REVIEW

The intentional search for meaning: developing technical editing skills

Tom Lang

Tom Lang Communications and Training International, USA; tomlangcom@aol.com

Abstract

The purpose of technical editing is to prepare specific information, for a specific medium, to help a specific audience, accomplish a specific goal. What defines technical editing is its purpose—to help readers act—not the scientific discipline in which it is found. Still, traditions of technical editing differ greatly by subject matter (nuclear physics, field biology), document types (scientific articles, computer user manuals), audiences (regulatory agencies, consumers), and specific publication conventions (writing instruction manuals, documenting experiments). Because technical editing developed in the physical sciences and engineering, the term often refers only to editing in those fields. However, whereas technical editors in industry often enter the profession with degrees in technical communications, editors in other scientific fields typically receive little or no professional training in editing. Accordingly, I describe here four techniques proven to be effective in training technical editors in any branch of science. A basic technique involves applying 12 specific and evidence-based 'edits' that improve comprehension. In an intermediate technique, 'structured editing,' described here for the first time, editors follow a structured process of analysing and revising a text by completing four sequential tasks. An advanced technique—shortening a 250-word abstract to 100 words without losing content—will develop critical thinking and sharpen language skills. Finally, I describe a collaborative technique based on 'deliberate practice,' in which a small group of editors discusses a text in detail, in long sessions, over extended periods, to develop a high degree of skill.

Keywords: editing, training technical editors, technical writing, education

Introduction

It seems clear that whatever most technical editors have learned, they have had to assemble for themselves, picking it up by a kind of apprenticeship and by analogy—both for the Do's and for the Don't's.

Florence E Wall, 1948[1]

In 1948, when Ms Wall spoke these words, training in technical editing was indeed hard to find.[2] Today, in the physical sciences and engineering, more than 100 North American universities offer degrees in technical communication that range from certificates to PhDs. In contrast, I know of no academic writing and editing programmes specific to life science or social science disciplines, other than a few for medical writing and editing. Even then, fewer than 10 US universities offer such programmes, almost all awarding only certificates and focusing on regulatory writing (not editing). Unconfirmed estimates are that Europe has about 30 degree programmes in technical writing and editing and fewer than 10 university courses in medical writing and editing.

As described above, unlike many technical editors in industry who enter the profession with degrees in the field,[2] editors in other fields typically lack formal training in technical editing. Some have backgrounds and even PhDs in composition, literature, or journalism.[2] These disciplines develop writing skills but do not address the perspectives and skills of technical editing. In fact, literary, journalistic, and technical writing-editing differ in important ways, (Table 1)[3] including having separate degree programmes, professional societies, and career tracks. All of these differences mean that specific training in technical editing is desirable.[4]

What defines technical editing is its purpose—to help readers act—not the scientific discipline in which it is found. Still, traditions of technical editing do differ greatly by subject matter (nuclear physics, field biology), document types (scientific articles, computer user manuals), audiences (regulatory agencies, consumers), and specific publication conventions (writing instructions, documenting experiments). Nevertheless, the fundamental editing skills are the same. So, for current and future technical editors, I describe here four techniques to develop editing skills.

Why do editors need specific training?

Editing: the art of 'cutting things out without cutting anything out'

Donald W Bush 1995[5]

The writing we learn in school is not the writing we do in science. In school, we wrote term papers for an audience of one (the instructor), who knew more about the topic than we did, and who did not have to the use the information we provided.[6] Our writing was graded (appropriately) on how well we expressed our thoughts and on the 'quality' of our writing, usually its grammatical correctness and organization. In contrast, in science, we write technical documents for a few to a few thousand people who know less about the topic than we do and who have to use the information we provide. In science, technical documents are judged by what readers are able to do with what they read. Thus, writing and editing in the sciences require a perspective and skills that differ from those needed to complete most academic writing assignments (Table 1).[4,6]

Table 1. Characteristics of three traditions of writing (and editing)

Characteristic	Literary, academic, or creative writing	Popular writing/ journalism	Technical writing
Purpose of writing	General: to entertain, enthral, evoke, sooth, challenge; inform	General: to report and comment on 'news'; to inform; to entertain	Specific: to provide specific information to help a specific audience accomplish a specific goal
Readership	Usually general: a diverse public often differentiated by genre (for example, juvenile fiction; humour)	Usually general: a diverse public often differentiated by market sector (for example, business; world news)	Usually more specific: readers with similar interests and backgrounds in an organization or profession
Qualities of the content	Text must engage readers, usually in both content and presentation (style)	Text must engage readers, usually in both content and presentation (style)	Text must provide information needed by readers to perform their tasks
Motivation to read	Reading is optional, so the text must therefore be interesting to read; sensationalism can be a value; readers self-select	Reading is optional, so the text must therefore be interesting to increase 'depth of read'; sensationalism can be a value; readers self-select	Reading is often required or even assigned; readers often self-select when the topic is of interest
Evaluation criteria	How well readers enjoy what they read; popularity of the text over time; evaluations by literary critics	How well readers enjoy what they read; financial success of newspaper or magazine; critics' evaluations of the topics covered and how well they are covered	How well readers understand, find, remember, and use information; usability testing evaluates how well the text accomplishes these goals

In school, we may not learn technical writing, but we do learn to revise our writing. In fact, 'there are no good writers, only good rewriters'.[7] But revision by an author is not the same as editing by an editor. Editors and authors approach the same text differently.[2] Whereas authors focus primarily (but not only) on topics and content, editors focus primarily (but not only) on readers and presentation. Skilled editors have several goals:

- Verify that the text fulfils its intended purpose(s) and addresses the primary audience.
- Confirm that the information is relevant, accurate, complete, and accessible.
- Make sure the writing is clear, organized, concise, and grammatically correct.
- Help readers understand, find, remember, and use information.
- Try not to assume that the text makes sense until it proves that it does.
- Insist on understanding the author's meaning.
- Look for what is missing, vague, or ambiguous.
- Edit everything (for example, captions, graphs, images, headings)
- Are able to justify every proposed edit and revision.
- Stay visually aware of tables, images, and graphic design and know when these visuals need to be edited, replaced, or removed.
- Check basic arithmetic, such as sums and percentages.
- Evaluate the entire document for its clarity and organization, its effectiveness and usefulness to readers, and its compatibility with standards in the scientific literature or its adherence to the house style of a sponsoring organization.

Most importantly, editors can protect authors from the problems of 'reading over'—skipping past text that is presumed to be correct but is not—and of 'reading in'—assuming that needed information has been presented when it has not. Authors are at higher risk for making these mistakes because they are reading familiar content and are looking for accuracy, whereas editors are at lower risk because they are usually processing less familiar content and are looking for consistency.[8]

The basic technique: 12 evidence-based edits

> If all grammarians in the world were placed end-to-end, it would be a good thing.
>
> *Judith A Tarutz, 1992*[9]

Several specific grammatical forms (hereafter, 'edits') can make a text easier to understand.[10] Research has established the effectiveness of the 12 edits described below.[11–13] Applied together, they can substantially improve the clarity of a text. In addition, applying these edits as part of skilled editing can reduce the length of many texts by up to 30% without losing content.[14,15]

Below, examples are *italicized*, and in the sentences, the subject is CAPITALIZED, and the verb is underlined.

Edit 1. Prefer shorter sentences.
Although shorter sentences are often associated with better comprehension, no studies show that simply shortening sentences improves comprehension. Complexity is the real problem;[11,12] shorter sentences simply have fewer opportunities to become complex. Although long sentences can be understandable, consider keeping them to fewer than, say, 25 words.

Edit 2. Keep the verb close to the subject.
The more words between the subject and verb, the greater the chance they will interfere with understanding the subject-verb relationship, which is key to effective communication.[11,12] Compare the following sentences:

"*Every STEP of the procedure, including the criteria for selecting patients, the surgical approach, the operative technique, and the postoperative nursing care, <u>had to be evaluated</u>*."

"*Every STEP of the procedure <u>had to be evaluated</u>, including the criteria for selecting patients, the surgical approach, the operative technique, and the post-operative nursing care.*"

Edit 3. Avoid using empty words and clauses. (A clause is a phrase with a subject and a verb and is thus a complete sentence.) 'Empty' words and clauses have no useful information, but readers still have to process them, which takes time and can lead to misunderstanding. In this sentence, "*IT <u>appears</u> that the data have been reported correctly*," the words '*IT <u>appears</u>*' are the subject and verb of a complete sentence (a clause) but provide no useful information. Without the empty words, the sentence becomes, "*The DATA <u>appear</u> to have been reported correctly.*"

Edit 4. Prefer the active voice.
The most common sentence structure in English is subject-verb-object, a structure called the 'active voice': *The NURSE <u>corrected</u> the chart*. Native English speakers are used to having the subject come before the verb, so the relationship between subject and verb is usually clear in the active voice.[11,12] However, keeping the subject of the sentence consistent with the topic of the surrounding text is sometimes useful. The five sentences below mean the same, but the subject of each reflects the larger topic and keeps attention on that topic. The first three are in the active voice, and the last two are in the passive voice. (See Edit 5.)

Topic being considered	Sentences whose subjects are consistent with the topic
Costs	"*COSTS <u>decreased</u> because medics responded quickly.*"
Response times	"*The timely RESPONSE by medics <u>decreased</u> the costs.*"
Performance of medics	"*MEDICS <u>responded</u> quickly, which decreased the cost.*"
Changes in costs	"*The DECREASE in cost was <u>caused</u> by the timely response by medics.*"
Causes of changes in costs	"*The CAUSE of the decrease in costs <u>was</u> the timely response by medics.*"

Edit 5. Be careful when using the passive voice.
In contrast to the active voice, the structure of a sentence in the 'passive voice' is 'object-verb-subject': *The CHART <u>was corrected</u> by the nurse*.[11,12] The passive voice also always uses a form of the auxiliary verb 'to be': is, was, were or has, have, or had been. (See the last two sentences in the above table.)

Some journal editors still require authors to write in the passive voice, usually because they think the passive voice is somehow more 'objective'. It is not. "*The CHART <u>was corrected</u> by the nurse*" is no more objective than "*The NURSE <u>corrected</u> the chart*"; there is nothing subjective in either sentence.

Contrary to common belief, the passive voice is grammatically correct and acceptable, especially when describing research methods. It is usually as easily understood as the active voice, even though the subject is not in the usual place. The problem comes when the passive voice is combined with nominalizations, as discussed below.

Edit 6. Use nominalizations only when necessary.
A nominalization is a verb that has been changed into a noun: 'to examine' becomes 'an examination'. Many nominalizations are common and useful: an amendment (to amend), a breath (to breathe), an injection (to inject). However, when the verb of a sentence is nominalized, it has to be replaced with a new verb, which is typically weaker.[11,12] In the following 23-word sentence, the nominalizations are in **bold**:

"*The CREATION of such guidelines, including the **development** of interventions, <u>requires</u> an **assessment** of the literature, along with **characterization** of potential risk factors.*"

Using the verb form of these nominalizations, the revised sentence becomes:

"*CREATING such guidelines, including **developing** the interventions, <u>requires</u> **assessing** the literature and **characterizing** potential risk factors.*"

'**Creating**' in this sentence is a gerund, a verb serving as a noun, and is used appropriately here as the subject of 'requires'. This 15-word sentence is 35% shorter than the original.

Edit 7. Be careful about using the passive voice and nominalizations in the same sentence.
When the expected verb of a sentence has been hidden as a nominalization, and because the passive voice makes the subject of the sentence harder to find, sentences in the passive voice that contain nominalizations can greatly reduce comprehension;[11,12] it takes time to sort everything out:

"***REGENERATION** of the resin bed <u>is achieved</u> by a calcium chloride solution.*"

Revised:

"*The resin BED <u>is regenerated</u> by a calcium chloride solution.*"

Or, in the active voice:

"*A calcium chloride SOLUTION <u>regenerates</u> the resin bed.*"

Unfortunately, nominalizations encourage the use of the passive voice, so this combination is common.

Edit 8. Make the units of a sentence parallel when possible.
Patterns help readers know what to expect. Compare these two sentences:

"*RESEARCH <u>was conducted</u> to determine whether the drug was safe and effective and whether it was well-tolerated for long-term administration.*" *(20 words)*

"*The DRUG <u>was assessed</u> for safety, effectiveness, and long-term tolerability.*" *(10 words; 50% shorter)*

Edit 9. Use personal pronouns ('I,' 'we,' and 'us') where appropriate. (Here, pronouns are in **bold**.) Which sentence do you prefer?

*"In this chapter, the AUTHORS <u>summarize</u> **their** research on synthetic ligaments. READERS <u>interested</u> in synthetic menisci should see Chapter 17."*

*"In this chapter, **WE** <u>summarize</u> **our** research on synthetic ligaments. For **our** research on synthetic menisci, [**YOU**] <u>see</u> Chapter 17."*

Some journal editors still do not allow authors to use 'I' and 'we' because, again, these words are somehow 'less objective'. However, most readers know that 'we analysed the data' is as objective as 'the authors analysed the data,' and everyone knows who the authors are. Personal pronouns have been encouraged in medical writing since at least 1900, and there are good reasons to use them in all branches of science and technology.[11,12,16]

Edit 10. Make sure every pronoun has a 'referent' or an "antecedent"; the word the pronoun represents.
(Pronouns are in **bold**.) Consider this sentence,

*"Animal STUDIES <u>suggest</u> that flow through capillary beds depends on diastolic times and pressures. Given that **these** <u>are</u> greater in cardiac patients, **THEY** <u>may cause</u> hyperperfusion."*

Here, what do 'these' and 'they' refer to? Capillary beds or diastolic times and pressures? Their referent is missing or ambiguous. 'Empty' words and clauses (Edit 3) are often pronouns without referents: 'these are,' 'that was,' 'who does'. Below, the bolded meaning of 'they' is clear, despite following 'patients'.

*"Animal STUDIES <u>suggest</u> that flow through capillary beds depends on diastolic times and pressure. Given that **diastolic times** and **pressures are greater** in cardiac patients, **THEY** <u>may cause</u> hyperperfusion."*

Edit 11. Use only a few common, standard, abbreviations.
Abbreviations can save a writer time and effort, but they can potentially confuse and frustrate readers.[17] Abbreviations must be defined at first mention because the same abbreviation may have several meanings, even in the same field; in cardiology, TVP can mean tricuspid valve plasty, temporary transvenous pacing, or transplant vasculopathy. Too many abbreviations can also make reading difficult: "Both NO deficiency and excess ET-1 appear to contribute to the development of PH in left HF."[17]

Edit 12: Use 'echo words' to smooth transitions between sentences.
This edit (called the 'given-new' contract[18]) links sentences by repeating a term used in an earlier sentence as an 'echo word' in the next sentence. This repetition makes the transition between sentences easier and improves the flow of the writing.

Here is a passage without echo words:

The hospital installed its new computer system in 2015 and upgraded it in 2018 to accommodate the new diagnostic categories. This presented medical staff with new reporting problems, which is why we scheduled today's meeting. (The word '*this*' at the beginning of the second sentence is a pronoun without a clear referent, and '*This presented*' is an empty clause.)

In this sentence, the echo words are in **bold**:

*The hospital installed its new computer **system** in 2015. The **system** was upgraded in 2018 to accommodate the **new diagnostic categories**. The **system** and the **new categories** have presented medical staff with new reporting **problems**. These **problems** are the subject of today's meeting.*

The intermediate technique: structured editing

Edit technical manuscripts systematically; strive to be as organized and as efficient as possible.

Joseph E Mancuso, 1992[19]

Editing can be approached in several ways. Technical editors often work with **levels of edit**.[20] Briefly, each level of edit (the number varies, usually from two to nine) consists of content that (mostly) can be edited independently of other levels. For example, an 'integrity' edit will verify all cross references, and a 'language' edit will address copy-editing issues. **Editorial passes** is a more general approach in which the text is edited in several beginning-to-end 'readthroughs' and improved during each pass.[21] Yet a third approach (new to me) is to follow a checklist of **410 specific editing tasks** relevant to technical texts, such as verifying that the axes of graphs are labelled and that the text has an appropriate degree of formality.[22]

Here, I describe 'structured editing,' which involves four sequential tasks completed in at least two passes through a text (Table 2). Editors complete two tasks during the first pass.

Table 2. The four tasks of structured editing

Characteristic	Task 1. Determine the literal meaning	Task 2. Sharpen the wording	Task 3. Determine the likely intended meaning	Task 4. Recommend the wording that conveys the author's intended meaning, meets readers' needs, and follows publication standards
Questions to ask about the text	What do the words actually say?	What changes would better express the authors meaning?	What did the author likely intend to say?	What changes will better convey the author's meaning, meet the readers' needs, satisfy peer reviewers, and meet journal's requirements?
The goal of the task	Determine the meaning of the wording out of context	Edit the wording to more clearly communicate the meaning developed in Task 1.	Determine the meaning of a sentence in the context of the entire text.	Revise the wording to more clearly communicate the author's meaning developed in Task 3 and reconcile this meaning with other information required to understand and document the research and to meet the needs of readers, peer reviewers, and journal editors.
Example of wording	'The outcome was negative.'	'The result of the study was negative.'	'The difference between groups was not significant.'	'The mean difference in blood pressure between groups was neither clinically important nor statistically significant (9 mm Hg, 95% CI, 2 to 16 mm Hg)."

Task 1. Determine the literal meaning of a sentence.
Strictly interpret the words *as written*, without reading too much into the sentence or making assumptions about it (Table 3). A simple example is a figure of speech, such as 'falling in love'. We do not literally fall, and love is not somewhere something can land, but we still know what the phrase means. Likewise, a strict interpretation of the author's words is not necessarily what the author meant to say or needs to say. Task 1 includes clarifying information in tables, graphs, and visuals as well.

Task 2. Sharpen the wording of the sentence.
The purpose of Task 2 is to 'get the text ready to edit' by fixing the errors and awkward wording or punctuation identified in Task 1 (Table 3). Completing Task 2 can require substantial revisions, additions, and deletions. Again, little meaning is inferred; the goal is simply to make the original text read better by sharpening its meaning as identified in Task 1. For example, sharpening the wording in 'falling in love' might become 'She decided she loved him'. As before, the sharpened meaning may not be the intended or the recommended meaning (see below); it is just clearer and more explicit than the original text.

Tasks 1 and 2 are completed one sentence at a time in the first pass.

Task 3. Determine the likely intended meaning.
The intended meaning is determined by reconciling the sharpened meaning with the information from the full text and by inferring meaning or 'second guessing' whenever necessary or possible (Table 3). Given what you now know about the entire text, what did the author probably want to say? This step involves editing in the deeper sense because now you are reading in, guessing at the meaning, and questioning the author's assumptions. Task 3 requires the most analysis and deepest thinking to complete.

Task 4. Revise the text to convey the 'recommended wording'.
The recommended wording is what you return to the author and should be able to defend if asked (Table 3). Task 4 often requires incorporating information into the text that was not provided by the author. The likely intended meaning now has to be expressed with the changes required to meet readers' needs for clarity, accuracy, and organization; to apply reporting requirements for documenting research methods and results; and to adhere to the publisher's instructions for authors or a style guide. Task 4 is what editing is all about: helping authors say what they want to say as clearly and as concisely as possible (Table 3).

More passes are also usually required to confirm sequences (for example, table, figure, and reference numbers), consistency (for example, terms, numbers), adherence to reporting standards (for example, sample selection, dates of data collection) and formatting requirements (word counts, reference styles), polishing, and proofreading.

Completing each of the Tasks in sequence should allow editors, especially those new to the profession, to systematically develop the desired meaning and wording more accurately and with fewer unconsidered questions than when editing 'intuitively'.

Table 3. Examples of the four tasks of structured editing

Note **Additions are in UPPERCASE and deletions are in ~~strike-out type~~.**

Task 1: The original wording (as submitted)	Several studies have been carried out reporting that appropriate nursing staff in intensive care units has a positive effect on reduction in the rate of nosocomial infection, bed sore, duration of mechanical ventilation and hospital stay.
Task 2: The sharpened wording	Several studies ~~have been carried out reporting~~ **HAVE REPORTED** that appropriate nurse staffing in intensive care units ~~has a positive effect on reduction in~~ reduces the rate of nosocomial infection**S**, bed sore**S**, duration of mechanical ventilation, and hospital stay**S**.
Changes accepted	Several studies have reported that appropriate nurse staffing in intensive care units reduces the rate of nosocomial infections, bed sores, duration of mechanical ventilation, and hospital stays.
Task 3: The intended meaning	~~Several studies have been carried out reporting that~~ Appropriate nurse staffing in intensive care units ~~has a positive effect on reduction in~~ **REDUCES** the rate of nosocomial infection**S,**[2] bed sore**S,**[3] duration of mechanical ventilation,[2,4] and hospital stay**S.**[3,5]
Changes accepted	Appropriate nurse staffing in intensive care units reduces the rate of nosocomial infections,[2] bed sores,[3] duration of mechanical ventilation,[2,4] and hospital stays.[3,5]
Task 4: The recommended wording	~~Several studies have been carried out reporting that~~ Nurse staffing in intensive care units, if **CONTROLLED FOR NURSING SKILL MIX AND CASE SEVERITY MIX,** ~~nursing staff appropriate has~~ **CAN LOWER** ~~a positive effect on reduction in~~ the rate **INCIDENCE** of nosocomial infection**S**[2] **AND** bed sore**S**[3] **AND SHORTEN THE** duration of mechanical ventilation[2,4] and hospital stay**S.**[3,5]
Changes accepted	Nurse staffing in intensive care units, if controlled for nursing skill mix and case severity mix, can lower the incidence of nosocomial infections[2] and bed sores[3] and shorten the duration of mechanical ventilation[2,4] and hospital stays.[3,5]

The advanced technique: shortening

> I would never use a long word when a short one would answer the purpose. I know surgeons who 'ligate' arteries. Other surgeons only tie them, and it stops the bleeding just as well.

> *Oliver Wendell Holmes, Sr (1809–1894)[23]*

An excellent training exercise for technical editors is to shorten a 250-word abstract to 100 words (a 60% reduction) without losing content. A trained editor can shorten texts without losing content because untrained writers (authors) typically do not know which features of a text can be routinely shortened or how to shorten them. Some common examples are below; there are many more.[24]

- Use prefixes instead of qualifying words:
  Original: *Most neurons had **not completely developed**.* (six words)
  Revised: *Most neurons were **underdeveloped**.* (four words; 30% shorter)
- Replace phrases with single, more specific, words that have the same meaning:
  Original: *Experiments 1 and 2 were run **at the same time**.* (10 words)
  Revised: *Experiments 1 and 2 were run **simultaneously**.* (seven words; 30% shorter. This kind of revision requires a good command of the language in which the text is written.)
- Put common elements first in a list to avoid repetition:
  Original: *Median BMI was reduced **by** 8% in the treatment group, **by** 6% in the usual-care group, and **by** 4% in the placebo control group*. (24 words)
  Revised: ***Median reductions in BMI** by group were: treatment, 8%; usual-care, 6%; and placebo, 4%.* (14 words; 42% shorter.)

The collaborative technique: mentor-guided analytical thinking

> Good editors need two basic skills. They need to know 'what is right,' and they also need to know how they know it's right.

> *Charles Kemnitz, 1994[25]*

Mentor-guided analytical thinking is how I was trained to be an editor in 1975.[26] The process involves a mentor, who may be an experienced editor or supervisor, guiding a small group of participants (seven at most; three is optimal) for hours at a time, over weeks or months, in considering and discussing the implications of each word, phrase, punctuation mark, and idea of a text and then proposing changes; in other words, completing the tasks in structured editing. One participant interprets the meaning, strengths, weaknesses, and implications of a sentence, which the group then discusses. When the discussion is over, the next participant takes the second sentence, and so on. Analysing a single paragraph can take hours but it is usually time well spent.

The mentor directs the discussion in several ways:

1. Guides participants to 'attend' to the important aspects of both the content and the presentation of a text. The process teaches them what to look for and what to question. The discussions literally go through a text one idea at a time. The goal is to sharpen critical thinking skills and the awareness of unconscious assumptions participants make when reading a text.
2. Uses the Socratic method—the oldest and still the most powerful technique for developing critical thinking—to continually challenge and lead participants in exploring the qualities and options of various aspects of the text. The mentor rarely offers solutions and instead asks probing questions, such as 'So what?', "If this part of the text is true, what must have been true before and what must be true later?", "What does this word really mean?", "What is the author really saying and why?", "What assumptions is the author making?", and "What do you need to know to really understand this sentence?"[27]
3. Helps participants stay on track during prolonged and intense sessions. Learning to attend to new things involves breaking down less-effective patterns of thinking and developing more-effective ones. The session goes until most participants reach the point of confusion, which is the point at which old thought patterns are challenged and new patterns are being developed.
4. Has participants, on their own time, revise that portion of the text discussed in the session. Revising the text up to, say, three times, and improving it each time, helps participants apply what they have learned and to see how they are developing as editors.
5. Ideally, works with participants as described above at least once a week over several months.

The process can be simplified by having, say, weekly discussions about a text for an hour, led by a member of the group who simply directs the conversation without necessarily serving as a mentor.

Mentor-guided analytical thinking is an example of 'deliberate practice,' a process identified in studies of how experts become experts.[28] Deliberate practice asserts that expert performance differs qualitatively from normal performance; that experts have characteristics and abilities that non-experts do not have; and that the difference between experts and non-experts is the result of a long-term, deliberate effort to improve performance. The process itself requires learners to

- be motivated and willing to improve their performance
- attend to the task and exert effort to improve performance
- receive immediate and informative feedback about their performance
- repeatedly perform the same or similar tasks over long periods.

Conclusions

> Few people are so devoid of life that they read technical manuals, reports, and proposals for amusement.

> *Judith A Tarutz, 1992[9]*

Editors have jobs because "most writers try to economize the mental effort of the writer, not the reader".[29] Of course, editors, working as editors, are neither writers nor readers, but they are responsible to both and are the link between those who create ideas and those who use them.[30] Thus, their goal is not to find every weakness in the document but to provide edits that will cause the author to produce the best possible document.[31]

Competing interests

Tom Lang is an associate editor of *European Science Editing* and self-employed as Tom Lang Communications and Training International.

References

1 Wall F. Requirements and responsibilities of a technical editor. *Journal of Chemical Education*. 1953 Oct;516-521.

2 Cunningham D, Malone E, Rothschild J. *Technical Editing: An Introduction to Editing in the Workplace*. New York: Oxford University Press; 2019.

3 Lang T. Medical writing up close and professional: establishing our identity. *AMWA Journal*. 2015;30(1):10-17.

4 Lang TA. Who me? Ideas for faculty who never expected to be teaching public health students to write. *Public Health Reports*. 2019 Mar;134(2):206-214.

5 Bush D, Campbell C. *How to Edit Technical Documents*. Phoenix, AZ: Oryx Press; 1995.

6 Britton W. The trouble with technical writing is freshman English. *Journal of Technical Writing Communication*. 1974;4(2):127-131.

7 Barzun J. *Simple & Direct: A Rhetoric for Writers*. New York: Harper & Row, Publishers; 1975.

8 French B. Internal editing of technical papers and articles. In: Kemnitz C, editor. *Technical Editing: Basic Theory and Practice*. New York: Reinhold Publishing Company; 1958.

9 Tarutz J. *Technical Editing: The Practical Guide for Editors and Writers*. Reading, MA: Addison-Wesley Publishing Company; 1992.

10 Seaman L, Lang T. *International Medical Writing: English for a Global Audience*. Tokyo: Life Science Publishing; 2019.

11 Felker D, editor. *Document Design: A Review of the Relevant Research*. Bethesda, MD: American Institutes of Research; 1980.

12 American Institutes for Research. *Guidelines for Document Designers*. Washington, DC: American Institutes for Research; 1981.

13 Charrow R, Charrow V. Making legal language understandable: a psycholinguistic study of jury instructions. *Columbia Law Review*. 1979;79:1306-1374.

14 Lang T. How to shorten a text by up to 30% and improve clarity without losing information. *Medical Writing*. 2017;26(1):21-25.

15 Osborne H. Criticism and Creativity. In: Zook L, editor. *Technical Editing: Principles and Practices*. Washington, D.C.: Society for Technical Communication; 1975. (Anthology Series).

16 Gould G. *Suggestions to Medical Writers*. Philadelphia, PA: The Philadelphia Medical Publishing Company; 1900.

17 Lang T. Abbreviations: expectations, permutations, revelations, reservations, and applications of shortened words and phrases. *AMWA Journal*. 2019;34(4):152-157.

18 Haviland S, Clark H. What's new? Acquiring new information as a process in comprehension. *Journal of Verbal Learning and Verbal Behavior*. 1974;13:512-521.

19 Mancuso J. *Technical Editing*. Englewood Cliffs, NJ: Prentice Hall; 1992.

20 Van Buren R, Buehler M. *The Levels of Edit, Second Edition*. Pasadena, CA: Jet Propulsion Laboratory, California Institute of Technology; 1980.

21 Cortelyou E. Some qualifications of a technical editor. *STWE*. 1958;5(2):5-9.

22 Peterson N. *Revising Theory: A Universal Framework for the Comprehensive Editing of Technical Communications*. University of Wisconsin-Stout; 2017.

23 Holmes OW. *Scholastic and Bedside Teaching*. Boston: The Boston Society for the Diffusion of Useful Knowledge; 1842.

24 Lang T. *How to Write, Publish, and Present in the Health Sciences: A Guide for Physicians and Laboratory Researchers*. Philadelphia, PA: American College of Physicians; 2009.

25 Kemnitz C. *Technical Editing: Basic Theory and Practice*. Fairfax, VA: Society for Technical Communication; 1994.

26 Lang T. Mentor-guided analytical thinking (MAT): a method for training medical writers and editors. *AMWA Journal*. 2002;17(1):26-27.

27 Lang T. The illusion of certainty and the certainty of illusion: a case study of misunderstandings in scientific articles. *AMWA Journal*. 2013;28(3):105-109.

28 Ericsson K, Krampe R, Tesch-Romer C. The role of deliberate practice in the acquisition of expert performance. *Psychological Review*. 1993;100(3):363-406.

29 Rickard T. *Technical Writing*. New York: John Wiley & Sons, Inc.; 1920.

30 Coggin W, Porter L. *Editing for the Technical Professions*. New York: Macmillan Publishing Company; 1993.

31 Bush D. Semantics (words are chameleons). In: *Technical Editing: Principles and Practices*. Fairfax, VA: Society for Technical Communication; 1975.