Effective Writing
Improving scientific, technical and business communication
SECOND EDITION

Christopher Turk
Senior Research Fellow
University of Wales
College of Cardiff

John Kirkman
Consultant on Scientific and Technical Communication

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7 Style for readability

Functional style

The word 'style' is usually associated with literary writing. We are conscious that to offer to discuss style will remind many of our readers of school poetry lessons; but to have style in the sense we use in this chapter does not mean to be 'florid' or 'ornate': it is to adapt the language code to particular ends. Language can be used for a variety of purposes; it can, among other things, announce or warn (notices), instruct (operating instructions), persuade (advertising), and inform (reports and articles). What is efficient in writing can be measured only in relation to the purpose of the writing. If the purpose is to give pleasure, then attractiveness becomes one of the criteria of the efficient manipulation of the code; but if the purpose is to warn or to instruct, then notices like 'Keep off the grass' are admirable. They manipulate the resources of the code to achieve their ends. In other words they have good style.

There is a distinction between imaginative literature (with which the idea of style is usually associated) and functional writing.¹ We are concerned in this Chapter solely with effective style for the communication of information; what is efficient for this context is what is clearest and quickest. Elegance may or may not be a by-product; but it can never be an intention. Style for functional writing should be unobtrusive, an invisible medium, like a window pane through which the information can be clearly seen.² Of course, lapses from good taste, or unacceptable usage, can be unfunctional, in that they disturb and distract the reader. But equally distracting is any usage where the motivation is display or ornamentation, rather than clarity.

Effective style will contain a variety of structures and usages, and will not ban any feature of the language code. Our experience is that the poor quality of much scientific and technical writing is the result not of misguided attempts at stylistliness, but of attempts to use only a restricted set of choices from the language code. Much writing is tedious because it restricts itself to passive, roundabout and impersonal constructions, and to a Latinate vocabulary. We shall not be arguing that any of these types of structure or vocabulary should be banned. But if they are used to the exclusion of many other constructions, they gradually become blunt and tasteless. If a particular feature is used exclusively, its contrastive effect disappears, and less meaning is perceived. Too many writers fail to vary their manipulation of the code; their flexibility is limited.

We would diagnose this lack of flexibility and variety as the major cause of the indigestibility of much writing. Sadly, readers get used to leaden scientific idioms. They get used to digging for meaning in the heavy soil of scientific prose; they even get inured to supplying a meaning where vapid abstraction leaves none obviously available. Sadly also, writers feel more secure if they restrict themselves to traditional phrasing and vocabulary. A stiff and formal style, lacking variety and comfort, seems to them to suit scientific truth. We hope in this chapter to show that such an unadventurous usage of the language code is unnecessary and unproductive.

Many books on writing stress that scientific style must be simple, clear and concise. Indeed our readers, most of whom must have heard such advice at some time, might be forgiven for thinking that there was nothing else to say. We intend to offer both reason and example to support our advice. We shall look first at the factors which underpin advice on effective style, and then in detail at the ways in which the language code can be handled to achieve the aim of comfortable, readable writing.

Much research has been done to discover what it is that makes some pieces of writing more difficult to read than others. It is everyone's experience that some writing - for instance a Harold Robbins novel - is so easy to read it can be difficult to put down. But some writing is so difficult to read that as we push ourselves through it we develop a headache. Too many textbooks and scientific papers fall into the second category. There are also, of course, types of writing which fall between these two extremes.

If we want writing to be as efficient as possible, we should make reading as easy as possible, for papers that present extra barriers between their message and their readers are obviously inefficient. Equally important, they are unlikely to get promo-
tion for the person who wrote them. It will not be his or her discoveries that the scientific community uses and is grateful for.

Each of us would like his or her writing to be readable; but how should we go about ensuring this? The first stage in acquiring an effective and readable style is to understand the factors which contribute to unreadable writing. Much work has been done on the measurement of readability. We do not want to write a thesis on the linguistic discipline of stylistics (as the science of style is called), but in the following sections discussing factors that influence readability, we have tried to give brief justifications for our assertions. We give details of a well-known readability formula in the appendix.

In analysing the factors which affect readability, we can distinguish three components: writer, text and readers. First, the writer, principally by careful selection of material, by organization, signposting and variation of emphasis, affects the readability of the text. If the writer’s choices accurately reflect the interests, needs and prior knowledge of the readers, the text is more likely to be readable. Second, the text itself affects readability. Both the language (structures and vocabulary) and the physical appearance (layout, headings, white space) contribute to the efficiency of the communication. Third, the readers’ motivation and attitudes contribute to their responses to the text. For example, someone with a bet on the Derby finds the racing results highly readable, though they are hardly a model of prose for report writing.

Clearly, whether readers find what they expect to find in a text affects their attitudes, and therefore the text’s readability. Here, good titling and signposting will help improve the overall readability. If readers are clearly warned what to expect, and are shown frequent signposts along the way, they are unlikely to stumble over incorrect ideas about what the text is saying. The readers’ mental states will also affect readability. The writer may be able to do little about distractions or tiredness, but he or she can reduce their impact. By making a text more readable, the writer reduces fatigue during reading and avoids irritating readers by inflated choices of language.

We shall not concern ourselves with questions of interest and motivation. On the whole, most scientific and technical writing is read because reading it is part of a job. Consequently, we may assume that, on average, most readers have broadly similar motivation when reading functional writing. For practical purposes, interest remains constant. Other factors become therefore more important in determining a text’s readability.

Readability research shows that long sentences make texts more difficult for readers to absorb. Almost all readers experience this, although they may not identify its cause. Many readers are so generous that they attribute their growing discomfort to lack of concentration or ability. They may also think that a difficult subject, rather than a difficult style makes their task so unpalatable. But the effect of sentence length on readability is indisputable. Try reading this sentence:

The coil pump supplies eluent phase at column pressure to the injection valve by way of a cut off valve activated by either a power failure or by a digital output from the computer, the digital output operating a relay switching the electrical supply to the valve, which has two solvent (5/1) passages and is arranged such that the eluent phase can flow through one whilst the sample passes through the other, injection being achieved by switching the slide valve by a pneumatic controller operated by means of a signal switch from the timer unit of the Cecil sample charger.

We doubt if many readers can grasp this without reading it through more than once. Yet it is not the technical content that is the source of difficulty, and only the word ‘eluent’ is likely to be unfamiliar to most technical audiences. It is the encoding, rather than the content, which causes difficulty.

Long sentences are difficult because of the way in which we read. After reading a paragraph of text, we do not remember every word, but retain ideas, facts and images. Yet as we read a sentence, we probably retain each word until we get to the full stop; only then can we confidently decode the sentence as a unit. What happens is that our short-term memory retains all the words until it can extract the content and store it more permanently in a longer-term memory. Our short-term memory for words is necessarily limited. Long sentences, such as the example we just used, overflow the short-term memory and the information is lost. As more and more words are crammed into an interminable sentence, the words we read at the beginning are forgotten.
Observe what readers do when a sentence is too long. Most go back to the beginning again, and start to re-read; but they usually do not re-read the whole sentence. They simply refresh their memory of the opening part of the sentence. If readers are in a hurry, they will not spare time to go back to the beginning of every long sentence; they take a guess at the meaning, and carry on. In this way, a fog of uncertainty builds up in their minds, and they end up with an incomplete and erroneous idea of what the text was about. All readers find continuous reading of long sentences a strain. The writer continually makes maximum, and sometimes unreasonable, demands on their short-term memories; gradually they get tired, and concentration lapses. The writer of long sentences risks making readers inattentive.

Many writers feel that long sentences are inevitable if complex interactions have to be expressed. This is a mistake. Any subject can be broken up into longer or shorter items of information at will, and the determining factor is how much the reader can comfortably absorb, not how much information is logically joined together. All the information on a complex subject is logically connected, and could therefore in theory be expressed in one sentence. It never is, because such a sentence would not communicate. Sentence length should be determined by what the reader can effectively decode. An example is the following sentence:

> It seems possible that the adrenergic–cholinergic antagonism may be mediated through the adenyl–cyclase system, since it is known that whereas noradrenaline increases the synthesis of cyclic AMP, acetyl choline inhibits this process, thus the acetyl choline liberated at vagal endings may decrease the quantity of noradrenaline released at postsynaptic terminals and also decrease the accelerated rate of cyclic AMP synthesis in myocardial cells initiated by noradrenaline liberated during sympathetic neural activity.

For most readers this will be an unfamiliar and technical subject; it is also an enormous sentence. The writer doubtless thought that the idea expressed was all one, and certainly the logical connectors make it appear so. The logical ‘bones’ of the sentence are:

> It seems possible that...since it is known that...thus the...may decrease the...and also decrease the...in...
is a mind-full. We might re-write it into shorter sentences:

Care must be taken not to act against the provisions of the law. Nevertheless certain steps can be taken to further the interests of the IBH group. A number of discussions were held on this topic with members of IBH, Holland. The ideas contributed by all personnel should be analysed. They should be formed into a commercial policy. This should then be communicated up and down the IBH selling team. This is so that the tactics followed by the manager, representatives, technical and administrative team follow the same lines.

Most readers find this 'bitty' to read. The flow of the information is constantly arrested by full-stops, and there is an uncomfortably jerky feeling. There are two reasons why such writing is not a good solution to making a text readable.

First, short sentences of similar lengths become monotonous. Readers are sensitive to repetition, whether of words, structures, ideas, or sentence lengths. Variety is valuable since it aids attention, and makes reading more interesting, so sentence lengths should vary in order to make ever-varying demands on the reader. A simple idea should be a chance to write a simple sentence. In particular, important, startling, and major facts or ideas should have simple sentences. This emphasizes their importance, and makes it easier for the reader to grasp. Thus:

The script process is located at present in building 20. Raw-material and final product tankers use the road at two per week, but expansion of the plant and a higher proportion of bulk product customers will greatly affect this. Eventually, access could limit production. However, building 5 is in a far less congested area and no problems are expected with road traffic.

Access for road tankers is the deciding argument for using building 5 rather than building 20. The encoding of the information underlines this in a way which makes it easier for the reader to grasp the importance of the point.

The second reason why use of too many short sentences is undesirable is related to the complexity of the information. The passage on adrenaline contained many technical terms, and a simpler sentence structure gave more time to absorb these unfamiliar words. The passage on selling had few technical terms, and so larger sentences could be managed. The unloading rate was too high in one example, too low in the other. Thus the complexity of the information affects the length of the sentence it can be encoded in. The following sentence is not very long, but it is unmanageable because of the amount of detail:

Crystals were grown as hexagonal plates, up to 300 µm x 100 µm thick by vapour diffusion of 2.1 M-ammonium sulphate, in tri-acetate buffer (pH 7.0), in the presence of 0.01 M-Mg as described by Rein et al. (1973). Such a mass of information requires several sentences to be communicated effectively. The writer must decide if the material is familiar or new to the readers. Will they find it easy to grasp, or will it strike them as complex, and require great effort? How important is it? Will the readers need to grasp all the detail, or do they need only the overall outline? Is the information repetitive, or is it information the reader has not met before in the same passage? Does the logic of the ideas flow easily, or are there a series of complex interacting ideas? All these factors will determine how long a sentence the reader can comfortably decode. Anything unfamiliar, complex, and new will require stating in shorter sentences, while a review of familiar information can be coded in longer sentences. Here, by contrast, is an example of information which is not in itself complex, but which is unmanageable because of the way in which it is presented:

Both sets of costs are lower than the forecast made in April 1972, since more steam was available for the turbo-alternator than was anticipated because production of nitric acid and sulphuric acid was higher than forecast and space heating requirements were lower than forecast, but less steam from Ableton boilers would have been required to keep the turbo-alternator fully loaded.

The reader has to remember a complex series of interacting relations: 'lower, more, higher, lower, less.' The demands are too great, and communication fails. The complexity of the content, in the broadest sense and from the readers' point of view, determines the comfortable length of the sentences. Complicated information should be in shorter sentences.

Where the information is complex, there are many other techniques of presentation available to the writer, besides changing sentence length. The full-stop breaks up information in a way
which the eye recognizes. Paragraph breaks, headings, indentation, and other devices of layout act in a similar way. Where information does not fit comfortably into a sentence structure, the layout code can provide additional aids. This sentence is awkward for the reader as it stands:

It is clear that the decay curve is a sum probably of two exponentials, a slower phase with a half time \( t_\text{h} \) of 4 minutes and representing 85% of the total decay — calculated from the intercept 1.15 which is where it would have been expected to originate if the fast phase were infinitely fast, and a smaller fast phase which has a \( t_\text{h} \) of less than 30 seconds.

It can be laid out more conveniently in this way:

It is clear that the decay curve is a sum probably of two exponentials:

1. a slower phase with a half time \( t_\text{h} \) of 4 minutes and representing 85% of the total decay (calculated from the intercept 1.15 which is where it would have been expected to originate if the fast phase were infinitely fast);
2. a smaller fast phase which has a \( t_\text{h} \) of less than 30 seconds.

Notice that the extra white space, the list form, the underlining, and the brackets are all used to make what is still one sentence more understandable.

Sentence length and structure are important influences on readability. Because readers cannot retain large numbers of words at once, sentences must be manageable; but what is manageable depends on the complexity and density of the information and the reader's familiarity with it. Flexibility and variety in sentence length makes writing easier to read, and shorter sentences make complex, important, and arresting information stand out. Intelligent use of sentence length and structure is an important ingredient of effective style for informative writing.

**Long words** The second factor that affects readability is the use of long and unfamiliar words. We must define what we mean by long words. Some words with many syllables are quite familiar — for instance 'electricity'. It is the unfamiliarity of a word in combination with its length which makes it less easy to read. Linguists have made word lists which list the frequency with which words occur. The word 'and' in one study occurred on average once every 47 words, whereas words such as 'purpose' once every 1172 words.\(^4\) Words such as 'epistemology' occur very infrequently in ordinary language, and many readers do not understand them. Words which are infrequently used are likely to be unfamiliar; they are less easy to read for that reason. The mental pathways which decode familiar words are well-worn, but unfamiliar words make us pause very briefly, and leave a sense of extra strain in the overall effort of decoding the message.

Writing which uses long, unfamiliar words is more difficult to read:

This work has involved the acquisition of skills and techniques required when working with . . .

Words like 'involve', 'acquisition' and 'required' are longer than are needed to do the job. The writer could have written more readable:

In this work we have learned new ways of working with . . .

In a short example the difference is small, but when these longer words are repeated in sentence after sentence, the feeling of struggling through a morass builds up:

The choice between alternatives must of course be influenced by the reliability of the factors which affect the savings predicted. It may be difficult to make satisfactory 'pot mend' repairs to vessels and more extensive temporary repairs could reduce sales realization in 1979, a factor which adversely affects scheme two. Also this type of limitation is more likely to be apparent in the second year . . .

The writer of this passage is inconsiderate of readers' efforts and patience. This style takes risks with readers' attention. Even more seriously, it risks readers' distaste. Words like 'alternatives', 'influenced', 'adversely', 'apparent' are not in themselves unusual, but strung together they build up an air of pompous preening. The writer sounds like a show-off; and this naturally irritates readers, especially when it is done at the expense of their convenience in decoding the information they need. So to avoid this impression, go for the simpler word. Not:

. . . the stability of the metal-carbon bond is enhanced by co-ordination . . .
But:  
... co-ordination improves the stability of the metal carbon bond ...  

Not:  
... the gas cell exhibits an absorption profile with a 'Lamb' dip ...  

But:  
... the gas cell has an absorption profile with a 'Lamb' dip ...  

Long words do not impress  

Many unusual words are chosen by writers for the air of intellectualty they give to the writing. Yet such words are often awkward and distracting:  

... with adequate ancillary labour to assist ... (... with enough extra labour to help ...)

The precise mechanism responsible for this antagonism cannot be elucidated ...

(We do not know what causes this antagonism ...)

Readers are usually not impressed by such words. These words are not objectionable because readers cannot understand them. First, they are objectionable because they are more difficult to decode: they take longer, and consume more mental energy because they are relatively unfamiliar. Second, they create an atmosphere of overformality.

Writers sometimes use words so unfamiliar that many readers find decoding them genuinely troublesome. They have to search their memory for the meaning, and may come up with ambiguous, or incorrect guesses:

When the lines are symmetrically placed about the centre of the gain curve, the perturbations in frequency usually disappear.

Burn and Rand have provided evidence for their postulation that ...

These results indicate that it is possible for calves ... to become refractory to reinfection.

Are 'perturbations' small or large movements? Is a 'postulation'

a guess, a hypothesis, or an adamant claim? Does 'refractory' mean resist slightly, or totally, or is it a place where monks eat? Before you reach for a dictionary, or smile with satisfaction at your own knowledge, remember that the case we are arguing is not that all readers will misunderstand these words. It is that some of them may. Even if most readers eventually understand, areas of uncertainty will remain; and virtually all readers find reading texts which contain such words more difficult. We are not arguing that these words should be banned from use; indeed we do not believe that any of the resources of language should be banned. We are arguing that they should be used only when required. Such words are rarely used in everyday language, and they should remain so. Where no other words will convey the exact meaning, then they have a place, but where familiar, everyday words are available to do the same job, the everyday words should be used.

Why do writers use long and unfamiliar words? Clearly, it is not in order to contribute to the convenience and comfort of their readers; readers find simple writing more readable. We have formed the opinion, from talking to many writers of reports in industry, that writers use long words for two reasons: to confuse and to impress.

Long words often confuse readers. The precise meaning of each word may not be clear. The words may be high-order generalizations which have no single concrete meaning, but cover a large number of related activities. Thus 'assay' can mean to measure, estimate, weigh, analyse, try the purity of, or to attempt. By using this word, rather than any of the more exact descriptions available, a writer leaves his or her exact activities surrounded with an aura of mystery. The writer may hope to gain respect, feeling that it will be difficult for readers to criticize the work, simply because they have not been given enough clear information about it. But the advantages for readers are nil, and it is likely that the writer will produce precisely the opposite to the hoped-for effect.

Long words are also used in the hope of impressing readers. Perhaps at one time they did do so, but this time is long past. In the Middle Ages, educated people spoke Latin to each other when discussing intellectual matters. They had a separate language for what they saw as a separate activity; it marked them off from everyone else, and was the badge of the educated man.
Because of the history of the language, English has two words for many things, one of Latin origin, one of Anglo-Saxon origin. 'Initiate' is of Latin origin, 'start' is Anglo-Saxon; 'commence' is of Latin origin, 'begin' is Anglo-Saxon; 'terminate' is Latin in origin, 'end' is Anglo-Saxon. Since the end of the Middle Ages, educated people have not spoken Latin, but the influence of Latin on the language has meant that they have had available a Latinate vocabulary in English. This Latin vocabulary was associated with intellectual life; it was also often not understood by uneducated people. By contrast, the Anglo-Saxon vocabulary was associated with common people. It was therefore possible to acquire the reputation for being educated, intellectual, or 'clever' by using a Latinate vocabulary. Indeed, for many this was the only way of appearing clever. Renaissance doctors could probably do very little for their patients, but by using intellectual-sounding Latin names for things, they reassured their clients, and earned large fees. We regret to say that the attempt to acquire a spurious reputation for knowledge by using Latinate words persists in many professions.

Our advice to writers is that this Latinate vocabulary no longer has the effect they want, nor is it a sensible way of communicating information. In the first place, readers are no longer impressed by Latinate writing. The research we reported at the end of Chapter 1 shows that simple writing is more impressive. Most readers react against the inflated and pompous atmosphere created by a Latinate vocabulary. They are disturbed by the suspicion of pretence; they are repelled by the unpleasant verbosity; they are doubtful of the honesty of a writer who needs such camouflage. In the second place, much technical information is so complex and impressive that there is no need to wrap it in flowery language. When professional people have little to say, they needed the cloak of intellectual-sounding language. Modern sciences and technologies are impressive enough in themselves; they do not need any adornment.

The advice to avoid long and unfamiliar words is not a ban on jargon. Jargon is a short and convenient way to name new ideas and concepts. The phrase 'update' seems to us an excellent and brief way to say 'to revise and edit so as to bring up to date'. New ideas or new objects need names, and a new name is better than a long string of old ones. But technical words are often used not for these reasons, but to create a spurious impressiveness:

Each task is assigned a maximum period of time, or time quantum, for which it may run.

The word 'quantum' adds nothing to the content, and disturbs the readers' trust in the writer's good intentions. A similar 'buzz-word' flavour surrounds this:

The Scheduler, then, has to perform the dual-capability of scheduling timesharing tasks and real-time tasks. (The Scheduler, then, has to schedule both timesharing and real-time tasks.)

The compound 'dual-capability' adds nothing. Often a simple idea is made to sound sophisticated by the unnecessary use of a jargon word.

Consideration should be given to the interface of the suite with the customer's main complex.

This was not part of a computer manual, nor even instructions to a tailor measuring a gentleman's trousers; it was instructions to a planner about siting rooms. Jargon used in this way is not only unhelpful: it positively impedes communication by the stumbling block it creates to both comprehension and trust. Jargon words are sometimes added entirely unnecessarily:

... the dilutions follow sequentially down the series ...
A 'terminal session' is not the last big shoot-out in a Western, but a period of work at a computer terminal. Writers become so inured to the implications of the jargon that they cease to observe the more normal meanings of words.

Jargon, then, is an important resource; technical communication would be cumbersome and inefficient without it. But writers are often tempted to use it for wrong reasons, and seek to obtain spurious credibility from sounding 'clever' at the expense of their reader's time and patience. Where jargon is used aggressively, carelessly and unnecessarily, it impedes communication; where it is devalued it reduces the resources of the code. Wherever it is used without having a specific and real function in the communication of the message, it reduces readability, without offering any compensating gains.

Ladders of abstraction

Long, unfamiliar words are often highly abstract, and fail to communicate because they embrace too many different meanings. Readers are not able to decode clear ideas or images; they are left confused, unable to settle on a specific picture of the action involved. More mental energy is used in searching the 'file' for possibilities, and less information is extracted. Imprecise communication is made in:

... and no adverse interactions have been seen ...

The phrase 'adverse interactions' covers everything from a bar fight to a chemical explosion. A writer on economics complains of:

The regressiveness and anomalies caused by the export duty and surcharge ...

but leaves readers with no clear picture of what these 'regressiveness and anomalies' are in specific terms. There are hierarchies of increasingly abstract and general terms. For examples, names such as:

Construction
Building
Dwelling
House

Each term higher on the list covers a larger area.

This hierarchy is called a 'ladder of abstraction'. Sometimes it is necessary to rise towards the top of this ladder; abstract words exist because they are a convenient shorthand to compress many particular ideas into one general statement.

But abstract words are less easy to decode because the reader has to 'scan' all the possibilities subconsciously before deciding on a specific meaning. Because science often deals in generalized concepts, it is familiar with abstract words. Where these are necessary, there can be no objection to their use, but to use such abstractions where there is a more accurate, concrete word available adds unnecessarily to the readers' burden.

Phrases as well as words are often chosen for their impressive sound and massive weight rather than for brevity and clarity. We distinguish the use of unnecessary or repetitious words, and the use of whole phrases where single words will do.

Unnecessary words often repeat an idea which is already expressed in another word, and thus waste space and blunt the message. At first glance, the following phrases have an aura of technicality:

Insert the electrodes and, stirring mechanically, titrate potentiometrically ...

Calculate the end-point mathematically ...

But even an inattentive reader feels uncomfortable, since the only form of 'stirring' is 'mechanical', just as the only form of 'calculation' normally used is 'mathematical'. A familiar example of the same looseness is:

Potential hazards must be identified and examined ...

Since a hazard is a potential danger, the words 'potential
hazard' support each other uneasily; 'hazards' will do duty alone, and witnesses a firmer grasp of meaning.

Simple adjectives are often turned into longer phrases by the addition of spare nouns which add nothing to the meaning:

... they are not normally of a critical nature ...
...(they are not normally critical . . .)

... ribbon showed surface roughness to a bad degree ...
...(ribbon showed bad surface roughness . . .)

Other words which add nothing are 'located' in:

... the control room should be located adjacent to the scanner room . . .
...(the control room should be adjacent to the scanner room . . .)

or 'visibly' in:

... especially when the farmer can visibly see the tapeworm segments . . .
...(especially when the farmer can see the tapeworm segments . . .)

Words are added which are redundant because the opposite is impossible:

... the error signal is suitably processed . . .

Is it likely that a procedure would be designed to process the signal unsuitably? Such words subtract from the impact of the message.

Sometimes writers use several words for ideas which can be expressed more clearly in one:

This is done by means of inserting a Fogarty 3F arterial embolectomy catheter...resulting in exposure of the subendothelial layer.
(This is done by inserting a Fogarty 3F arterial embolectomy catheter...exposing the subendothelial layer)

The phrases 'by means of' and 'resulting in' add nothing to the information in the sentence, but they do add to its length. The more economical the encoding of the message, in general, the clearer the meaning. One writer laboriously explained:

The reason for this increase in tissue levels was probably due to de-novo biosynthesis.

instead of simply saying:

Tissue levels increased, probably because of de-novo biosynthesis.

Another writer declared:

If problems arise in your office with regards to the completion of the CNF . . .

instead of:

If your office has problems completing the CNF . . .

Roundabout phrasing, instead of direct and simple expression, can lead to statements of elaborate tortuousness:

He had a complaint from a customer to the effect that on consuming a drink which happened to contain Autoflav irritation of the mouth had been experienced.
(A customer complained that a drink which contained Autoflav had irritated his mouth.)

Long-winded phrases are especially common in time references. Perhaps because we must say simple things like 'before', and 'after', and 'now' so often, the writer misguided looks for variety. A financial analyst once observed that the stock market can do only two things: rise or fall; but this simple fact is celebrated in a plethora of poetic metaphors. The same urge to elaborate can affect writers when they have to say 'now':

We are at the present time in communication with the Board regarding the scheme to . . .

Or 'several times':

On a number of occasions during the summer it was necessary to restrict or stop production . . .

Or 'soon':

Within a comparatively short period they will need 15 tonnes per month . . .

Simple prepositions are often elaborated into longer phrases; for example 'near' in:

No concentration of pentane was detected in the immediate vicinity of the machine.

The constant use of unnecessarily long phrases adds to the
burdens on the reader; the length of the document increases, and so does the mental effort needed to decode it. The overall impression is one of flabby wandering, rather than incisive thinking. The simplest word which will communicate the meaning accurately is the best choice for both writer and reader.

Nominalization

A common feature of technical writing is ‘nominalization’. Many books on technical style discuss it, but few name it; admittedly ‘nominalization’ is a technical word from linguistics, but it is not a difficult or confusing concept. Nominalization is so prevalent that it seems worth dealing with it separately even though many people are nervous about ‘grammar’.

Nominalization is the habit of turning verbs into nouns, or names. For example, a simple statement might be:

The probe measured the internal diameter.

But it is common in scientific writing to think of ‘measurement’ as a concept, or activity, and to construct a sentence round the noun ‘measurement’, rather than to use the verb ‘measure’:

Measurement of the internal diameter was performed by the probe.

This is nominalization. Its habitual use reduces the effectiveness of writing because it requires the construction of a passive sentence, and it also requires the use of a meaningless ‘general-purpose’ verb. The writer cannot say ‘measurement was measured’ so must find another verb to replace the one that has been nominalized. Since the action is named in the noun, the verb chosen must have no meaning in the sentence. Convenient verbs are ‘performed, carried out, undertaken, conducted’, and a host of others. If any meaning is given to these verbs, the sentences become funny:

The experiment was carried out . . . (where to?)
The measurement was conducted . . . (with a baton?)
The treatment was undertaken . . . (in a coffin?)
Analysis was performed . . . (on a stage?)

The forces which operate to encourage nominalization are understandable. Dealing continually in concepts, scientific and technical writers tend to isolate activities such as ‘experimenting’, ‘measuring’, and ‘analysing’ as abstract conceptual units in their minds. They are also pushed towards passive constructions, both by tradition and by their own desire to step aside and allow their work to speak for itself. These forces produce characteristic constructions such as:

A similar experiment was carried out using the material . . .

‘Sigma’ preparation was carried out as described . . .

So common has ‘carried out’ become as a general purpose verb that it is a recognized marker of ‘scientific’ reporting, and television news bulletins commonly adopt the construction when reporting scientific work. Such constructions, with consequent nominalizations, add to the length and complexity of statements, and rob writing of force:

The test substance is easily absorbed, therefore spillage of the material on the skin must be avoided.

(The test substance is easily absorbed, so avoid spilling it on the skin.)

. . . using this thin wall material a reduction in costs would be obtained.

( . . . using this thin wall material, costs would be reduced.)

There are some cases where nominalization is a useful resource, but these cases should be a minority. Where writing continually nominalizes, it becomes tiring and flat: more effort is required to disentangle the roundabout structures which result, the meaning is spread more thinly, and the passive structures with meaningless general purpose verbs rob the writing of its impact and energy. Linguists use the words static (static) and dynamic in discussing the general characteristics of nouns and verbs respectively. It is no surprise if writing that is heavily nominalized seems to lack dynamism.

Once recognised, nominalization is easy to correct. Whenever you see general-purpose verbs such as ‘carry out’, ‘perform’, ‘undertake’, or ‘conduct’ look for the word which names the action. Turning the name of the activity back into a verb (preferably active) will undo the nominalization, and make the sentence more direct and easier to read.

Passive structures reverse the most common order of a sentence. Instead of saying ‘the analyser tested the sample’ (the
active form), writers can say 'The sample was tested by the
analyser' (passive form). The main purpose of this reversal is to
provide emphasis, by bringing to the head of the sentence the
thing acted on, rather than the thing doing the action. Such a
simple grammatical device is clearly useful and unobjectionable.
However, the average number of passive constructions in the
type of language used in novels is about 6%; the total in one
study of scientific writing was 32%.

In many cases these
reversals of sentence order have no evident purpose:

The intensities were measured on a computer-controlled
densitometer . . .
(A computer-controlled densitometer measured the intensities . . .)

Or:

The benzyl solutions are decomposed by daylight . . .
(Daylight decomposes the benzyl solutions . . .)

Or:

The identification of the animals in the experiment is by cage
cards . . .
(Cage cards identify the animals in the experiment . . .)

In such examples, the passive structure lengthens and elaborates
the sentence unnecessarily. Readers absorb active sentences
more easily than passive ones, because it is easier to focus
on the agent of the action if it is named first. Thus, where an
action is being attributed to some person, it is usually more
comfortable for the reader if the person is named first:

The responsibility of booking the IMS Test System lies with
the Chief Applications Programmer and all requests . . .
(The Chief Applications Programmer is responsible for booking the
IMS Test System and all requests . . .)

Or:

This machine was evaluated by the Applications Laboratory
and was found to give very consistent processing results . . .
(The Applications Laboratory evaluated this machine, which gave
very consistent processing results . . .)

Passive structures should be used only where they have a
specific encoding function, because otherwise they add
unnecessarily to the complexity of a statement. Any feature of
writing which does not have a communicative function should
be deleted in informative writing.

The common reason for using so many passive constructions
is that they can be made impersonal. The active construction 'we
started the test', turned into the passive construction 'the test
was started by us', can be transformed into an impersonal
structure by the simple deletion of the last part of the sentence:
'the test was started'. Because traditions of scientific and
technical reporting seem to require impersonality, writers turn
gratefully to the passive structure as an undemanding way of
achieving the safety of facelessness. But it is a mistake to think
that the passive is the only way to avoid mentioning the human
experimenter. For example, a writer used a passive structure to
avoid personal reference in:

In the previous report the rationale for studies in prostaglan-
din (PG) receptors was discussed.

He did not want to write:

We discussed the rationale for prostaglandin (PG) studies in
the previous report.

But this was not the only alternative: an active construction,
which would have avoided the personal reference is:

The previous report discussed the rationale for studies on
prostaglandin (PG) receptors.

Where the active cannot be made impersonal, the passive is
roundabout and vague:

A study has been made of the effect of storage for up to 28
days.

Who made this study? We would argue that it is more natural,
comfortable and accurate to use a personal pronoun:

We have studied the effect of storage for up to 28 days.

Readers will decode the message in this way in any case. If the
components of a sentence are complex, the added complexity of
the passive structure can be the straw which breaks the back of
readers' comprehension. They may have to go back and re-read,
and their sense of progress through the technical argument is
disrupted by their difficulties with the encoding of that argu-
ment. Also, if passive structures are used continually, they
become obtrusively repetitious. Readers are kept alert and
interested by variety in the use of the language code. Thought-
less repetition, where a structure is emphasized out of propor-
tion to its normal frequency of use, wearies readers.
The homogenate was filtered through muslin and retained material re-homogenized. The combined filtrates were centrifuged and the fraction sedimenting between 1000 g and 50 000 g was collected. The pellets were resuspended and stored in small aliquots at -20°C.

We are not arguing for a complete ban on passive structures in scientific and technical writing; we think their use should be restricted to places where they have a specific function. A normal variety of structures should be used, including occasional personal references, with a limited number of passives.

During the last century, it became an accepted dogma of scientific writing that there should be no references to the person doing the work, and this is now firmly established in many writers' minds. In fact, the reporting of science prior to the nineteenth century frequently used personal structures. The formality of much Victorian writing became the norm for intellectual writing in general, and in science this has survived into the twentieth century. But there is no good reason why personal pronouns should be scrupulously avoided. Readers are aware they are reading about the work of people, and their assessment of the experimental work reported will include an assessment of the personal competence of the scientist. It is artificial to avoid personal references in scientific writing.

The organization you are writing for may try to operate a ban on personal constructions; but there are occasions where accurate reporting requires identification of the person who acted. The alternatives (which are often used in these circumstances) to the simple personal pronouns 'I' and 'we' are more obtrusive. More attention is attracted by the circumlocutions than by the naked pronoun. Thus:

However, the writer's view was advised that such expenses should be included in the trading results.

(However, I expressed the view that such expenses should be included in the trading results.)

Other circumlocutions are just as obtrusive:

From the literature already published on laser frequency stabilization, the method most applicable to the author's requirements appeared to be . . .

(From the literature already published on laser frequency stabilization, the method most applicable to my requirements appeared to be . . .)

Such circumlocutions can also lead to clumsy statements which a sane reader can only laugh at:

The author was to some extent relieved to learn that similar tests had been carried out . . .

One major reason for using personal pronouns is, therefore, that the alternatives are clumsier and more obtrusive.

The following passage stumbles into another problem which is created by a blanket ban on personal constructions:

One could rationalize the asymmetric binding data by proposing a conformational change upon binding the first mole of substrate (Fersht, 1975). Recent experiments involving diffusing APT into the crystals have resulted in . . .

Readers are made uncomfortable by the rather pompous 'one' instead of 'I' or 'We'. Their discomfort when the writer is embarrassed at identifying ideas as his or her own is turned into genuine puzzlement in the next sentence. The 'recent experiments' are not attributed to anyone. Custom leads readers to think they are the author's, since such impersonal references are the norm. But the previous sentence has referred to Fersht, and doubts must enter readers' minds as to whether they are reading a continuing report of other work or whether they have just started to read about the author's original work.

A ban on personal references can therefore be ambiguous. In science, the attribution of work to named workers is an integral part of the system of reporting and publishing results. Thus the writer who reported:

From preliminary studies using the microscope, it was found that three 'passes' were required.

left it unclear whether the studies being described were his or her own preliminary studies, or those of other workers. Ambiguity which makes the source and history of the conclusions unclear, is bad; uncertainty about the claimed status of a hypothesis is often worse:

It is not possible to state the exact mode of operation of the drug.

This leaves serious doubts in readers' minds. They may well
translate this sentence, following familiar scientific idioms, as saying:

We do not know how the drug works.

But this is a different claim from the assertion that the operation of the drug is beyond any elucidation, a complete impossibility. Which did the writer intend?

Attribution of decision, as well as of hypothesis and results, requires precision. Impersonal constructions are ambiguous, and therefore introduce a worrying uncertainty. In commercial organizations, who made the decision may be important. To allow the identification to go by default is to buy anonymity at a high price.

The fear of identifying personal involvement in a scientific or technical matter extends so far that even clearly personal concepts are expressed in impersonal form:

Originally this was believed to be due to an extra production of $E_2$.

Belief is a personal, human, activity. But here it is not attributed to anyone, and the impersonality adds nothing. The natural structure is both easier to read, and inspires more confidence in the writer’s directness, precision and honesty:

I originally believed this was due to extra production of $E_2$.

Impersonal constructions are not only obtrusive, and often ambiguous, but also cumbersome:

Examination and discussion of the concentrations obtained, are necessary before a decision is taken.

(We must examine and discuss the concentrations before we decide.)

Impersonal writing invites unnecessary nominalization:

The work was carried out using injection moulded containers of general purpose polystyrene.

(We used injection-moulded containers of general-purpose polystyrene.)

It seems to encourage roundabout phrasing, and unnecessary verbosity:

Finally, further attempts have been made to prepare samples of heparin.

(Finally, we have tried again to prepare samples of heparin.)

It also leads writers into pompous vocabulary:

Current work has therefore been aimed at establishing the nature of this non-specific binding.

(So we are now trying to find out how this non-specific binding works.)

In the examples we have been looking at so far, the use of ‘I’ (or the alternative ‘we’ where the work of a team or organization is being reported) has seemed the natural choice. We argue that to avoid personal pronouns where it is natural to use them is unnecessarily cumbersome, and detracts from the reader’s comfort. This also applies to the other personal pronouns. The introduction to a manual read:

The sections assume the person has a basic understanding of our AN process control computer system.

The context made it clear that ‘the person’ was the reader. Why therefore use the circumlocution ‘the person’, instead of writing:

The sections assume you have a basic understanding of our AN process control computer system.

Our advice to use personal pronouns where they are the natural choice does not, of course, mean that they should be used indiscriminately. In normal conversation, we use a variety of constructions, and variety is always refreshing and helpful in digesting a written text. The writer who obtrudes personal pronouns at every opportunity is quite as tiresome as the writer who always conceals personal identities. It is not necessary to mention the observer of the result each time a result is reported. In conversation we do not guard every statement with the provision, ‘I observe’ or ‘I saw that’. Someone who reported ‘I went outside the door and I felt rain. By inspection I observed that the sky was overcast and I saw it was getting dark’ might be correct about the source of his information, but would be tiresome to listen to. The natural structures might be ‘I went outside, and felt rain. The sky was overcast and it was getting dark.’ Normal decoding allows for the fact that the message depends on the reporter. We do not need to be reminded of this in every sentence. So with scientific reporting; information in a paper is encased in the inverted commas which enable us to understand the whole paper as the report of a series of observations by its writer. Within that context, facts can be reported as simple statements, and do not need the constant elaboration of ‘I confirmed . . . ’ or ‘I found . . . ’.
But note, too, that normal usage does mix personal and impersonal statements. Our example would have seemed very artificial if it had run: ‘The present writer went outside the door and rain was felt. It was observed that the sky was overcast...’ The heavy, over-formal tone of much scientific writing stems largely from an artificial attempt to restrict expression to just one impersonal form.

The use of rigidly impersonal constructions in scientific and technical documentation is gradually dying. Both civil service and armed services writing now contain personal pronouns. If you belong to an organization which still bans personal pronouns in its documents, or if you have been convinced that they are inappropriate in scientific writing, we would ask you to rethink your reasons for this belief. You may think that personal pronouns are obtrusive and unscientific, yet our examples show that the impersonal alternatives are often more obtrusive, and less precise. Readability research shows that writing containing personal pronouns is, on the whole, easier to read. The circumlocutions, passive constructions, and omissions required for impersonal writing absorb extra energy in decoding the message.

Conclusion

We have dealt in this Chapter with some of the most distracting stylistic habits of scientific and technical reporting. There are obviously many other identifiable habits which are undesirable or awkward. We make no pretence at completeness. Indeed, it is the nature of language to offer almost endless variety and complexity; the ways in which ideas can be clumsily expressed are as diverse as the ways in which they can be precisely expressed.

But effective style is felt by many to be the key to good writing. Certainly, readers’ sense of the precision, grasp and exactness of his or her thought processes is often derived from the style of the text. For this reason, we think you may want to read further about effective style for informative writing. We recommend Sir Ernest Gowers’ The Complete Plain Words, and John Kirkman’s Good Style for Scientific and Engineering Writing.

When writing, and especially when editing, bear in mind the basic points made here. Avoid over-long sentences, try to use a vocabulary which is simple while still being exact, avoid misuse of jargon and thoughtlessly abstract words where concrete ones convey the exact meaning. Think again about roundabout, wordy phrases, the over-use of passive structures, and the temptation to use regular nominalization. Try also to use personal pronouns where they are appropriate.

Draft your documents, and then read through, looking for the types of clumsiness we have identified in this Chapter; it is possible to acquire considerable skill at seeing and correcting stylistic ineptitudes. Our chief advice is to be varied and flexible in the use of the wide resources of the language code, but you must also recognize that the precise and incisive encoding of information is a difficult achievement. Even for experienced writers it is not always, or even often, achieved first time. Learn to be a critical editor, as well as a thoughtful writer, and the quality, and impressiveness, of your documents will undoubtedly improve.

References

5. Kirkman, J. (1975) Readable Writing for Scientific Papers. Bulletin of the British Ecological Society, VI, (1), 5-9. 57.4% preferred ‘Direct, verbs mainly active, minimum of special vocabulary, judicious use of personal and impersonal constructions, sentences of varied length but mainly short and not complex.’ The five alternative versions, using less simple style, scored between 1.1% and 16.4% preference.
Style for readability


The majority of writers now use computers (as word-processors) for their writing. The use of computers does not change the principles of good writing, but it does make achieving them easier in many ways. It also calls for extra care over the writing process. We are sometimes told that the so-called 'electronic office' will make our advice on writing unnecessary. We doubt that. Indeed, we think more, not less, training of 'authors' will be required as new technology makes it easier to prepare and duplicate 'texts'.

Word-processing changes the way text is created and extended, and the ways in which writers think and work. At the simplest level, a word-processor is little more than a clever typewriter, with electronic correcting fluid. The main advantage of the word-processor is the ease with which mistakes can be corrected. Clean copies can be produced without the need to re-type the whole document. The labour of typing several drafts is eliminated, and the temptation to let a draft through with small mistakes disappears. Final copies are cleaner, neater, and should be error-free. Revision, that corner-stone of good writing, becomes a regular practice rather than a distant ideal.

With a manual typewriter, revisions are possible; but to see their effect properly requires complete retyping. The word-processor makes it possible to revise documents bit by bit, and to see the effect of each batch of alterations without having to go through the labour of re-typing the whole text.

We recommend that you use the same technique of rapid writing when you revise, as when you write the first draft: read rapidly, and mark passages, words, and sentences that need looking at carefully. If you stop for too long to wrestle with a hydra of a sentence, you will distort your memory of the overall