
ENGLISH FOR SCIENCE AND TECHNOLOGY **A Handbook for Nonnative Speakers**

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McGRAW-HILL BOOK COMPANY

New York	St. Louis	San Francisco	Auckland	Bogotá	Hamburg
Johannesburg	London	Madrid	Mexico	Montreal	New Delhi
Panama	Paris	São Paulo	Singapore	Sydney	Tokyo
					Toronto

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2 3 4 5 6 7 8 9 0 HALHAL 8 9 8 7 6 5 4 3

ISBN 0-07-030821-7

This book was set in Souvenir by Waldman Graphics, Inc.
The editors were Phillip A. Butcher, Jim Dodd and Claudia Tantillo;
the designer was Nicholas Krenitsky;
the production supervisor was Diane Renda.
The drawings were done by J & R Services, Inc.
Halliday Lithograph Corporation was printer and binder.

Library of Congress Cataloging in Publication Data

Huckin, Thomas N.

English for science and technology.

"Includes chapters 1-15 and 23 of Principles of communication for science and technology by Leslie A. Olsen and Thomas N. Huckin"—T.p. verso.

Includes index.

1. Technical writing. 2. English language—Text-books for foreigners. I. Olsen, Leslie A. II. Title.
T11.H823 1983 808'.0665021 82-20900
ISBN 0-07-030821-7

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WRITING PARAGRAPHS

Unlike readers in the academic world, most readers in the “real world” read *selectively*: rather than thoroughly digesting a piece of writing, they skim-read most of it, skipping from one main idea to another until they come to something that particularly interests them. Such readers are forced to read this way. They are overwhelmed with reading material and simply don’t have the time to read everything carefully.

As a writer, therefore, you should do everything possible to ease this kind of reader’s burden; in particular, you should make your writing *easy to skim-read*. One of the best ways to do this is to write good paragraphs. What makes for a good paragraph in scientific/technical writing? First of all, a good paragraph has *unity*: it focuses on a single idea or theme. Secondly, a good paragraph has *coherence*: one sentence leads to the next in some kind of logical sequence. Finally, a good paragraph has *adequate content*: it has an appropriate selection and number of details to support the main idea of the paragraph. Readers expect to find these qualities in paragraphs, and you as writer should take care not to frustrate their expectations.

There are two principal tools you can use to invest your paragraphs with the qualities just described: (1) a good topic statement and (2) an appropriate pattern of organization.

2.1

WRITE A GOOD TOPIC STATEMENT

The topic of a paragraph is its main idea or theme, i.e., what the paragraph is about. As with a larger piece of writing, readers of a paragraph want to know right away what the topic is. They also like to have some idea of how this topic will be developed. In other words, readers will use whatever cues they can to quickly generate expectations about the paragraph as a whole. This strategy serves two purposes: (1) it allows readers to guess what’s coming and thus digest it more easily and (2) it allows them to avoid reading the paragraph altogether if the subject matter holds no interest for them.

You can help your readers, therefore, by providing a good topic statement right at the beginning of the paragraph. It does not have to be confined to a single sentence: often a topic statement is extended over the first two sentences of a paragraph. It should, however, always contain one or more key words directly related to the topic, and it should be as complete a statement of the main idea as possible, without getting into too much detail and

making the sentence(s) forbiddingly long. In addition, if possible, it should suggest how the topic will be developed (by comparison and contrast, by cause-and-effect analysis, etc.).

Here is an example of an effective topic statement.

Unlike gasohol-powered cars, the fuel cell alternative is virtually pollution-free. A methanol fuel cell system works through chemical reactions that leave the air clean. A fuel processor breaks the methanol down into carbon dioxide and hydrogen; the hydrogen is then pumped to the cell itself, where it combines with oxygen to form water. Current is then produced when the electrons traded between molecules in this reaction travel through an external circuit. The net products are carbon dioxide, water, and electricity. By contrast, when gasohol is burned in an internal combustion engine, it produces the same nitrous oxides that gasoline does.¹ [italics added]

This topic statement is a good one because it tells the reader immediately what the theme of the paragraph is (fuel cell cars don't pollute) and because it's consistent with how the rest of the paragraph is developed (as a cause-and-effect description of how the fuel cell process works). Notice how the writer has used the key term *fuel cell* in the most important position in the sentence, the main-clause subject position, thus establishing it as the paragraph topic, i.e., what the paragraph is about.

For an example of what *not* to do, here is a paragraph from a student report on whether to use an argon recovery process or a hydrogen recovery process in a proposed ammonia plant:

NEGATIVE EXAMPLE

Utility costs for the argon process are 75 percent greater than for the proposed hydrogen process. Initial capital cost is \$5.4 million, roughly three times the hydrogen process cost. However, annual income from the sale of argon, increased ammonia production, and reduced natural gas requirements elsewhere in the plant is 160 percent higher than that generated by the hydrogen process. Present worth analysis shows that the argon process is the better investment. The present worth of the argon process is \$10.25 million. The present worth of the hydrogen process is \$4.14 million.

Most readers will quickly conclude, on the basis of the first two sentences of this paragraph, that the argon process is more costly than the hydrogen one and should therefore not be chosen. But this is just the opposite of what the writer wants them to understand! For later on—buried near the bottom of the paragraph—the report states that “the argon process is the better investment.” This statement is actually the topic statement of the paragraph. By “burying” it, the writer is running a serious risk of having the readers—especially those busy *important* readers!—completely overlook it.

A few simple changes can easily remedy the situation: (1) promoting the topic statement to initial position in the paragraph, (2) combining the next two sentences and subordinating them to the next one, (3) combining the last two sentences, and (4) adding a few words for emphasis:

The argon process is clearly a better investment than the hydrogen process. Although it has higher utility costs (by 75%) and a higher initial capital cost (by 300%), it generates annual income—from the sale of argon, from increased ammonia production, and from reduced natural gas requirements elsewhere in the plant—that is 160% greater than that generated by the hydrogen process. Present worth analysis shows that the argon process is valued at \$10.25 million whereas the hydrogen process is valued at only \$4.14 million.

Notice how much more readable the rewritten version is. The topic statement serves to establish the main point and also to suggest how the rest of the paragraph will be developed (as a comparison-and-contrast pattern). The key term *argon process* (or its pronoun equivalent *it*) is used repeatedly in sentence-subject or clause-subject positions, thus keeping the reader's mind focused on it; all reference to the hydrogen process, by contrast, is deliberately subordinated.

The basic principle behind a well-written topic statement is this: by the time a reader has finished reading the first sentence or two of a paragraph, he or she should be able to predict what the rest of the paragraph is generally about and how it will probably be developed. Suppose, for example, you were reading an article on transport across membranes in a popular-science magazine and began reading this paragraph opening:

The human body is made up of millions and billions of cells, each of which contains, among other substances, millions and billions of protein molecules. . . .²

How do you think the rest of the paragraph will go? What will it be about? Do you expect it to elaborate on other substances, on cells, on the human body generally? Probably not. Instead, there seems to be a narrowing down of focus to the term *protein molecules*; this is probably what the paragraph is about. How will this topic be developed? Well, the pattern of development used in this opening sentence is one of classification-division. Perhaps that pattern will be continued. Or maybe the writer has used some other pattern—a general-to-particular ordering of details, say, or a comparison of protein molecules with other kinds of molecules. Maybe the writer has used two patterns together. Of all the possibilities, though, you'd probably expect the classification-division pattern to be continued. It's a general fact about human nature that once we perceive a pattern in something, we expect it to continue—unless, of course, it's explicitly broken. Let's see what happens with

this paragraph:

... An average cell contains hundreds of different kinds of proteins, and all of the cells of the human body contain, among them, as many as 100,000 different kinds of proteins. These proteins can perform millions of different functions, a versatility which is largely responsible for the phenomenon called "life."²

The writer has indeed continued with the classification-division pattern set up in the first sentence. Notice, too, how the pattern proceeds from general to particular; the grammatical subjects of the three sentences show this progression quite clearly: *The human body*. . . . *An average cell*. . . . *These proteins*. . . .

Though paragraphs sometimes exist in isolation, they are usually linked to other paragraphs, forming larger conceptual units. In such cases, either the topic and pattern set up in one paragraph may be carried on to the next or the break between paragraphs can be used to switch to a new topic and/or a new pattern. In any event, it is usually desirable to maintain some kind of continuity when moving from one paragraph to the next. This is most often done by incorporating a key word or term from one paragraph into the first sentence of the next. In the membrane transport article, for example, the first sentence of the next paragraph begins as follows:

The proteins derive their versatility from their structure—they are made up of chains of molecules of amino acids, substances of which there are 20 different ones in the human organism. . . .²

Notice how the writer has picked up on the key word *versatility* from the last sentence of the first paragraph and used it as a transition to the subject matter of the second paragraph.

And what is the subject matter of this new paragraph? If the topic statement (above) is a good one, you should be able to predict with some assurance what it is. First of all, two new words appear prominently in this statement: *structure* and *amino acids*. We might suppose, therefore, that the theme of this paragraph is the structure of amino acids. Furthermore, since the writer has begun discussing amino acids by saying that there are 20 different types of them, we might expect the rest of the paragraph to be a discussion of the structural variety of amino acids, perhaps according to a classification-division pattern, a comparison-contrast pattern, or a general-to-particular ordering of details. Let's see how it actually does continue:

An average protein molecule consists of about 500 molecules of amino acids of different kinds (seldom all 20), arranged in some particular sequence. A sequence of 500 amino acids composed of all the 20 different ones would have as many as 1×10^{60} (1 followed by 60 zeros) possible arrangements,

each arrangement having particular chemical properties and therefore chemical capabilities. From these few facts alone, we can readily appreciate how important the study of the amino acids is to our understanding of proteins, of the cell, and of life.²

As you can see, the paragraph as a whole *does* satisfy the expectations raised by the topic statement. It is about the structural variety of amino acids, and it *does* follow a general-to-particular pattern of development.

EXERCISE 2-1 For each of the following paragraphs, circle an appropriate topic statement from among the three possibilities given. Be prepared to defend your choices.

- A
- i Many researchers believe that the cost of platinum will level off in the not-too-distant future.
 - ii Fuel cell cars may someday be designed to operate with a catalyst different from the one being used today.
 - iii Further development of fuel cell cars, despite their advantages, awaits more compelling economics.

While the soaring price of oil might have made the fuel cell car economically attractive, the rising value of precious metals has had the opposite effect. Fuel cells designed to run on methanol use platinum as a catalyst, and the price of that metal quadrupled during 1979. The cost of platinum alone could add a few thousand dollars to the price of a fuel cell car. Researchers have been trying to decrease the amount of platinum needed in the cells or to substitute a different, cheaper catalyst.¹

- B
- i The quantity of coal left in the earth is impressive.
 - ii Coal is a more viable source of energy than petroleum.
 - iii The mining of coal entails a number of difficulties.

There are known to be 198 billion tons of coal at a depth of less than 1000 feet and lying in beds at least 3.5 feet deep for bituminous coal and at least 10 feet thick for beds of lower grade coal. An equal quantity of coal of the same accessibility is identified as “undiscovered recoverable reserves.” In addition, there are even larger quantities of marginally available coal resources, amounting to 1 trillion, 400 billion tons. At 35 million Btu’s per ton, coal can provide a great deal of energy for many years to come.³

- C
- i Many molecular biologists are now convinced that the discovery of movable genetic elements holds the key to the solution of several long-standing mysteries.
 - ii It has become evident that in eucaryotes, unlike procaryotes, the genes coding for protein production do not exist as one continuous stretch of DNA.
 - iii Wrapping of the DNA on the enzyme with a positive superhelical sense ensures that the reaction will produce negative supercoiling once the wrapped segment is translocated.

It seems to go a long way, for instance, toward explaining how the human body is able to synthesize a million and more different molecular antibody species, each tailor-made to grapple with a specific antigen. Movable elements may help answer the age-old question of differentiation: how a fertilized egg divides and ultimately becomes, in the course of embryonic development, many different kinds of tissue cells. Jumping genes may also provide a mechanism for satisfying scientists who have been arguing that point mutations alone were far from enough to account for the story of evolution.⁴

EXERCISE 2-2 Each of the following sentences has been taken from an original text where it serves as an effective topic statement for a well-written paragraph. See if you can guess roughly how each paragraph is developed beyond the topic statement: what the key words are, what the pattern of organization is.

- A The first modular home to be tested by government engineers for durability exceeded the criteria for the National Bureau of Standards.⁵
- B At the time of its explosion, Mount St. Helens was probably the most closely watched volcano in the world.⁶
- C The production of an important heavy chemical, nitric acid (HNO_3), requires large quantities of ammonia.⁷
- D Until 1922, no one knew how a signal crosses the junction between one nerve cell and another.⁸
- E The basic property of gyroscopic action is that the gyroscope stays spinning in exactly the same direction in space over both short and long periods of time.⁹