The Structure of Technical English

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Preface

This practice book is intended for foreign engineers or students of engineering who have already mastered the elements of English, and who now want to use their knowledge of the language to read books on their own subjects. Readers should understand, however, that the purpose of the book is to teach language, not to teach engineering.

The language in which scientific and technical facts are expressed is certainly not a different language from that of everyday life, but all the same it presents the foreign student with a number of special problems. The most obvious and the most widely recognised of these problems is the vocabulary. Fortunately a number of excellent dictionaries of scientific and technical terms exist. There is, of course, a vast vocabulary of technical words, but the problem is not so frightening as it looks. In the first place, many of these highly technical words are fairly international; and in the second place, they usually have very specialised meanings. In any case, they are not the concern of this book. Much more difficult are the semi-scientific or semi-technical words, which have a whole range of meanings and are frequently used idiomatically. One of the aims of this practice book is to present as many of these words as possible, and as often as possible: words such as *work* and *plant* and *load* and *feed* and *force*. Words like these look harmless, but they can cause a lot of trouble to the student.

And then there is another kind of word which is important: the verbs, adjectives and adverbs which are not specifically scientific, but which belong to the phraseology of science. These are usually formal, dignified and foreign-sounding words, like *extrude* and *propagate* and *obviate* and *negligible*, which are partly responsible for the slightly fossilised appearance of the typical scientific statement. A wide selection of these words will be found in this book.

But more than anything else, I have tried to describe the technical statement: that is, the completed sentence rather than the individual word. Many of the structures illustrated in the book are found also in ordinary language though not so commonly. But they are essential to the expression of technical facts and ideas – at least for the present. Perhaps in time a more amiable way of writing will emerge, and in fact technical writers are already conscious of the obscurity and pomposity of a great deal of technical writing. But there is a justification for many of their tricks of style, and I have not attempted to criticise them at all, merely to analyse them. The structures and practice sentences in this book are intended to familiarise the foreign student with the kind of writing and the kind of statements he is likely to find in his reading of scientific and technical literature.

In writing technical sentences at all, one is forced to assume that the reader knows a certain amount of the subject. But the knowledge assumed here is not very great. I have taken for granted a knowledge of the terms of elementary mechanics and physics of the kind that would be studied in High Schools. The majority of the sentences in the exercises refer either to common knowledge or to the material contained in the preceding reading sections. This may explain the lack of diversity in the exercise statements, but the only alternative was to assume a wide knowledge of all branches of engineering, which did not seem a good idea. It is expected that the teacher will provide further illustrative material in the subject which his students are taking.

The reading passages which begin each section have been specially written to illustrate features of technical style, and for no other purpose. But I hope that they are reasonably accurate from the engineering point of view, and for this I must express my grateful thanks to a number of lecturers in the University of Birmingham who had read sections of the book and corrected a number of mis-statements: to Dr J. W. R. Griffiths of the Department of Electrical Engineering; to Mr K. E. Porter of the Department of Chemical Engineering; to Mr F. D. Hobbs of the Graduate School in Highway and Traffic Engineering; and above all to Mr P. D. Allen of the Department of Mechanical Engineering, who has given me a great deal of help and answered a layman's questions with endless patience.

A. J. Herbert

Substitution Tables

Some patterns of English structure are set out in this book as in this example:

<table>
<tr><td rowspan="2">A safety valve is provided</td><td>to
so as to
in order to</td><td>allow</td><td rowspan="2">excess pressure to escape.</td></tr>
<tr><td>for the purpose of
with the object of
with the aim of
with a view to</td><td>allowing</td></tr>
</table>

From this table we can make seven sentences; we may cross vertical lines but not horizontal lines: *to*, *so as to*, *in order to* must be followed by *allow* and not by *allowing*. Two of the seven sentences would be:

A safety valve is provided *so as to allow* excess pressure to escape.
A safety valve is provided *with a view to allowing* excess pressure to escape.

Sentences with Common Features

Numbered (in some cases, lettered) sentences are often set out in such a way as to show a common word or phrase, as in:

<table>
<tr><td>1. The work</td><td rowspan="3">is likely to
will probably</td><td>start early next year.</td></tr>
<tr><td>2. The new engine</td><td>be a good one.</td></tr>
<tr><td>3. An explosion</td><td>occur at any minute.</td></tr>
</table>

In this case we make only six sentences, since a numbered sentence is continued only on the same line. The first three of our six sentences are:

1. The work *is likely to* start early next year.
2. The work *will probably* start early next year.
3. The new engine *is likely to* be a good one.

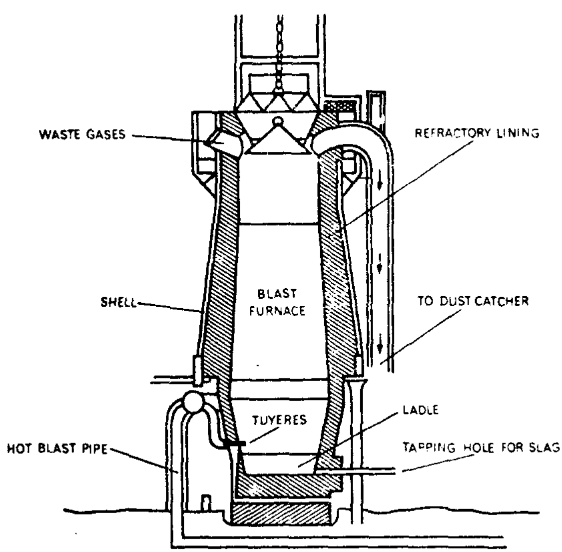
Contents

Section I

Reading: Iron and Steel

The earth **contains** a *large number* of metals which are useful to man. One of the most important of these is iron. Modern industry needs *considerable quantities* of this metal, either in the form of iron or in the form of steel. A *certain number* of non-ferrous metals, **including** aluminium and zinc, are also important, but even today *the majority* of our engineering products are of iron or steel. Moreover, iron possesses magnetic properties, which have made the development of electrical power possible.

The iron ore which we find in the earth is not pure. It *contains* some impurities which we must remove by smelting. The process of smelting **consists** of heating the ore in a blast furnace with coke and limestone, and reducing it to metal. Blasts of hot air enter the furnace from the bottom and provide the oxygen which is necessary for the reduction of the ore. The ore becomes molten, and its oxides combine with carbon from the coke. The non-metallic **constituents** of the ore combine with the limestone to form a liquid slag.



Cross-section of blast furnace

This floats on top of the molten iron, and passes out of the furnace through a tap. The metal which remains is pig-iron.

We can melt this down again in another furnace – a cupola – with more coke and limestone, and tap it out into a ladle or directly into moulds. This is cast-iron. Cast-iron does not have the strength of steel. It is brittle and may fracture under tension. But it possesses certain properties which make it very useful in the manufacture of machinery. In the molten state it is very fluid, and therefore it is easy to cast it into intricate shapes. Also it is easy to machine it. Cast-iron **contains** *small proportions* of other substances. These non-metallic **constituents** of cast-iron **include** carbon, silicon and sulphur, and the presence of these substances affects the behaviour of the metal. Iron which **contains** a *negligible quantity* of carbon, for example wrought-iron, behaves differently from iron which **contains** a lot of carbon.

The carbon in cast-iron is present partly as free graphite and partly as a chemical combination of iron and carbon which we call cementite. This is a very hard substance, and it makes the iron hard too. However, iron can only hold about 1½% of cementite. Any carbon **content** above that *percentage* is present in the form of a flaky graphite. Steel **contains** no free graphite, and its carbon **content** ranges from almost nothing to 1½%. We make wire and tubing from mild steel with a very low carbon **content**, and drills and cutting tools from high carbon steel.

WORD STUDY

Negligible, Considerable, Substantial, etc.

A *negligible* amount of something is very small.
It is so small that we can *neglect* or *ignore* it.

A *considerable* / An *appreciable* / A *substantial* / A *material* } amount of something is quite large.

An *appreciable* amount is large enough to be worth *appreciating* or *noticing*.
A *considerable* amount is large enough to be worth *considering* or *noticing*.
A *substantial* amount is large enough to be noticed, like a *substance*.
A *material* amount is large enough to be noticed, like a *material*.

Melt, Molten, Smelt

Ice-cream *melts* in the sun.
Ice *melts* in the summer.
The *melted* ice comes down the mountain in rivers.

At a certain temperature, metals *melt*. They become *molten*.
The *molten* iron passes out of the furnace into moulds.

We *smelt* iron ore by heat, and change the ore into its metal state.
During *smelting*, the temperature in the furnace is raised and the iron *melts*.
When the ore is *smelted*, it becomes pig-iron.

Property

Every metal possesses certain *properties*, or *characteristics* or *qualities* which we can find by experiment; these *properties* may make the metal suitable or unsuitable for any particular purpose. Designers of high-speed aircraft need new materials with special *properties* such as heat resistance and strength at high temperatures.

Here are some of the *properties* which metals may have:

The metal is *fluid.*	It has *fluidity.*	It flows easily when it melts.
plastic.	*plasticity.*	It pulls out of shape without breaking.
elastic.	*elasticity.*	It always returns to its original shape.
ductile.	*ductility.*	It can be stretched without breaking.
malleable.	*malleability.*	It can be hammered out of shape without breaking.

PATTERNS

1. **Make** + *Noun* + *Adjective*

This	makes	the problem	easy.[1] difficult. interesting.
	makes renders	the metal	hard. soft. strong. tough.

					WITH A FEW COMPARATIVES, ANOTHER STRUCTURE IS POSSIBLE		
This	makes renders	the metal	harder. softer. stronger. weaker.	=	This	hardens softens strengthens weakens	the metal.
This	makes	the metal	longer. shorter.	=	This	lengthens shortens	the metal.
		the screw	tighter. looser. flatter.			tightens loosens flattens	the screw.
		the hole	wider. deeper. broader.			widens deepens broadens	the hole.

[1] Students unfamiliar with this form of substitution table will find an explanation on page xii.

2. **Quantity**

<table>
<tr><td colspan="2" rowspan="4">The earth contains</td><td colspan="3">few
not many
a few
some</td><td rowspan="2">precious metals.</td></tr>
<tr><td rowspan="2">a</td><td>small
moderate
certain</td><td rowspan="2">number of</td></tr>
<tr><td>large
great
considerable</td><td rowspan="2">useful substances.</td></tr>
<tr><td colspan="3">a great many
a lot of
plenty of</td></tr>
<tr><td colspan="2" rowspan="4">The earth contains</td><td colspan="3">little
not much
a little
some</td><td rowspan="2">uranium.</td></tr>
<tr><td rowspan="2">a</td><td>small
moderate
certain</td><td rowspan="2">amount of</td></tr>
<tr><td>large
great
considerable</td><td rowspan="2">iron ore.</td></tr>
<tr><td colspan="3">a great deal of
a lot of
plenty of</td></tr>
<tr><td>The engine
The motor</td><td>produces</td><td>a</td><td>certain
negligible
small
moderate
considerable
large
great</td><td>amount of</td><td>power.</td></tr>
<tr><td>A</td><td colspan="2">certain
moderate
considerable
large</td><td>percentage
proportion
part
amount</td><td colspan="2">of the world's coal lies in this country.</td></tr>
</table>

EXERCISE

Answer these questions, using an appropriate phrase from the table above.

1. How many substances are present in iron ore?
2. What proportion of countries use electricity from nuclear power stations?
3. How much carbon does wrought-iron contain?
4. How much power do you need to drive a large liner through the water?
5. Are there many gold-fields in the world?
6. How much petroleum is pumped out of the ground every year?
7. What percentage of people in your country work in factories?
8. Are any metals besides ferrous metals used in industry?
9. How much oxygen is needed to burn a ton of coal?
10. How much soil do the rivers carry down to the sea in a year?
11. What proportion of passengers flying in aircraft are killed in crashes?
12. How much of your country's electrical supply is derived from water power?

3. Contents

Contain, Consist, Comprise, Constitute, Include

1. The packet	*contains*	20 cigarettes.[1]
2. The gas		about 5½% of carbon monoxide.
3. The alloy		5% nickel and 5% iron.
4. The tank		100 gallons of oil.

5. The carbon monoxide	*content*	was about 5%.
6. The moisture		of the cylinder increased.
7. Part of the heat		of the gases is lost.

8. He emptied out the *contents* of the box.
9. A tank is a large *container* for holding liquids.

10. The class *consists of* twenty-four students.
11. The atmosphere *comprises* a number of gases.
12. The machine *is composed of* several different parts.
13. Cast-iron *is made up of* about six different substances.

14. The factory produces *components* for aircraft.
15. The resultant force acting on an aircraft wing may be resolved into a vertical *component* and a horizontal *component*.
16. The *composition* of cast-iron is different for different purposes.

17. Twenty-four students *constitute* the class.
18. A number of gases *form* the atmosphere.
19. Ferrite and carbon *make up* mild steel.
20. Ferrite and carbon are the *constituents* of mild steel.

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[1] Students unfamiliar with this way of presenting alternatives will find an explanation on page xii.

21. The students in the class *include* three from Germany and four from France.
22. The gases in the atmosphere *include* oxygen and nitrogen.
23. The mixture in the furnace *includes* a certain amount of limestone.

EXERCISE

Complete these statements with the proper 'Content' word:

1. The metals which we find in the earth ...... iron, lead and copper.
2. The carbon ...... of wrought-iron is very low.
3. We know the chemical ...... of the liquid from previous analysis.
4. Smelting ...... of heating the iron ore in a furnace and removing the slag.
5. The ...... of moulding sand ...... quartz, felspar and mica.
6. The atom ...... a nucleus, and electrons moving round it in space.
7. All matter ...... of atoms.
8. Metals which we use widely in industry ...... aluminium and steel.
9. We can discover the ...... gases of a fuel by chemical analysis.
10. The total floor space of the factory ...... 20,000 square feet on two floors.
11. The moisture ...... of the gas can be reduced by condensation.
12. Chromium is a necessary ...... of stainless steels.
13. This concrete ...... 1 part lime, 2 parts sand and 4 parts aggregate.
14. Most fuels ...... a mixture of different substances.
15. This company does not manufacture the engine itself, but only certain ...... of it.
16. The compound strip ...... two strips riveted together, one of iron and the other of copper.
17. It is easy for any faulty ...... to be taken out of the machine and replaced.
18. A flask of water, a glass rod and a rubber bung ...... the only equipment which we need for the experiment.
19. The flask ...... a very small amount of water.
20. The 30,000 books in the library ...... a substantial number of books on engineering.

Section 2

Reading: Heat Treatment of Steel

We can alter the characteristics of steel in various ways. In the first place, steel which contains very little carbon will be *milder than* steel which contains a higher percentage of carbon, up to the limit of about $1\frac{1}{2}\%$. Secondly, we can heat the steel above a certain critical temperature, and then **allow** it **to** cool at different rates. At this critical temperature, changes begin to take place in the molecular structure of the metal. In the process known as annealing, we heat the steel above the critical temperature and **permit** it **to** cool very slowly. This **causes** the metal **to** become softer than before, and *much easier to machine.* Annealing has a second advantage. It helps to relieve any internal stresses which exist in the metal. These stresses are liable to occur through hammering or working the metal, or through rapid cooling. Metal which we **cause to** cool rapidly contracts *more rapidly* on the outside *than* on the inside. This produces unequal contractions, which may give rise to distortion or cracking. Metal which cools slowly is *less liable* to have these internal stresses *than* metal which cools quickly.

On the other hand, we can make steel harder by rapid cooling. We heat it up beyond the critical temperature, and then quench it in water or some other liquid. The rapid temperature drop fixes the structural change in the steel which occurred at the critical temperature, and makes it very hard. But a bar of this hardened steel is *more liable to fracture than* normal steel. We therefore heat it again to a temperature below the critical temperature, and cool it slowly. This treatment is called tempering. It helps to relieve the internal stresses, and makes the steel *less brittle than* before. The properties of tempered steel **enable** us **to** use it in the manufacture of tools which need a fairly hard steel. High carbon steel is *harder than* tempered steel, but it is *much more difficult to work.*

These heat treatments take place during the various shaping operations. We can obtain bars and sheets of steel by rolling the metal through huge rolls in a rolling-mill. The roll pressures must be *much greater* for cold rolling *than* for hot rolling, but cold rolling **enables** the operators **to** produce rolls of great accuracy and uniformity, and with a better surface finish. Other shaping operations include drawing into wire, casting in moulds, and forging.