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Communicating IN THE 21st CENTURY

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Contents

6 Scientific and technical writing

CHAPTER 6

Scientific and technical writing

LEARNING OBJECTIVES

After reading this chapter you should be able to:

- Explain the differences and similarities between writing for general audiences and writing for scientific and technical audiences
- Discuss the problems and opportunities that might arise when content or subject-matter experts need to work with professional technical/scientific writers
- Identify the key components of scientific and technical style, and the pitfalls associated with that style
- Explain the similarities and differences between three genres of technical and scientific writing (reports, papers or articles, and manuals or instructions)
- Identify the structural, style and audience factors that need to be borne in mind when writing reports
- Identify the structural, style and audience factors that need to be borne in mind when writing articles or papers
- Identify the structural, style and audience factors that need to be borne in mind when writing manuals or instructions

Communicating in science and technology

We live in a society exquisitely dependent on science and technology, in which hardly anyone knows anything about science and technology. (Carl Sagan)

Scientists and technologists need to be able to communicate with their peers and with the outside world – the world of non-scientists and non-technologists. In other words, scientists and technologists need to be able to communicate with different audiences, and this almost certainly means that scientists and technologists need to:

- learn to vary their writing style and to match the needs, abilities and motivations of differing audiences
- learn to use differing document types to convey different messages, or to convey the same message in different ways
- learn to use differing channels and technologies of communication, from written documents to online documents to oral presentations (see chapter 1, 'Communication today', pp. 19–25).

As a communicator of science and/or technology, therefore, you need to become versatile and flexible – in order to get across the content of your expertise, you also need to become an expert in process or form. You not only need to be a writer, but a 'translator' as well; you need to be able to get messages through to people from professional backgrounds that differ from your own.

There are perils and opportunities associated with doing this, including:

- We may distort the essence of what we are trying to communicate; that, in 'talking down' to our lay or non-specialist audience, we may over-simplify.
- We may end up sounding patronising in the way we communicate.

Opportunities can arise, however, when we are compelled to communicate with multiple audiences.

- Technical expertise often varies inversely with budget authority. That is, many people with the power to grant resources and funding essential for your work will not necessarily understand your work for what it is. If you can communicate what you want with style and lucidity, therefore, you stand a better chance of getting what you want.
- Being known as a good communicator is a good career move.
- 'Translating' your work sometimes gives fresh insights into that work.
- 'Translating' sometimes allows you to see that you might have become too close to the problem when communicating with peers, and in fact have developed blind spots and misperceptions about the work – a form of 'groupthink' (see chapter 20, 'Team communication', pp. 684–8).

Deficit model: A mode of thinking held by some scientists that communication with the public is top-down and one-way

Davies (2008), for example, notes that many scientists, in communicating with the wider public, operate from the **deficit model**, which assumes 'public deficiency but scientific sufficiency'.

This model adopted a one-way, top-down communication process, in which scientists – with all the required information – filled the knowledge vacuum in the scientifically illiterate general public as they saw fit. In descriptions such as these, a model of the public (as ignorant) leads to a model of communication (filling a 'knowledge vacuum'). It is, therefore, not surprising that within this data the two concepts are also tightly tied together (see chapter 1, 'Communication today'; chapter 9, 'Interpersonal skills 1: emotional intelligence, self-talk and assertiveness'; and chapter 17, 'Organisational communication').

But, as she notes, sometimes communication is more interesting than that. The interaction of scientists with members of the community (e.g. in a public briefing or media program) might demonstrate that there is not just one 'public' but several or many 'publics', and those publics may have knowledge of their own, which could be useful to scientists (see also online chapter 4, 'Plain English').

In communicating effectively with publics, Davies (2008, p. 417) found two underlying principles:

- Be relevant and relate your work to people's lives.
- Communicate 'big ideas' or key principles rather than the details of your research.

These perils and opportunities arise in diverse situations, from the writing of manuals to research articles to journalism to production of mass media documentaries. Such perils and opportunities also present themselves with spoken, mediated, as well as written, communication.

Scientific and technical writers also sometimes misunderstand the nature of the communication process in other ways. This is because too many of them think that they are only in the business of information, not persuasion (see chapter 5, 'Reports and proposals'). They are wrong. As Kovac points out, scientists are thinkers and writers, not robots, or just recorders of data that 'write up' their findings. In fact, the 'scientific article is a human-made text designed to persuade'. Therefore, rhetoric and rhetorical devices, like metaphors, usually only associated with genres like literature, can help science writers to achieve conceptual or paradigm breakthroughs. For a glimpse into the world of rhetoric, see online chapter 3, 'Style'.

Thus, Van Hooijdonk and Krahmer (2008, p. 59) compared the impact of communicating the same message – avoiding repetition strain injury (RSI) – using text, pictures and film clips. All three channels had strengths and weaknesses. For example, some movements can be concisely described in language because the entire movement has been 'coded' in a fixed expression (e.g. *make fists*), whereas other movements can be rather cumbersome to describe. Also, expressing how a particular movement 'feels' (e.g. *spread your fingers until a mild stretch between the fingers is felt*) is obviously easier in language than in static or dynamic visuals. For such exercises, a textual presentation might have an added value over other presentation formats.

For effective communication, match your message to the medium or channel (see chapter 1, 'Communication today').

Writers and experts

Sometimes, when writing scientific or technical documents, you will wear two hats: you will be both the expert on content or subject matter, and also the writer. This, however, is not always the case.

In some technical and scientific writing situations, professional writers need to work with subject-matter specialists to produce documents of various kinds (Lee & Mehlenbacher 2000; Lagnado 2003). Such working partnerships can be highly productive and enlightening for both sides; but, equally, such partnerships can be acrimonious and unproductive when meta-communication – communicating about communication – breaks down. Typically, when this happens:

- *subject-matter specialists* may feel that professional writers are patronising them, are not technically literate enough to understand the problem or are in fact frustrated subject-matter specialists who step over the line
- *professional writers* may feel that subject-matter specialists do not give enough of their time, may lack respect for what the writer is trying to do, do not understand documentation processes or lack communication skills.

General versus scientific/technical writing

Being versatile and flexible in writing style means that we need to be able to switch back and forth between writing for general audiences and writing for specific scientific/technical audiences (table 6.1) (see chapter 5, 'Reports and proposals', pp. 157–8, 160–1, 163–4).

Table 6.1: Writing for general and specific audiences

Aspect	General writing	Technical writing
Purpose	• To entertain and inform	• Primarily to inform
Emphasis	• General	• Specific
Time frame or shelf life	• More ephemeral	• More permanent; for the record • Ongoing/multiple/revised editions common
Relationship of writer to publishing organisation	• Mainly internal (journalists), some external (freelance writers) • Book authors external	• Internal (writers of reports, specifications, manuals/instructions) • External (writers contributing articles to journals, book authors)
Single/multiple authorship	• Usually single	• Often multiple
Relationship of writer to subject matter	• Usually observer only	• Participant and observer
External validation of writing	• Writing is often verified by fact-checkers, editors	• Writing (e.g. journal articles) may be reviewed anonymously by referees
Style	• Quotation common • Slang, puns, humour acceptable • Few footnotes, references • First- and second-person references common • Passive voice used less often	• Quotation uncommon • Slang, puns, humour not readily acceptable • Footnotes, references common • First- and second-person references uncommon • Passive voice used more often
Language/register	• Specific/technical terms usually defined	• Some terms not defined; assumption that readership already knows
Presentation	• Emphasis on medium as well as message • Colour and layout important	• Emphasis on message rather than medium • Colour and layout less important
Audience loyalty	• Low: high turnover expected	• High: low turnover expected
Focus and impact of writing	• Descriptive focus: few impacts occur after writing has been read	• Programmatic focus: what happens now? Consumers act on instructions, decision-makers implement or do not implement recommendations, other researchers attempt to replicate findings

These distinctions between different types of writing are by no means hard and fast: some professionally produced science and technology journals, and manuals and instructions, are beginning to feature colour, dramatic layout and idiomatic language in ways that were unthinkable 20 years ago. Even 'amateur' writers of reports and other documents now may have access to powerful desktop publishing software that produce documents that are radically different from those previously available. Similarly, 'mere journalism' – a genre of writing that tends to be linear, short and ephemeral – is beginning to use footnotes and often features arcane technical terms. The barriers are becoming somewhat blurred (see chapter 2, 'Document design and graphic communication' and online chapter 8).

Scientific and technical style

Let's jump back slightly and consider in greater detail the points about style and language or register in table 6.1. The style of many scientific and technical documents tends to be characterised by:

- extensive use of passive voice, particularly the agentless passive (see Dawson 2007; Carraway 2006)
- almost complete avoidance of first- and second-person pronouns
- extensive use of nominalisations
- technical vocabulary, with emphasis on polysyllabic Latinate lexis rather than monosyllabic Anglo-Saxon lexis
- long rather than short sentences
- long rather than short paragraphs
- standardised rather than idiosyncratic expression
- minimal use of layout or information design strategies such as bullet points and font variation.

Such style often results in scientific/technical prose that has demanding readability scores – that is, can only be read with some ease by readers with upper secondary or tertiary levels of education. Readability scores can be given by most modern word processing packages, so that you can check the readability of your own documents. The two major scoring systems are the Flesch Reading Ease (the lower the score, the more demanding the text) and the Flesch–Kincaid Grade (the higher the score, the more demanding the text). See online chapter 3, 'Style', and online chapter 4 'Plain English'.

In figure 6.1, it would be true to say that writing sample A in figure 6.1 is more typical of some scientific/technical writing than writing sample B (see also online chapter 3).

Figure 6.1: Two samples of writing

Writing sample A	Writing sample B
The thermal environment was manipulated to determine sample volatility. Temperatures above 110°C produced substantial surface excitation.	We tried different levels of heat to see how stable or unstable the chemical was. Heat above 110°C made the sample boil.
Passive sentences: 50% Flesch Reading Ease: 0 Flesch–Kincaid Grade: 19.9	Passive sentences: 0% Flesch Reading Ease: 64.9 Flesch–Kincaid Grade: 6.9

The advantages of writing style A are:

- The reader can concentrate on what is being written about rather than the writing skill (or lack of skill) or the personality of the writer.
- Standardised vocabulary, developed over decades or centuries, can be used to precisely describe the subject matter.
- It is traditional, and satisfies the norms of a professional audience.

The disadvantages of writing style A are:

- The readability level is quite demanding.
- The impersonality of the approach may mask other factors, such as personal responsibility for what is being described or shortcomings in method.

Pitfalls in scientific/technical writing

As a rule, write in a way that allows your audience to understand you. In the case of some documents, this means using the traditional scientific/technical writing style – indeed, you would be unwise not to use it. When writing technical or scientific documents, however, be wary of the following pitfalls:

Readability: a statistical measure of the complexity of text. The longer the words and the sentences in a sample of text, the less readable it will be

- *Low readability.* Even when writing for professional peers, consider using standard plain English techniques to improve the **readability** of your text. Such techniques include using more verbs instead of nominalisations, using shorter words, shorter sentences and shorter paragraphs, as well as using graphic communication where appropriate. Even professional audiences do not always appreciate wading through culpably obscure text. Hartley, Sotto and Pennebaker (2002), in their analysis of scientific articles, found that articles that had good readability scores – that is, that could be read by more, rather than less, people with limited education – were also more influential within the audiences they were aimed at (see online chapter 3 and online chapter 4; Hayden 2008).

Hedging: writing in such a way as to qualify assertions made in a passage of writing

- *Hedging.* Some writers are so uncertain of what they are saying that they cannot convey information without **hedging**. That is, they encrust their basic argument with layers of reservations, qualifications and disclaimers. 'It should be possible to identify the intrinsic uncertainty of…research without inventing dubious extrapolations and marking out escape routes from challenge' (*The Lancet*, editorial, 1995). Judicious hedging, however, is appropriate in certain situations (see chapter 7, 'Academic writing: the essay', p. 241).

Waffling: padding out passages with unnecessary words

- *Waffling.* **Waffling** is simply padding out text with meaningless or unnecessary words. Sometimes this is done to merely meet a word-count objective; sometimes it is done by rehashing your own or someone else's existing words to meet a 'publish or perish' imperative; and sometimes it is done when communicating with lay audiences by restating the blindingly obvious, dressed up in superficially impressive technical language. Let your writing be known for its quality, not its quantity (see chapter 7, p. 240).

Super-compression: leaving out transitional and contextual material that might otherwise help to clarify the meaning of a passage

- *Super-compression.* This is the opposite of waffling. **Super-compression** leads to a breakdown in communication by simply not giving enough information, or by suppressing intermediate steps and contextual cues that give your words meaning. Don't presume that certain things are 'obvious' to all, because they may not be. By the same token, don't 'dumb down' your writing by explaining everything at an elementary level. It is always a problem when writing a document to try and pitch it at a level appropriate to your audience. When in doubt, create a multilevel or multisection document with glossaries, diagrammatic exposition of concepts and hypertext, and break down dense packages of words into sequences. Super-compression is often seen in technical specifications. Distortion occurs when cause–effect sequences are obscure, when undefined terms are used, and when sloppy terminology about quantities is used. A clearer version may take up more space, but will at least be more likely to be understood by users and readers (figure 6.2).

Ambiguity: resulting from sentences with ambiguous or confusing grammatical constructions

- *Ambiguity.* **Ambiguity** occurs when writers do not have sufficient command of grammar, and unintentionally come up with double entendres or absurdities that will have their audiences stop and scratch their head, trying to separate the constituent parts of a sentence simply to understand what the writer is trying to say (Carraway 2006). For example:

Original	Re-write
Without human intervention to reduce the concentration of CH_4, the 2 million people along the Lake Kivu shoreline may suffer a catastrophic gas release.	Human intervention is needed to reduce the high levels of CH_4 concentrated in Lake Kivu to avert a lethal gas release that will result in the deaths of many of the 2 million people living near the shoreline.

Source: Adapted from Carraway 2006, p. 307.

Carraway also suggests that writers should try reading their manuscripts aloud to determine whether the meaning of the text is clear (see also online chapter 1).

Super-compressed text	Expanded text
Bus No. 2 shall be fed from WITR-2 IAW ABI Spec. 1.21.31 and adherent to approximate cycling characteristics across terminals 11–12 at about point A.12 to simulate permissive contacts from control panel 1-B12 then observe 480 ± 10% VAC on Bus No. 1 to assure it is ready for checkout then proceed.	1. Bus No. 2 shall be energised first. 2. Bus No. 2 shall be fed from Transformer No. 2. 3. (Company name) specification 1.21.31 shall be used to cycle power per table 1 of that document to readings shown for terminals 11–12 for point A.12 on Startup Drawing No. 1.21.31. 4. Simulate permissive contacts from control panel 1-B12. 5. Energise Bus. No. 2 by closing circuit. 6. Observe 480 ± 10% VAC on control panel instrument. 7. Monitor for five minutes, noting fluctuations. Shutdown if out of tolerance with step 6, above; go to troubleshooting, if necessary. 8. Energise transformer by closing circuit. 9. Go to (Company name) manual for transformer operation.

Figure 6.2: Undoing the damage of super-compressed style. *Source:* Adapted from Whalen (1982).

Over-citation: using too many references in support of points, or using too many references that lack relevance to a point made

- *Over-citation*. **Over-citation** is using too many references in a paper or article, and may highlight the writer's lack of understanding of the subject area.

In his amusing paper, 'How to write consistently boring scientific literature', Sand-Jensen (2007, p. 726) has this advice on how to maintain the 'essential boring tone':

> When all else is lost, and one's scientific paper is beginning to make too much sense, read too clearly, and display too much insight and enthusiasm . . . make sure that all written statements, even trivial ones, must be supported by one or more references. It does not matter that these statements are self-evident or that they comply with well-established knowledge, add a reference, or preferable 3–5, anyhow. Excessive quotation can be developed to perfection such that the meaning of whole paragraphs is veiled in the limited space between references. This technique maintains the boring quality of scientific publications by slowing down the reader, hiding any interesting information, and taking up valuable space. When authors are unsure of which paper to cite, they should always resort to citing their own work regardless of its relevance.

This is a mistake often made by writers in all subject areas, although it is not always a mistake – if you are standing on the shoulders of others, and use citation or referencing as a demonstration of your wider reading, then all to the good. But if your referencing technique is overkill, and not always relevant, then it comes across either as a smokescreen that you are using to conceal your weak grasp of the idea, or just name-dropping (see chapter 7, 'Academic writing: the essay', 'The Sanitary Engineer', p. 254, and chapter 3, 'Doing and using research'). It may also reveal your life inexperience in that some quotations are part of public domain, and do not need citing. We want to know what YOU think. As the 19th century American writer Ralph Waldon Emerson put it, 'I hate quotations. Tell me what you know'.

Over-long sentences: stringing sequences of subordinate phrases together with prepositions that make the meaning of a sentence unclear

- *Over-long sentences*. Using **over-long sentences** highlights a writer's poor grasp of grammar and style. Van Way (2007) cites this example:

Original	Re-write
The results of this study support the hypothesis that appetite for protein is regulated by the synthesis of ghrelin.	This study's results support the hypothesis that ghrelin synthesis regulates protein appetite.

Using prepositions that lead into subordinate phrases makes the intended meaning of the sentence unclear (Van Way 2007, p. 260). Don't simply pile units of meaning on top of the other hoping that they will reach a conclusion: decide at the outset what your conclusion is, state it in a declarative sentence (see online chapter 3, 'Style'). Make sentences clear, elegant and as short as possible. Like green lights at an intersection, they are not an endangered species, and there will be another (and another, and another, etc.) along before too long. Patience, sequence, and exposition will get you there, and with much more style and clarity.

Noun stacks: stringing nouns together to create unnecessarily complex concepts in sentences that cause ambiguity and create jargon

- *Noun stacks:* **Noun stacks** are another way of creating over-long sentences and occur when nouns are used as modifiers (usually adjectives). A 'stack' can mean a pile or sequence, but it also is a colloquialism for 'collision'. A noun stack can create a collision of meanings and they should be avoided because of the ambiguity they create (e.g. 'emergency pilot orientation program', and 'minister automobile transport certificates') (Eunson 1996, p. 88). Using Eunson's examples, here are some strategies to avoid creating noun stacks:

Ambiguity reduction strategy	Examples
Change the noun to an adjective	ministerial automobile transport certificates
Use possessive case	emergency pilots' orientation program
Change the noun to a modifying phrase	program in emergency pilot orientation
	certificates for transport vehicles carrying ministerial automobiles
	certificates for transporting ministerial automobiles
	a program for orientating emergency pilots
	an emergency program for orientating pilots

Herring notes similar trends in scientific and technical writing, and suggests using the following guidelines when using noun strings:

- add hyphens in order to group words into grammatical units that best describe the technology

- re-order the noun string by adding one or more prepositions, thereby emphasising unstated relationships
- use acronyms to replace strings.

Using these guidelines, 'low cost fuel handling and storage systems' becomes 'low-cost systems for handling and storing fuel' or 'small atmospheric fluidised bed combustors' could be 'small AFB combustors'. However . . . use acronyms sparingly, and . . . always define them. Too many acronyms in a single passage can be confusing. (Herring 1995)

Teleology: implying that phenomena are subject to final goals or purposes

- *Teleology.* **Teleology** refers to the ultimate purpose of something, or the way in which something has been designed to reach an ultimate end. However, organisms do not act or evolve with intent. Therefore, it is wise to avoid constructions such as 'Insects may have evolved flight in order to escape predators' and instead express the thought as 'Flight in insects may have been selected in response to predation pressure' (Pechenik 2001).

Anthropomorphism: implying that phenomena have human characteristics

- *Anthropomorphism.* **Anthropomorphism** occurs when we project human behaviour and characteristics onto non-human animals, substances or systems. Avoid expressions such as 'The existence of sage in the harsh climate of the American plains results from Nature's timeless experimentation' and opt instead for expressions such as 'Sage is one of the few plants capable of withstanding the harsh, dry climate of the American plains' (Pechenik 2001).

Bear in mind that teleology, and to a lesser extent, anthropomorphism, are ideas that are based on a reductionist and evolutionary perspective, in which there is no place or no need for grand plans or hidden purposes in reality (such as God or gods controlling the destiny of humans or the universe). Recent work by some scientists, however, suggests that, while acknowledging the workings of natural selection, there may well be proof of purposive structure or 'intelligent design' in the universe. And if there is purpose, will there also be teleology, and perhaps even some type of anthropomorphism (Davies 1993; Polkinghorne 2001; Shanks & Dawkins 2004; Manson 2003; Nissen 1998)?

ASSESS YOURSELF

1. If you have not already done so, get to know the readability statistics features of the word processing package you use. These produce statistics similar to those in figure 6.1 (p. 5).
   (a) Copy at least two 100-word samples of technical or scientific writing into a file, and determine the readability statistics
   (b) Rewrite the text samples so that they become more readable.
2. Browse the literature of a scientific or technical field you are familiar with, and find one example each of (a) hedging, (b) waffling, (c) super-compression, (d) ambiguity, (e) over-citation, (f) over-long sentences, (g) noun stacks, (h) teleology, and (i) anthropomorphism.

Scientific and technical documents

Different readers not only have different backgrounds and levels and types of knowledge, they have different motivations. For example, some people *read to learn* – that is, they want to extract information from a document and then use that information at a later time. Other people *read to do* – that is, they want to extract information now, act on it immediately, and then forget that information. This means that various types or genres of document will need to be written in different ways to communicate with various audiences (table 6.2) (see also chapter 5, 'Reports and proposals', pp. 157–8).

Table 6.2: Aspects of various types of scientific/technical document

Document type	Size	Purpose	When used	How used
Report/proposal	• Often short (1–10 pages), sometimes longer • Index often unnecessary	• Defines a phenomenon, situation • Records current data describing a situation	• Read by decision-makers needing to monitor situations or guidance for action • Sometimes some urgency involved	• Read sequentially, all the way through (or else abstract only is read) • Usually read only once • Situation-oriented • Reading to learn
Research article/ paper	• Usually short, sometimes long	• Provides a view, usually specialised in focus • Originality important	• Read to determine latest developments in a field	• Reading to learn
Manual/ instructions	• Can be very short to quite long • Index often necessary	• Gives step-by-step guide to procedure • Originality and point of view not important • Critical to market success of product or process	• Often read in crisis, after an event	• Read in bits, non-sequentially • Rarely read all the way through • Likely to be updated; multiple editions • Reading to do

Let's now look in detail at some of these document types or genres.

Reports and proposals

Reports and proposals are considered in greater detail in chapter 5. Reports can be long or short, and can perform a variety of functions. Reports can be wholly informative, wholly persuasive, or a mixture of the two.

Shorter reports tend to be more informative, and are vital in the world of science and technology for recording data on people, places, processes and things. Longer reports tend to be persuasive as well as informative, and often follow the three-part structure outlined in chapter 5 (p. 168):

1. *Front matter:* first section of large reports, and can contain the cover, letter or memorandum of transmittal, title page, summary/synopsis/abstract/precis, contents page and list of illustrations components
2. *Report body:* middle section of large reports, usually containing the introduction, discussion, conclusion and recommendations
3. *End matter:* last section of large reports, and can contain the references, appendices, glossary and index components.

Proposals, or submissions or tenders, are close relatives of the longer report, and are often more persuasive (rather than just being purely informative) in style than a standard report (see chapter 5, pp. 195–8).

Communicators in the realms of technology and science are often comfortable with the idea of documents providing records and information, but increasingly are coming to terms with the idea of needing to persuade audiences as well as to inform them. For example, in the quest for funding of programs, competition means that a case needs to be mounted that will differentiate one candidate project from another.

Not only do communicators need to become more skilled in the production of persuasive documents, but they also may need to become more skilled in backing up and reinforcing the written word by making persuasive verbal presentations and in lobbying or pitching for their projects (see chapters 5, p. 159 and 11, 'Oral communication').

Specific types of reports

In the realm of science and technology, many reports and proposals are quite similar to those considered in chapter 5. Writing styles and genres in differing disciplines, areas of enquiry and industries develop over decades or centuries and are sometimes unique; but ultimately all such non-fiction documents show more similarities than dissimilarities. Nevertheless, the fields of science and technology have sometimes developed interesting variations on basic document formats. Some of these formats are shown in table 6.3.

Table 6.3: Samples of different scientific and technical reports

Document type	Typical topics
Technical brief	• A voice synthesiser computer system • A batch-mixing process for paint/adhesive manufacture
Feasibility report	• Options for the recycling/reuse of waste materials in a paper-production plant • Potential applications of a small industrial robot system
Experimental/ research report	• A solar-power installation for passenger vehicles • Peptide synthesis in the development of anti-hepatitis vaccines • The environmental ageing of polyethylene insulation materials
Progress report	• Construction of an urban storm-water drainage system: stage 1 • Installation of an industrial heating and air-conditioning system: stage 2
Procedure/task report	• Specimen preparation for the transmission electron microscope • Exterior painting procedures for mould-prone areas • Health and safety procedures in herbicide spraying
Field report	• A survey of the mollusc population at Mallacoota Inlet • A field performance report on roofing products • Methods of density testing of road-making materials
Quality control report	• A purchasing and procurement system for quality control in a restaurant • A defect analysis program for an electronics parts service organisation • Quality control of raw materials in plasterboard manufacture
Investigation report	• A comparative evaluation of the effectiveness of domestic smoke-detector systems • An investigation of analogue electronics used in secondary science teaching • An investigation into the failure of a security alarm system
Test/laboratory report	• A test report on a foam system of fire extinguishment • An analysis of whey protein preparations in dairy research • Fatigue and fracture properties of PH stainless steel • A sterility test for cosmetic perfumes
Hazard report	• Potential environmental hazards of a ceramics production plant • A health and safety audit of a sawmill
Evaluation report	• An evaluation of a pilot program in local salinity control • An evaluation of a project in computer-aided design for domestic building
Proposal report	• A proposal to reduce energy consumption in a wool-processing plant • An improved layout for a school chemistry laboratory • A concept proposal for landscape design in a tourist complex

Source: Adapted from Wilshire (1992).

SOAPE: mnemonic acronym used for construction of nursing reports: subjective data, objective data, assessment, plan, evaluation

Other types of document have evolved to meet specific circumstances. For example, laboratory reports, used primarily to record and analyse data, tend to follow the patterns shown in figure 6.3; whereas nursing reports may follow the **SOAPE** format (figure 6.4).

1	Summary/abstract
2	Statement of the problem
3	Apparatus
4	Procedure
5	Test results
6	Analysis
7	Conclusions
8	References

Figure 6.3: Laboratory report format

Section	Explanation	Example
Subjective data	What the patient said about his/her reaction to nursing care	*Patient states she is feeling better but getting out of bed exhausts her.*
Objective data	What the nurse observes, inspects, palpates, peruses or auscultates, and any nursing procedure that is performed	*Respiratory rate 30, pulse 120, temperature 38.7. Moist cough, expectorating thick yellow sputum. Dyspnoea on exertion, rate up to 40. Peak flow pre Ventolin 150, post Ventolin 200.*
Assessment	The nursing analysis of the patient's progress or lack of progress from the nurse's and patient's perspective. The resulting nursing clinical judgement is the nursing diagnosis.	*Patient condition starting to show improvement.*
Plan	The nursing action that is provided to the patient, documented as the 'patient care plan'.	*Encourage patient to rest between episodes of care. Continue chest physio 2/24 and monitor respiration, conscious state and O_2 saturation. Ventolin nebuliser and peak flow 2/52. Continue O_2 therapy and medications as per drug chart. IV infusion as ordered.*
Evaluation	The patient's response to implemented care.	*Patient resting in bed. Cooperating well with chest physio. Expectorating effectively. Peak flow reading improved: now 300 post Ventolin. Has been able to sit out of bed for 10 mins without undue stress.*

Figure 6.4: SOAPE format for nursing reports

Source: Adapted from material supplied by Preston and Northcote Community Hospital.

The advantage of having an accepted format for a report, such as the IMRAD sequence used in research papers, is that such formats can act as a discipline for writers to stick to pre-ordained sequences, and audiences for such documents can concentrate on the content of the document and forget about structure. This advantage exists only if formats facilitate information and persuasion, rather than straitjacket them.

Whereas some scientific/technical documents can be quite long, many are short; and short reports tend to be more informative than persuasive. A report is a document that is structured according to the needs of you as a communicator and of the organisation you are communicating with, and you should not be constrained by any 'formulas' about what is a short report, or for that matter, what is a long report, submission or proposal.

How short is 'short'? How long is a piece of string? People's definitions of 'short' vary considerably, but within most organisations, a 'short' report would be less than four A4 pages or less than approximately 1200 words in length.

ASSESS YOURSELF

1. Using print or Internet sources, obtain copies of reports created in different industries or academic disciplines. Compare and contrast them. What conventions of structure and style are used?
2. Consider the differences between reports and essays (see chapters 5 and 7). Compare the structure and style used. What differences and similarities are there?

Research articles and papers

> *There is no form of prose more difficult to understand and more tedious to read than the average scientific paper.* (Crick 1995)

A research article or paper is usually published in a professional journal. It is usually refereed – that is, one or several anonymous reviewers will read the paper and make recommendations about whether it should be published or not, or whether changes might be needed to it.

Articles or papers usually communicate details of research: new information created by the person or persons writing it. They usually deal with the testing of a hypothesis via experimentation; but they can also deal with other matters, such as a review of a particular area or body of work, or a case study (for example, the explanation of a new medical procedure).

There are numerous reasons why people write articles or papers, from the most altruistic to the most self-centred, including (Van Teijlingen & Hundley 2002; Rosenfeldt et al. 2000):

- to add to the body of knowledge about a particular topic; knowledge cannot accumulate if it is kept private
- to lay claim of ownership to a particular idea or findings
- to improve the writer's chances for promotion and recognition from professional peers
- to improve the writer's chances for professional survival: in a 'publish or perish' culture (the sheer necessity to be seen to be doing something, irrespective of quality, may be an incentive to publish work that is not exactly paradigm-breaking)
- to boost the reputation of the professional organisation(s) where the writer works
- to satisfy the ego of the writer
- to develop the writing abilities and knowledge of the writer. Writing imposes a discipline that forces issues to be thought through in a logical way, allowing weaknesses in an argument to be detected. Searching existing literature to ensure that the idea has not already been fully explored is a worthwhile exercise in itself.

Audiences and markets

Before planning a research article or paper, you need to ask yourself this question: What have I got to say or contribute that is new or interesting? (See chapter 7, p. 233.) If you don't have anything new or interesting to write about, it may be better to wait until such circumstances arise (although cynics might say that such ethical considerations have never stopped some writers yet). If you believe that you have got something to say, you then need to think about who might publish you. This means that you have to familiarise yourself with the journals in your professional area, and find out about:

- the prestige of the journal
- the focus or emphasis of the journal, as distinct from others in the field
- the manuscript submission requirements and instructions to authors (e.g. presentation of text and graphics, mailed versus online submission, referencing conventions)
- which abstracting services cover the journal (i.e. the chances of having the abstract of your article circulated widely).

It may well be that more than one journal would be suitable for your article. In fact, given that the rejection rate for articles is quite high, you may end up submitting the article to more than one journal, a process that could take months. The process itself can become quite complicated (figure 6.5), but complexity in a process can work for you as well as against you. In other words, perseverance – the ability to take on board the criticisms of others, the ability to work your ideas through multiple drafts, the ability to workshop your ideas in spoken presentations or delivered papers at professional meetings and conferences, and the ability to handle rejection – may be almost as important as the ideas you are trying to communicate.

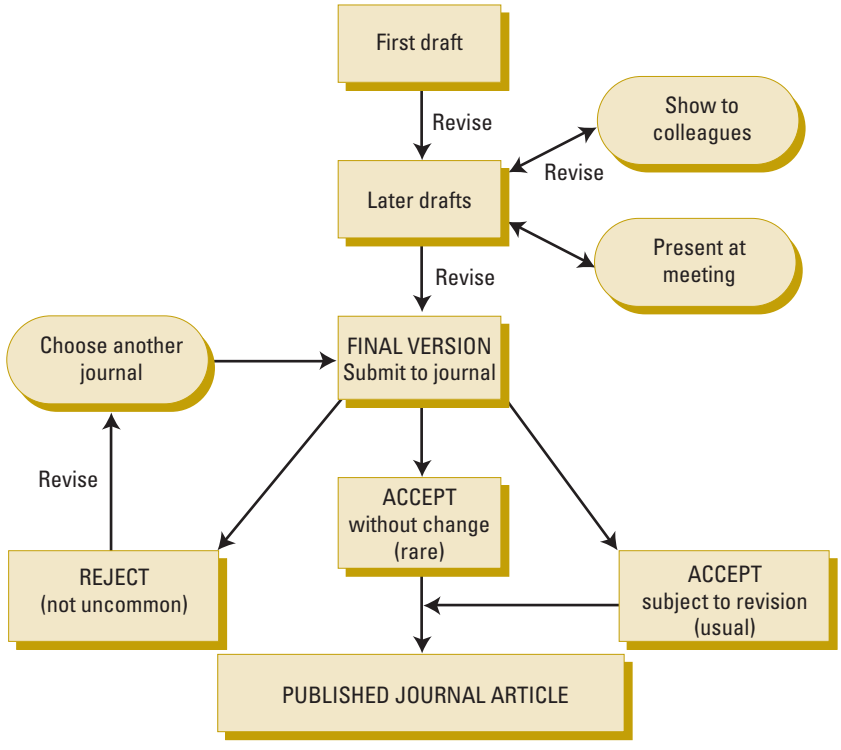

Figure 6.5: The process of writing and publishing an article or paper.
Source: Rosenfeldt et al. (2000, p. 86). Reproduced with permission.

Bear in mind that there is no final guarantee that a journal will accept your article at all. This could be for a number of reasons:

- It's no good.
- It's no good in its current form.

- Someone else has beaten you to it.
- The journal editor is not making wise decisions because of the volume of submissions received, or because he or she is biased or incompetent.
- The anonymous referees are not making good decisions because of the volume of articles they have to referee, or because they are biased or are incompetent.

Structure of research papers

The conventionally accepted structure for research papers or articles is:

T Title
A Abstract
I Introduction
M Methods and materials
R Results
A And
D Discussion.

Title and abstract

The title and the abstract are more important than they might seem at first glance, and this is because in the world of journal publication, there is no guarantee that your audience will be able to read the entire article, or have the inclination to do so even if the article is available. Not everyone can access paper or online journals. This is primarily due to rising subscription costs and the sheer profusion of new journal titles. Even when the full text of your article is available, your potential audience may not have the time or motivation to read every word. They may, however, have the time or motivation to read the title and the abstract; and because it costs so much less to make the title and abstract available through paper or online abstracting services, it is more likely that your title and abstract will become known to the world than it is for the full text. You need, therefore, to prepare a memorable and meaningful title, and a useful abstract.

The title should give maximum information in minimum space. Imagine a conversation where people ask you what your article is about, but you only have 10 seconds to tell them. That sums up the restraints and the challenges of writing a good title. Consider:

- wording that will put your ideas in a broader context
- wording related to ongoing controversies
- a title phrased as a question
- some (but not too much) humour or wordplay.

The abstract itself (normally 100–200 words) should deal with four different considerations:

- Why what was done was done
- What was done
- What was found
- What was concluded.

In fact, these four considerations mirror the **IMRAD** structure of the main text.

IMRAD: mnemonic acronym used for construction of papers or articles; introduction, then methods and materials, then results and discussion

A sample abstract, satisfying these requirements, is shown in figure 6.6. When writing an abstract, be specific about the outcomes; do not generalise with a meaningless statement such as 'some trends became apparent, and this is discussed'. Remember that many readers of your abstract will not be able to, or will not want to, avail themselves of your full text. For them, the abstract *is* the article.

Abstract section	Contents	Example
Why what was done was done	Should contain one or two sentences to orientate the reader and indicate the reasons for the study	*Snibbo is a novel compound for the treatment of road rage. A randomised double-blind placebo-controlled trial was carried out to assess its effectiveness.*
What was done	Should briefly describe the methods used	*All drivers of white vans stopped by British police on a major highway were invited to participate. Daily Snibbo (2 mg/kg) was compared with placebo. Participants were assessed at 0, 1 and 4 weeks by a standardised outside lane crawler test and their IQ-adjusted apoplexy scores recorded.*
What was found	Should include a synopsis of the results, including the size of the study groups and all basic figures	*One hundred volunteers were recruited: 48 received Snibbo and 52 placebo. There was no difference in the apoplexy scores at 0 and 1 week, but at 4 weeks those in the Snibbo group had a range of scores of 2–40 (median 22) compared with 17–82 (median 47) in the control group, allowing a difference in median score of 25 (95% confidence interval 15–45; p <0.01).*
What was concluded	Records what can be learnt from the paper and should make clear its message to the world	*For the relief of road rage in those particularly at risk, Snibbo appears to be more effective than placebo, but only after it has been taken for more than one week.*

Figure 6.6: Sample abstract of a research paper

Source: Adapted with permission from Lilleyman (1998, p. 41).

ABSTRACT: mnemonic acronym used for data presentation and interpretation; absolutely, straightforward, actual

Alexandrov and Hennerici (2007) suggest the mnemonic **ABSTRACT** for data presentation and interpretation:

AB	*ab*solutely
STR	*str*aightforward
ACT	*act*ual

They identify common mistakes in abstracts as being the failure to state the hypothesis, rationale for the study, sample size, speculations and opinions in the place of data, and conclusions. Cartwright, Khoo and Cardozo (2007) note that if there are inconsistencies between the abstract as presented (e.g. at a conference) and the abstract in the final publication, there could be a delay in publication.

The abstract and title come first, but may be written last. In fact, as you proceed through multiple drafts of your text, you may find that the actual exercise of writing the abstract and title triggers thoughts, doubts and insights about just what it is you are trying to achieve, leading you to modify or expand your actual research endeavours (see chapter 5, p. 170).

You may also be required to provide key words for your paper. These are words that identify the salient and unique aspects of your work and place it in a broader context. Key words or descriptors help automatic database searching by other workers in the field. In fact, it may help make your work more discoverable if you put one of your keywords as the first word in your title (see chapter 6, 'Online writing', p. 221).

Introduction, methods, results and discussion

The abstract reflects the IMRAD structure of the main text, so now let's consider just what is involved in IMRAD.

The introduction helps set the scene for your text by answering these questions: What is new about what you are attempting, and how does it fit in with the dominant paradigms of the area? What is your hypothesis? What patterns, relationships, interactions or cause–effect sequences are you attempting to prove (or disprove)? (See chapter 13, 'Argument: logic, persuasion and influence', p. 413.)

The methods and materials section is where you show what experimental procedures and resources were used in your research. There should be enough detail here for another reader to replicate your experiment, one of the key bases of scientific method (Lindsay 1996). Give details of statistical methods, constants and variables, samples and populations, and equipment and facilities used, but do not overwhelm the reader with too much detail.

The results section should provide the number-crunching details of what you have achieved. Give the facts, but do not get into detailed interpretation of the facts. One of the major weaknesses of some report writers is that they mix in fact and opinion, and it is sometimes difficult to separate the two. Save the opinions and the major part of interpretation for the discussion section (see chapter 5, pp. 157–8 and chapter 7, pp. 232–3).

You may need to cut back or edit your data if you have a profusion of results. The main criterion for inclusion of data is that it directly bears on your hypothesis. If you find that you have so much material, and you find new hypotheses evolving, then perhaps more than one paper is required (Lindsay 1996). This is not really a problem, and in fact may well be good news for your publication activities. Review and edit, and save good material for other documents.

Consider how you will communicate results: Is the data best presented in text, in diagrams, tables or photographs, or a mixture of these? Consideration of the strengths and weaknesses of each of these forms, and the synergies between them, will help you decide (see chapter 2).

The discussion section should tell the reader about (Spence 1998):

- the main findings
- the shortcomings you may see in your own methods
- the relationship of your findings to other published findings
- the implications that can be drawn from your findings.

Now you can interpret in full what has been developed in the previous sections. You may find that you need to cite the work of others in the field in this section more extensively than you have done in other sections. You may also signpost what further work needs to be done in the area, even after your efforts have perhaps materially pushed back the horizons of understanding in your field. This is also the section in which you may need to acknowledge the assistance of others, of funding bodies and the like.

Whereas the IMRAD sequence is the dominant paradigm for structuring research writing, it is interesting to note that the use of the sequence has been questioned in recent times. A more informal writing style, using the active voice and simple language, is likely to allow authors to present their work in a more readable and interesting way. Many people who describe their work clearly when talking about it, often resort to pompous verbosity in the written form (Waldron 1995). Medawar (1963) believes that the discussion section of a scientific paper should come first, followed by the facts and acts. This would avoid the 'inductive format', where one section is derived from the preceding one.

Writing with others

The research paper or article is possibly the genre in which you are more likely to collaborate with other writers. This is because of:

- the interdependent or team nature of much research
- the unlikelihood of being the sole expert in different aspects of the one research topic
- the desirability of attaching your name to those of more experienced and/or prestigious writers in the field.

Collaborating with others can be a rewarding experience, but it can also have its own frustrations, and you need to be aware of such dynamics (see chapter 2).

Writing for readers and writing for listeners

Papers or articles are not always written solely for the purpose of publication. Sometimes you may write an article or paper as a basis of a spoken presentation to a professional meeting, seminar or conference. In fact, you may find it useful to present a rough version of your final published paper at a gathering as a way of workshopping your ideas; any feedback you get from professional peers about your presentation can further develop ideas for your final written text. Sometimes conference proceedings are published anyway, but you may be given the chance to re-draft a proceedings paper so that it more closely meets your own standards for published work (see chapter 11, p. 347).

Therefore, it is useful to understand that a seminar or conference paper or article is different from a journal paper in its planning, construction and delivery.

ASSESS YOURSELF

1. Select 3–6 journals in a professional area you are familiar with. Compare and contrast each journal's:
   (a) approach to the area
   (b) approach to layout and presentation
   (c) manuscript submission requirements
   (d) paper and online availability
   (e) website (What does it say about the journal's market position?)
   (f) prestige and influence vis-à-vis other journals
   (g) accessibility by abstracting services and databases.
2. Select 3–6 journals from completely different areas. Evaluate each of them according to the criteria set out in question 1.
3. Research a topic via a database. Consider the article titles listed. Which titles are more likely to motivate you to find out further about the abstract and full text? Why are some titles more effective than others?
4. Compare the abstracts to the full text of three articles. How effective were the abstracts?
5. What are the strengths and weaknesses of the IMRAD model of construction?
6. Create a pattern diagram or tree diagram of an article or paper you might consider writing in a professional field you are familiar with (see online chapter 5).

Instructions and manuals

Consider the following documents:

- a one-page assembly instructions sheet for a toy
- an information booklet accompanying a sewing machine
- a manual for a new car

- a manual for some computer software
- a brochure from the local council explaining how to position your rubbish bin for collection by a new automated rubbish truck
- a sign in a laundromat showing how to use the machines
- a note from one person (suddenly taken ill) to another, explaining how to perform a job role
- an office manual, setting out policies and procedures for employees.

All these documents are important: they tell us how to achieve things that are important to us. Many of these documents are now seen to be vital marketing tools for products and processes; if they are not done well, then potential customers just won't buy, and existing customers won't buy again. Instructions and manuals also have important legal implications: if they are not written well, and something goes wrong because of ambiguous, confusing or incorrect text and visuals, then customers will sue (Lannon 2002).

Yet instructions and manuals:

- are often used in an unsystematic way
- are often misunderstood
- are often poorly written
- often go unread.

Many people work on the assumption of 'when all else fails, read the manual'. In other words, instead of the information document being the first resort for the user when trying to understand a product or process, too often it is the last resort. Studies have found that users of software manuals tend to proceed in the following order when seeking information (Horton 1993; see also Jansen & Balijon 2002):

1. Try and see what happens (in other words, play around with it)
2. Ask another user
3. Call the vendor
4. Search online documentation ('help' screens within the software)
5. Read the manual.

Documentation writers often characterise such user behaviour as profoundly irrational. Some users counter this charge by saying that their behaviour is quite rational, given the poor quality of much documentation. Obviously, there is a lot more happening in the apparently simple field of instructional documentation than at first meets the eye.

Dummies, idiots, beginners and readers

It is interesting to note, for example, the publishing phenomena of books aimed at 'dummies,' 'complete idiots' and 'beginners'. These books, while not always successful at communicating ideas, nevertheless seem to connect with readers because of their use of everyday language, graphics and humour. Therefore a person may buy, for example, some software, and then buy a popular book on that software rather than read the manual or online help facility that comes with the software.

The more effective documents are, the more likely they will be read and used. True effectiveness entails considerations of grammar, layout, style, editing, and analysis and understanding of the process or product being described. It also entails an appreciation of the audience.

The audience

The audience, strictly speaking, is anyone and everyone, but that is not terribly helpful. There tend to be two types of manual:

- Manuals written for the general public – for example, a manual accompanying a new washing machine
- Manuals written for a narrower group – for example, a service manual for a washing machine service person, a procedures manual for employees of a particular organisation.

The first type of manual tends to be general and non-technical; whereas the second type tends to be specific and technical. The sheer generalness of the audience imposes special restrictions on writing. Advanced literacy, for example, cannot be assumed. The US Army, a great producer and consumer of manuals, found that, in 1982, almost 40 per cent of its junior enlisted personnel had reading abilities below the sixth-grade level, or were in fact illiterate by United Nations standards (Meyer 1992; see also online chapter 3). English has become the de facto 'global language', although this does not mean that all people who have a grasp of the language do so at a sophisticated level. This means that:

- organisations from English-speaking countries intent on exporting products and processes must create documentation that can be understood by people of non-English speaking backgrounds
- organisations from countries where English is not the first language must create documents that can be understood both by users who have English as their first language and those who do not.

Language in instructional documents that is complex rather than simple will therefore present problems. Consider also someone who has just bought a product, has unpacked it, and is now confronted with the product and the manual. This person may now be experiencing a number of strong, perhaps contradictory, states of mind (table 6.4).

The presence of several of these states of mind will guarantee that the user will not immediately extract the maximum amount of information available from a manual. Even when the user is motivated to use a manual, he or she will use it in a manner not necessarily envisaged by the manual's writers. Users rarely read manuals from cover to cover: we all have good intentions of doing this, but this ideal is rarely achieved. Most users *skim* and *skip* their way through a manual, picking out slabs of information that are relevant in a particular situation.

Table 6.4: States of mind of users of instruction manuals

State of mind	Accompanying thoughts
Excitement	Gosh, doesn't it look fantastic! I can't concentrate on anything else at this moment, least of all a manual!
Impatience	I want it to work *now*. I don't want to spend time ploughing through this manual.
Fear	What if I break it? I'd better read the manual.
Justified competence	I know all this. I don't need to look at this manual.
Arrogance	Any fool can operate this. I don't need to consult a manual.
Justified cynicism	Most manuals I've come across have been confusing or insulting to my intelligence. Why should this one be any different?
Despair	Look at the size of this manual! Where do you start?
Ignorance	Manuals don't work. I wonder what will happen if I press this?

Users are *reading to do* rather than *reading to learn*. This means that they are not passively reading, as they might be if they were reading a report or memo or novel. When using a manual, they are usually engaged in doing something: assembling, operating, troubleshooting. Indeed, the very word 'user' is one that we would rarely apply to people reading other types of documents, such as memos, articles, reports or novels.

Not infrequently, users are in a state of crisis – something has gone wrong, and they need answers fast: 'Quick, where's the manual?' They therefore need a document that:

- can be physically handled with ease (is not too big, is not too heavy, can be held in one hand, can lie flat)
- is physically robust
- is user friendly and can provide rapid access to different types of information.

The user is, to state the obvious, the customer – the one who in the final analysis pays the bills in the organisation that creates products or processes, instructions or manuals. This truth is not, however, as obvious as it should be to the more ineffective writers of instructions and manuals.

The writers

Instructions and manuals are often seen as examples of boring and unimaginative writing. Yet imagination, combined with a good memory, are perhaps the prime qualities writers of such documents must have. Writers must *remember* what it was like to be without the expert knowledge they now have and to put themselves in the position of absolute beginners; and they must *imagine* the needs of a variety of users, who necessarily have a variety of needs and ways of perceiving things (Eisenberg 1989).

We have already considered the tensions and synergies between subject-matter specialists and professional technical writers. These factors tend to become particularly salient when instructional text and manuals need to be created. Instructions and manuals are sometimes written by technicians, or the people who have been most closely involved with the development of a product or process – for example, the engineers who designed and built an appliance. Sometimes the documentation is prepared by professional technical writers, who must then learn about the technicalities of the product or process in order to communicate the information the users require.

Technical knowledge forms the basis of the *content* of a document, whereas writing skill forms the basis of the *process* of communication. Technicians are content experts, but are usually process amateurs. Professional writers are usually content amateurs, but process experts. Who, then, are best equipped to write instructions and manuals? It's almost impossible to generalise about this. Sometimes technicians can do a much better job than professional writers, because only technicians can understand the subtleties involved. It's also possible that a particular technician might also be a more gifted communicator than a particular professional writer. By contrast, the professional writer may do a much better job, because he or she can get a better overview of things. A technician, for example, may have put so much emotional energy into creating a product or process and believe that end users will share the enthusiasm for every conceptual detail. The enthusiast quickly becomes a bore, and frustrates and annoys the audience of users. A professional writer may be able to unsentimentally edit out such detail, or at least more readily place it in a less prominent part of the document for those users who actually are interested (see chapter 13, pp. 422–3).

A little ignorance, or content amateurism, can in fact be a good thing. Some software companies have their documentation written by their newest staff members, because such novice technicians can bring a fresh eye to the situation, and will be more likely to mirror the actual abilities of the users. This approach has much in common with the naive user test.

Maintaining a neutral style

Technical and science writers must also take care to maintain the neutral style of a 'manual'. The presence of the word 'manual' in a publication reassures many people that the content is clear, objective and unbiased. Yet, when Merrill et al. (2008) studied 'talk to your children about drinking' manuals from two groups, the alcohol industry and non-industry (usually government and non-profit) organisations, they found more bias in the alcohol industry manuals. This was a case of omission rather than commission: the alcohol industry manuals provided substantially fewer reasons why teens should not drink, and showed significantly lower rates of mention for most problems and public health issues (driving risks, mental health, sexual issues, injuries, violence, crime, alcoholism, school goals, and gateways to drugs).

In fact, the more we investigate the technical and scientific genres of writing, we see that its reputation for absolute clarity, objectivity and truth sometimes takes a beating. (See www.techstandards.com for examples of winners of the 'Worst Manual Contest'.)

Structure and layout

The key qualities of any manual or set of instructions are *accessibility* and *user friendliness*. These are, however, very subjective qualities: what is user friendly to one person will be very user unfriendly to another. This subjectivity can be eliminated substantially (but not totally) by proper editing and testing.

Accessibility and user friendliness are ways of describing the packaging of information, and physical structure and layout are key parts of that packaging for manuals and instructions. Key aspects of structure and layout are given below (table 6.5).

Table 6.5: Key aspects of structure and layout for manuals and instructions

Property	Key questions
Weight	• Is the document too heavy to hold in one hand? • Is it so light that it could be blown away? • Do perceptions of weight vary between sexes, cultures?
Size	• Is the document too large to be propped on a desk or opened on a lap? • Is it too small to be read quickly and in comfort? • Might instructions be folded out to form a poster?
Texture	• Is the document pleasant or unpleasant to touch? • Is it practical for certain situations or environments? (For example, will it become slippery if moisture is present?)
Finish	• Is the document produced on gloss or matt paper? • Are surfaces treated against moisture or chemicals for use in specific environments?
Binding	• Is binding (glued or perfect, sewn, spiral, ring or loose leaf) appropriate? • Does document lie flat? • Is document hard cover/hardback or soft cover/paperback? • Is document rigid enough to stand by itself on a flat surface? • Is it robust? (For example, a thick paperback format with cheap glue will become unusable fairly quickly.)
Pagination	• Is document paginated continuously throughout, or is it paginated in different sections or chapters? (Document creators often prefer sectional pagination — when combined with ring/loose-leaf binding, sectional pagination allows pages to be replaced and updated. Document users, however, are often annoyed by such pagination, finding it inconvenient and sometimes confusing.)

Property	Key questions
Physical aids	• Is understanding helped by features such as: – tabs showing different sections/chapters? – thumb-index indentations? – colour-coding of pages in different sections/chapters? – quick-reference cards? – cardboard templates (for example, for placement on computer keyboards)? – fold-outs? – posters?
Clear sequence	• Is there clear reference to and clear separation of: – title? – table of contents? – installation instructions? – operating instructions? – tutorial/demonstration/case study material/examples? – reference material/theoretical background? – troubleshooting/help advice? – maintenance suggestions? – assembly/disassembly? – specifications? – index/indexes? – cross-references? – glossary? – appendices?
Clear layout	• Is understanding helped by devices such as: – hierarchically-structured headings (see online chapter 5, pp. 14–17)? – overviews, previews and summaries? – intelligent and tasteful use of different fonts/typefaces? – intelligent and tasteful use of colour (where affordable)? – generous use of white space, ensuring that text is not too cramped? – clearly numbered steps/sequences? – strongly highlighted warnings, alerting reader to potential safety problems? – setting out of key points in bulleted text (as in this table), rather than blocks of narrative text? – setting out of troubleshooting information in tables/matrices rather than narrative text (where appropriate)? – strong use of appropriate visuals, icons, symbols? – visuals kept close to relevant text? – appropriate layout of text in columns?

Logical development

In communicating information to users, the key factors you should bear in mind are *sequence*, *reinforcement* and *simplicity*.

Sequence

Sequence simply means starting at the beginning, proceeding on through the middle and finishing at the end. Where is the beginning? Remember, a leap of imagination and memory is required by document writers in order to put themselves in the position of users. The beginning, for absolute beginners, may entail quite basic information. It may be better for writers to err on the side of over-simplification rather than assume prior knowledge and jump in at a level that will simply confuse and annoy beginners. Sample beginnings are shown in figure 6.7.

For an appliance manual	Expression of thanks for purchasing the appliance, followed by the unpacking instructions
For a policies and procedures manual	Welcome from organisation's chief executive officer, followed by a brief overview of organisation
For a pH testing kit instruction sheet	Checklist of chemicals and equipment items, followed by a brief diagrammatic exposition of acidity and alkalinity

Figure 6.7: Sample beginnings in manuals and instructions

Once the beginning is done, writers may then develop their exposition of the product or process, usually one step at a time, often with an illustration for each step. Stepwise development can be shown using one or several methods:

- from start to stop
- from simple to complex
- from input to output
- from outside to inside
- via case studies, tutorials, examples or scenarios.

Reinforcement

Sequence needs to be tempered with *reinforcement* or preventative repetition. Never presume that the user has read everything prior to a particular point in the document. To counteract this, don't be afraid to repeat material, use cross-referencing and alert the user to any prior knowledge or competencies required for a particular section or chapter – especially whenever any danger might arise from lack of such knowledge or competencies. Reinforcement can also be achieved by saying something twice in the one location: once in text, once in visuals (see chapter 1, p. 19).

Simplicity

Finally, in explaining a process or product, remember the KISS principle:

> **K**eep **I**t **S**imple, **S**tupid.

Resist the temptation to 'blind 'em with science' – it's counterproductive. The more complex your document is, the more difficult it will be to use, and therefore the less it will be used. This does not mean that you should over-simplify, trivialise or distort your message; treat it with appropriate respect and use appropriate concepts. Always bear in mind, however, one of the paradoxes and challenges of good technical writing: complexity is easy for the writer, but difficult for the audience – simplicity is difficult for the writer, but easy for the audience (see chapter 2, p. 44).

Language and rapport

Consideration should be applied to the language you use. Keep your language simple, rather than complex. This means using short sentences and paragraphs rather than long sentences and paragraphs, and simple sentences rather than complex or compound ones. Active rather

than passive voice constructions, and imperative rather than indicative or subjunctive mood, are also characteristic of good manuals and instructions (see online chapters 1 and 3).

Rapport can be established with users in a number of ways. The personal pronoun 'you' can establish a conversational tone. For example, 'If you load it in this way (Diagram B), then the mechanism can jam'. This construction can help to soften the harshness that can occur with the overuse of imperatives ('Do not load as in Diagram B, as mechanism can jam.').

The conversational tone can be enhanced by using contractions: 'you'll' instead of you will, 'it's' instead of it is, 'that's' instead of that is, and so on. The use of question and answer format is another way to establish rapport (see online chapter 5). Questions are posed, often from the user's point of view, with the writer providing the answers:

Q. *What happens if I press the red button instead of the blue one?*

A. If you press the red button…

Q. *Under what circumstances would the guarantee be valid after six months?*

A. The guarantee can be extended if…

Rapport can also be created with humour – but use it with care and economy because readers who are *reading to do* tend to be very task-oriented, and may not be in the mood for jokes. Keep in mind also that instructions and manuals tend to be referred to again and again, and what was funny the first time may not be so funny on the fifteenth. Also, humour is subjective, and the writer's sense of humour may not necessarily appeal to the user.

Keep the pace moving with the use of transitional words, cueing the user to the dynamic progression being described – for example, *first* do this, *then* do that, *next* bring in this, and *finally* press this (see online chapter 3).

Finally, a warning on the use of jargon in manuals and instructions. Jargon, of course, is a relative concept: what may be jargon for one person is perfectly clear, acceptable and effective language for another. The test is: what does the audience think is jargon? Try not to overwhelm users with many specific technical terms. If a number of terms are indispensable, either define them in the text the first time they occur, or provide a glossary, or use both approaches (see online chapter 4).

The overall approach to manuals and instructions is shown in table 6.6.

Table 6.6: Key aspects of logical development and language in manuals and instructions

Factor	Points to note
Sequence	Stepwise progression shown by start–stop, simple/complex, input–output, outside/inside models, case studies, tutorials, examples and scenarios
Redundancy	Necessary repetition: don't assume user has read everything prior to a specific sentence or section
Simplicity	KISS principle
Sentences, paragraphs	Short, not long
Voice, mood	Active, imperative
Rapport	Established via use of 'you' approach, contractions, question–answer approach
Humour	Use sparingly
Keep pace	Use transitional words
Jargon	Use sparingly: define and/or provide glossary

A writing–editing sequence to maximise usability

We now have a fair idea of who is the audience for manuals and instructions, and who should be doing the writing. We also have an idea of what is involved in structure, layout, logical development and language of such documents. How can we put all of these factors together to ensure that the final document has high **usability** – that is, that the document is as user friendly and successful as possible? A useful model for the writing and editing of user-friendly and successful documents is seen in figure 6.8.

Usability: the extent to which a document or process or product can be understood and used

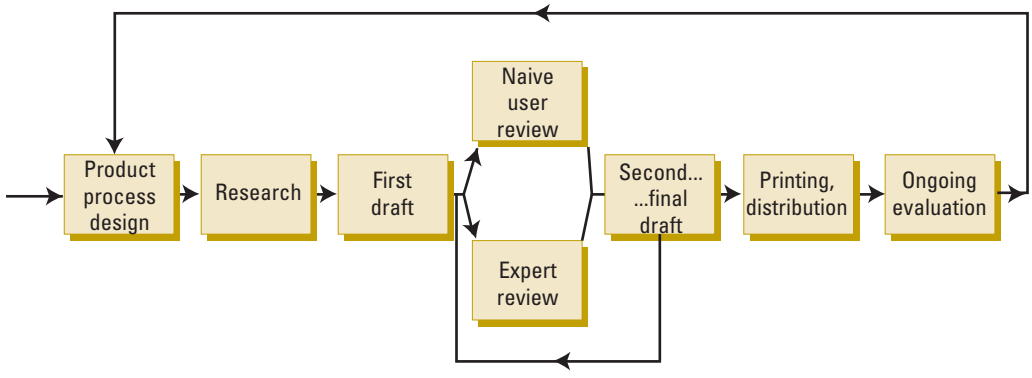

Figure 6.8: Sequence to improve usability

Drafting

Imagine a situation where a process or product has already been designed, and a manual or instructions writer is now brought in to produce a document. The first thing the writer must do is some basic research. A writer not versed in the technical specifics of the process or product will have to get a good grasp of such detail. A technical expert, however, may need to discover more about the craft of writing. Our expert or our non-expert will need to find out more about the audience, from interviews, market research and anecdotes.

Once this research is complete, a first draft can be completed. Such a draft is then submitted to an expert panel: people who know their stuff technically, and who can give approval or make suggestions for rewriting. But the world is comprised of more non-experts than experts, and their opinions are valuable as well. A naive user review can be extremely useful here. People who know nothing or very little about the product or process work through the manual or instructions. As they do so, they take notes on the usability of the document, or talk aloud, describing perceptions and interpretations of the document's message. Many problems not immediately obvious to the writer – misleading instructions, ambiguous or confusing phrasing and visuals, ineffective cross-referencing, inefficient layout – can be revealed in this way.

Redrafting

Data from the expert review and the naive user review is used to construct a second draft. This is then submitted to both review processes again, and this resubmission happens again and again until a final, satisfactory draft is produced. This draft is then printed and distributed.

Is that the end of the matter? Not at all. Evaluation continues on an ongoing basis. Customer feedback – both positive and negative – will indicate how effective the document is, but it will also indicate just how effective the actual product or process is. That information can be fed back into the product or process design phase. In fact, in a truly effective situation, the documentation writer will not be brought in *after* the product or process is completed, but instead will be brought in *during* the development process. The writer's perspective and initial drafts of documentation may give insights into potential problems or opportunities for

redesign that simply might not have occurred in any other way. (This process has some interesting similarities to strategic listening to customers and to organisational communication.)

The paperless product

Horton (1993) has suggested that many products available today are unnecessarily complex. Because of this, the operation of such products is not obvious to the users. Because of this lack of obviousness, there is a great need for manuals and instructions. But the behaviour of users shows that they do not use the manuals and instructions, unless as a last resort.

Horton's solution is twofold:

1. Make products so that they are less complex.
2. Make products with embedded information – so that in fact an information implosion takes place, moving information from the periphery of a product to its core (for example, via help screens within software).

This would mean that paper documentation would diminish in some cases, and wither away entirely in others. The paperless product, and the paperless process? Possibly. The paperless office has been heralded for some time, but is evolving slowly. Increasing numbers of documents such as memos, reports, forms and faxes are electronic entities only, and are rarely printed out as hard-copy. People are motivated to use help screens in software and 'onboard' diagnostics and troubleshooting readouts in automobiles and sewing machines because they are fun, and because they are fast. It remains to be seen, however, whether users will be able to extract enough information from tangible products – let alone intangible processes – by non-paper means.

ASSESS YOURSELF

1. Collect at least four manuals and sets of instructions. Using the checklists given in this section, evaluate the documents. What are their strengths? What are their weaknesses?
2. Working with a group, construct a 'horror list' of the worst manuals or sets of instructions you have ever come across. How might these documents have been improved?

Summary

In this chapter we considered aspects of scientific and technical writing. We looked at differences and similarities between writing for general audiences and writing for scientific and technical audiences. We noted that to communicate effectively with different audiences, scientists and technologists need to learn to vary their writing style to match the needs, abilities and motivations of differing audiences. To achieve this they must learn to use differing document types to convey different messages, or to convey the same message in different ways, and use differing channels and technologies of communication – from written documents to online documents to oral presentations. We examined the problems and opportunities that might arise when content experts work with professional technical/scientific writers. We identified the key components of scientific and technical style, and the pitfalls associated with that style, as well as exploring the similarities and differences among three genres of technical and scientific writing (reports, papers or articles, and manuals or instructions). We considered the structural, style and audience factors that bear on these different genres of technical writing.

Student study guide

KEY TERMS

ABSTRACT *p. 6.16*
ambiguity *p. 6.6*
anthropomorphism *p. 6.9*
deficit model *p. 6.2*
hedging *p. 6.6*
IMRAD *p. 6.15*
noun stacks *p. 6.8*
over-citation *p. 6.7*
over-long sentences *p. 6.8*
readability *p. 6.6*
SOAPE *p. 6.12*
super-compression *p. 6.6*
teleology *p. 6.9*
usability *p. 6.26*
waffling *p. 6.6*

REVIEW QUESTIONS

1. Identify at least two style aspects of scientific/technical writing that we would be unlikely to find in writing aimed at general audiences.
2. Name two disadvantages and two advantages of 'translating' technical or scientific writing so that broader audiences might understand our message.
3. What is meta-communication, and how can it break down?
4. Identify at least three pitfalls of scientific/technical writing.
5. Identify at least four different types of scientific or technical reports.
6. Why is the abstract of a research article or paper so important?
7. Give at least three reasons for writing a research article or paper.
8. Why are manuals or instructions so often ignored or misunderstood?

APPLIED ACTIVITIES

1. Find examples of general writing and scientific/technical writing dealing with the same topic (e.g. the greenhouse effect, a medical treatment, the explanation of a mechanical process such as internal combustion). What differences and similarities are there between the two styles?
2. 'The major advantage of writing a report or a funding proposal in the worlds of science and technology is that you don't have to get involved in the politics of getting people to read your document – people are rational, and they will respond to the logical arguments you present.' Discuss.
3. 'The IMRAD model of research paper writing is too constricting and is doomed.' Discuss.
4. Think of a process you are familiar with – driving a car, making a meal, playing a game, performing a task – and write a set of instructions for the process.
5. Give the instructions you wrote for question 4 to someone unfamiliar with the process you outlined. Conduct a naive user or usability test (see pp. 24–5) of your instructions. How effective/ineffective were they? Why?
6. Compare the official documentation that accompanies a product (for example, a software manual or a series of online help screens) with a 'dummies' or 'idiots' book on the same topic. What similarities and differences do you see?

WHAT WOULD YOU DO?

You are Manager, New Projects, at Kybernet 3000, a high-technology company. The most important project you have been overseeing recently is the new HaloHolo screen, a holographic screen and projection frame. The project has not been going well, but you do have hopes for it over the long term. Last week, you wrote a report for the board of directors and the shareholders' annual report. You pride yourself on telling it as it is, using plain English and clear diagrams to indicate the progress and problems with HaloHolo. This morning, you receive via email a copy of the report sent to the board and the editor of the annual report. You are shocked to find that someone – probably someone working in the chief executive officer's area – had substantially redrafted your report, to give it an unrealistically up-beat feel. Your jargon-free style is almost unrecognisable, as are the conclusions drawn. For example, your 'image sharpness is still not satisfactory, being only in the range above those of sub-$1000 analogue TV receivers' has become 'photoluminescent stabilisation and chroma saturation coefficients have improved markedly over the first prototypes, and are now well in excess of non-digital/HDTV reception parameters'. You also notice that some of your graphs have been changed to give an unrealistically favourable view of the performance of current and upcoming builds of the HaloHolo. You are furious, and storm up to the CEO's office. You have been waiting for half an hour when he walks in and says to his secretary, 'Check out our share price on the Internet. It's gone through the roof since the market got wind of how good HaloHolo is going to be!' He then turns to you, and says, 'Hi! What's happening?'

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