

NOTES ON TECHNICAL WRITING

The purpose of technical writing is to inform the reader of something; the style should further that purpose, not detract from it by trying to entertain, cajole, or confuse the reader. Considering the number of people whose writing only impedes the reader, a few remarks on the elementary techniques of writing clear prose might be worthwhile.

Among the large class of poor writers, three general groups can be separated by their styles. Some attempt to write literary prose which would be both entertaining and informative. Suffice to say that the number of people possessing this rare talent is considerably smaller than the number who fancy that they possess it. Another frequently-encountered format is formal writing carried to an extreme. Characterized by the virtual absence of verbs in the active voice and the presence of singularly awkward sentence structure, this style fails because the content is lost amid the ponderous form. A third style, the most common one, can be loosely described as the "tossed-salad" style, for disorder is its chief characteristic. One finds a collection of ambiguous constructions, incomplete phrases, separations of noun and modifying phrase, and non-parallel constructions. This style has all the polish of rough-hewn lumber.

Good technical writing has just the opposite characteristics. It is clear and direct. It is grammatically correct both in letter and in spirit. Furthermore, it utilizes the great richness and variety in English expression to convey ideas in the most efficient and effective manner.

However, there is no shortage of material criticizing poor writing and extolling good. What is required is a definite suggestion for improvement. It is one thing to determine that paper A is better written than paper B; it is another to prescribe concrete methods for correcting the individual faults of paper B. The remainder of this essay is devoted to this latter project.

The first step in writing anything of consequence is to prepare an outline indicating the organization and content of the paper. The outline should include each assertion together with the evidence for it. This outline is actually a first draft for the preparation and revision of the organization of the paper. At this point, one considers the general thesis of the paper and how the various sections should be organized to develop it best. The logic of the argument or development is thus determined. Once the framework is covered with the sentences of the first draft, one cannot see the forest for the trees, and it is virtually impossible to correct the poor organization. The consequences of failure to make an outline cannot be specified by pointing to one or two sentences that are bad, but they are seen in a general diffuseness and incoherence in the final result. Each sentence and even each paragraph may seem satisfactory, but one suspects that if the pages were not numbered, there would be no way to order them.

The ease of rearranging sentences, paragraphs, and even sections with word processors may seem to make outlines unnecessary and obsolete, but that is a dangerous misperception. If a paper does not begin well organized, successive rearrangements generally obey the second law of thermodynamics -- a system always proceeds in time to greater disorder. The word processor should be considered instead to facilitate outlines. With a processor, it is trivial to proceed from coarse to detailed outlines sequentially.

After one has completed and revised the outline, the first draft of the text may be prepared. The major concern in writing the first draft is the structure and content of the paragraphs; details of sentence structure may be corrected in revisions. The first rule is that different ideas should be placed in separate paragraphs.

As an additional aid to the reader, the first sentence or two of each paragraph should indicate the content of the paragraph. The use of "topic sentences" may seem like an out-grown form from grade school, but it is of great value to the reader who is trying to decide what is being discussed. For an example, suppose one is going to devote a paragraph to the derivation of Y. The proof has several steps, the first of which is X. The paragraph should not begin with "The first step is X." One should give at least some indication of the scope of the paragraph, e.g. "To obtain Y, begin with X." or "In proving Y, the first step is X." An even better construction would be: "The result Y can be deduced directly. The first step is X." This latter form makes the content and significance of the paragraph completely obvious.

When one has completed the development of an idea in a paragraph, a smooth transition to the following paragraph should be made. The transition may be either in the final sentence of one paragraph or in the first one of the following unit. These transitions have more than literary merit; they indicate the relation between successive ideas and supply the logical connections of the argument. If the two paragraphs are not closely related, as between two major divisions in a paper, then this should be indicated. The writer should warn the reader of a major change in thought. Phrases such as, "Returning to ...," "Turning to a new topic," "From a different viewpoint," etc. will often suffice.

Having written a well-organized and logically sound first draft, the arduous process of revision may begin. If the task to this point has been performed carefully, only questions of individual sentence structure and vocabulary will remain. At the very most, three successive sentences may have to be rearranged. However, most of the work will concern the revision of single sentences. For this, a thorough knowledge of English grammar is essential. One must know and appreciate the rich, complex structure of English: adjective and adverbial phrases; noun, adjective, and adverbial clauses; and verbals like participles, gerunds, and infinitives. A person who is conscious of grammatical form would naturally correct most errors and deficiencies in sentence structure.

Acquiring a sound knowledge of English grammar is not easy. Thick books have been written on the subject. A reference like "Fowler's Modern English Usage" is valuable both for its extensive advice and as an example of basic expository style. Few physics textbooks would qualify as examples to be emulated. Goldstein's "Classical Mechanics" is the exception. Although this essay cannot undertake a systematic or encyclopedic treatment of grammar, a few examples of common errors may be useful.

As a simple illustration of grammatical ambiguity, consider the statement "The derivatives of the potential and the field are observable." Unless the reader already knows the fact, he would be unable to decide whether it is "the field and the derivatives of the potential" or "the derivatives of both the potential and field" that are observable. The original sentence certainly does not determine which is to be inferred because the writer did not appreciate the grammatical ability of "and the field" to be conjoined to either "derivatives" or "potential."

Another common error and source of ambiguity arises when adjective phrases are separated from nouns which they modify. The rule in English is that adjectives precede the noun, whereas adjective phrase and clauses immediately follow the noun. An exception is the participle that may begin the sentence and modify the subject. Disregard of this rule leads to uninformative sentences like the following: "Both the experiments of Jones and the data of Smith differ from the calculated values, even employing the accurate new measuring technique X." The content of the participle "employing ..." indicates that it does not modify "calculated values" as the grammar would imply. Although the context permits a partial compensation of the error, the reader can only guess whether the comment applies to Jones, Smith, or both. This sort of error is often occasioned by rapid writing or revising, in which new ideas are inserted without adequate thought.

These examples should demonstrate that grammatical rules are not merely arbitrary conventions to establish snobbery; grammar is essential to effective expression. By making full use of the grammatical diversity of English, one can convey much more information clearly in each sentence.

The goal of good sentence formation is to achieve a grammatical structure that embodies the structure and relations of the content. The main verb should express the principle idea, whereas the subsidiary ideas are relegated to subordinate clauses or phrases. As an example of a defect and its correction, consider the basic sentence "One might expect that X." In a literary work, the principal emphasis may well be on the hero's expectations, but in technical reporting, the statement "X" is the dominant idea, while the expectation is merely a qualification. Such incidentals might better be put in one of the following ways: "According to expectations, X;" "If these conditions are correct, X;" "With this assumption, X."

Following this ideal of structural analogy, equivalent ideas should be given equivalent expressions; this is the reason for the rule of parallel construction. An instance of the incoherence that is the consequence of neglecting this rule is cited here: "The principle difficulties were construction of the magnet bending the beam, flipping the spins and focusing the beam, and to design and calibrate the detector." (If this appears garbled, just change the punctuation rule from the traditional "x, y, and z" to a 'modern simplification' "x, y and z" and note the additional ambiguity. Does the magnet perform three functions?)

The sentences of the first draft should be recast to improve their structure and smoothness. Smoothness is a property of good writing that is hard to define, but perhaps it may be characterized by two features. The first is clear inter-sentence relationships; each sentence is obviously related to the previous one without loss of continuity. The second feature is transparent sentence structure; one need not reread a sentence to grasp its meaning. This implies no long sentences.* Care should be taken to avoid monotony of form, over-use of passive voice, and similar excesses, but these will naturally vanish if the sentences are carefully crafted to express the content optimally.

In addition to perfecting sentence structure, the revision of the first draft should also include vocabulary refinement. The English vocabulary, the richest of any language, is well suited to precise expression. Repetition of a single word can generally be removed by substitution of an accurate synonym, perhaps better suited to the nuance desired. General words like "thing," "is," and "has" can be replaced with words that denote the exact meaning intended.

As the final step, the revised copy should be reread to guarantee that the final result is smooth and intelligible. Pronouns should be largely eliminated and retained only where they have obvious antecedents. Verbs should agree with subjects, and the tenses of verbs should be consistent in successive sentences and indicative of the times of the events. Spelling checkers are useful, but they also miss certain forms of error. If possible, hold the draft for a few days untouched so that you can read it without prejudice.

This concludes the writing of the paper. The general principle for good writing can be stated concisely: At each level of organization in the paper, carefully construct the form to indicate the relationships of the ideas discussed.

* Sentence length varies with author and style. Some journalists, e.g. White, insist on brevity. English writers generally prefer more complex constructions, of which this essay is an example. Inexperienced writers are particularly advised to keep sentences short. Although the result can be somewhat choppy and lacking in style, short sentences offer fewer opportunities for errors, and the product will be clear and serviceable.