TECHNICAL PROSE: ENGLISH OR TECHLISH?

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IF THE SENIOR CHEMICAL engineering student feels burdened by report writing, he can take no comfort from what lies ahead, for writing will likely occupy an even greater proportion of his time as a practicing engineer. Moreover, success will depend as much on development of communication skills as on technical ability.

One learns to write just as one learns to ride a bicycle, to play a musical instrument, or to make love. Bad performances are not only common, but easily recognized. Remedial instruction is by criticism and example. Unfortunately, professors are seldom accomplished writers, and provide far more bad examples than good. Thus by the time a student is required to write a technical report he slips naturally into a special written language, which we call Techlish. Fortunately, it bears some relation to English and a literate engineer can often understand its general drift, if not its precise meaning.

Take a straight-forward English sentence: *He followed her in hot pursuit.* Not one engineering student in a hundred would put to paper any thought so directly and so evocative of an image of what is afoot. Translated into Techlish, it becomes, *It was she who was followed by him in hot pursuance,* or perhaps, *It seemed necessary that he should heatedly follow her in a pursuit-type mode.*

THE STUDENT REPORT

EXAMPLES OF FULL-BLOWN Techlish abound in almost any student report, and we quote verbatim in what follows from several that were submitted in a process-design course. Consider the punch line, the final sentence, of one report: *The finalized design appears promising and the results of this study urges further pursuance.* One notes the ungrammatical combination, "the results . . . urges", wherein the subject and verb do not agree in number. Although such errors are common in student reports, they are not essential to Techlish. The grammatically correct expression, "the results . . . urge," illustrates a basic characteristic of Techlish, namely, the combination of words which in common use do not belong together. Results do not urge; people urge: *She urged him on in hot pursuit.* Other unhappy word choices are "finalized" for "final" and "pursuance" for "pursuit". Another characteristic of Techlish is the total lack of assignment. To whom does the design "appear promising"; who is to pursue the matter further? But the crucial problem is that we are not sure what the author means. The distinctive quality of Techlish is that it always confronts the reader with this problem. Translated directly into English, the sentence reads, "The final design may not be final." However, as a sentence from a student's report its true message is probably: "I hope the design is reasonable; if not, further work should make it so". The student is really suggesting to the teacher that he deserves a good grade in either event.

Not only does habitual use of the passive voice make for dull writing; it forces a convoluted style almost impossible for an engineer to make concise, precise and grammatical.

We start with this last sentence of a report because it points to a basic problem for the student. He is asked in a design course to assume the role of a practicing engineer writing a report for his supervisor. In this role, his objective is to provide information that will allow his supervisor to make some sort of recommendation to higher management. Large sums of money may be involved; employee safety and public health may

be considerations. Such matters are not trivial, and the author of the report is assumed expert with respect to his subject. For a student to play this role successfully, he must suppress his natural propensity to behave as a student whose sole objective is to impress his teacher and to earn a good grade. The transition from pupil to expert is abrupt, and few students can believe it is expected, let alone respond properly. Thus student reports are laced with all sorts of irrelevant material that no supervisor would care to read, but which is thought to impress a teacher. There are, for example, long discussions of what was *not* done, comments on the great difficulty or extent of the calculations, narrative expositions of step-by-step calculations, derivations of standard equations copied from readily available sources, and convoluted excuses proffered in compensation for an inadequate effort. One finds such gems as,

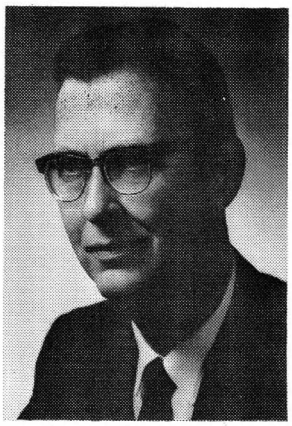
> *This is a close approximation, since the whole process was designed by a series of approximations.*

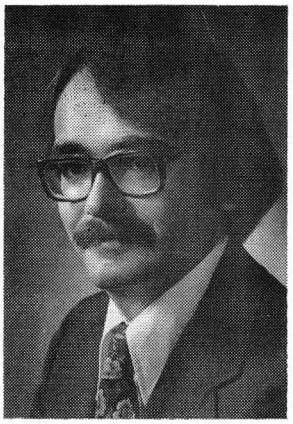
The logic is of course absurd, but the student feels he should suggest some reason for the teacher to accept his result.

A report must be written with the intended reader in mind. This is the cardinal rule of report writing. A process-design report goes to the boss. In a design course the student has no real boss, but must imagine one. Although the teacher grades the report, he is not the boss; he merely judges the report with respect to its acceptability to an imagined boss. When writing for the boss, either real or imagined, one may safely assume that:

1. He is busy, or at least believes he is, and
2. He has a general technical knowledge at least equal to one's own.

The report is written to help the boss; it must not waste his time. He is interested in the results and their justification, and these must be the focus of the report. They must occupy a prominent position in a separate section or sections. They do not belong in the abstract, the introduction, or the conclusions. They must be stated concisely, with authority, and without ambiguity. Figures and tables are appropriately used to aid clarity and to summarize and order results succinctly; each must be numbered and referred to in the text. A process description is always written with reference to a carefully labelled diagram.





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Professors Abbott and Van Ness are coauthors of a number of research papers on thermodynamics and of two books: "Schaum's Outline of Theory and Problems of Thermodynamics", McGraw-Hill, 1972, and (with M. W. Zemansky) "Basic Engineering Thermodynamics", 2nd. ed., McGraw-Hill, 1975. They do not guarantee these works to be free of Techlish, but have made a conscious effort to follow their own rules.

Although the results of a report are presumed the work of an expert, the boss will likely check them at least in part. He must find this an easy task through reference to an appendix, where all calculations are carefully laid out and thoroughly annotated.

No universal agreement exists as to the proper format of a report, and we can suggest none. The reasons are, first, that the nature of the report should influence the format, and second, that the style of a report and hence its format should reflect the individuality of the writer. However, an abstract is essential, as it tells a prospective reader what is in the report. An example of a suitable abstract of a process-design report is:

> *A preliminary design of the heat-recovery unit for a plant to produce shale oil is described. Circulating gas picks up heat from a moving packed bed of spent shale and transfers it to raw shale in a similar bed. Technical feasibility of the process is demonstrated.*

One needs no more than this to know what the report is about. It is brief, to the point, and it

stands by itself.

Unless it is very short, the body of a report is divided into sections. Students are often given a list of "standard" section headings, such as,

Introduction
Procedure
Results
Discussion
Conclusions and Recommendations

These may or may not be appropriate for a particular report prepared by a particular individual. The report abstracted above might well be divided according to the headings:

Process Description
Heat Recovery from Spent Shale
Preheating the Raw Shale
Auxiliary Equipment
Recommendations

Appropriate headings are also used with appended material, such as notation, literature citations, and calculations. In our view the introduction, which simply sets the stage, needs no heading. What else could the first several paragraphs of a report be?

PRINCIPLES OF WRITING

WE RETURN NOW to our main theme, the language of a report, the writing of technical prose. Engineering students often are convinced of several misconceptions about writing:

1. **Engineers are naturally poor writers.**
2. **Writing is not important for engineers.**
3. **The rules for writing technical prose are different from those for non-technical prose.**

The first two misconceptions tend to go together with some sort of reciprocal justification, and we simply contradict them. The third is a mistaken impression gained from wide exposure to Techlish. Here we can by example show the difference between Techlish and English. But first we offer a few general principles designed to guide one away from the most objectionable excesses of Techlish.

I. Be concise; be brief; eliminate "bull." Provided you recognize it when you see it, "bull" is effectively pruned as follows: Write a first draft, put it out of sight and mind for a day or two, then rewrite it, cutting the length by 25% or more. This process can usually be repeated.

II. Be precise; be specific; say what you mean; avoid ambiguities. Your work is too important to be misunderstood. Your sentences must make literal sense. Read them aloud; change any that sound ridiculous. You can gain experience with whatever you read; an example is the following sentence from an official university bulletin: *Faculty, staff, and students are asked to cut back on energy waste by the President.*

III. Prefer the active voice. The active voice results when the subject of the sentence *carries out* the action implied by the verb:

We calculate density by the ideal-gas equation.

In contrast, the passive voice results when the subject of the sentence receives the action implied by the verb:

Density is calculated by the ideal-gas equation.

One learns to write just as one learns to ride a bicycle, to play a musical instrument, or to make love. Bad performances are not only common, but easily recognized. Remedial instruction is by criticism and example. Unfortunately, professors are seldom accomplished writers, and provide far more bad examples that good.

This sentence does not say who does the calculation; it is impersonal. Herein lies the origin of Techlish. For many years the dominant attitude with respect to scientific and technical writing was that it should be impersonal, because science and technology were said to be impersonal. This forced adoption of the passive voice, and promoted the lifeless syntax, the witless style, to say nothing of the grammatical mistakes of technical prose. We repudiate the whole of it. Not only does habitual use of the passive voice make for dull writing; it forces a convoluted style almost impossible for an engineer to make concise, precise, and grammatical. *I* and *we* are not four-letter words; they are entirely acceptable in technical reports and publications. We do not suggest that every sentence start with *I* or *we;* one seeks variety. If you are too humble or shy to bring yoursel to write *I,* use *we,* in the sense of you, the reader, and I, the writer. *One* also has its place. Do not think you can avoid responsibility for what you write by adopting an impersonal style. No way; your name is on the title page. Take some pride in it; you are the expert.

IV. Write in the present tense, unless it is clearly inappropriate. In some technical writing,

changes of tense are nearly as numerous as sentences. In student reports one often finds past, present, and future tenses all in the same paragraph, even in the same sentence. This confuses the reader, and is usually senseless. The results given in a design report are of course determined in the past, but they still exist, and should be presented and discussed in the present tense.

V. Avoid Techlishese. This heading covers a variety of literary vices:

(a) Jargon, elongated or fancy words. For example:

"Finalized" for 'final"
"Pursuance" for "pursuit"
"Utilize" or "utilization" or "usage" for "use"
"Systematize" for "order"
"Synthesize" for "make"
"Hypothesize" for "assume"

(b) "Using" (and its variants) as a preposition. Examples:

Density is calculated using the ideal-gas equation.

... by using ...
... by use of ...
... by utilizing ...
... by utilization of ...
... by making use of ...

In each case the simple preposition *by* adequately replaces the verbal expression.

(c) Possessives. Possession is usually associated with living things: "the consultant's fee," "the horse's mouth." An expression such as "the heat exchanger's tubes" is at best graceless. To speak of "Martha's tubes" might also be graceless, but is syntactically proper.

Note also that "it's" is not a possessive, but a contraction of "it is."

(d) "Due to" is not a synonym for "because of." It means "caused by":

The fire was due to a weld rupture.

Compare the following sentences.

Techlish: *Due to the fact that the pressure was low, the ideal-gas equation is used to calculate density.*

English: *Because the pressure is low, we calculate density by the ideal-gas equation.*

(e) "So" is not a co-ordinating conjunction, and does not mean "therefore" in formal prose.

Techlish: *The pressure is low, so we calculate density ...*

English: *The pressure is low; therefore we calculate density ...*

Note the semicolon which separates the two independent clauses of the second sentence; use of a comma here is wrong.

VI. Shun the dangling modifier. A verbal phrase at the beginning of a sentence must refer to the subject of the sentence:

Being hotly pursued, she saw the garden ahead.

"She" is the subject of the sentence, and "she" is being pursued. The logical relationship is more evident if we transpose the verbal phrase:

She, being hotly pursued, saw the garden ahead.

Note that we cannot put this verbal phrase at the end of the sentence without producing an absurdity:

She saw the garden ahead being hotly pursued.

Forced to write in the passive voice of Techlish, the engineer likely recasts this sentence into something like:

Being hotly pursued, the garden came into view.

Presumably the garden is not being pursued, but we cannot tell that from the sentence. "Garden" is the subject of the sentence, and the verbal phrase, regardless of its location, refers to the garden:

The garden, being hotly pursued, came into view.

The garden came into view being hotly pursued.

Do we find this sort of nonense in technical writing? In fact, we do, frequently. Consider:

To calculate the gas density, ideality is assumed.

The subject of the sentence is "ideality"; the verbal phrase "to calculate" must refer to it. Does "ideality" do the calculation? Try it the other way:

Ideality is assumed to calculate the gas density.

Even if we understand the sentence, it does not reveal who does the calculation or who does the assuming. The verbal phrase is said to dangle. In contrast, we have the unambiguous statement in the active voice:

To calculate the gas density, we assume ideality.

There are other possibilities:

Techlish: *Assuming ideality, the gas density is calculated.*

English: *Assuming ideality, we calculate the gas density.*

Entirely proper sentences can also be constructed with the verbal phrase as the subject of the sentence:

Assuming ideality allows calculation of the gas density.

Calculating the gas density is simplified by the assumption of ideality.

The richness of English derives from the many possible arrangements of words by which a message may be expressed; however, we can suggest nothing more direct or clearer than:

We calculate density by the ideal-gas equation.

We have stated an absolute rule respecting verbal phrases at the beginning of a sentence, because that is the usual location of the most insidious dangling modifier. However, verbal phrases can dangle in other locations, and clarity, if not grammar, requires that they be revised out of technical prose. The test of whether a phrase dangles is simple enough: If it is obvious from the sentence who or what is doing what the verb implies, the phrase does not dangle.

VII. Heed rules of particular importance to technical writers.

(a) Units. Most numbers are associated with units, and these must be clearly expressed. For this purpose pick conventions and stick to them. Many possibilities exist; for example:

4 (atm)	or 4 atm.	or 4 atm
12 (cm)	or 12 cm.	or 12 cm
17 $(cm)^3$	or 17 cu.cm.	or 17 cu cm
30 (ft) / (s)	or 30 ft./s.	or 30 ft/s
24 (J) / (s) $(cm)^2$	or 24 J./s.-$cm.^2$	or 24 J/s-sq cm

(b) Symbols and numerals. Do not begin sentences with them. The simplest reason is that one runs into conflict with the capitalization rule for the first letter of a sentence. How does one write an upper-case 2?

Two liters of water are added.

Not

2 liters of water are added.

Is the symbol q capitalized at the head of a sentence?

The symbol q represents heat.

Not

q (or Q?) is the symbol for heat.

(c) Hyphens. Technical language abounds with groups of words that serve as a single adjective; hyphenation is required when such adjectives modify a noun:

ideal-gas equation
constant-presssure heat capacity
standard-state fugacity
2-inch pipe
heat-exchange fluid
220-volt circuit
4-foot-long duct

The hyphens connect all words which alone do not modify the final noun. Thus in ideal-gas equation, we are writing about neither an "ideal equation" nor a "gas equation"; in constant-pressure-heat capacity, "constant" modifies "pressure" and the compound adjective "constant-pressure" modifies "capacity", which is also modified by "heat". The reason for this rule is that without it one cannot make the necessary distinctions between, for example:

one armed bandit	**and**	**one-armed bandit**
a high school girl	**and**	**a high-school girl**
3 foot-long tubes	**and**	**3-foot-long tubes**

(d) Bibliography. Reference is frequently made in technical writing to outside sources of information. The use of footnotes is not generally satisfactory, and references are usually collected in a separate section at the end. A consistent format for all references is essential in this section; pick one, and stick to it. The current trend is to include the title of the reference. For example:

1. **Seeder, A. B., and V. D. Chitnis, "Laser Technology in Ancient Greece," J. Early Physics, 6, 4298 (1977).**

In the text, reference is usually made to this entry by a number in parentheses:

Seeder and Chitnis (1) report that . . .

Note that "in Perry" is not a proper reference to the Chemical Engineers' Handbook, no matter how widely known it may be. This volume is listed in the Bibliography as:

2. **Perry, R. H., and C. H. Chilton, editors. Chemical Engineers' Handbook, 5th ed., McGraw-Hill Book Company, New York, 1973.**

EXAMPLES OF STUDENT PROSE

CONSIDER NOW SOME typical examples of student prose. Occasionally one finds a short, plain sentence:

The number of tubes was economically determined.

Unfortunately, brevity and simplicity are outweighed by faults. The passive voice and past tense don't help, but the real problem is that the sentence does not say what is meant and misses the opportunity to convey important information.

The design of a heat exchanger obviously requires determination (economically or otherwise) of the number of tubes; it is this number that is important. The sentence should be replaced by:

The most economical number of tubes is 145.

This is a positive, definite statement devoid of "bull".

Another short, plain sentence:

Make-up gas was calculated from energy considerations.

This one is plain nonsense. Gas (make-up or any other kind) cannot be calculated; calculation gives an amount or a rate. "Energy considerations" is too indefinite. What kind of considerations? Again, the sentence should be replaced by a positive, specific statement, such as,

An energy balance yields the make-up-gas flow rate.

One can understand the following sentence, but it is pure Techlish:

Using the McCabe-Thiele method, 34 equilibrium stages were necessary.

Thus, by the time a student is required to write a technical report he slips naturally into a special written language which we call Techlish.

Who is "using the McCabe-Thiele method?" Certainly not the "34 equilibrium stages" as is implied by the sentence structure. The 34 stages were necessary. Is this true now? The sentence is easily translated into English.

The number of equilibrium stages, calculated by the McCabe-Thiele method, is 34.

or

The McCabe-Thiele procedure yields 34 equilibrium stages.

"Using" (and its variants) is the most overworked word of Techlish; revision of a sentence to exclude it almost always results in improvement. This is true also of such common Techlish expressions as "it was necessary" and "in order to":

Techlish: *In order to maintain isothermal conditions it is necessary to cool the reactor.*

English: *The isothermal reactor requires cooling.*

Techlish: *In order to calculate the tower required, it was necessary to have vapor-liquid equilibrium data. This data was found by use of vapor pressures and assuming ideal solutions and ideal gas (Raoult's Law).*

English: *Raoult's law provides the vapor-liquid equilibrium data required for calculation of the number of trays in the tower.*

The last example of Techlish is so bad as to make a complete list of faults impractical. We note the following:

- **Passive voice.**
- **Past tense.**
- **"to calculate" refers to "it," and is a dangling verbal phrase.**
- **Evidently a tower is calculated. Absurd.**
- **Techlish: "In order to," "it was necessary," "by use of".**
- **"This data was . . ." "Data" is the plural of datum, and requires plural modifiers and a plural verb: "These data were . . .", or "these data are . . ."**
- **Non-parallel construction in the second sentence: "by use of . . . and assuming"**
- **An explanation of Raoult's law. Why insult the boss's intelligence?**

The following is an example of an inappropriate narrative style:

In this design of this heat transfer system we assume the moving bed to be a packed bed throughout the duration of this operation. To assure we have a packed bed system we had to find the superficial fluidization velocity. Our fluidization velocity was equal to 1905 ft/hr. When finding the dimensions of the preheater and post-cooler we need superficial velocities which were at most 75% of the fluidization velocity.

The translation into English:

Gas velocities through the moving packed beds of the preheater and post-cooler are no greater than 1430 ft/hr, about 75% of the fluidization velocity.

The story-telling version is of course replete with "bull", which when squeezed out reduces the length by two-thirds. Other problems with the Techlish text:

- **"this design," "this heat transfer system," "this operation." Is it clear what each "this" refers to?**
- **Multiple changes in tense.**
- **Lack of hyphens in "heat-transfer system" and "packed-bed system."**

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The course aims to present a rigorous and formal introduction to biochemical engineering, emphasizing the students' ChE background. Analogies are drawn with reaction kinetics, heat and mass transfer, and design learned at the undergraduate level. The student is provided with the elementary tools in biochemistry and microbiology, and a familiarity with current views and literature in these areas. Clearly further coursework in applied microbiology or biochemistry is required for those students doing graduate work in the area, and this is usually a component of the graduate coursework for M.S. and Ph.D. candidates. Thoroughout the course homework problems are assigned to supplement the lecture material. As there is no convenient text source of problems, some of these are taken from fairly recent literature articles. This helps to emphasize the quantitative rather than descriptive nature of the area. □

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- **The second sentence says that finding a velocity assures a packed-bed system. Nonsense.**
- **Not afraid of the first person, the author over-does a good thing; "Our fluidization velocity" is inappropriately personal.**

Two final quotations and their translations illustrate several of the points made earlier.

Techlish: *To attain this area the heat exchanger contains 100 9 foot long pipes with an inner diameter of one inch.*

English: *A heat exchanger with 100 9-foot-long, 1-inch-i.d. pipes provides the required area.*

Techlish: *The shale preheater has a feed of raw shale supplied to it between 60-90°F which is to be heated to 600°F and then fed into the reactor. The exchanger is to utilize exhaust gas from the reactor as its heat transfer fluid.*

English: *Before entering the reactor, raw shale is preheated from about 60°F to 600°F. Exhaust gas from the reactor serves as the heat-exchange fluid.*

The "shale preheater" of the second quotation comes as a surprise; we would have expected steel or perhaps cast iron.

Writing good technical prose is a difficult task; few persons can do it easily or quickly. A first draft is usually in need of substantial revision; several rewritings are normally required. Some expert help is provided by a good dictionary, which should be consulted frequently for the proper meanings (and spellings) of words. Especially useful is a little book, called "The Elements of Style", by William Strunk, Jr. and E. B. White. The second edition of this book, published by Macmillan, is printed in paper-back at under $2.00. In 78 pages the authors say all that need be said on the subject. Every engineer should keep a copy at hand.

Rather than supply our own ending to this piece, we offer the closing words of a student report:

> *Due to the small choice of alternatives related to this study, the complexity of our conclusions remain at a minimum. In conclusion it is readily apparent that further research would definitely pay off in the form of further insight into this problem.*

Who could disagree? □