.....

Typical report structure

Reports will clearly vary in structure and content from task to task, and should be customised accordingly. For example, the Interim Reports in Part IIA projects may just be a background review leading to a plan for a set of experiments or a design activity. Nonetheless, it is helpful to run through the common sequence of report headings in a generic way. This serves as a starting point, if no other guidance is provided, and also clarifies what should and shouldn't appear under these headings, when used. Some points of structure will apply virtually any report: Title, Abstract, some form of Conclusions, and suitable References, Tables, and Figures.

Title and Authors

- **Keep the title meaningful and brief.**

For example:

Fatigue of Metal Foams

is better than:

**The Mechanical Response of Cymat and Alporas Metallic Foams
to Uniaxial Cyclic Loading**

even though it is less specific.

- **Give the names of the authors, with all initials.**
- **Give additional author detail as appropriate – e.g. college affiliation (for all Tripos coursework), subject group (for Part IIB projects), or full address of the Department and email contact (for reports going to industrial sponsors, journals).**
- **Include the report date (month and year).**

Abstract (or sometimes Summary)

- **Try for one sentence each on *motive, method, key results, conclusions*.**
- **Don't exceed 3 sentences on any one.**
- **Write this last, when you know what it should say!**

The reader of an Abstract has been lured by the title; the Abstract tells them whether to read any more. So tell them succinctly what it's about – no waffle, no spurious details. Most Abstracts need not exceed 100 words – see *Examples of Effective Writing*. Sometimes an extended "Technical Abstract" is required, a page or two in length (e.g. Part IIB project, or PhD thesis). The same principles apply, with a little more depth, and it may be appropriate to incorporate reference to the sections or chapters that cover Introduction/Background, Methods, Results etc.

Introduction (sometimes also Background or Literature Review)

- **What is the problem and why is it interesting?**
- **Who are the main previous contributors, and what did they do?**
- **What novel follow-up will the rest of your report present?**

Outline the problem and why it was worth tackling. Review the literature, recording briefly the main contributors and summarising the status of the field when you started the research. Avoid simply “cataloguing” articles just to prove you have done some reading (i.e. Smith said this, Jones said that, etc). Better to think of the sequence of themes in the literature that you wish to cover, and group the references by theme, highlighting common aspects, or contrasts in approach or conclusions.

Start assembling your list of references as you go, and adopt any required referencing style from the outset (see section on *References* for details). Provide any specialised information that the reader will need in order to understand what follows. A good Introduction or Literature Review feeds a number of mental “hooks” to the reader, so that they are prepared for what follows, and recognise it when it comes. It often helps to conclude the Introduction with a summary of what you will do in the rest of the report that has not been done before (new experimental approach? new data? new model? new interpretation?). Keep it as brief as you can whilst still doing all of this.

Another golden rule: **start with a good first sentence**, or you will lose the reader immediately – see section on *Good writing style*.

Main Body of Report: Method, Results and Discussion

The distinction between Methods, Results and Discussion is often confused, but they are almost always distinct from one another, and in this sequence. Very occasionally, the presentation of the data involves analysis and interpretation that naturally invites discussion as you go along. And also occasionally a long report may cover a number of related but nonetheless self-contained sub-studies. In this case it can make sense to have separate chapters on each study, each with its own results and discussion. If you find yourself repeating common material, then think again about the structure. Abstract, Introduction, Literature Review and Conclusions should remain as single sections for the whole report – the Introduction and Literature Review can then serve to explain why the main body of the report is structured in a somewhat non-standard way, and the Conclusions can gather up the findings of each study in separate paragraphs or bulleted lists.

Method

- ***Experimental paper: equipment, materials, method***
Modelling paper: assumptions, mathematical tools, method
Computational paper: inputs, computational tools, method

- **Explain what is especially different about your method.**
- **Give sufficient detail that the reader could reproduce what you did, but no more.**
- **Don't mix Method with Results or Discussion—they come next.**

This should be an easy section to write: just say what you did, succinctly, adding to your reference list as you go (see section on *References*). Use “we” very sparingly, if at all: too many “we’s” sounds too childish: “first we did this, then we did that.” It is always possible to re-express the content impersonally: “we measured the hardness of the samples” = “the hardness of the samples was measured”.

Results

- **Present the output of the experiments, model or computation.**
- **Use meaningful precision in the data (i.e. think how many significant figures can be justified).**
- **Don't mix Results with Discussion (almost always).**

This, too, should be an easy section to write. Report your results simply, without opinion or interpretation at this stage. Define all symbols and units. Present data in a form other people can use. Emphasise in the text the most important aspects of the tables, graphs or figures (another example of “setting up” the reader for what is to come in the Discussion). Give error-bars or confidence-limits for numerical or graphical data. Sampling statistics should be meaningful, and avoid confidence-eroding statements such as “33.3% of the samples failed: 33.3% survived; the rest were unfortunately misplaced.”

Aim for a concise, economical style (see section on *Good writing style*):

Poor: It is clearly shown in Figure 3 that the shear loading had caused the cell-walls to suffer ductile fracture or possibly brittle failure.

Better: Shear loading fractured the cell-walls (Figure 3).

Discussion

- **Extract principles, relationships, generalisations.**
- **Present analysis, model or theory.**
- **Show the relationships between the results and analysis, model or theory, and comment.**

Sometimes the key discussion points from the results will speak for themselves, e.g.

The novel heat-treatment described in Section 2 gives steels which are 10% stronger and 20% tougher than those heat-treated in the normal way.

could be all you need.

Most Discussion sections are more involved, and you need to describe connections and comparisons between results, models and theories. So identify the most significant outcomes first; develop subsidiary findings after that.

Be clear and concise; a Discussion is not a license to waffle. See *Examples of Effective Writing* for samples of waffle, and what to do about it.

Conclusion

- **Draw together the most important results and their consequences.**
- **List any reservations or limitations.**

The busy reader scanning your report will read the Abstract and the Conclusions, glance at the Figures and move on. Do not duplicate the Abstract as the Conclusions or *vice versa*. The Abstract is an overview of the entire paper; the Conclusions are a summing up of the advances in knowledge that have emerged from it. It is acceptable to present conclusions as a bullet-pointed list.

Acknowledgements

- **Thank people who helped you with ideas, technical assistance, materials or finance.**

Keep it simple, give full names and affiliation, and don't get sentimental or over-familiar.

A formula such as this works well:

I wish to thank Prof. M.F. Ashby of the Engineering Department, Cambridge University for permission to use extracts from his review of technical writing.

References

- **Cite significant previous work.**
- **Cite sources of theories, data, or anything else you have taken from elsewhere.**
- **References must be complete: name, initials, year, title, journal, volume, start-page and finish-page.**
- **References to the Web should be given in full, including the date when accessed.**

References tell the reader where an idea, prior results and data have come from. It is a conventional courtesy, and essential for your integrity as a professional, to reference the originators of ideas, data, theories or models, even if you modify them.

See the section on *References* under *Guidance on Technical Writing* for recommended styles.

Tables

- **Tables summarise data (results, or parameters input to analysis).**
- **Externally sourced data must be referenced.**

Tables may be embedded in the body of the text – at the next paragraph break after the first reference to the Table – or gathered together in a section at the end.

Figures

- **Flow charts show methods, procedures.**
- **Graphs present data, or model output (e.g. as predicted curves).**
- **Schematics show how equipment works, or illustrate a physical mechanism.**
- **Drawings and photographs illustrate equipment, microstructures etc.**
- **Externally sourced figures must be referenced (and used with permission if published in the public domain).**

Anyone scanning your report will look at the figures and their captions, even if they do not read the text, so make each figure as self-contained as possible. Figures too may be embedded in the body of the text – at the next paragraph break after the first reference to the Figure – or gathered together in a section at the end.

See the section on *Figures* under *Guidance on Technical Writing* for further details on how to produce clear figures.

Appendices

- **Essential material that would interrupt the flow of the main text.**

An appendix must have purpose; it is not a bottom drawer for the stuff that you cannot bear to throw away. It is the place for tedious but essential derivations, or for data tables or descriptions of procedures, that would disrupt the flow of ideas in the main text. It should be well-structured and stand by itself. Give it a title: “*Appendix A1: Derivation of The Toughness Equations*”. Many journals set Appendices in a smaller font size than the main text – this is acceptable in Department reports.

4 Guidance on technical writing

Introduction: developing good writing style

Writing good English is not easy – it evolves with practice, and it is impossible to cover all aspects here. Concise but fairly comprehensive advice is provided in the sections below; *Further Reading* lists other sources of advice.

Your Part IA Exposition leaders will start the process, and they (and later, project supervisors) will have plenty to say, in their own personal fashion, about your writing style and how to develop it. By way of initial pointers (e.g. for Exposition in the first term), there are some simple things to take on board:

- write in short, succinct sentences (G.B. Shaw once apologised for writing a long letter because he didn't have time to write a short one!). The result should not just be a series of staccato phrases but should retain a flow and continuity of expression.
- avoid slang and unnecessary jargon, and define specialist terms (including new abbreviations) the first time you use them.
- use standard SI symbols and abbreviations, which are listed in your *Guide to Units* booklet (CUED databooks).
- standard English grammar and standard English spelling are important. See *Guidance on technical writing*; a good general reference is: Gowers I., *The Complete Plain Words* (Penguin books, London, 1975).
- avoid the use of the 'first person' (I, we, my, us, etc.) in technical writing.
- be aware of, and avoid, sexist language (to which engineering is particularly prone), e.g. always using 'he' when there is also 'she' (which can largely be overcome by careful drafting and the use of plurals: 'they'). And be aware that gender bias easily slips in unnoticed, e.g. using male-oriented examples to illustrate a technical idea: engineering is not all about cars!

Grammar

Grammar tells the reader the function of words and their relationship. Mess up the grammar and you confuse the reader. Correct spelling is also important to convey meaning accurately. What follows is a brief summary of the simplest essentials of grammar and spelling.

(1) *The parts of speech*

Parts of speech are descriptors for the *functions* of words. There are eight.

- **Nouns** are the names of peoples or thing: *Instron, metal, computer, foam*.

Nouns can be used as adjectives. When so used, they are generally hyphenated to the noun they qualify: *table-tennis, metal-foam, computer-power*.

- **Pronouns** stand for nouns: *he, she, it, they*.
- **Adjectives** qualify nouns: *a small Instron, a red metal, a digital computer*.
- **Verbs** signify being or action: *is, seems, go, interpret, understand*.
 Transitive verbs have a subject and an object: *The load / deforms / the material*.
 Intransitive verbs have no object: *Flowers / bloom. The research / evolved*.
 “Being” verbs have a complement: *The test / was / completed. The theory / seemed / correct*. (“Completed” and “correct” are complements)
 Many verbs have both a transitive and an intransitive form: *Time / passed. And: Pass the biscuits*.
- **Adverbs** qualify verbs: *today we interpret this differently*.
- **Conjunctions** link words and sentences: *and, but, because...*
- **Prepositions** precede nouns, usually having to do with place or time: *on the table, after this procedure, on the graph, from the appendix*.
- **Interjections** are exclamations; the polite ones include: *Alas! Great! Cheers!* Many are impolite. They are inappropriate in technical writing.

(2) **Sentence structure**

A simple sentence has a subject and a predicate. The *subject* identifies what or whom the sentence is about. The *predicate*, containing a verb, says something about the subject.

Subject	Predicate
<i>The sample</i>	<i>failed.</i>
<i>The measurements</i>	<i>fell into two classes.</i>
<i>Fatigue-loading</i>	<i>causes microstructural damage.</i>

(3) **Phrases and clauses**

Phrases and clauses are groups of words that do the jobs of the parts of speech listed in (1) above.

A *phrase* is a group of words that does not contain a verb.

Type of phrase	Example
Noun phrase	<i>The interpretation of the experiment presents a problem.</i>
Adjective phrase	<i>The red and white striped cable is live.</i>
Adverbial phrase	<i>We examined the results with considerable care.</i>
Conjunctive phrase	<i>The test ended owing to the fact that the specimen failed.</i>

Avoid the last of these; there is always a simpler, one-word conjunction (here: “because”).

A *clause* contains a verb and its subject or object. Sentences are made by linking clauses. A sentence made with two equal clauses (each a separate sentence but linked together) is called a compound sentence. A sentence made with a main clause linked to one or more subordinate clauses, which cannot stand by themselves as separate sentences, is called a complex sentence.

Adjective clauses do the work of adjectives; adverb clauses do the work of adverbs.

Type of Clause	Example
Adjective clause	A computation <i>that uses FE methods</i> is appropriate.
Adverb clause	The modem will operate <i>wherever a phone-line is available</i> .

(4) **Compound sentences**

A compound sentence has two co-ordinate (“equal”) clauses linked by a conjunction:

We measured the temperature and (we) adjusted the thermostat.

The tooling cost is high but the material cost is low.

The parts of a compound sentence must be of comparable weight. “*We analysed the microstructures using SEM and left for lunch at midday*” is unbalanced.

(5) **Complex sentences**

A complex sentence has a main clause and a subordinate clause:

What these results signify / is the subject of a paper by Wegst (1998).

Maine (1998) demonstrates / that technical cost modelling is feasible.

It is possible / that the conclusions were mistaken.

(6) **“that” and “which”**

“The computations *that were performed on a Cray* were the more accurate.”

“The computations, *which were performed on a Cray*, were the more accurate.”

These two sentences appear at first sight to say the same thing, but they do not. The italicised part of the first sentence is an adjective clause, qualifying the word “computations”; it has the effect of limiting the computations the sentence is talking about to the ones done on the a Cray, as distinct (say) from those done on a Silicon Graphics work station. Adjective clauses are just like adjectives; they are not separated from the noun they qualify by commas.

The italicised part of the second sentence, separated by commas from the rest, adds a new factor of equal importance to that contained in the main sentence. The two statements are: the computations were performed on a Cray; and they were more accurate. The emphases of the two sentences differ. The italicised clause in the first sentence is *subordinate*, merely qualifying the noun. The italicised clause in the second sentence is *co-ordinate*, meaning that it introduces a new fact.

Spelling

Use the spell-checker on your computer, but don't forget the existence of *dictionaries* (books or computer-based). Remember that spell-checkers will fail to distinguish "their" from "there", "form" from "from", "whose" and "who's", "its" from "it's", and many more. (Remember that apostrophes indicate missing words: "it's" = "it is"; more on this under *Punctuation*).

Watch out particularly for:

"separate" (not "seperate")

"affect" (*verb*) and "effect" (*noun*)

"principal" (*adjective*) and "principle" (*noun*)

"practise" (*verb*) and "practice" (*noun*)

Most, but not all, words ending in "-ise" (e.g. specialise) can also be spelt "-ize" (common in US English). If in doubt use "-ise" (the more common UK English usage).

Some further common spelling advice is summarised below, from: *Guidelines for Essay Writing and Presentation* by Susan Manning (CU Faculty of English), 1999.

1. 'i' before 'e' except after 'c' when the 'i' and the 'e' make the sound double 'e', as in:
 - ceiling, achievement, deceitful, receipt.

This rule almost always works – you just have to remember the few exceptions:

- weir, protein, seize.

2. When you add an 's' to a word that ends in 'y' the 'y' changes to 'ie' unless there is a vowel before the 'y', for example:

- try, tries; ➤ alloy, alloys; ➤ fly, flies.

3. Prefixes: in a compound word formed by adding a prefix like dis- or un-, it is often helpful to think about how the word was originally spelt:

dis + appear = disappear

un + necessary = unnecessary

dis + satisfied = dissatisfied

un + inspiring = uninspiring

Punctuation

Punctuation orders prose and sends signals to the reader about how to interpret it. Combined with good sentence structure, punctuation makes reading flow; it warns of what is to come; it helps the reader read once, without having to re-read. Meaning is changed, sometimes dramatically, by punctuation. This section gives a resumé, but if you really want the low-down on punctuation, and to be entertained at the same time, read "Eats, Shoots and Leaves" by Lynne Truss, listed under *Further Reading*.

(1) **The full stop, or period** .

The full stop is used to mark the end of a declarative sentence, and to signify abbreviation:
Dr. A.M.K. Esawi, Ph.D.

(2) **The comma** ,

The comma keeps apart two words or larger parts of a sentence which would confuse if they touched. Forget any rules you have heard about the comma and simply use it when it improves the sense and readability of the sentence. Try the sentence with and without the comma; keep it if, without it, the sentence becomes ambiguous or hard-going. Thus:

The measurements employed a photo-diode and a laser was used to check adjustment requires a comma after photo-diode to avoid a momentary misinterpretation, slowing the reader down.

(3) **The semi-colon** ;

The semi-colon is used to break up sentences when a comma is not enough, but a full stop is a more complete break than the sense demands. Most commonly, it is used between closely related independent clauses:

At one time the optical microscope was the principal tool of metallography; today, it is the scanning electron microscope.

When conjunctive adverbs *accordingly, also, hence, likewise, similarly...* link clauses, they are preceded by a semi-colon. It is used, too, to separate members of a list when the comma is not enough:

The literature includes Gibson (1997), who studied simple compression; Olurin (1998), who studied the effect of holes and notches; Deshpande (1999), who....

(4) **The colon** :

The colon introduces part of a sentence that exemplifies, restates or explains the preceding parts. It is expectant, and sets the reader up to anticipate elaboration:

This raises the question: is the model right or wrong?

There are two reasons for repeating this experiment: the first, to improve the precision; the second, to establish reproducibility.

(5) **The exclamation mark** !

The exclamation mark signals surprise, excitement, imperative, even contradiction; it turns up the volume.

Harte reports that metal foams sink in water.

is a simple statement;

Harte reports that metal foams sink in water!

implies that this is startling, perhaps even mistaken. Scientific writing does not need this sort of emphasis or innuendo. Delete it, and say what you want to say in a direct way.

(6) *The question mark* ?

The question mark is used after a direct question:

Why was this work undertaken? The reason.....

It is used to indicate uncertainty:

Euclid, 450? —374 BC.

It is optional after a rhetorical question:

Who would trust that model.

So what.

(7) *The hyphen* -

The hyphen connects part of a compound word:

Well-known; half-expected; curiosity-provoking; a ball-and-stick model.

It is generally required when a noun is used as an adjective: *a box-girder, a bar-chart*. Its most engaging property is its capacity to create new words and meanings by combinations both established and original:

A Fleck-inspired interpretation; a shark-skin-textured surface.

Treat this with caution; it can easily descend into stomach-lurching purple-prosed absurdity.

(8) *The dash* —

The dash sets off parenthetical material that results in a break in continuity in a sentence.

Magnetic materials—carbon steels for instance—contain atoms with unpaired electron spins.

This conclusion—and it is a significant one—appears to violate the first law of thermodynamics.

The remaining specimens—those which had not fractured—were sent for analysis.

A dash can lead to an upshot, a final summary word or statement, and give emphasis:

Cell-wall bending, cell-wall buckling and cell-wall fracture—are all equally probable.

(9) *The quotation mark* “ ”

Quotation marks enclose direct “word-for-word” quotations and dialogue.

“Uncork the flagon; let the wine-cups flow.”—Horace, Odes, 27BC.

“One small step for a man; one giant leap for mankind.”—Neil Armstrong, US astronaut, 1969.

Quotation marks are sometimes used to enclose an original, ironic or unusual turn-of-phrase:

This research took a “try-it-and-see approach.”

This colloquial phraseology is uncomfortable in scientific writing; avoid it.

(10) *The apostrophe* ’

The apostrophe shows either possession or contraction; thus, the possessive forms:

Sutcliffe’s theory; everyone’s idea.

There is no apostrophe in the possessive *his*, *her* or particularly, *its*.

In contractions, the apostrophe indicates missing letters: *Don’t*, *isn’t*, *it’s* (meaning “it is”).

Contractions of this sort are inappropriate in scientific writing, but can be acceptable in informal or popular writing, as here.

(11) *Italics*

Underline, embolden or italicise? All three attach emphasis and importance to a word or phrase. In contemporary scientific writing italics are preferred. Bold tends to be reserved for headings. Underlining can appear over-emphatic and, within a text, bold can seem authoritarian. Italics allow smooth definitions of terms:

“The critical value of the fatigue limit, or *fatigue threshold*, is listed...”

allows the italicised words to be used thereafter in place of the longer definition. Book titles are often italicised “*The Theory of Shell Structures*” by C.R.Calladine, as are words in foreign languages. To write more on this would be *de trop*.

(12) *Parentheses* () *and Brackets* []

Parentheses—literally: putting-asides—embrace material of all sorts, and help structure scientific writing. But do not let them take over, clouding the meaning of the sentence with too many asides.

Face-centred cubic metals (copper, silver, and gold, for instance) have nine independent elastic constants.

Shercliff (1998) surveys the status of modeling in Material Sciences.

It is plausible (although not everyone agrees) that this theory is correct.

Brackets are used to indicate editorial comments or words inserted as explanation:

[continued on p. 62], [see footnote].

Good writing style

Good style lifts writing from that which is dull and ordinary to that which is distinguished, memorable, individual. There is no formula for instant style—it is partly a personal thing—but there are useful guidelines. Style is approached through plainness, simplicity, good structure and desire to convey information to the reader in the most accessible way.

(1) ***Be clear***

The essence of technical writing is *communication*. The first quality, with precedence over all others, is clarity. Use simple language and simple, concise construction; short words rather than long; familiar words, not obscure. When you've said something, make sure that you've really said it. The writers of these headlines (all from newspapers in 1998) hadn't:

Red tape holds up new bridge.

Something went wrong in jet crash, expert says.

Chef throws heart in to help feed the hungry.

Prostitutes appeal to Pope.

Panda mating fails; vet takes over.

These are funny because the intended meaning can be guessed. More often, it can't; then the loss of clarity misleads and confuses.

AND DON'T WAFFLE. Consider this, from a well-known Materials text:

“The selection of the proper material is a key step in the design process because it is the crucial decision that links computer calculations and the lines on an engineering drawing with a real or working design”.

What does it say? “Materials selection is important”, and we knew that already. It is wasting the reader's time.

(2) ***Write from an appropriate design***

Poor writing lacks order, mixes ideas that should develop separately, fails to progress in a logical sequence. A concept-sheet or extended Table of Contents gives structure: there is a place in it for each part of your story. In making it, decide where the bits will go, the logical order, the way they will fit together.

Remember who you are writing for. Tell them what they want to know, not what they know already or do not want to know.

(3) ***Define everything***

Define all symbols and abbreviations.

The mass m scales as E/ρ where E is Young's modulus and ρ is the density...

(leaving a double space on either side of a symbol when it appears in the text).

The measurements, made with a scanning electron microscope (SEM), ...

(after which you can just use the abbreviation, SEM).

(4) ***Avoid empty words***

Avoid clichés (standard formalised phrases): they are corpses devoid of the vitality which makes meaning spring from the page:

The long and the short of it is that digital methods are the flavour of the month; the bottom line is that analogue computation is old hat—avoid it like the plague.

Avoid weak qualifiers: *very, rather, somewhat, quite...*

This very important point ... makes less impact than: *This important point ...*

or, more simply: *This point*

The agreement with theory is quite good ... suggests that it is not.

These ideas could rather easily be extended to the non-linear case ... makes the reader wonder why you didn't do it.

(5) Do not overstate, over-emphasise or apologise

All of these undermine the reader's confidence in your judgement.

This paper questions the basic assumptions of fracture mechanics ... (this from a real manuscript) fills the reader with mistrust; after all, fracture mechanics works.

This very important result... or *This significant finding...* are better replaced by the simpler: *This result...* and *This finding....*

Leave the reader to decide on importance and significance. And never, ever, apologise:

Unfortunately, there was insufficient time to complete the last set of tests suggests bad planning, laziness, incompetence.

(6) Avoid being patronising, condescending or eccentric

Write in a way that draws attention to the sense and substance or the writing, not to the mood or whimsical humour of the author. If the writing is solid and good, the character of the author will emerge. To achieve style, start by trying for none.

Don't patronise: *The amazingly perceptive comment by Fleck*

Don't be condescending: *Readers familiar with my work will know*

Do not affect a breezy manner, what you might call Web-speak:

Hi! me again with some hot news about engineering at CUED, or Q'Ed as we call it. It's been a helluva term for good stuff—we got more going on here than ever before...

The author says nothing and is showing off, drawing attention to himself.

(7) Use appropriate language

Use standard symbols and terms. Calling Young's modulus G (instead of E) will confuse, even after you've defined it.

Minimise the use of acronyms and abbreviations:

The MEM, analysed by FE methods, was photographed by SEM and chemically characterised by SAM.

is bad writing. Find other ways of saying it, even if it takes more words.

Avoid jargon. Jargon is the secret language of the field. It excludes the intelligent, otherwise well-informed, reader, and speaks only to the initiated. Some jargon is unavoidable—new concepts sometimes need new words. But don't be tempted to use it to show that you are an insider. See *Examples of effective writing* for more on jargon.

(8) *Good first sentence*

Don't start introductions (or anything else) with platitudes. Tell the reader something he does not already know. Openings such as:

It is widely accepted that X (your topic) is important ...

has the reader yawning before you've started. Try to get a new fact, new idea or a revealing comparison into the first line.

Poor Opening: Metal foams are a new class of material attracting interest world-wide and with great potential... X, Y, Z have measured their strength properties ...P, Q, and R have developed theoretical models ... Comparison of the experiments with the models suggests that the measured strength are less than those predicted ...

The first sentence is a platitude; the second and third involve the reader in details, the relevance of which is not yet clear; only in the fourth does the point start to emerge.

Better: Metal foams are not as strong as they should be. Models, which describe polymer foams well, overestimate the strength of metal foams by factor of 2 to 5. This research explores the reasons. *To be more specific...* (details of literature X, Y, Z, P, Q, R here).

The first two sentences now highlight the problem. The third says what the paper is going to do. The details that follow then have relevance.

Use a quotation only if it is spot-on; inappropriate quotations give the impression that the writer is trying too hard.

“God created solids, but the Devil created surfaces”—anon.

could be a good first line for a review-article on friction and wear, but it is pretentious as an opening to a paper on (say) the wear of bronze journal bearings. If you do use a quotation, make sure you get it right—see Quotations, in *Further Reading*.

(9) *Seek helpful examples and analogies*

Ferro-magnetic material—steels, for example—can be shock-loaded by pulsed magnetic fields.

The example of steels makes the generalisation concrete.

One cause of rolling friction is material damping. A rolling ball deforms the surface on which it rolls. If the work done in this deformation is lost through damping, a frictional force opposes motion. It is like riding a bicycle through sand: the rubbing sand particles dissipate energy much as atom or molecular rearrangements do.

The bicycle analogy is appropriate; it relates the scientific problem to one which is familiar.

There are more examples of analogies in *Examples of effective writing*.

(10) *Linking sentences*

Each sentence in a paragraph should lead logically to the next. When you read a paragraph, where does it jar? Why did you have to pause or re-read? What word-change will fix it? Edit for readability.

It helps the reader if one paragraph ends with a device that links it to the next: a word or phrase picked up in the first sentence of the following paragraph, or a statement of what is coming next (though be sparing with this, it can get tedious).

.....**To progress further, we need a way to rank the materials—a material index.**

A material index is a

The repeated words link the two paragraphs.

.....**This behaviour suggests that the process is diffusion-controlled. A model based on this idea is developed next.**

The stresses at grain boundaries can be relaxed by diffusion. ...

The reader knows what the second paragraph is about before reading it.

(11) Observe good writing

When you read a good opening, an apt analogy, an illuminating example, or an idea well expressed, re-read it. Don't try to imitate it directly, but observe how the author did it. Bit by bit you can absorb the techniques.

(12) Finally...

Style takes its final shape from an attitude of mind, not from principles of composition. Focus on clarity. Write the first draft with the simple aim of getting the facts down; then leave it for a few days and revise. Make sure you've said what you think you've said. Remember who your readers are; seek to express your results and ideas in ways they will most easily grasp.

Figures

The role of Figures and their prominence in planning a report are discussed in *Planning a technical report (Drafting, and Typical report structure)*. Here are some tips on formatting Figures for reports.

Size, shape, title and captions

Many figures are generated in a software package (Excel, Matlab etc) with default settings for the shape of the graph (and many other formatting details). So make sure you consider the final size and location on the page of the figures in print, before committing yourself to a figure style. This may require experimentation – often figures can look too bold in the original package, but are then fine when pasted into the report and reduced in size.

There is no need to give a title on the figure itself in addition to an informative caption (below the figure) – use the same space to make the figure larger. Figure captions should be numbered sequentially, Figure 1, 2.... (or alternatively, Figure 1.1, 1.2.... if numbered by chapter or section – the advantage being that new figures inserted later do not disrupt later sections). Use "Figure ...", not Graph, Illustration etc. Figure captions should provide enough detail to interpret the figure, but should not include discussion points (which should be in the body of the text).

Scales and Axes

In general, it is best to use a true axis, but if the graph is meant to show a trend over a range that is relatively small compared to the absolute magnitude of the data (e.g. between 210 and 220), then a 'false origin' is clearer – e.g. starting at 200 means that the data can span the whole graph and trend lines will rise or fall at 45°. If a false origin *is* used, it should be clearly identified. Note that a false axis will emphasise variations in data when compared visually to a graph with true axes, and can lead to over-interpretation of what is simply experimental scatter.

Choose scales that are easy to read. Remember that semi-log and log-log plots may be appropriate to reveal possible mathematical relationships that are not evident on linear axes (or they can spread the data more meaningfully when the data range spans more than an order of magnitude). The axes should extend *beyond* the end data points, which otherwise tend to be overlooked. Frame the graph with a solid line, rather than having only x and y axes. Use a sensible number of ticks along each axis, with ranges that subdivide into sensible round numbers, e.g. data spanning 1 – 17 are best shown on an axis from 0 – 20, with ticks at intervals of 5, rather than 0 – 18, with ticks every 3. It is a common failing of using graph plotting software that the axis ranges are determined automatically from the data ranges, and need to be reset manually. Ticks inside are better than outside – the graph frame is larger for the same area on the page. Gridlines and background shading are hardly ever useful – Excel in particular includes these as a default: remove them.

Make sure that the axes are properly labelled, including units, and choose a font style and size that are clear in the final figure size. Use a clear legend to differentiate between sets of data or curves. Colour is good for this differentiation, and gives a more pleasing appearance – but bear in mind that copies may be made in black-and-white: contrast will be lost, and pale colours can disappear altogether! And your printing costs will be greater.

Accuracy and Errors

Datapoints with a trend line drawn through them give an initial indication of experimental scatter, and suggest the likely uncertainty in your results without elaborate calculation. Plotting results as you go is a standard technique of the good experimentalist – your appreciation of the trend and the scatter build up as you go, and you can refine the number of measurements taken at the time: much better than finding out later that the data are insufficient, when the equipment may no longer be available.

Given sufficient data, including repeated measurements, there are of course formal statistical ways to estimate the errors in your results. Generally the controlled stimulus or 'input' is plotted along the abscissa (x axis) and the error is predominantly in the response or 'output', along the ordinate (y axis). Error bars are then shown as a vertical line conventionally drawn as one standard deviation above and below the datum (though errors can be shown both ways, if both axes are measured variables of significant uncertainty).

Cleaning-up Data

It has been known for lazy or indeed unscrupulous scientists to ‘doctor’ their data. It is one thing to query an outlier, a data point so far from the trend as to suggest it might be the result of a gross error in procedure; it is quite another simply to remove the outlier as an embarrassment. Progressive degrees of adjustment, removal of points, cleaning up or incorrect reporting of results can lead to corrupted and incorrect conclusions. So what should be done with stray data? Standard advice is to repeat any case which gives such stray points and to take additional points close by. If three such repetitions show the original point is not reproducible, then it can be discarded. Strictly speaking even this lacks rigour – one should really test *all* the data points and not query only those that look out of line. Great experimentalists, like Cambridge’s Lord Rutherford, showed that apparent outliers can be genuine and lead to new discoveries.

References

The importance and purpose of References are discussed in the *Introduction to technical writing (Integrity, record-keeping, plagiarism and referencing)* and *Planning a technical report (Typical report structure)*. Here we summarise the formatting of the references in the report.

There are many different formats for references. Many are automated within word processors and associated reference databases (such as ENDNOTE or other software). Best for drafts, and for final versions (unless another format is specified), is the Name/Year system (also called the Harvard system):

In the text : “Lu (1998)”. If there are two names then “Lu and Chen (1998)”. If there are more than two, then “Lu *et al.* (1998)”. This is commonly used in two ways:

Lu and Chen (1998) investigated the compressive behaviour of aluminium foams.

Various authors have investigated the compressive behaviour of aluminium foams (Lu and Chen, 1998;).

The main alternative to Name/Year referencing is numbered references. These examples would then be:

Lu and Chen investigated the compressive behaviour of aluminium foams ¹.

Various authors have investigated the compressive behaviour of aluminium foams ^{1,.....}.

In the reference list, the Name/Year system orders references alphabetically; the numbered system obviously lists them in numerical order. In general, it is acceptable to use single-spacing with some space between successive references (even if the main body of the report is specified as 1.5 or double-spaced).

Whichever system is used in the text, the references themselves should follow a consistent style, and provide complete information. Do not be tempted to make a reference list without all of the details specified. It takes far longer to track down the missing information later than to do it right in the first place.

For example, for papers in a journal:

Lu T.J and Chen C. (1998), *An Analysis of Defects in Metal Foams*, Acta Mater. 15, 222-226.

Notes: the **15** is the volume number, sometimes followed in brackets by issue number, e.g. **15(3)**; the 222-226 are the page numbers for the whole article, sometimes “pp.222-226”. All journals have standard abbreviations for their titles: e.g. Acta Mater. in full is Acta Materialia.

If there are more than two authors, list them all in full in the reference list. If there are multiple papers in the same year by identical authors, then in the Name/Year system these would be referred to in the text (and the reference list) as: Lu and Chen (1998a, 1998b). This is clearly not an issue with numbered referencing.

Note the distinction between *References* and *Bibliography*, though these are sometimes used interchangeably. But a Bibliography is often simply a list of related publications (usually books) that are not specifically referred to as sources in the text.

In summary, standard recommended reference list formats are:

For *journal papers*: Names + initials, year, title, journal, volume, start page-end page.

(Example above)

For *conference papers*: Names + initials, year, title, conference, (editors), location, start page-end page.

Bratland D.H., Grong Ø., Shercliff H.R., Tjøtta S. and Myhr O.R. (1994), *Process model based optimisation of cooling schedules for AA6082 extrusions*, Proc. 4th Int. Conf. on Aluminium Alloys (ICAA4), (E.A. Starke and R. Sanders, eds.), Atlanta, USA, Sept. 1994.

Notes: “Proc.” is an abbreviation for “Proceedings”; editor details are not always included; and as conference proceedings are commonly issued on CD, page numbers cease to exist.

For *books*: Name, initials, year, title, edition, publisher, city and country of publisher, chapter number, start page-end page (if relevant).

Ashby M.F. and Jones D.R.H. (2006), *Engineering Materials 2*, 3rd edition, Butterworth-Heinemann, Oxford, UK, Chapter 4, pp.35-47.

Note: if a direct quotation is taken from a book, then give the specific page reference (and make sure the quote is enclosed by quotation marks).

For *newspaper articles*: Newspaper, year, title, publication date, page number.

Financial Times (2004), *Windows everywhere?*, 31/02/04, p23.

For *Web references*: Name, year, (title, if available), URL, (Accessed: Date)

**Rush J. (2004), *Windows warfare*,
http://channel4.com/news/2004/10/week_2/09_windows.html (Accessed: 14/11/04)**

5 Further reading

There are lots of books on how to write, spell, punctuate. Many are deadly dull. But there are some good ones, some *really* good ones—not just instructive, but inspirational almost, and entertaining too. These are starred (★) in the list below.

Texts on how to write technical prose

“The Complete Plain Words” 3rd edition, by E. Gower, revised by Greenbourn, S. and Whitcut, J. Penguin Books, London, UK (1986)

“A Writers Guide for Engineers and Scientists” By R. R. Rathbone & J.B. Stone, Prentice-Hall Inc, Englewood Cliffs, NJ, USA (1962)

★ “The Reader Over Your Shoulder” By R. Graves & A. Hodge, Collier Books, New York, USA (1943).

“The Elements Of Style” By W. Strunck Jr., & E.B White, Macmillan Co, New York, USA (1959).

“Communication in Science”, 2nd edition, by Vernon Booth, Cambridge University Press, Cambridge UK (1993).

“The Little Brown Handbook”, 6th edition, by H.R. Fowler and J.E. Aaron, Harper Collins, New York, (1995)

Instructions on preparing scientific papers

“General notes on the Preparation of Scientific Papers”, 3rd edition, (1974), The Royal Society, London.

Grammar

“Clear English’ by Vivian Summers”, Penguin Books, London, UK (1991)

“Chambers English Grammar” by A. J. Taylor, W & R Chambers Ltd (1990)

Punctuation

★ “Eats, Shoots and Leaves” by Lynne Truss, Profile Books, London, UK (2003)

“The Well-Tempered Sentence” By K.E Gordon, Horton Mifflin Co Boston, USA (1993)

Spelling

The friendliest dictionary is.....

The Chambers Dictionary, Chambers Harrop Publishers, London U.K. (1998)

.....but the ultimate authorities remain

The Concise Oxford Dictionary, 8th edition, Clarendon Press, Oxford UK (1990)

The Shorter Oxford English Dictionary, 4th edition, Clarendon Press, Oxford UK (1990)

Quotations

The Oxford Dictionary of Quotations, 4th edition, Oxford University Press, Oxford U.K. (1996)

Synonyms and Antonyms (*words that say the same or the opposite*)

The Penguin Dictionary English Synonyms and Antonyms, Penguin Books, London, UK (1992).

Entertaining Reading

If words fascinate you, the following are delightful:

- ★ “Troublesome Words” 2nd edition, by Bill Bryson, Penguin Books, London, UK (1987).
- ★ “Panati’s Extraordinary Origins of Everyday Things” by C. Panati, Harper and Row, New York, USA (1987).
- ★ “Panati’s Extraordinary Endings of Practically Everything and Everybody” by C. Panati, Harper and Row, New York, USA (1989).
- ★ “Dictionary of Word Origins” By J.T. Shipley, Littlefield, Adams & Co, NJ, USA (1977).
- ★ “Word Histories and Mysteries” Edited By K. Ellis, Houghton Mifflin Co Boston, USA (1974).
- ★ “The Penguin Dictionary of Curious and Interesting Words” By G.S. Sausy III, Penguin Books, UK And Viking Books USA (1984).

Appendix: Examples of effective writing

Good Abstract

Temography of Shear Bands in Metal Foams

Metal foams, when compressed, deform by shear banding; the bands broaden as deformation progresses. The nucleation and broadening of shear bands have been investigated by laser-speckle strain-mapping. The foams were non-homogeneous, with spatial variations of density of a factor of 2; the shear bands nucleate in the low-density zones, and broaden into the high-density regions as strain progresses. These results indicate that processing to minimise the density fluctuations could increase the initial compressive yield strength of the foams, when shear bands first form, by a factor of 1.5.

This, in four sentences and 94 words, gives a clear, concise portrait of the paper, devoid of unnecessary detail and secondary information.

Good opening sentence

From a review article on the elastic properties of materials:

“Ut tensio, sic vis”. As it is stretched, so it resists. With these words Robert Hooke enunciated in 1674 the law of elasticity that bears his name

(from Enzo Manzini, in “The Materials of Invention”, Design Council, London 1989).

The quotation nicely suggests the history and introduces the subject.

Good analogy (1)

Structured Programming

‘Music, poetry, and programming, all three as symbolic constructs of the human brain, are found to be naturally structured into hierarchies which have many different nested levels. Sounds form meaningful units, which in turn form words; words group into phrases, which group into sentences; sentences make paragraphs and these are organised into higher levels of meaning. Notes form musical phrases, which form themes, counterpoints, harmonies etc; which form movements, which form concertos symphonies and so on.

Structure in programs is equally hierarchical, if not so universally recognised....’

(from ‘Numerical Recipes’ by Press, H W. Flannery, B.P. Teukolsky, S.A. and Vetterling W.T. Cambridge University Press, Cambridge, UK, 1986).

The analogy is a little long-winded, but it achieves the writers’ aims: to convey the importance of structure in programming, and, by association, to portray programming as an art-form and to elevate its stature as an intellectual activity.

Good analogy (2)

The Character of a Volvo

‘Volvos have a certain character. Purchasers see them as solid, safe, long-lasting, reliably masculine, with built-in Scandinavian qualities of good design — it’s what we call the “Product DNA”’

(Ford Company spokesman explaining that Ford, who have just bought Volvo, will retain and develop the Volvo character).

The DNA analogy captures in a word the subtle combination of real and perceived values which lie at the heart of customer loyalty.

Avoid Waffle

The Role of the Materials Engineer in Design

‘The role of the Materials Engineer in the design and manufacture of today’s highly sophisticated products is varied, complex, exciting and always changing. Because it is not always the metallurgical or materials engineer who specifies the materials, this *ASM Handbook on Materials Selection and Design* is prepared to benefit all engineers who are involved with selecting materials with their related processes that lead to a ready to assemble manufactured component.’

(extract from the Introduction to *ASM Metals Handbook* vol. 20, ASM International, 1998, Metals Park, Ohio, USA)

There is a warning here for us all. What they wanted to say is: “Engineers need to choose materials and to find processes to shape and join them. This *ASM Handbook* is designed to help them.”

But that sounds too short, too plain, not grand enough. The fear of sounding trivial, of not being sufficiently heavyweight, haunts all writers when they are asked to write for audiences with whom they are unfamiliar. The temptation is to use long words, to sound sophisticated, to get fancy; and the effect is to dilute the message until its true flavour is lost. Don’t do it. Say what you mean to say, and say it clearly and simply. Remember who your readers are.

The Act of Design

‘Designing is a creative activity that calls for a sound grounding in mathematics, physics, chemistry, mechanics, thermodynamics, hydrodynamics, electro-engineering, production engineering, materials technology and design theory, together with practical knowledge and experience in specialist fields. Initiative, resolution, economic insight, tenacity, optimism, sociability and teamwork are qualities that will stand designers in good stead and are indispensable to those in responsible positions.’

(from a distinguished book on Engineering Design)

How many people do you know who could meet that job description? The authors wish to convey the idea that design is an inter-disciplinary activity, and one that has technical, managerial, and social facets, but they have done so in a way that intimidates. They have lost touch with their readers.

An alternative with the same message might be:

Designers cannot be expected to know everything, yet there are times when it might seem that they must. Design involves an exceptionally broad base of technical competence and practical experience, leadership, teamwork and management skills.

Try not to alienate your readers. Phrase your message with them in mind.

Jargon (1)

A Definition of love

‘... the cognitive-affective state characterised by intrusive and obsessive fantasising concerning reciprocity of amorous feelings by the object of the amoration.’

(from a US Conference of Sociologists (1977), cited by Bryson (1987)—see *Further Reading*)

This sort of stuff is rife in critiques of music and art, and in writing on Psychiatry, Psychology and Sociology. It surfaces, too, in books on Industrial Design, and, less frequently, in scientific and technical writing. Don't let the jargon-bug infect your own style.

Jargon (2)

The justification for a travel grant

My mathematical work is in the area of Symplectic Geometry and Differential Equations, in particular on a geometrical interpretation of the Painlevé equations. I have succeeded in attacking the Isomonodromical Deformation problem for higher order singularities by symplectic means. On the one hand, this involves a symplectic structure obtained from infinite-dimensional considerations and on the other an analysis of the geometry of the Stokes matrices in the language of Poisson Lie groups.

(from a student's application for a travel grant, 1999)

There's nothing wrong with the grammar, punctuation or spelling here—all are fine. But how much does the statement convey to the panel awarding the travel grant, all of them scientists or engineers, but none specialists in this sort of mathematics? Practically nothing. The meaning is hidden in the jargon; the writer has made no attempt to translate his ideas into a language the rest of the world can understand. It is not always easy to do so—the subject of Symplectic Geometry may be a difficult one to illustrate with simple examples or analogies—but it is always worth trying.