TECHNICAL WRITING

I. GENERAL PRINCIPLES

It has been stated, by Sir James M. Barrie, that "the man of science appears to be the only man who has something to say, just now—and the only man who does not know how to say it". The friendly jibe of the novelist contains enough exaggeration to make it humorous to the followers of Huxley and Spencer; but could any litterateur poke similar fun at the exponents of the avowedly utilitarian branches of science—the men of technology—without suggesting an unpleasant truth?

Indeed the engineer does bungle language deplorably. He makes a fetish of efficiency, yet he shows no regard for the effective use of one of his most important tools—the pen; he believes devoutly in accuracy, yet he employs an instrument of precision as carelessly as a small boy handles a gun. This inconsistency may be due to causes such as were indicated by the Academic Senate when it undertook to explain the defective writing of the students in this university.* The Senate suggested that the student is "constantly subjected by his environment to the unedifying influence of myriad examples of poor English", and that he is also affected by "a certain public prejudice against correctness of expression". With these statements most of us will agree. Our local newspapers, for instance, tend to spoil the student's taste for good English; later in life, as an engineer, his daily contact with illiterate men inclines him to careless speech and slovenly writing. As

* The University of California, where these lectures were delivered.

Brander Matthews says: "The uneducated are inclined to resent any speech more polished than their own".

A distinguished engineer and veteran manager of mines, Arthur D. Foote, recently complained to me about the careless writing of the young men that applied to him, by letter, for professional employment. Most of these letters, he asserted, were so untidy in appearance and so turgid in expression that he threw them into the waste-paper basket; but, he added, whenever he received a letter neatly written and clearly expressed he gave it kindly consideration. He told me also that he had been unable to promote several bright young fellows on his staff because they did not know how to keep a legible record or how to use English intelligibly. "Such bad English; drummer's English!" he exclaimed. In the course of further conversation he recalled an interview with the late Professor Christy, of this university, who asked him to give an address to the mining students. "No", Mr. Foote replied, "the engineer is called upon to do everything but preach; from that he is excused." Christy then asked: "If you were to give a talk, what would be your subject?". Foote replied: "Writing; your students need to be taught that. I would not allow any of them to disfigure our mine-records". "But that", pleaded Christy, "is the business of the high-school." "They appear to shirk it", said Foote, "you ought to see that they don't get through the mining-school without some training in the writing of reports and technical papers."

The engineer graduates of this university are not peculiar in being unable to handle skilfully a tool that they must use as long as they live. In this respect many graduates of other technical colleges are equally deficient. A. S. Hill,* Professor of Rhetoric in Harvard University, has said: " Every year Harvard sends out men—some of them high scholars—whose manuscripts would disgrace a boy of twelve; and yet the College can hardly be blamed, for she cannot be expected to conduct an infant-school for adults". The cure is for engineering

* Whose ' Principles of Rhetoric ' is a most useful textbook.

colleges to refuse degrees to students that show no regard for precision of language, meanwhile making an effort to remedy the defect by giving them the necessary instruction.

There should be no need to lay stress upon the part that writing plays in an engineer's life. Until he accomplishes some notable work he is known to most other men only through his writings, in the form of letters, articles, and reports. In default of personal acquaintance, a man—particularly a young man with his reputation to make—is likely to be judged by his business letters. From the style of these, his correspondents infer the quality of his mind and the order of his method. The ability to write a terse report, to state facts plainly, and to convey information intelligibly wins instant respect for him, and opens the door to wider opportunity. Similarly, an article contributed by an engineer to a technical periodical may mark him as well informed, careful in observation, and accurate in statement. An agreeable and capable writer makes friends—even clients—of his readers. To be known honorably is capital.

In my own experience I have found that nicety of phrasing is regarded by many engineers as effeminate. Several of those whose writings I have revised would applaud the statement of a Denver editor that literary form is "a mere frill"; all that is needed, said he, is "to get there", to say what you have to say in your own way, no matter how imperfectly, so long as you say it. This goes to the heart of the matter. You may, of course, make yourself intelligible even if you disregard many of the principles of the art—for writing is an art; but this lecture was not intended for those that are satisfied with such a performance. Although you may make yourself understood in some measure by following such a method—or lack of method—you can not convey your ideas clearly, and fine distinctions of meaning will elude you completely. Furthermore, such writing will stamp you as uncultured or careless, and therefore not equipped for scientific work. The aim of all of us—not the Denver editor alone—is "to get there", that is,

to accomplish our purpose. "For", as Hamlet says, "every man has business and desire, such as it is." What then is the purpose of writing? It is to convey ideas: to tell what we have seen, what we think, what we believe. Language is a vehicle of expression; it is not intended for soliloquy; civilized man does not live by himself; nor does he talk to himself, except when drunk.

Assuming therefore that the purpose of writing is to convey ideas, and that ideas can not be conveyed successfully in defiance of technique, let us consider how to acquire the art of expression. No one can attain proficiency without care and without method, least of all when he is discussing technology or explaining matters that require mental alertness on the part of both the persons concerned, the writer and the reader. At best human speech is an inadequate vehicle of thought; much of the idea is lost in transit; the part that reaches its destination is travel-worn. Rarely does a thought impinge upon the reader's mind with the freshness and the vigor with which it issued from the brain of the writer. To expect to succeed without effort is childish, because it is contrary to experience. It is as if a farmer, going to market, were to put his potatoes, not into sacks, but loosely into a wagon that needed repair, and then, taking any road that offered, were to drive without regard to ruts or stones, rapidly and recklessly, just "to get there". The result would be that many of his potatoes would be thrown out of the wagon, and those that survived the journey would be so bruised as to be unfit for sale. Another farmer, with more sense, puts his potatoes into sacks, which are packed securely in a tight wagon, with axles well oiled and the brake in good order. He selects the road that leads as directly as possible to his destination, he drives carefully and avoids obstacles, so as to deliver his potatoes speedily and safely at the nearest market, where they promptly fulfil his purpose. He 'gets there' in the full meaning of the phrase; the other fellow fails. Henry James, in an address at Bryn Mawr, said: "There are in every quarter, in our social order, impunities of aggression

and corruption in plenty; but there are none, I think, showing so unperturbed a face—wearing, I should slangily say, if slang were permitted me here, so impudent a 'mug'—as the forces assembled to make you believe that no form of speech is provably better than another, and that just this matter of 'care' is an affront to the majesty of sovereign ignorance".

The Denver editor who considered literary form "a mere frill", and expected "to get there" by writing in his own undisciplined way, might be forgiven for claiming that some of his notions were approved in such a book as Lounsbury's 'The Standard of Usage in English'. The Yale professor argues that the standard of speech is the usage of the cultivated; that correctness is determined by the practice and consent of the great authors; in short, that the best usage is the usage of the best writers. To him the grammarian, the purist, the pedant are all anathema. "The mere opinions of individuals, no matter how eminent", he says, "will never carry much weight with the users of speech." Why then waste time in writing on the subject? If a great writer has used words in a manner contrary to the dictum of a grammarian, then it is the grammarian that has erred in his dictum, not the great writer in his practice. Such is his argument. But, I venture to ask, what is grammar but the crystallization of accepted convention, the precise recognition of the best usage, a system of rules based upon the literary habits of good writers? The best usage is not the usage of the best writers, but the best usage of the best writers. Even the best of them make slips and fall occasionally into a bad habit. No writer is impeccant. Those that prepare grammars and other textbooks on the art of writing base their generalizations on the practice of the best writers when at their best, and that is why in the main such books are trustworthy guides. If I were to say to an engineering student: "Don't bother about textbooks in English; ignore the grammarians; just imitate the best writers", I should be giving a counsel of imperfection that would stultify itself. On the contrary, I say: "Take note of the rules of grammar, which state

the functions and relations of the parts of speech; read the textbooks, which summarize the methods that have been found expedient for good writing; make yourself familiar with the great writers, who illustrate the correct application of these teachings; and then develop your own critical faculty so that you may hold fast to that which is good".

Before proceeding further I think it proper to say that I speak to you as an elder brother. Like some of you, I was trained to be a mining engineer; I practised my profession for 18 years, until I began to earn my living as an editor, 15 years ago;* it is as a technical writer that I address you, as one in sympathy with your profession and keenly aware of the importance of being able to write well. I have long been learning, and I am still learning by the application of the ideas and methods that I offer now for your guidance. I speak to you as a student, not as a master; as an amateur who has become a professional, not as a professor.

Having practised the art of writing for an essentially practical purpose, I understand the difficulty of it, and also the delight of doing it well occasionally. In my daily work as an editor, revising manuscript, I am often astonished to see how illiterate the scientific man can be, and how little of university culture clings to the engineer. For instance, he will commonly use the word 'data' as if it were of the singular number.†

The data is [are] plentiful.‡

Much [many] data is [are] available.

It was not possible to obtain a value for WO_3 in scheelite from so **little** [few] data.

There will be **less** [fewer] data from which to make an estimate.

An officer of the U. S. Geological Survey says:

No data is [are] available concerning the supply of such material.

* This was said in 1916.

† See also p. 256.

‡ In the examples quoted for the purpose of illustration, the words that should be omitted or to which critical attention is called will be printed in bold-faced type, and the words to be substituted will be placed between brackets.

A physicist of the U. S. Bureau of Mines says:

Data pertaining to these condensers is [are] assembled in Table III.

A State Mineralogist writes:

The data was [were] obtained by making personal investigations.

A similar blunder is made with 'phenomenon'. A technical journal remarks:

Sir Oliver Lodge re-discovered the same phenomena and suggested its [their] application to purifying the atmosphere.

It would be better to say, "and suggested that they be studied with reference to the purification of the atmosphere".

An Assistant Principal of a School of Metallurgy writes:

Later I discovered this same phenomena in other kinds of glass.

The plural form might have been considered a typist's error, if perpetrated once, but he wrote again:

He gives the causes of this phenomena.

The error might be only an unhappy coincidence, but when he says a third time, "The fact that this phenomena occurs", I know that the poor fellow is the victim of a dreadful habit.

In 'Scribner's Magazine', I find:

When Mrs. Adams made report of this phenomena, Miss Bart raised her eyebrows.

And well she might! But where was the editor?

Chemists have yet to agree upon the explanation of much [many] of the phenomena to be observed.

The use of rods, instead of balls, as a grinding media . . .

Perhaps, as Landor suggested, we ought to Anglicize such Latin or Greek words and write datums, stratums, phenomenons, as we write mediums, factotums, and ultimatums, without apologizing. Indeed one thoroughly capable metallurgist objected to an editorial correction of this common solecism. If a university graduate does not know that 'data' is the plural of 'datum', he is no better informed than the miner who speaks of "them quartz" or of "stratas that prospect". An engineer wrote to me about the "foliae" of the schist in Rhodesia. The plural of *folium*, of course, is *folia*. Those who make such blunders also write about the "ration" of 10 : 1 and the "Seward peninsular".

You may say that these blunders arise from ignorance of Latin, but this is not the whole truth; they come from ignoring good usage, and from reading an illiterate daily press. The editor of the San Francisco 'Chronicle' writes:

Armed with this data, the U-boats have crossed the Atlantic to find a more fruitful field for their operations.

The editor of the 'Examiner' says:

Data is being gathered on intensive farming.

A writer for the U. S. Bureau of Mines evidently had an inkling that things were wrong, so he compromised:

Since this data were collected.

It may not be necessary to be a classical scholar in order to write good English—such as John Bright spoke—but I believe it true that some knowledge of Latin and Greek is necessary to an intimate understanding of English, particularly that part of it which deals with technical science, the terms of which are derived mainly from the classical languages. Most of our Anglo-Saxon words have been so long used to describe the every-day affairs of life and to convey simple ideas that they carry connotations unfitting them to express the new concepts of science and the precise ideas of technology. Our civilization came from the Mediterranean; our literature came through Bede, not Beowulf; through the songs of Provence, not the sagas of Schleswig. I submit to you that the Anglo-Saxon tradition has been over-done; the renaissance of learning began in Italy and its voice was Latin.* It speaks in the two classics of English literature: the King James version of the Bible and the plays of Shakespeare. Nearly two-thirds of the words in the English language are of Latin derivation. I do not refer to colloquial language, but to literature. The idea that the purity and simplicity of our literature depend upon the use of words of Anglo-Saxon origin is based upon a fallacy. In the foregoing

* 'The Art of Writing', by Sir Arthur Quiller-Couch. Lectures VIII and IX.

sentence "words" is Anglo-Saxon, "idea" is Greek, but "purity", "simplicity", "literature", "depend", "use", "origin", "based", and "fallacy" are all from the Latin. These are the principal words; the grammatical links, of course, are Anglo-Saxon, which is the matrix of English.

Since the advancement of science in the Victorian period, the vocabulary of technology has grown rapidly, borrowing words from the languages of ancient learning, so that now a scientific man can hardly speak or write intelligently without knowing the derivation of the terms he is compelled to employ. Do not use words unless you know their meaning. If your classics were skimped at school, study the dictionary;* above all, read the best writings. "Imitation is the sincerest flattery." There is a good deal of what Marion Crawford called "the everlasting monkey" in man. That reminds me of Stevenson's phrase, "sedulous aping". He recommended the imitation of good writers for the sake of acquiring style, and described how he himself learned to write, while a student at Edinburgh, by imitating passages from Macaulay for a month, then copying Froude for another month, then Carlyle, and so on; thereby attaining the felicity of expression for which he became famous. But, be it noted, Stevenson did this for practice only; it did not prevent him from acquiring a style all his own, because he did not subject himself intellectually to another writer by setting him up as an idol.

If so many of our young engineers write uncouthly, it is because they read so little good literature. The time given to the piffle of the press is lamentable. Our grandfathers used to read the Bible daily; we read the daily newspaper. Even the magazines rarely furnish safe models of writing, and the ordinary textbook is but the dry bones of a great art. If you would absorb style subconsciously read Huxley's essays and Froude's short studies; read Ruskin and Stevenson; read Defoe's 'Robinson Crusoe' again, and Dana's 'Two Years

* 'The Concise Oxford Dictionary' or 'Webster's Collegiate Dictionary' are recommended. Both are of convenient size.

before the Mast'; read Washington Irving's 'Alhambra' and John Muir's 'Climbing the Sierras'; but in order to appreciate such books, and learn from them, you must read intensively—the kind of reading that learns its lesson when done once, and once only.

Of style it is too soon to speak, "yet the man of science ought best to know that style and matter can no more be dissociated than skin and bone. In scientific prose words should be used as carefully as symbols in mathematics".* Our aim is to be understood. The art of writing is based on scientific method. Science is organized common-sense. A blunder—made not infrequently even by scientific men—is to assume that good writing is extrinsic to its subject. On the contrary, "science and literature are not two things, but two sides of the same thing". Huxley said that; and he illustrated his own maxim, so that his writings became glimpses of the obvious and his lectures opened windows into the infinite. Science, I repeat, is not divorced from literature, and no valid reason exists why technology should be regarded as if it were legally separated from good English. Technical writing is the precise expression of special knowledge. The information of the average man is like a turbid solution, the technology of an engineer is like a clean precipitate; the one is amorphous, the other crystalline.

"The development of the mind is an advance from the indefinite to the definite." The technical man in his processes, whether of the mine and mill, or in the reducing operations of his own mind, follows a similar line of action. His constant effort is to distinguish between what he knows and what he thinks he knows, between fact and fancy, between observation at first-hand and information at second-hand. When he begins to place himself on record, he should follow the same mental process, but with a difference: in his technical operations he deals with insentient matter; in his technical writing he must keep in mind the human element; for he is recording

* Sir Clifford Allbutt, whose 'Notes on the Composition of Scientific Papers' can be recommended to the technical student.

himself not in the sand of the seashore, but on paper to be read by his fellows. Thus I come to a fundamental rule: REMEMBER THE READER. The Denver editor, who was contemptuous of the effort to write well, ignored this rule. Spencer, who studied style as an adjunct to philosophy, said: "The good instructor is one in whom nature or discipline has produced what we may call intellectual sympathy—such an insight into another's mental state as is needed rightly to adjust the sequence of ideas to be communicated". If you wish to communicate ideas, you must think of the other fellow, of the man at the other end of the line of mental communication represented by your writing. Thus, in order to be effective, you must be sympathetic; you will spare the reader doubt as to the meaning of what you have written, perplexity caused by the turgidity of your style, annoyance at the queerness of your terms, and weariness due to your verbosity. You will communicate what you have to say in language involving the least trouble to the reader. Some trouble he himself must take; for he also must be sympathetic and willing to expend his brain-tissue. Avoid trespassing on his patience. "Those are the most effective modes of expression which absorb the smallest amount of the recipient's attention in interpreting the symbols of thought, leaving the greatest amount for the thought itself." So said Spencer. This is the first great principle of writing: economy of mental effort on the part of the reader. Put yourself in his place, I repeat; if you do so sincerely, you will avoid most of the errors that prevent language from becoming an effective medium for the transmission of thought.

I spoke just now of economizing the mental effort of the reader; this the writer can achieve only by being willing to take pains. If you read a technical article, for example, and find that you understand it easily and comfortably, obtaining useful information without undue mental fatigue, you may rest assured that somebody else has taken trouble over the article and thereby has spared you the labor of probing the writing to discover its meaning. Either the author has made a

successful effort to be perspicuous or the editor has corrected and revised the manuscript so as to make the rough places smooth. Somebody must put hard work into every technical article that is written for publication; if not the author, then the editor; if both the author and the editor shirk their duty, the reader will have a headache. Therefore, REMEMBER THE READER. As Allbutt says: "A writer who writes to convince and not merely to see his name in print must learn to lay his mind alongside that of his reader".

The next desirable thing is to have a reader worthy of respect, so as to stimulate you to conscientious effort. Most of the letters, reports, or articles that the engineer is called upon to write are addressed to persons whom he respects. I assume therefore that you are writing to somebody or to some group of persons to whom you wish to convey technical information or scientific opinions effectively and pleasantly. To accomplish this purpose your writing must be natural, clear, precise, and convincing.