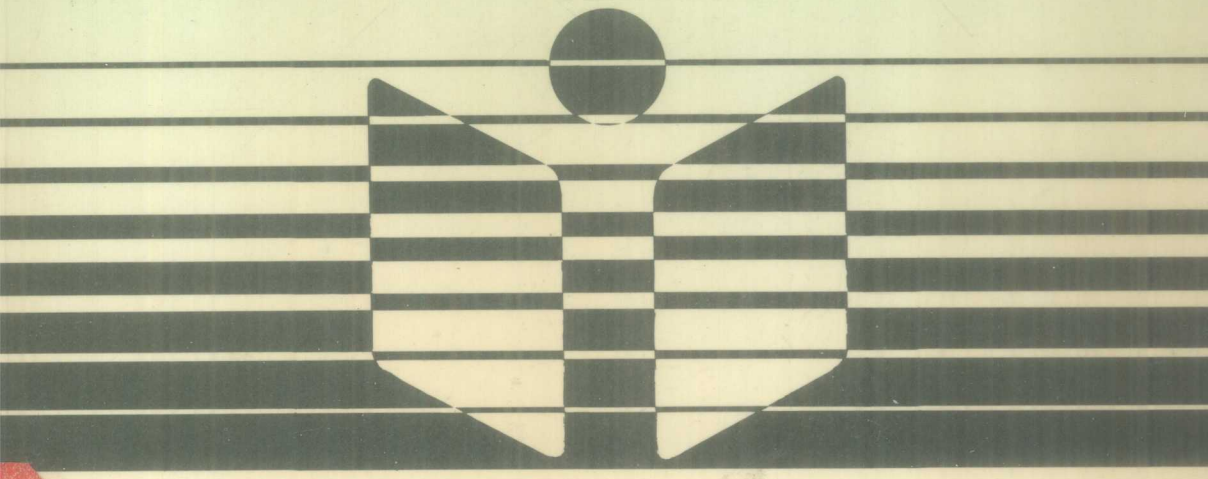
EPISODES IN ESP

John Swales



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EPISODES IN ESP

A source and reference book on the development of English for Science and Technology

JOHN SWALES

University of Michigan

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That was the real lesson to learn; never to make an end of the means, never to be so immersed in the medium, the formulae, the techniques, as to forget the end to which they were but subsidiary.

A. L. Rowse
Discoveries and Reviews
(Macmillan, 1975, p. 2)

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I would like to thank all those colleagues and students from many parts of the world who offered comments on a preliminary version of this book and made valued suggestions for its improvement. I am also very grateful to Fiona Waterhouse for her rapid and accurate typing of the manuscript; and last but not least, I am indebted to Claire, Harvey and Kirby, without whose equanimity this book would not have been possible.

— INTRODUCTION —

With one exception, the currently available books on English for Specific Purposes are all collections of articles, either with or without some editorial commentary. Better known examples of these collections are *English for Specific Purposes* edited by Mackay and Mountford (Longman 1978) and *English for Academic and Technical Purposes* edited by Selinker, Tarone and Hanzeli (Newbury House 1981). Such volumes certainly contain much material of lasting interest, but the articles are usually written by specialists for specialists and the volumes as a whole tend to offer the shared views of like-minded contributors as to 'the state of the ESP art' in, say, 1975, 1978 or 1981. As a result, the articles they contain are not easy to evaluate by those relatively unfamiliar with this branch of English language teaching; in particular it can be difficult to see why and how the arguments presented are reactions *against* previous approaches and reactions *to* current developments in linguistic and educational thinking. Therefore, one of my main purposes in *Episodes* is to offer a volume that does attempt to explain and illustrate the major lines of development in what David Wilkins has described as 'the sometimes bewildering world of English for Specific Purposes'.

The exception I referred to at the beginning of the previous paragraph is Pauline Robinson's *ESP (English for Specific Purposes)* (Pergamon 1980). Robinson provides a succinct and coherent overview of ESP work produced up to about 1979; she discusses various definitions of ESP, surveys a number of influential theoretical positions, analyses the available ESP teaching materials and concludes with a justly-admired 500-item bibliography. It is not my intention that *Episodes* should compete with or update Robinson's book in any way; rather, I see *Episodes* as complementary—as a companion volume. The scope of the present volume is in some ways broader and in others narrower than in Robinson's survey.

The scope is broader in a historical sense, for I have selected and arranged in chronological order fifteen actual items from the ESP literature. These fifteen Episodes are made up of eleven articles and four extracts from textbooks. Although this volume is in no sense a history of ESP, I have deliberately set out to try and establish a historical perspective. One reason for this I have already mentioned: that is, a wish to try and show something of the causes and effects that link the Episodes together. Another is my wish to demonstrate the value of pioneering contributions. My own experience of the ESP profession over a period of fifteen years or more is that the profession as a whole, and with all too few exceptions, operates within the 'here and now' of their actual teaching situation. The profession itself is composed of ESP *practitioners*—the term I prefer because it nicely illustrates the range of teaching, materials production, course design, and research activities that make up many ESP job-specifications. ESP practitioners tend not to look *across* to other ESP situations and to other ESP endeavours, whether similar or dissimilar to their own, to see what lessons might be learnt, what insights might be gained, or what useful short-cuts can be made. Nor do they often look *back* to previous work in their own departments or in others. My feeling is that such 'isolationist' attitudes can lead to reduplication of effort and inefficient use of time, and my hope is that this volume will do something to persuade the profession that contributions from other places and other times are at least potentially relevant to the 'here and now'. A third reason for a historical approach relates to the fact that ESP—like many other recently developed areas of social and educational science—has been subject to marked and perhaps exaggerated changes in fashion. A source book like *Episodes*, with its emphasis on the emergence of longer-term trends, can perhaps show that beneath the clash and controversy of debate, there is more agreement about the appropriate principles and practices for carrying out ESP work than appears on the surface.

ESP is a relatively recent development in the major worldwide industry of Teaching English as a Second or Foreign Language; indeed, nobody has yet retired from spending a professional

lifetime working within it. Moreover, it has no clear and indisputable beginning; the fixing of the moment when the prehistory of ESP became the beginning of its history must be a personal and somewhat arbitrary choice. Peter Strevens has observed that phrase-books for foreign tourists have been in existence for four hundred years and Kurt Opitz has shown that mariners have been making use of highly-specialized bilingual maritime dictionaries for more than half of that long period. But for me the real history of ESP is shorter than that by an order of magnitude, and I have set the beginning of the story in 1962 with the publication of Barber's article 'Some Measurable Characteristics of Modern Scientific Prose'. And at least the choice of 1962 allows me, when writing the final section of this volume in 1983, to consider the question of whether English for Specific Purposes has yet come of age.

If the choice of Barber for Episode One was not altogether an easy one to make, the choice of each succeeding Episode became increasingly harder. The ESP literature has expanded enormously over the twenty-year period covered by this volume. I believe I can illustrate this most easily by showing the increase in the number of items held in the ESP Reference Collection built up by my colleagues and myself, originally at the University of Khartoum and now at the University of Aston in Birmingham:

Items held in a working ESP Reference Collection

Date	Number of Items (approximately)
1972	30
1975	60
1978	150
1981	400
1984 (estimate)	1300

Therefore selecting as few as fifteen items illustrating the development of ESP has been an invidious task and many sacrifices of really excellent work have had to be made. Further, I have fairly rigorously applied two criteria:—

(1) I have tended to choose items that actually exemplify teaching material or deal fairly closely with either an actual teaching situation or with the language of science and technology. In view of my aim to put together a volume that may be of use to English teachers venturing into ESP for the first time or to those undergoing teacher-education courses in ELT and Applied Linguistics, I have restricted the entries to those directly concerned with the ESP classroom or with an understanding of the specialized language that will be taught (by one route or another) in that classroom. I have therefore decided to exclude papers dealing entirely with higher-order matters such as course and syllabus design, needs analysis, the management of ESP projects, and ESP evaluation and testing.

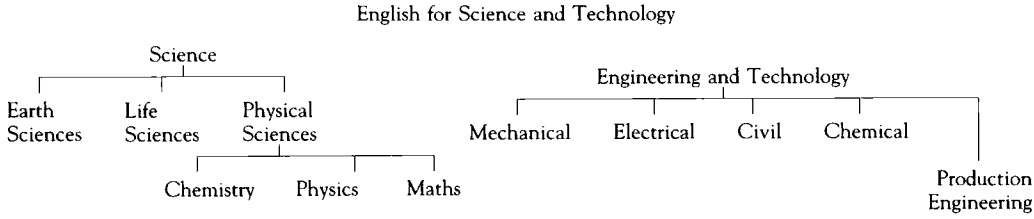
(2) In order to create a reasonable basis for chronological comparison over a twenty-year period, I have further restricted the selection to English for Science and Technology, or EST. EST is the senior branch of ESP—senior in age, larger in volume of publications and greater in number of practitioners employed. It therefore seemed to me that because of the predominant position of EST, the major developments of ESP as a whole could best be told through it. With one or two exceptions, particularly in such areas as games and simulations, English for Science and Technology has always set and continues to set the trend in theoretical discussion, in ways of analysing language, and in the variety of actual teaching materials. Further, I have tended to concentrate on Episodes which deal with the mainstream areas of reading and writing scientific and technological English at tertiary level. However, in order to see the implications of all these restrictions, it is first necessary to review some of the divisions typically accepted—and occasionally rejected—in English for Specific Purposes.

One way of subcategorizing EST (and other ESP activities) is into educational level, and here the normal and self-evidently sensible procedure is to subcategorize according to institutional setting. Thus we have courses differently designed for:—

A *Schools* (especially technical secondary and trade schools)
B *Technical Colleges*
C *Polytechnics and Universities*—undergraduate level
D *Polytechnics and Universities*—postgraduate level
E *Polytechnics and Universities*—research and academic staff
F *Specialized Institutions* (technical translation, patents, research administration etc.)

Category C has attracted the lion's share of attention; and indeed nine of the fifteen Episodes are firmly targeted on providing improved service English courses for first- and second-year students on BSc programmes. Reasons for this concentration are not hard to find. Those in charge of tertiary administration see the early years as being the most obvious place for service courses of various kinds; the medium of instruction may change from the first language to English on entry to the University or Polytechnic; and most entering students will find that they are required to use a large library for the first time in their lives, and will also find a considerable part of that library stock will be written in English, whatever the medium of instruction used in lectures and classes. Although there continue to be doubts about the wisdom of putting all the EST eggs in the basket of the first two or three semesters, there is little doubt that in practice the amount of materials preparation and the amount of teaching is greater on this level than on any of the others.

A second way of subcategorizing English for Science and Technology is in terms of subject-matter. Again the common practice has been to follow institutional boundaries:



And again the central areas of the above diagram (particularly the physical sciences) have produced more research and pedagogical work than those on the sides. The emphasis on physics, chemistry, mechanical and electrical engineering is particularly apparent in the earlier Episodes, but in the later ones I have been able to choose extracts that illustrate work on a wider or on a more general range of subject-matter. I do not want at this stage to face up to the question of whether such a subject-matter subcategorization is well motivated as far as ESP programmes are concerned, nor do I wish to consider at this point what sort of evidence would establish (or disestablish) the need for, say, a specific course for geologists. Questions such as these occur and recur throughout this volume and are best discussed against fairly specific historical and educational backgrounds.

A third way of dividing up the broad area of EST is to establish a set of activity-types that our students of sciences and engineering are required to engage in. Such a set might include:—

A Reading and making notes on textbooks
B Reading scientific articles
C Following and taking notes on lectures
D Carrying out and writing up experiments
E Writing technical reports
F Answering examination questions
G Taking part in seminars and tutorials
H Using technical manuals and other instructional literature

Once more, the literature in general, and this book in particular, reflects clear priorities. The major area of interest has been in developing a capacity to process information in textbooks; quite a lot of attention has been given to developing writing, especially at a fairly straightforward descriptive level; the listening and speaking skills have received rather less. In fact, none of the Episodes in this volume deals principally with the matters relating to spoken scientific English, although several make some reference to it.

I have in the previous paragraphs given three separate ways of looking at EST, but of course they are all interrelated. However, how they are interrelated remains at the moment rather obscure. Which is the really important *variable*? Is it *educational level*, or *subject-matter*, or is it *activity-type*? Or is it none of these, but something else like *communicative purpose*? And a further set of questions about the relationship between science and its linguistic expression also arises. Does science have a general methodology, or do its component disciplines have distinct methodologies and cognitive styles? Or is it the case that a particular educational institution exerts a powerful influence on what takes place within it? We have at present no definitive answers to such fundamental questions, but at various places throughout this volume partial answers are proposed and discussed.

We can now see that EST is central to ESP in another way. ESP itself is often, if somewhat uncomfortably, divided into a set of operating categories that further specify the *specific*:—

English for Academic Purposes
English for Occupational or Vocational Purposes
English for Professional Purposes

Courses in other areas such as business and commerce are largely concerned with the second and third of those categories, whereas, as we have seen, EST is more likely to fall within the first. Although at a training level teaching English for Science and Technology may be seen to be EOP or EVP, and at a level where graduating students are being prepared to be effective communicators within industry and government various professional elements may become important, it remains true that the great majority of EST programmes are designed to help their customers survive and succeed in an academic environment. This is particularly the case in the 'classic' context of courses for first-year students aimed principally at improving their comprehension of textbooks in the physical and engineering sciences.

Because of the criteria I have applied to the selection of Episodes my scope is considerably narrower than Pauline Robinson's. I have attempted to elucidate the development of one central area of ESP interest rather than (like her) to offer a survey of the scene as a whole. The restrictions of both level of discussion and content have also meant that actual examples of the writings of certain key figures in ESP are missing. There is no Episode containing an article by Peter Strevens because his articles have offered clarifications of ESP as a whole rather than dealt with classroom practice. For rather similar reasons, I have not been able to find a place for even one of the many papers written by Ron Mackay. Henry Widdowson is only represented by the well-known 1974 article of which he was joint author. Yet Widdowson's influence on EST over the last fifteen years has been greater than that of anybody else; for establishing subtle distinctions, for level of argument, for confident evaluation of the relevance of the work of linguists and for elegance of expression he is unrivalled. However, Widdowson's own intellectual development is well chronicled in the volume entitled *Explorations in Applied Linguistics*, and indeed his thinking is detectable at numerous places in this anthology. The names of Christopher Candlin and John Sinclair do not feature on the contents page at all, again largely as a result of the criteria I have used. Nevertheless, their work is represented here by their associates; the paper by Hutchinson and Waters has been chosen to illustrate Lancaster radicalism and the work of Sinclair's Department at Birmingham can be seen in Episode Twelve.

I equally regret the fact that all the principal authors of the Episodes are native speakers of English. As it happens, EST is one area where up until now the impact of non-native speakers on development has been relatively minor. In other branches of ESP the situation is rather different; elsewhere we find major contributors who do not speak English as their first language,

such as Angele Tadros in English for students of Economics and Vijay Bhatia in English for Academic Legal Purposes. That said, I venture to think that the selection I have made does have certain merits. First, the contributors represent a wide cross-section of professional activity; one or two are academics, one is now a full-time textbook-writer, many are practitioners in the sense that I have defined that term, a few would consider themselves as pre-eminently classroom teachers. Secondly, the provenance of the work reported is equally wide; certainly Britain and the United States are well represented, but there is also work that originated in such diverse countries as Chile, Colombia, Iran, Kuwait, Libya, Sudan and Thailand. In this way I have hoped to show that ESP excellence is neither the preserve of developed countries nor the preserve of those who hold important positions in the ELT hierarchy.

Each *Episode* has five sections. Each opens with a *Setting* wherein I try to place the textbook extract or article that follows against its background, to assess its relationship to other work, to highlight its novel and original elements and to signal its limitations—in short, to offer the reader a framework through which he or she can approach the original with some idea of its movitations and repercussions. The second section is the Episode itself accompanied by a number of commentary notes. Some of the notes pick out topics and themes that recur in other Episodes, some explain or exemplify observations and technical terms that I felt some readers would have difficulty in understanding, some comment on the uses other practitioners have made of ideas and suggestions contained within the Episode itself, and others are essentially questioning or critical. I have set some store by the last in that I hope it will show readers new or relatively new to this type of literature ways of developing a critical awareness of what precisely is being described or claimed or concluded.

The third section is entitled *Activities* and offers a small number of exercises based on the particular Episode. In teacher-training situations one or more of these may be set as individual, pair or group work. (I have not provided a key because many are rather open-ended, but if anybody would like possible outline solutions I should be able to provide them.) Section IV is entitled *Evaluation* and asks the reader to review what he or she has just read and to come to various sorts of judgment about that reading. If this book is used with students or student-teachers a number of these *Evaluations* could be set as written assignments. The Episodes close with a short annotated list of *Related Readings* that are designed to steer the user of this book towards comparable work if he or she should be so inclined. In fact, my original intention was to round off *Episodes* with a comprehensive update of Robinson's ESP bibliography, but the number of items to be included is now approaching fifteen hundred and an entry of this size would make this volume both excessively long and seriously unbalanced. I am therefore hoping that the Bibliography will appear as a separate volume.

At the end of the day, *Episodes in English for Science and Technology* is a selection of items that I personally have found and still find imaginative, significant and exciting. I suspect that in making the difficult decisions of choosing so few from so many I have, as ever, been influenced by my essentially pragmatic approach to ESP—by my distrust of theories that do not quite work out in the litmus-paper realities of the classroom. Colleagues who have also spent years charting the coastlines of the mysterious and fascinating world of ESP might have made a different selection, and might well want to make different assessments of the Episodes that I have chosen. Only time—and comments both favourable and unfavourable—will tell whether I have persuaded the ESP profession that their judgments might accord with mine.

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K. Opitz, **'Linguistics between Artificiality and Art: Walking the Tightrope of LSP Research'**, *CILA Bulletin 37*, Neuchâtel, 1983.

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CONTENTS

EPISODE ONE 1962

C. L. Barber, 'Some Measurable Characteristics of Modern Scientific Prose' in *Contributions to English Syntax and Phonology*, Almquist & Wiksell, Stockholm, 1962.

I
SETTING

For those few people involved in ESP in the mid-sixties this article had a special importance. First, it was a clear demonstration that the descriptive techniques of Modern Linguistics, as most influentially represented in *The Linguistic Sciences and Language Teaching* by Halliday, MacIntosh and Strevens (Longman, 1964), could be successfully applied to the language of science and technology. Secondly, the useful statistical information it contained provided ammunition for those EST teachers trying to convince their colleagues and superiors in Departments of English that 'Scientific English' was different from 'General English' or 'Literary English' in ways other than its use of technical or specialized vocabulary. After all, we need to remember that in the early sixties syllabuses were essentially structural, and, for example, all the tenses of English were taught simply because they were *there*—as part of the language system. Barber's results could be—and were—used as an argument for *not* teaching the progressive tenses in 'Scientific English' classes. The article additionally served as a model for further work on frequency analysis. With one difference, however: Barber chose to express his findings in terms of traditional grammar, whilst other workers chose some version of Halliday's category and scale grammar.

Copies of this article have always been difficult to obtain, and I believe a certain belated justice is being done by giving 'Some Measurable Characteristics' pride of place in this collection. There was in fact a certain amount of similar research taking place in England and elsewhere at this time and in the years immediately following, usually by students on postgraduate courses, but the resulting projects and dissertations have long been buried in departmental and university libraries and are now almost completely forgotten.

Although I have just suggested that the type of frequency analysis as represented by Barber has found little favour in British (and American) ESP work in recent years, it has by no means been abandoned in all quarters of the globe. On the continent of Europe—and perhaps especially in the Eastern bloc—a tradition of 'lexicostatistics' continues. Indeed it may well be undergoing something of a revival as a result of the fact that frequency analysis is ideally suited to computerization.

Twenty years on, Barber's study of scientific syntax and vocabulary still seems, within the limited scope he has set himself, thoroughly professional. The suggestions for the teacher of scientific English are cautious and sensitive, and the honesty with which he relates problems and difficulties sets a standard of intellectual responsibility that has not always been maintained. This is not to say that Barber's study does not have serious limitations, even within its own narrow objectives. A further reason, therefore, for selecting Barber as the opening Episode is that it offers an excellent opportunity for developing a capacity to read ESP papers

critically. In particular, a close reading should raise questions about the selection of a corpus (or body of texts) for analysis, about the consequences of choosing a particular scheme of analysis, and about the interpretation of statistical findings. The point of such questioning is not, of course, to arrive at a position whereby we dismiss Barber's article simply because it is not in tune with contemporary thinking; rather we should be looking for ways of incorporating the more useful of his findings within our knowledge of scientific English for our specific teaching purposes. To this end, I have written rather longer commentary notes for the first Episode than for most of the subsequent ones.

Barber's original 1962 article is quite long, and for this volume I have included only the first two-thirds which deals with syntax; the final section on vocabulary is omitted.

II

TEXT AND COMMENTARY

Some Measurable Characteristics of Modern Scientific Prose

by C. L. Barber *University of Leeds*

During recent years, English has increasingly become a medium for the teaching and learning of other subjects. This use of English as an auxiliary language is especially important in those countries where a great deal of university-teaching is carried out in English (e.g. India); but it is also important in many other countries, which rely to a great extent on textbooks written in English, especially at the university level. This dependence on textbooks in English seems to be particularly marked in scientific and technical subjects, and there must be many thousands of students of these subjects who rely wholly or largely on books published in Britain or the United States. It is therefore of interest to teachers of English abroad, and especially of course to those who teach English to scientists and technologists, to examine the characteristics of modern scientific English; and some of these characteristics, as exemplified in small samples of recent scientific writing, will be examined in this article. Since the bias is towards the needs of the teacher, I shall use traditional terminology (e.g. in the discussion of verb-tenses and of subordinate clauses); but I hope that the material will also have some general stylistic and linguistic interest.

The investigation reported in this article must be considered merely as a preliminary one; it is only a small-scale study, confined to a limited body of material, and this must be borne in mind when the results are considered: they are obtained from a small sample. As material for analysis, I have chosen three different texts: Text A is an excerpt from a textbook of university standard on the engineering applications of electronics;[1] Text B is more concerned with basic research, (a) and is in *the field of biochemistry*;[2] Text C is from an elementary university textbook on astronomy, and consists of a chapter on astronomical instruments.[3] The approximate lengths of the three passages are 7,500 words, 6,300 words, and 9,600 words respectively. All three passages are from American books; this is partly an accident; but in any case it is desirable, given so small a body of material, to confine oneself either to British or to American English; and it is clear that the United States is now the main source of technical and scientific writing in English, and will continue to be so. On the surface, there is not much difference between British and American scientific English;[4] though a statistical comparison would no doubt reveal differences.

[1] D. G. Fink, *Engineering Electronics* (New York 1938), pp. 3–13, 306–21.
[2] L. Michaelis, 'The nature of the interaction of nucleic acids and nuclei with basic dyestuffs', in *Cold Spring Harbor Symposia on Quantitative Biology* XII (1947), pp. 131–40.
[3] H. N. Russell, R. S. Dugan, and J. Q. Stewart, *Astronomy* (rev. ed. Boston 1945), pp. 37–73.
[4] See T. H. Savory, *The Language of Science* (London 1953), pp. 28–30.

(a) Barber's choice of texts calls for some comment. Huddlestone (1971) categorized his science texts into three 'levels of brow':—

(1) 'High-brow', e.g. scholarly journal articles;
(2) 'Mid-brow', e.g. undergraduate textbooks;
(3) 'Low-brow', e.g. popular science for the general reader.

However, it could be argued that 'level of brow' is not as important as the expected relationship between the

(a) continued overleaf

The texts that I have chosen, besides coming from totally different scientific fields, also
(b) straddle two fields each (electronics and engineering, biology and chemistry, astronomy and instrumental optics). In this way I hope, even with so little material, to get some idea of the things that are *generally* useful to the foreign reader or teacher, by seeing what things are common to all these fields; this is especially important in the study of the vocabulary.

Occasionally, I shall compare my findings with those of two colleagues, who have done similar work as part of their postgraduate studies at the University of Leeds, and whose unpublished findings I quote with their permission. Mr W. Rumszewicz, of Olsztyn in Poland, has examined the language used in four recent English textbooks in the sphere of agricultural studies (crop husbandry, animal husbandry, agricultural chemistry, agricultural botany); for the purposes of comparison, he has also examined four passages of recent prose drama. He thus has eight texts in all; they are very short (1,000 words each), but he has analysed them in great detail. Mr M. Siddiqui, of Karachi, West Pakistan, has done a study of the vocabulary of scientific textbooks, on the same lines as my own (to be described later in this article), but using more material: he has five texts from five different fields (civil engineering, organic chemistry, physics of matter, plant botany, meteor astronomy), each running to about 15,000 words.

My own analysis falls into two main parts: (1) a study of sentence-structure and verb-forms, and (2) a study of vocabulary. Ideally, one would like a complete analysis of structures used, but in this preliminary investigation I have had to content myself with a small part of this: I have examined sentence-length, clause-types, verb-tenses, and the uses of non-finite verbs. The figures for sentence-length and clause-types refer to Text C only; the remaining statistics refer to the whole material.

(c) Text C, consisting of 9,648 words (tokens), contains 350 sentences; for the purposes of
(d) analysis, a sentence has been considered to begin with a capital letter and to end with a full-stop.[5] Of these 350 sentences, 2 are commands; 3 are statements with commands in parenthesis; and 345 are statements; there are no questions or requests. Rumszewicz has similar results from his material: in his scientific texts, all sentences are statements; but in his dramatic texts, only two-thirds are statements, the remainder being questions or requests.

[5] In two exceptional cases, I have reckoned a sentence as ending at a colon, when no alternative analysis seemed realistic. My figures for numbers of words and sentences do not include captions to figures, or section-headings.

author and reader. In (1) the researcher is reporting results to his fellow-researchers; in (2) the relationship is that of teacher and student; and in (3) a journalist/scientist is attempting to interest a section of the general public. Thus, we can see that 'high-brow' and 'low-brow' texts are essentially informational, whereas 'mid-brow' textbooks are essentially instructional. Barber's Texts A and C are textbooks, but his text B is a high-brow research article. Putting the two sorts of text together may have been unwise. We can, however, get some idea of why Barber did this by reconsidering the opening paragraph. He begins by correctly identifying the textbook as representing the type of text of greatest importance to teachers of Scientific English, but he closes with the hope that his findings 'will also have some general stylistic and linguistic interest'. Presumably it is this hope that led him to include a basic research text written to provide information for colleagues.

(b) Certainly today not many people would consider Electronic Engineering, Biochemistry and Astronomical Instrumentation to be *interdisciplinary* fields.

(c) *Tokens and types. Tokens* are the actual occurrences of any words. *Types* are the occurrences of different words. Thus, in the two short sentences I have just written, we have the following numbers of tokens and types.

Tokens (i.e. total number of words) = 15.
Types (i.e. number of different words) = 10.
(tokens/are/the/actual/Occurrences/of/any/words/types/different)

This is then expressed as a type–token ratio, i.e. 10/15 = 1/1.5.

The ratio thus gives some measure of *lexical density*; in other words, the number of times words recur. The *lower* the type–token ratio, the *fewer* the number of repeated words. For example, if the fifteen words in my two sentences had been all different the type–token ratio would have been 1/1, and if they had been all the same—

In my material, the average sentence-length is 27.6 words. The distribution of sentence-
(e) lengths is shown in Table 1. The modal length is 16–20 words, which seems surprisingly short for expositional prose; there may possibly be another peak, however, at 26–30 words. In Rumszewicz's scientific texts, the average sentence-length is slightly less, 23.6 words, and most numerous are sentences in the group 20–29 words; in his dramatic texts, on the other hand, the average sentence-length is only 7.0 words, and most numerous are sentences in the group 1–9 words.

TABLE 1. *Text C: Number of Sentences of Different Lengths*

Length in words	1 to 5	6 to 10	11 to 15	16 to 20	21 to 25	26 to 30	31 to 35	36 to 40	41 to 45	46 to 50	51 to 55	56 to 60	61 to 65	66 to 70	71 to 75	76 to 80	81 to 85
Number	5	24	51	64	38	46	30	25	20	15	12	6	6	4	2	1	1

I have also analysed the sentences of Text C according to the number of main and subordinate clauses that each contains. The results are given in Table 2; one sentence, containing 7 main and 2 subordinate clauses, has been omitted from the table, for simplicity of presentation. In the Table, the figures in the matrix show the number of sentences having the clause-structure indicated; thus there are 8 sentences in Text C that have 2 main clauses and 3 subordinate clauses. The striking thing about this table is the degree of simplicity it reveals in the typical clause-structure of the passage, which is shown by the density of the figures in the top left-hand corner of the table. Out of 350 sentences (one of which, it will be remembered, is omitted from the table), no less than 250 (71%) have only one main clause; only 12 sentences (3.4%) have more than two main clauses. No less than 190 sentences (54%) have no subordinate clauses at all; only 24 sentences (6.9%) have more than two subordinate clauses. Only 17 sentences (5.2%) have a total clause-number exceeding 4. By far the commonest type of sentence (144, 41%) is that with one main clause and no subordinate clauses, i.e. what is traditionally known as the 'simple sentence'. Not all such sentences, indeed, are simple in the

TABLE 2. *Number of Clauses per Sentence (Text C)*

Subordinate Clauses		0	1	2	3	4	5	Total
Main Clauses	1	144	57	36	9	4	0	250
	2	41	23	14	8	1	1	88
	3	5	4	0	0	0	0	9
	4	0	2	0	0	0	0	2
Total		190	86	50	17	5	1	349

as might happen in a computer print-out—it would have been 1/15. As might be expected, type–token ratios tend to be much lower in the life sciences than they are in mathematics. A final but important point about type–token ratios is that only texts of the same number of words can be compared. This is because as longer samples of text are taken, so the higher the type–token ratio will tend to be.

(d) In the previous paragraph Barber has announced his intention to examine sentence-length. He now needs a criterion to judge the end of sentences and he (entirely reasonably) relies on the traditional *full stop* or *period*. Unfortunately, this criterion becomes very much less useful if the text contains equations, chemical formulae and so on. It is by no means clear how such symbolic material is best handled by a sentence-grammar; for an interesting if difficult discussion, see Peter Roe, *Scientific Text*.

(e) *Modal* here means 'most common'; notice that it does not mean 'average'. *Expositional* is an unusual term; the more usual one is *expository*. Other researchers have found that scientific sentences have an average length of 20–30 words. The highest figures for sentence-length so far reported are those for legislative texts, which have a sentence-length of approximately double that of science.