How Well Do You Inform?

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Abstract—Handling details well is the hallmark of anyone who communicates well, yet most engineers write reports that are not analytical but catalogical. Catalogical writing tends to handle details serially without implying which ones are more important than others. Analytical writing, however, clearly distinguishes among the details. To be aware of the difference is an important step in creating an informative written report. Engineers can apply four tests to their writing to measure how well they are informing. They can (1) count the prepositional phrases and rewrite them into dependent clauses; (2) see how frequently their sentences are cast in subject-verb-object order and rewrite them for variety; (3) identify and replace abstract nouns with concrete nouns; and (4) recognize passive verbs and replace them with more active and more informative ones.

PROBABLY no good engineer has even been fired simply because he was a poor report writer. Far too often, however, good engineers have missed out on promotions and other rewards because their poorly written reports did not do justice to their technical achievements.

Of course, older engineers find that writing skill is vital in the transition to management responsibilities. But the ability to write may be even more important to the young engineer: Until he becomes a participant at committee meetings, executive lunches, and other conferences, he may have to rely almost exclusively on the written report to present his work and his ideas to higher management.

The four simple tests that follow are not the solution to all technical writing problems. But they will help the report writer answer the elusive question, "How well am I informing my readers?" Nothing else in engineering writing is nearly so important as being informative.

Informative writing can be defined as being easy to understand; it need not necessarily be "readable" (i.e., easy to read). In recent years, many books and scores of articles on the subject of readability have appeared. Written primarily to counteract the excesses of ponderous, cautious, academic writing, these publications seem to offer some rather simple solutions to writing problems—don't use big words, and don't use long sentences. Unfortunately, although short words and sentences are desirable if they can be used without oversimplification, neither are they a panacea for writing problems, nor do they necessarily lead to informative reports.

For instance, in a tabloid newspaper or popular magazine, the announcement of a new lubricant will be presented in very readable, perhaps even exciting, prose. However, to obtain the information he needs on the new lubricant, the engineer must turn to the manufacturer's brochure or to a business magazine where the language may contain such "unreadable" multisyllable words as "coefficient," "viscosity," and "pres-

sure differential." If the chemical engineer becomes confused or unhappy with this language, it will be because of the way these words are used—not because of the words themselves.

Actually, informative writing involves much more than the lengths of words, sentences, and paragraphs. While it does not involve "style" in the sense of grace or elegance, it does involve attention to sentence construction and choice of words. Also, the writer must know how to present these details logically.

These requirements will become clearer as we proceed with the four tests. Essentially, the tests should show the engineer not only what presentations are usually best, but also why they are the best.

(A word of warning: The tests require some knowledge of grammar. Because time is unkind to memory, grammatical terms are defined where appropriate. If you are still hazy after finishing this article, run, not walk, to the nearest grammar text. A few minutes of intensive study should be enough to clarify things.)

HANDLING DETAILS

In technical reports, where detail must play a far more significant role than in most other forms of writing, the goal of the engineer is to present pertinent details—major and minor—in an informative way.

Basically, there are two ways to present details in a sentence; let us first examine the bad way:

The unlikelihood of meeting orders from the majority of its new customers is of concern to the company, due to tardiness in the installation of its new manufacturing line.

Here is a good example of what might be called *catalogical writing,* in which the writer has cataloged or equated all his details, so that minor details become as important as major ones. In other words, there is no discrimination among details, so that the sentence is more difficult to understand than it should be.

Catalogical writing of this sort abounds in technical reports; in fact, more poor writing can be traced to the cataloging of details than to any other source. Happily, there is an infallible clue to the cataloging of details: *There is an inordinate use of the prepositional phrase.* By way of proof, let us repeat the example, this time with prepositional phrases—there are eight of them—in parentheses:

The unlikelihood (of meeting orders) (from the majority) (of its new customers) is (of concern) (to the company), due (to tardiness) (in the installation) (of its new manufacturing line).

In sentences, prepositional phrases act as adjectives or adverbs, that is, they add qualifying detail. (Adjective: The writer *of technical reports* is intelligent. Here the phrase modi-

fies the noun "writer." Adverb: The book is lying *on the table*. Here the phrase modifies the verb "is lying.")

When the qualifying details in a sentence are put into prepositional phrases, they are all treated in precisely the same way, technically speaking. But some details obviously are more important than others; hence, the cataloging of details clearly is a detriment to informing because the main details simply do not have the impact on the reader they should have. To repeat, the cataloging of details is the most serious error in most poorly written reports.

How can the technical writer eliminate as many prepositional phrases as possible? The following rewrite of the example says essentially the same thing as the original:

The company does not know whether it can meet most new-customer orders, because its new manufacturing line is not yet installed.

Here is a good example of *analytical writing*, which is the chief asset of good informative writing. If the clue to catalogical writing is overuse of the prepositional phrase, the clue to good analytical writing is *a judicious use of the dependent clause*. In the rewritten sentence, there are two dependent clauses: "whether it can meet most new-customer orders" and "because its new manufacturing line is not yet installed." There are no prepositional phrases.

For at least three good reasons, dependent clauses help make sentences more informative:

• They analyze detail, highlighting what is important. The very words that introduce clauses strengthen this analysis, because they tell the *when, if, because, who,* and so forth of the clause. These strong words help the reader interpret what is being described.
• They force the writer to break up the equating of detail that is characteristic of a series of prepositional phrases strung together.
• They make writing sound much more natural. Anyone who doubts this, should reread the examples in the section aloud.

In analytical writing, dependent clauses act as adjectives or adverbs in a sentence; in addition, they may act as nouns. Here are some examples:

I heard *what you said* (noun, object of the verb "heard").

The book *(that) I read* was very interesting (adjective, modifies the noun "book").

He sings *when he takes a shower* (adverb, modifies the verb "sings").

With a little practice, anyone can learn to recognize dependent clauses quickly. Three points need to be remembered: (1) A dependent clause is not a complete statement. (2) It must have an introductory conjunction or relative pronoun (*if, when, which, that, because, since,* and the like), although the relative pronoun *that* can often be omitted, as in the second example above. (3) To qualify as a clause, it must have both a subject and a verb, such as *you said, I read,* and *he takes* in the above statements.

Here is another example of the difference between catalogical and analytical writing; prepositional phrases are in parentheses, dependent clauses are italicized:

Catalogical: The need (in the company) for great increases) (in space), caused (by a steady growth) (in research work), has necessitated the addition (of a new wing) (to the laboratory).

Analytical: Because its research work has been growing steadily, the company is adding a new wing *that will greatly increase its laboratory space.*

Once again, the rewritten sentence eliminates every prepositional phrase. In most catalogical sentences, however, it is difficult if not impossible to eliminate every prepositional phrase, nor should a writer strive to do this. Yet it should be possible to reduce the number of these phrases by at least one-half. The report writer's tool for doing this is, of course, the dependent clause.

Here is a longer example of catalogical writing; the subject matter has to do with two-phase flow systems:

Variance of the mechanism for momentum transfer with respect to the flow pattern is to be expected, but this is not too well understood. Uncertainty even surrounds the correctness of reliance on visual description of flow patterns as a means of identifying the regions involved in possible changes in the mechanisms for momentum transfer. Consideration, in addition, of entrance effects, as well as the possibility of transient or unsteady state behavior being of importance, makes the relative efficiency of existing correlations seem even more remarkable. Knowledge of the flow pattern and all the physical and geometric properties of the system enables one to predict, in the best correlations, pressure drop within an accuracy of about 25 percent.

This four-sentence paragraph contains a large number of prepositional phrases (24, to be exact). There are no dependent clauses. This is a dull, uninformative catalog of details the reader must interpret if he is to extract concrete meanings. After wading through several paragraphs of this sort, most engineers would be ready to head for the hills.

A more analytical approach would have helped the reader immensely. Actually, the original version of this passage was more analytical; the above excerpt represents this writer's catalogical version of a well-written paragraph that appeared in a recent issue of *Chemical Engineering* (Dec. 6, 1965, p. 139). Here is the original paragraph, with its analytical approach restored:

It is to be expected that the mechanism for momentum transfer might vary with the flow pattern, but this is not too well understood. It is not even clear whether visual description of flow patterns is sufficient to identify the regions where the mechanisms for momentum transfer might change. When, in addition, entrance effects are considered, as well as the possibility that transient or unsteady state behavior is of importance, it is remarkable that the existing correlations work as well as they do. If one knows the flow pattern and all the physical and geometric properties of the system, the best correlations will predict the pressure drop within an accuracy of about 25 percent.

The statistics here are much more encouraging: The number of prepositional phrases has dropped from 24 to 12, and there

are now eight dependent clauses, listed below by introductory word, subject, and verb only:

that/mechanism/might vary
whether/description/is
where/mechanisms/might change
when/effects/are considered
that/behavior/is
that/correlations/work
as/they/do
if/one/knows

Because the paragraph is quoted out of context, and because some technical terms might not be familiar to everyone, this text cannot inform completely. But few persons would deny that the analytical version is much more informative than the catalogical one; it is also much more natural.

The report writer who has begun to suspect that his writing is more catalogical than it ought to be should take the following simple test:

Test 1: Take a short passage from one of your reports (one typewritten, double-spaced page is long enough). In the passage, blot out every prepositional phrase with a red pencil and every dependent clause with a green pencil. Blot out the whole phrase or clause, not just key words. If, when you have finished, more red than green is on the page, you can be reasonably certain that you are not handling details as informatively as you might.

HANDLING IDEAS

If details within a sentence must be presented carefully, it is equally important to concentrate on presenting ideas—sentences themselves—in an informative way. As with details, sentence construction can be catalogical or analytical. Learning to connect ideas or sentences analytically is a major step toward more informative writing.

In any paragraph, some ideas obviously are more important than others. But the writer who catalogs ideas refuses to recognize this fact. As a result, his technical reports are likely to follow the pattern of the following paragraph (in each sentence, the main subject and verb are in italics):

This expanding drum *brake* for motors *has* shoes made of electrical steel laminations, mounted on a common anchor pin. *They/serve* as armatures for the brake release solenoid. The *drum/is* aluminum. The brake *lining/ is bounded* directly to laminated shoes. The release *solenoid/is connected* across electric motor terminals. *It/is energized* when the motor starts, holding the shoes away from the drum. *Interrupting* current to the solenoid automatically *applies* shoes to the drum, with brake pressure applied by a helical spring between the shoes. Manual *release/is* by a cam, applying pressure below the pivot point of the shoes. The drum *brake/is* available for mounting on NEMA C frames or independently housed and foot-mounted. *It/is* available with 2 to 20 foot-pound ratings.

A quick examination of this ten-sentence paragraph reveals an interesting fact: Almost every sentence begins with the main subject and verb. What we have here is a tedious catalog of ideas, each technically constructed in precisely the same way. By limiting himself to this approach—subject-verb, subject-verb, subject-verb—the writer has made informing virtually impossible. In this paragraph, the main ideas simply don't get through clearly to the reader because minor ideas are given the same construction. Too, it is extremely difficult to tie ideas together when this pattern predominates; this sort of writing doesn't "track."

In informative writing, sentence construction is much more varied. Consider the following excerpt (once again, only the main subject and verb of each sentence are italicized):

Operating and maintenance *supervisors* of an oxygen generating plant *were* quick to credit polyelectrolytes with increaseing plant-operating efficiency, reducing downtime, and eliminating manual mud removal.

The *plant,* located on the site of a steel mill, *supplies* oxygen for steel making. Although it has a closed cooling system and makes up with clean water, a sticky *mud/ was settling* in its pipes, heat exchangers, and compressor jackets because atmospheric dust from the mill was entering the water through the cooling tower.

The *mud* greatly *reduced* heat-exchanger efficiency, *caused* power consumption to go up and operating efficiency to go down. Because the *operating temperatures* of the oxygen compressor ran high, the *compressor/had* to be shut down every two months and manually cleaned to restore temperatures to design levels. Besides the expense of cleaning, *oxygen/was vented* when the compressor was down.

In this passage, arrangement of main subject and verb is much more varied, as it should be. Some of the main subjects and verbs are preceded by dependent clauses, others by phrases. The writing does "track," and, incidentally, is much more natural than the catalog of ideas previously quoted.

Test 2: In a passage from your writing, underline the main subject and main verb in each sentence. (In this test, ignore the subjects and verbs of dependent clauses.) If the main subject and verb appear at the beginning of more than half the sentences in the passage, you have good reason to believe that you are not presenting ideas informatively.

The percentage (one-half) given in this test is arbitrary and perhaps a bit high, but it does give you a goal to strive for. If it does nothing else, it should provoke you into making a few thoughtful changes, such as putting a few connective phrases or clauses between ideas.

ABSTRACT vs. CONCRETE NOUNS

We can define the ideal engineering report as one that every reader will interpret exactly the same way.

Very often, engineering reports are hard to interpret not because they are too technical but because they contain too many ordinary, everyday words of a certain kind: abstract nouns. Abstract nouns are by definition ambiguous, and the more often they crop up, the less informative the writing.

Admittedly, abstraction appears in all forms of writing, including technical reports. Words like *profits, industry, economics,* and *manufacturing* are as abstract in their own way as words like *truth, love,* and *justice.* Whenever a writer has to

make a general statement (and he often does), abstract nouns are likely to creep in. The following statement, for example, is open to several interpretations, chiefly because of the abstract nouns (italicized):

> The *question* of where the company will locate its new plant depends upon such *factors* as the employment *situation*, local tax *conditions*, and transportation *facilities*.

Here is one concrete interpretation of this statement: 'The company wants to build its new plant near a major rail center, where local taxes are low and skilled labor is plentiful." This is, however, only one interpretation—not necessarily the correct one. No one except the actual writer of the statement can hope to know precisely what is meant.

In many technical reports sentences could be expressed more concretely. Generally, the main subjects of these sentences are abstract nouns. Here are some examples:

> The condition of the centrifuge is such that it requires replacement.
> The problem of increasing production was resolved when the company purchased an additional machine.
> The use of a computer will help a company to process its payroll faster.

Corrective surgery on sentences of this sort, to eliminate abstract nouns like *condition, problem,* and *use,* is not difficult. Usually, all the writer need do is look immediately behind the abstract noun where he will find a prepositional phrase with a concrete noun as its object. Promoting this noun to the main subject produces a more concrete sentence:

> The centrifuge needs to be replaced.
> Production increased when the company purchased an additional machine.
> A computer will help a company to process its payroll faster.

Sometimes the concrete or real subject of a sentence does not come immediately after the abstract main subject. But with a little practice, any writer can learn to spot quickly the real subject of a sentence.

Abstract nouns are bad for informative writing in another respect: They often attract awkward constructions that have no place in good writing. If the writer replaces an abstract noun with a concrete one, he often finds that the awkward construction disappears automatically. Here are some examples (abstract nouns and awkward constructions are italicized):

Abstract
The *nature* of helium is *such that* it is a gas at room temperature.
The *reason* production stopped was *due to the fact that* the workers went out on strike.
The *use* of the new compounds *in connection with* the cleaning of boiler tubes will result in the elimination of scale.

Concrete
Helium is a gas at room temperature.
Production stopped because the workers went out on strike.

The new compounds will eliminate scale from boiler tubes.

The following abstract nouns should be eliminated, if possible, from technical reports:

ability	effort	order	relation(ship)
activity	employment	persuasion	respect
basis	extent	policy	responsibility
case	facility	position	result
character	factor	possibility	situation
circumstance	instance	practice	standpoint
concept(ion)	intent	problem	substance
concern	interest	prospect	system
condition	manner	purpose	type
connection	measure	quality	use
course	method	question	utilization
degree	nature	reason	view
effect	necessity	reference	

Some of the nouns in this list can, of course, have concrete meanings at times. But there is a great deal of difference between the concrete "The instrument *case* is in *use*" and the abstract "In the *case* of the missing instrument, the use of our insurance policy may minimize the loss." The objection here is to the abstract usage of these nouns, which results in needless verbosity.

Here is a list of awkward phrases that crop up with great regularity in technical writing. These should also be eliminated:

according as to whether	in the course of
as far as . . . goes	in the form of
as regards	in the interests of
associated with	in the light of
as to	in view of
by means of	on the basis of
due to the fact that	on the order of
for the purpose of	on the part of
for the sake of	relative to
from the standpoint of	such that
in a manner of	to the extent that
in connection with	with reference to
in order to	with regard to
in relation to	with respect to
in the case of	with a view to

The lists of abstract nouns and awkward constructions suggest a third test for the report writer:

Test 3—In the passage from your writing that you are analyzing, draw a circle around every abstract noun and awkward construction that appear. If more than six circles appear on the page, your writing probably is more abstract than it should be.

PASSIVE vs. ACTIVE VERBS

In informative writing, active verbs usually outnumber passive verbs by a large ratio. When too many passive verbs creep into writing, prose tends to become unnatural, less direct, and far less forceful than it should be.

Passive verbs are easier to recognize than to avoid. Any verb that consists of some form of the auxiliary *to be* followed by the past participle of the verb is passive. In sen-

tences the subject of an active verb initiates the action described by the verb ("Jones *drives* his car to work"); the subject of a passive verb, on the other hand, receives the action described by the verb ("The car *is driven* to work by Jones").

The following passage, in which every verb but one is passive, typifies the unnatural writing that appears in many reports (verbs are italicized):

This handbook *has been written* to provide an authoritative single source of information on all facets of temperature control in these systems. It *is issued* for use by all who *are concerned* with design, development, and utilization of components or complete systems. This revision, as *will be* the case when future revisions *are considered* to be appropriate or necessary, *is based* on experience gained in usage of the handbook over a given period of time during which certain advancements *have been made* in the state of the art. This book is not *intended* to supersede any regulations, contracts, or documents referenced therein.

The contention here is that at least half the passive verbs that appear in technical writing can and should be replaced by active verbs. When this happens, writing almost always becomes more natural than the passage just quoted, and more informative. Our argument is not with the passive verb itself—no one can hope to avoid it completely—but with its consistent overuse.

There are, of course, many ways to rewrite sentences so that passive verbs become active. The three following techniques, however, accomplish this goal perhaps more easily than others:

1. In a sentence look immediately behind the passive verb where you will often find an infinitive that can be converted into an active verb that replaces the passive verb.

Passive Coal is used to heat the plant.
Active Coal heats the plant.
Passive Tests were made to verify the hypothesis.
Active Tests verified the hypothesis.
Passive In the process, a catalyst is provided to speed the reaction.
Active In the process, a catalyst speeds the reaction.

2. If an infinitive does not follow a weak passive verb, try converting a noun that appears in the sentence into an active verb.

Passive Sulphuric acid was employed in the removal of surface impurities from the specimen.
Active Sulphuric acid removed surface impurities from the specimen.
Passive Completion of the process is effected by a rust-preventive coating.
Active A rust-preventive coating completes the process.
Passive Correction of production errors was obtained through laboratory tests.
Active The laboratory tests corrected production errors.

3. Switch from an impersonal style, which is usually passive, to a personal style, which is usually active.

Passive Several laboratory tests were conducted on the specimens.

Active We conducted several laboratory tests on the specimens.
Passive After installation of the new equipment, production was doubled.
Active After installing the new equipment, the company doubled production.
Passive Procedures were initiated to reduce plant accidents.
Active They initiated procedures to reduce plant accidents.

Some report writers do not favor a personal style. The tone of technical writing, these people feel, is objective and impersonal. There is, of course, nothing wrong with an impersonal style, except that too much impersonal writing is passive, abstract, and catalogical. Also, there are times when the reader wants to know who did what. Note, for instance, that the statement "The reactor that was ordered was inspected" is *not only more* awkward but also less informative than "The materials engineer inspected the reactor that Dept. X had ordered."

The passive verbs in the following list are especially weak. Avoid them whenever possible by one of the three techniques described.

is accomplished	is facilitated
is attained	is featured
is based	is involved
is considered	is made
is designated	is observed
is effected	is permitted
is employed	is provided
is enabled	is used
is enjoyed	is utilized

Although impersonal writing can be informative, most professional writers prefer to be personal, simply because it makes the task of informing easier. In personal writing people do something, but in impersonal writing something is done to things. The writer who is consistently impersonal tends to become consistently unnatural in his use of language.

In seeking to reduce the number of passive verbs, the report writer should first try to eliminate the really weak passive verbs that appear in the box. These verbs almost never carry their own weight in sentences. When they appear, sentence construction is likely to become awkward and overly indirect.

Here is a fourth test that will show the report writer whether he is informing as well as he might:

Test 4—In a representative passage from your writing, underline the first 20 verbs. Count two points for each passive verb that appears in the box, one point for all other passive verbs. If your total score is more than 10, you have evidence that your writing is more passive than it should be.

WHAT THE TESTS SHOW

From the preceding examples, the reader should see that the four tests are intimately related. Almost always, catalogical writing is passive, abstract, and impersonal. Analytical writing, on the other hand, is usually concrete, active, and personal. Very often, making corrections in one area automatically improves writing in other areas. Thus, the writer who consciously avoids cataloging details is likely to present ideas informatively, actively, and concretely.