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A Handbook for Teaching Technical English

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A HANDBOOK FOR TEACHING TECHNICAL ENGLISH

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ABSTRACT

In this paper are discussed, first, the unique problems facing the teacher who finds himself teaching technical English. Second, ways in which that teacher can prepare himself to most effectively deal with these problems (used here in the sense of tasks to be mastered) are offered, together with practical strategies for establishing and maintaining his professional and emotional equilibrium. Finally, specific suggestions are made for presenting technical terminology to ESL students, as well as improving their general English language proficiency.

In addition, three appendices are provided. The first delineates examples of the special problems connected with teaching technical English. The second provides exercises to be used in working with a brief technical text. The last is a list of materials felt by the author to be particularly appropriate as reference works for the prospective or practicing ESL instructor interested in teaching technical English.

TABLE OF CONTENTS

INTRODUCTION

The purpose of this compilation of information is for the ESL teacher who finds herself confronted with the need to teach technical English. There is a growing trend in the ESL classroom to apply the essentials of ESL to the teaching of technical English. There is also a growing need by students to coordinate language learning and their professional goals in order to be better prepared for entrance into an American university or into a technically oriented course of study. There are various forms this orientation may take: from border-line technical material to highly technical material to material for advanced college-bound students for whom technical English could be incorporated into some aspect of an ESL program.

Prior to coming to S.I.T., I found myself in situations in which there was a need to teach some form of technical English. These experiences ranged from teaching for a company in the field of electronics to designing and teaching a course for a university in the field of engineering. In order to be effective in my job, as well as to preserve it, it was necessary to educate myself in whatever field was required. As I am not a particularly technically oriented person, the task of educating myself

was a painfully slow process. Obviously it could be done and it was, but at a sacrifice both to myself and to the students I initially taught. At the time I had no idea of the number of resources which existed in the field of technical English. For this reason, I feel that this compilation of information may be useful to other ESL teachers who find themselves in similar situations.

This paper contains some of my own ideas, past applications of materials which I have found were helpful to me, and an extensive bibliography of resources which may be helpful to others. The demand for teachers who can and will teach both ESL and technical material is immense. Personally, after some years of teaching "pure" ESL, I find adapting myself to technical teaching situations a rewarding and stimulating challenge. I feel it is time for ESL teachers to look at the professional needs of foreign students in a practical manner and be prepared to deal with these needs.

The teacher's role in teaching technical English must be one of facilitator. Unless one has had years of training in a technical field, it is impossible to become an "expert" overnight. To some teachers this is, to an extent, giving up control of the classroom. In any teaching/learning situation it is essential that both parties realistically admit the limitations of their knowledge. For the ESL teacher dealing with technical material, there seems to be

little choice. There are, however, commonalities in the teaching of technical English and conversational English which can be easily understood and presented once they are known.

I feel this paper is valuable to the teacher who is setting up an ESP program and to the teacher who is thrown into an existant program. All teachers wish to be considered competent in their field and need a bag of tricks to convey this competency. I hope this resource manual will help teachers develop some confidence in dealing with the field of technical English, or at least direct them to the substantial amount of work which has been done in this area.

THE PROBLEM

The linguistic differences in teaching technical and non-technical English are significant. There has been a good deal written on these grammatical differences and I will not try to duplicate them here. Many of the articles and texts which I have included in the resource bibliography cover them in far greater depth. I will address those problems which I have come across and I have included an Appendix (I) which refers to Jerome Ford's extensive writing on the subject. As this paper is aimed at the non-technically oriented teacher, I will not go into science-specific problems, but will attempt to give a general overview of some linguistic variations which may be encountered.

It is generally felt within the field of ESL that technical English is "an artificial language that emphasizes certain language conventions not common to standard English" (Drobnic). If these conventions are not common to standard English, where then may they be found? Generally they are found in technical journals and texts. Infrequently they may be found in more general writings, such as Time magazine. It is important to point out that technical English not only uses special terminology and jargon, but

also employs a variety of sentence constructions in place of more common phraseology (Ford, 1974).

Probably the most noticeable difference is of a lexical nature. Technical terminology involves specific terminology, fixed phrase structures and everyday words which have been given special meaning. The vocabulary can be difficult in that while one word may have a variety of meanings, each of those variants has a unique and precise meaning. Take the words channel, canal and chute; while at times they may be used interchangeably in conversational English, in technical English they possess distinct definitions. To the ESL teacher who is used to having a list of synonyms at hand, the exacting nature of vocabulary in technical English is an important consideration.

Other vocabulary differences which are not particularly common in everyday English are the use of noun-compounding, such as "calorie-protein ratio," and the consistent use of two-word verbs, such as "consist of" and "result from." While conversational English does use some expressions in which fixed word order is important ("from head to foot"), technical expressions ("owned and operated by") and fixed phrases ("conduct/perform an experiment") are standard means of description.

Along with terminology, different structures are emphasized in technical English. While one does see and hear the passive voice used in everyday English, it is not

used with the frequency that it is in technical writing. It is often the use of the passive, particularly without the agent, which tends to confuse students, ("the experiment was conducted in 1968"). The use of modals and their compounds are also emphasized. The distinctions of using modals in terms of ability, permission, possibility, probability and deduction are areas with which students may be vaguely familiar from their conversation classes. In reading and writing technical English, however, it is essential that students can express and understand the fine distinction between the possible and the probable. There is also an unusually high incidence of formal imperatives found in technical manuals, such as "Remove ...," and "Check ...."

Another area which causes confusion is the extensive use of the verb "to be" (Ford, 1974). This verb is used in a variety of ways and deciphering how it is used is generally done in context. It can be used for definition, establishment of equivalency or for stipulation of a condition. (Examples of this can be found in Appendix I.) Whether its use fits into one of the above functions or another is a good exercise in deduction.

Not only is sentence structure sometimes difficult, but the actual organization of a magazine article or a text presents problems as well. Most students will be familiar with the physical paragraph which includes a topic sentence, supporting evidence, and either a conclusive or a

transitional sentence. In technical English, students will encounter the conceptual paragraph, which may be one or many paragraphs from which the student cannot extract information out of context. A conceptual paragraph which describes an experiment might consist of three physical paragraphs: one describing the conditions of the experiment, one describing the actions of the experiment and one describing the results of the experiment.

It is important that the student realize the difference between these two types of paragraphs and that, for purposes of outlining and paraphrasing, he understand that no conclusive information is being imparted in any one of the paragraphs which make up the conceptual paragraph. It is not always easy to teach students to understand conceptualization in the written word.

The existance of the conceptual paragraph leads to another trouble spot: the notion of implicit rather than explicit understanding. Most foreign students tend to read English literally. While much of our writing is explicit, it is important to remember that in technical English, much of the writing is implicit and understanding of such writing relies upon different decoding skills. The skills needed can take the form of analyzing paragraph structure, definition or classification. At times this seems like a backward type of logic where one follows from the specific to the general. In my opinion, this demands a completely

different set of decoding and encoding skills than has been previously required of the student and some attention must be given to it.

The teacher of technical English must at some time become familiar with the study skills which the student must possess in order to study in any given technical field. While these are the same skills any college-bound native student would need, they are skills with which the foreign student is often not equipped. The student of technical English must be prepared to outline material, paraphrase material, deliver presentations, understand lectures, take notes and organize material in a number of different ways.

THE TEACHER

Once the areas of difficulty have been established, it is up to the teacher to school herself adequately in the grammatical variations involved in teaching technical English. It is not difficult to understand the grammatical differences and to concentrate upon them in class. The real challenge occurs when the ESL teacher must try to appear somewhat knowledgeable about the field of technology which she is teaching. It is important to remember that no matter what technological discipline is being taught, the reason for teaching English through technology is for communication. The teacher of technical English must always realize that technical English, as well as conversational English, is a means of communicating.

As it is impossible to become an expert in any technical field overnight, it is advisable that the teacher view her role as a facilitator. In order to be effective as a facilitator, two basic attitudes are considered essential: the ability to admit not knowing everything and the curiosity to discover the answers to what one does not know. Given these considerations, any competent ESL teacher can successfully and easily teach a course which emphasizes technical English.

There are several ways to go about understanding the content matter of a technical English course. If the class is homogeneous in its technical interest, then it is easy enough to pick up a programmed self-teaching text on the field. If one is working for a company, ask for advice on how and where to supplement the company training texts. Again, do not be shy about admitting ignorance; you have been hired as a language teacher, not a technologist. It is advisable to cover all the materials to be used in the course prior to going into the classroom. This will provide an overall picture of where all the bits and pieces fit in and prepare you for the inevitable questions concerning cause and effect relationships.

It is important that while you may claim no expertise in the field, you show the students possession of a solid understanding of the content materials which you are using to teach English. Sometimes your students may seem to know more than you -- don't be surprised. Admit the limits of your knowledge, tell them you will find out and do! You expect students to do their homework, so do yours too. If some students consistently know more than you do, draw upon them to answer questions from other students; it is a chance for them to practice English and for you to learn something.

Once you have an overall view of what and why you are teaching something, try to expand your knowledge outside the classroom. Read current magazines and journals which might

contain something new in the field which your texts do not cover. Even if it is something in the experimental stages, it can generate conversation and speculation by your students. If you have the time, and facilities exist, take a course (usually refunded by a company) in the specific field. Try to organize roundtable discussions or seminars with other teachers or request that the company provide periodic "information" sessions in which aspects of the field with which you feel uncomfortable can be elaborated upon. Arrange a weekly luncheon tutorial with someone from the company who is proficient in the field. Any of these activities will help you feel more confident and will be reflected in your teaching. It will show your students that you care not only that they learn English, but also become as well versed in their field as possible.

If you are in a college-bound class dealing with students who are going to be studying diverse disciplines of technology, your job as a facilitator will take on different proportions. From the outset it is more practical to level with your students; admit technical ignorance if necessary. Explain to your class how you can help them in grammatical and study-skills proficiencies, and then make a contract with them. You teach them English and they teach you technology. It's a fair exchange and one in which an ESL teacher should feel confident. You know the language and have a far more sophisticated means of decoding new

terminology and constructions than your students. They are here to learn the skills which they will need to study their chosen professions in an American university. It allows the students to build confidence in using English, in that they must express to you and others what they know in their field.

Once the contracts have been established and the various disciplines determined, it is easy to gather articles concerning the technological areas and to structure exercises around them. This is where knowing some of the grammatical and structural differences in technical English will help the teacher know where to start.

It is often difficult to determine what your students need to learn. While a carefully chosen standardized test may give some indication, generally it will not zero in on the specific skills needed to study technical English. It is best to develop a test yourself which deals with the areas which you feel are important and should be emphasized. It need not be presented as a test but more as a study sheet to be worked on as a group the first day of class. As you will not know which areas of technical study your students are pursuing prior to the first day, it is best to pick an article of general technical interest (i.e. nuclear power) and design exercises around it. As this is a diagnostic exercise, limit your input to that of defining vocabulary

and explaining directions. Let the class work as a group or individually.

Another means of determining needs is to make up a questionnaire, which can be quickly completed during the first fifteen or twenty minutes of class. Through this, educational background can be assessed. What are the student's strongest subjects, has he ever written a research paper or given a presentation, what are his weakest subjects, where do his interests lie and what areas of study skills does he wish to concentrate on in your course? Once these have been completed, discuss them with the class as a whole. Ask questions concerning the educational systems of students; were students expected to memorize information or was questioning and self-discovery encouraged.

If this method of determining levels is chosen, it is advisable to prepare a short lecture on the characteristics of higher education in the United States. You do not have to have been a science major to describe the expectations and academic standards of an American university. It is advisable that this be done prior to setting the objectives of the course, as some students may not realize that educational systems vary from one country to another or in what ways these differences are manifested. Upon learning of these variations, the objectives of the course and what the students feel they must master during their course of study may change significantly. While you as the

facilitator may know some of the problems which your students will encounter, it is important that students, being the technologists, have some sense of self-direction in setting the objectives for the course.

Whether teaching for a company or teaching a college-bound ESL class, the concept of the facilitator has far-reaching cultural connotations. In many cultures there is no free exchange between teachers and students, a teacher does not admit ignorance and a student never questions a teacher's statement. In both business and higher education in the United States, it is generally acknowledged that questioning and inquisitiveness are the markings of an intelligent, ambitious individual. It is extremely difficult to incorporate many aspects of our culture into the technically oriented classroom, and some will argue that there is no need to do so. I believe there is a need and this is one way to help students not only learn technical English, but learn to deal with other Americans.

TEACHING TOOLS

In the course of teaching technical English, I have come across some teaching tools, which seem more suitable to the field than others. Some which I mention here are considered techniques; others are tools which can be used in conjunction with other materials or around which an entire course could be developed. This list is by no means exhaustive. In contains just a few ideas which might give the novice technical English teacher an idea of where to start. Some of what I have included all ESL teachers will be familiar with; some of it may be somewhat new and different and not applicable to all teaching situations.

One way to illustrate material effectively, when presenting structures and/or concentrating on particular technical concepts, is the use of the dialogue. Through a dialogue, it is possible to isolate a structure or concept and to reinforce the terminology and known structures which are likely to be used in conjunction with the new material. A carefully constructed dialogue will present nothing new except the specific material which is to be studied. A dialogue is useful in that all language skills are, at some point, touched upon. It is particularly helpful in making use of aural-oral skills which often seem to have a hard

time finding their use in technical English. It is also a good exercise which can require students to make inferences.

There are several "how-to's" in making up a dialogue which are not unique to technical English. It should be short and address the material to be presented. It's meaning must be clear and explicit; there should be no question in the students' minds of what concept or linguistic feature is being dealt with. The vocabulary can be new, but should be decipherable in context; dictionary definitions should not be needed. The language should be natural; it is two people speaking with one another.

Keeping these guidelines in mind, please observe a dialogue[1] which is geared to a class learning technical English:

A: Hi, Dr. Einstein
B: Hello Ahmed. Are you ready for today's lesson?
A: Sure. You can ask me anything.
B: Okay. Can you tell me what an element is?
A: For example, oxygen is an element.
B: Oh? Why?
A: Oxygen has only one kind of atom-oxygen atom.
B: That's good, Ahmed. Is water an element?
A: No, water's a compound. It has two hydrogen atoms combined with one oxygen atom.
B: The atoms together form a water molecule, and that makes a compound.

Along similar lines, an operation also works well, particularly when dealing with experiments, following directions or discussing the make-up of a component.

A medium which I think has recently come into its own as a valuable teaching tool, especially for technical English, is film. The use of film can be split into two categories or can be combined, depending upon the sophistication of the class, the teacher's objectives and the nature of the film. Film can be used solely to define a concept. A film about an experiment and its conclusive results, lends itself to explicating a theory. A film of this sort can be discussed in terms of what was done, why, how it was done, always building vocabulary, reinforcing structures and emphasizing oral skills.

The students could be asked to write a brief essay contrasting the benefits of technology and traditional methods of investigation using specific structures and terminology. Or, they could be given the assignment of drawing a diagram of the specific experimental apparatus and labeling it. They could write something about the film process itself, i.e. camera angle, film processing, lighting or projection. Once these exercises were done, students could compare their observations and findings, discussing their own feelings about what they saw.

While these are exercises in which the teacher could participate as a learner, there are other exercises which the teacher/facilitator could design from the film experience. A word study guide could be made up as a homework assignment. The students could look-up the

definition of the words, use them in sentences and finally fill in the blanks in a close exercise. The purpose of the film could be to practice note-taking, as needed in a lecture situation, learning to tune in to key phrases, understand cause and effect relationships, and defining or differentiating logical versus rhetorical principles. As a follow-up exercise, students could be expected to make an outline from their notes and thus could check their comprehension and conceptual understanding through class discussion.

Films are functional in that one film can be used for many activities. Ideally, the teacher should view the film beforehand and develop some exercises in the areas of vocabulary or technical concepts which will prepare the student for the film. The student should see the film at least twice (this depends upon the comprehension level of the class). After the first showing, allow student questions; do not attempt to have the student take notes or answer comprehensive questions about the film at this time. After the first showing, clarify concepts, vocabulary, and difficult structures. If you find that much of the information has been missed or misunderstood by the students, spend a few lessons working on the areas needed to understand the film.

Once you are reasonably sure that the film will not result in a frustrating exercise for your students, show the

film again. At this time, have students take notes or give them a list of questions, the answers to which they should pay special attention to during the film. Always be sure to let the students know what purpose you expect the film to fulfill, whether it be an exercise in note-taking or an exercise in comprehension. A known expectation gives students something on which to focus. For most ESL students watching a film or listening to a lecture, whether the material is interesting or not, is a somewhat bewildering experience.

If a teacher has any ideas concerning structuring a course around films, I would recommend consulting the Morely film series. It is a comprehensive series which addresses various areas of general concern to academically oriented students through ten carefully selected films. All skills are involved, although the focus is on comprehension development. Morely has also developed an elaborate study guide for each film which deals with explanations of the text of the film, vocabulary definitions, and questions for reading, writing or discussion. The series involves different areas of social, economic and ecological concern. It is Morely's contention that the college-bound student should have, at least, a cursory knowledge of the issues which are relevant to American society today; and that too often the foreign student of technology appears less well

informed than his American counterpart due to lack of exposure.[2]

Whether one uses the Morely film series or not, in choosing films to be used in the classroom, I refer the instructor to Morely's list of criteria for selecting films. According to Morely, the film must be relevant, be of good quality, be intelligible, be well organized and structured and have manageable vocabulary.[3] In the bibliography of this paper, there are books which list films for ESL students which contain films ranging from entertaining to those to be used for developing listening comprehension and study skills. I also suggest that teachers become acquainted with the study guides which Morely has carefully prepared for each film as a reference for possible strategies in using films and exercises which are relevant to film.

Journals and newspapers can provide a rich source of material which is more controllable than the use of film. By selecting an article from a journal or newspaper, the teacher has more control over the sentence construction, vocabulary and technical concepts to be worked with. Journals and newspapers are a wonderful source of material to create exercises for going from the explicit to the implicit. They are also good for word study and are simple to devise vocabulary exercises from. As with films and dialogues, vocabulary definitions in context are reinforced.

In a college-bound class consisting of students studying several technical disciplines, finding magazine articles of interest is easy. It is important, however, that the article be comprehensive in content, particularly in supplying sufficient background information to make it comprehensible to all students. The type of vocabulary, though not necessarily the definitions, should be common to all fields of technology. In presenting an article of this sort, rely upon the student of that particular field to give a view of where this information fits into the overall picture of his discipline and to supply definitions of any science-specific vocabulary, if he can. This reinforces the contractual concept of "I'll teach you English, you teach me science," as well as asking the student to express himself communicatively in an area which has not been covered in class.

An article, like films, can cover a spectrum of exercises. An analysis of the text can be the basis for class discussion, which might include vocabulary definition, examining grammatical structures and different types of paragraphs which occur frequently in technical English. Word study exercises such as matching synonyms and building word families are always valuable activities. Sentence combining and/or compression, parallel paragraphs, summarizing and outlining, are all valid methods of examining and analyzing a text. While articles are

generally used to reinforce reading and writing skills, there is always room for stressing speaking skills as well.

An excellent means of preparing students for responsible positions as technologists which I've found, is to have them prepare lectures or presentations. In many fields it is important that students become comfortable with standing up before a group and this is often overlooked in the ESL classroom. Obviously this should be done gradually; an instructor cannot walk in the first day and ask a student to stand up and give a lecture. I have found that by modeling a short lecture or presentation, the instructor gives the shyer student a format to follow with confidence, but allows the more secure (or perhaps more experienced) student to be as creative as his linguistic competency and technological knowledge will allow. It is a good idea to let the students know that short presentations are expected from the outset of the course.

After the teacher models several short lectures, the use of magazine articles is a painless way to break students into public speaking. Assign an article as homework. Give one student the job of summarizing the article for the class. As most articles are reasonably short, this type of lecture or lecturette shouldn't take more than a few minutes. As all the students will have read the article, there should be little room for unnerving questions. However, as the teacher models presentations, students

should be encouraged to ask for clarification of concepts which they don't understand.

Forerunners of these presentations could take the form of exercises in which one student is an important person or an ambassador from another country and is being interviewed by others in the class. Students would be expected to ask pertinent questions and to write up a group report which could then be analyzed in a follow-up exercise. As students build confidence in speaking in front of the class, they should start on the preparation of their lectures. This begins with selecting a topic, learning how to limit its scope, how to research the necessary information, outlining and making notes; all of which are valuable means of reinforcing and/or imparting study skills.

Once the presentation has been prepared, the student must deliver it. At this point the "lecturer" alone is responsible for being understood, clarifying vocabulary and technical concepts and presenting the information in a logical progression. The audience should take notes and ask relevant questions. A suggested follow-up exercise to this is having the listeners write up a short essay on what they have heard and understood. In this way the teacher and the "lecturer" can check comprehension and make observations on the effectiveness of the speaker's communicative ability.

APPENDIX I

This appendix has been added to give some further examples of exactly what the linguistic variations involved in technical English instruction are. Complete credit for these examples is due to Jerome Ford. In Ford's lecture notes, "What Technical English is About," expansion and further explanation of these problems can be found.

FOOTNOTES

1. NAFSA Confernece on the Use of Global Issues in the ESL Classroom, unpublished. (Appendix II, p. 32)

2. J. Richard, ed., Teaching English for Science and Technology, p. 72.

3. ibid., p. 73.

A. Examples of Technical Terms

1. specific terms unique to a field:
"truss" -- engineering fibrillation -- medicine

2. terms with various meanings depending upon the field:
"joint" -- engineering, medicine, drugs
"skid" -- helicopters, automobiles

3. specific meaning given to a word:
"The same conditions obtained for the second experiment."
"obtained" -- hold, be operative, be in effect

4. preciseness of meanings:
pin, bolt, screw
tube, line
luminous vs. illuminated
electric vs. electrical

5. fixed word order of words in phrases:

a. everyday expressions:
"from head to foot"
"inside out"

b. technical expressions:
"supply and demand"
"profit and loss"

6. fixed phrases:
alimentary canal
operating room
surgery

7. preferences in technical usage:
look into -- investigate, research, study
parts; pieces -- components; constituents; component parts
cut holes in -- perforate; drill; bore; pierce

B. Shorthand Devices

1. examples of compounds

a. Noun + Adjective separated by a hyphen:
disease-resistant
light-sensitive
growth-retarding
tone-deaf

b. Noun + Noun (two words)
salt content
crop damage
feed crops

c. Noun + Verb (two words)
leaf fall
leaf kill

d. Adjective + Verb or Verb + Verb
dry rot
freeze dry

2. examples of acronyns:
LOX -- liquid oxygen
BP -- British Petroleum
SOP -- standard operating procedure
rpm -- revolutions per minute
cc -- cubic cycle

C. Nature of Sentences in Technical Writing

1. passive constructions:
"The conference was slated for March 30, 1976."
"Water was added to the mixture."
"The piston was broken by the angle of compression."
"Verticle planar motion is converted into rotating motion by the crankshaft."

2. use of the verb "BE"

a. stipulation of a condition (a modifier):
"Catalytic action is rapid."

b. definition:
"Clay is both compressible and impermeable."
"The pneumatic casing is pre-cast."

c. establishment of equivalency:
"Lift is induced drag."

3. use of stative constructions
"The bulkhead is secured."
"The counter is located near the site of the blast."
"The glass rod is snapped and the pieced fired individually."

4. absence of emotive terms

5. minimal use of variable or unspecific terms

APPENDIX II

This appendix contains some sample exercises which I hope will give the teacher some further insight into the use of teaching tools which I have mentioned in this paper. These are not of my own creation, but are excerpts from articles and texts on technical English which I think illustrate some of the differences and similarities between technical and non-technical English.

NAFSA CONFERENCE ON THE USE OF GLOBAL ISSUES IN THE ESL CLASSROOM

Teaching Advanced Reading and Writing Skills in Technical English

NUCLEAR POWER

Nuclear power -- the energy produced by splitting atoms -- has become a major source of electricity for the foreseeable future.

Like plants powered by fossil fuels, nuclear units produce steam to drive a turbine which is connected to an electric generator. In place of a fuel-burning furnace, a nuclear plant is equipped with a reactor in which a controlled nuclear chain reaction -- atomic fission -- provides the heat used for power generation.

Fission is the process by which individual atoms of uranium, under bombardment of atomic particles called neutrons, split into two lighter atoms, releasing heat and additional neutrons. These neutrons collide with surrounding uranium atoms to sustain the process in a controlled chain reaction.

Dilute quantities of fissionable material, Uranium 235, contained in small cylindrical pellets clad in metal tubes, provide fuel for the reaction. The tubes, assembled in bundles which are packed close together to promote fission, constitute the fuel core.

The fuel core is contained in a heavy steel vessel through which water circulates. The heat production is controlled by either inserting or withdrawing neutron-absorption control rods from between the fuel bundles.

There are two types of reactors in common use in the United States: the boiling water reactor (BWR) and the pressurized water reactor (PWR).

In a BWR, such as the one at the FitzPatrick Plant, water pumped into the reactor vessel from the bottom boils as it rises through the nuclear core. It leaves the reactor in the form of steam, which, after passing through steam separators and driers at the top of the vessel, is used to rotate the turbine. Spent steam is vented into the condenser to be cooled back to water and returned to the reactor.

The Indian Point and Greene County Plants were designed to use PWRs. In a PWR, water, kept under pressure to prevent boiling, flows in a closed loop consisting of the reactor and a heat exchange device called a steam generator. During its passage through the reactor, the water absorbs the heat produced by nuclear fission.

The heated water then passes through the steam generator where it transfers its energy to water in a second closed loop. The water in the first loop is then returned to the reactor. Pressure in the second loop is lower so the water in it is converted to steam to provide the driving force to spin the turbine. After exhausting its usable energy, the steam centers the condenser and is reconverted to water. It is then returned to the steam generator.

In both types of reactors, the nuclear generating components are enclosed in a massive containment shell, constructed of layers of heavy-gauge steel and reinforced concrete. Multiple redundant systems insure safe operation.

I. Analysis of Technical Text

A. Vocabulary
   1. Contextual Paraphrases
      a. drive a turbine
      b. rotate the turbine
      c. spin the turbine
   2. Science-Specific Terms
      a. fissionable
      b. cylindrical
   3. Terms which Change Meaning
      a. promote fission
   4. Noun Compounds
      a. neutron-absorbing control rods
      b. nuclear generating components
      c. massive containment shell
      d. heat exchange device
      e. multiple redundent systems
   5. Non-Technical Terms used Metaphorically
      a. clad in metal tubes
   6. Latinate Terms with Colloquial Equivalents
      a. collide
      b. sustain
      c. rotate
      d. insert, withdraw

B. Structure
   1. Agentless passives
   2. Simple present tense
   3. Complex sentences

C. Paragraph Types
   1. Explicit definition
   2. Implicit definition
   3. Process

II. Exercises

Ex. 1. Technical terms and their "non-technical" equivalents:

Match the terms in column 1 with those in column 2

	1		2
___ 1.	assemble	a.	use up
___ 2.	release	b.	turn (change) into
___ 3.	collide	c.	take out
___ 4.	sustain	d.	make up
___ 5.	insert	e.	keep up
___ 6.	withdraw	f.	give off
___ 7.	convert	g.	stick in
___ 8.	exhaust	h.	turn around
___ 9.	constitute	i.	put together
___10.	rotate	j.	run into

Choose the most appropriate term from either of the two lists above and fill in the blanks below.

1. After its energy is _____ steam enters the condenser.
2. Clumsy Clyde is always _____ the door.
3. Water is _____ into steam in the boiler.
4. The metal tubes are _____ in tightly packed bundles.
5. Skunks _____ a strong odor for protection.
6. _____ while I brush off your dandruff.

Ex. 2 Building Word Families:

Complete the table

Verb	Noun
absorb	
collide	
construct	
circulate	
rotate	
insert	
convert	
exhaust	
enclose	
bombard	
promote	
condense	

Ex. 3 Decoding Noun Compounds:

Give the long form of the noun compounds below

1. neutron-absorbing control rods
2. heat exchange device
3. fuel burning furnace
4. massive containment shell
5. boiling water reactor plant
6. nuclear generating components

Ex. 4 Writing Formal Definitions:

Complete the sentences below by naming the class to which each object belongs

1. A saw is a _____ which is used to cut wood.
2. A fork is a _____ which is used for eating.
3. A blender is a _____ which is used for mixing food.
4. A lathe is a _____ which is used for cutting or drilling holes in metal.
5. A truck is a _____ which is used for transporting goods.

Ex. 5 Sentence Compression:

Combine each group of words below to make a sentence. Leave out everything which is underlined and add the words above each group. Then write a paragraph combining your sentences into a logical order.

1. (to be, and)
   spent steam is vented into the condenser
   the steam is cooled back to water
   the steam is returned to the reactor

2. (which, as it)
   water is pumped into the reactor vessel
   water boils
   water rises through the nuclear core

3. (which, after passing)
   water leaves the reactor in the form of steam
   the steam is passed through the separators and driers at the top of the vessel
   the steam is used to rotate the turbine

English Through Chemistry: Pre-academic or Simplified Science

Dialogue 1

A: Hi, Dr. Einstein
B: Hello Ahmed. Are you ready for today's lesson?
A: Sure. You can ask me anything.
B: Okay. Can you tell me what an element is?
A: For example, oxygen is an element.
B: Oh? Why?
A: Oxygen has only one kind of atom-oxygen atom.
B: That's good, Ahmed. Is water an element?
A: No, water's a compound. It has two hydrogen atoms combined with one oxygen atom.
B: The atoms together form a water molecule, and that makes a compound.

Word Study: Nouns

Element - a substance with only one kind of atom.
1. Hydrogen is an element.
2. Some elements are radioactive.
Word Family: elemental (adj.) and elementary (adj.)

Compound - material made up of two or more elements.
1. Water is a compound.
2. Some compounds are liquid.

Atom - the smallest particle of an element able to enter into minimal change.
1. Dr. Dohr described a hydrogen atom.
2. Most atoms are radioactive.
Word Family: atomic (adj.)

Molecule - the smallest particle of a compound.
1. Different atoms joined together make a molecule.
2. Molecules are combinations of atoms.
Word Family: molecular (adj.)

Word Study: Verbs

To combine - to unite
1. Hydrogen, oxygen and sulfur combine to make sulferic acid.
2. The chemist combined several elements.
Word Family: combination (n)

To form - to make
1. Hydrogen and oxygen form water.
2. The chemist formed several compounds.
Word Family: form (n)

Substitution Drill

Is hydrogen an element?	Yes, it is
oxygen	
salt	No, it isn't
water	
Are atoms small?	Yes, they are
parts of elements?	
easy to see?	No. they aren't
usually radioactive?	
Can compounds be liquids?	Yes, they can
gases?	
solids?	No, they can't
elements?	
atoms?	
Could the chemist form water?	Yes, he could
salt?	
sulpheric acid?	
matter from energy?	No, he couldn't
Did the chemist combine several elements?	Yes, he did.
hydrogen and oxygen?	
sodium and chloride?	No, he didn't

Vocabulary and Writing

Directions - Study the vocabulary list below. Then, on a separate piece of paper write each sentence and fill in each blank space with a word from the list.

to combine	compound	atom
radioactive	energy	molecule
element	to form	solid

When a chemist _____ two parts hydrogen with one part oxygen, he makes water. Water is a _____. Two _____ of the element hydrogen combine with one atom of the _____ oxygen. This combination _____ the substance that covers most of the earth's surface. H_2O, the water _____, is one of the most plentiful compounds known to man.

Structure - Modal Auxiliary - Can

Can is not a verb. It is a modal auxiliary. It is always followed by the simple form of the verb. It refers to present and future time, never to past time. Can is used to indicate:

1. ability - You can heat this with a bunsen burner.
   Can scientists make gold?

2. permission - You can use my lab book.
   Can I watch you do the experiment?

3. possibility - This experiment can be dangerous.

Practice

Indicate the meaning of the underlined word in terms of ability, permission or possibility.

_____1. I can't find my chemistry notebook.
_____2. Can atoms combine?
_____3. Can compounds be solids?
_____4. Can I use your microscope?
_____5. Chemists can form compounds.

Structure - Modal Auxiliary - Could

Could is a modal auxiliary. It is not a verb. It is always followed by the simple form of the verb. Could is used to indicate:

1. the past tense of can - The chemist said he could make compounds.

2. present/future conditional - You could learn the formula if you tried.

Note

Could have and past participle is used to discuss something you had a chance to do, but you did not do it. This refers to the past time only.

The chemist could have explained it. (He did not.)

Reading Practice

Molecules are very, very small, but atoms are smaller. It is, in fact, the combining of atoms that form molecules. Because atoms of different types can combine, there are many, many different types of compounds in the universe. It is possible, and probable, that some of these compounds are still unknown.

1. Which are smallest?
   a. atoms b. molecules c. compounds d. reactions

2. Compounds are formed from the _____ of different atoms.
   a. combine b. combined c. combining d. combines

3. It is probable that some compounds are still unknown?
   a. yes b. no c. possibly d. unlikely

4. Which pair of atoms can combine to form a compound?
   a. hydrogen and oxygen b. oxygen and oxygen
   c. hydrogen and hydrogen d. none of the above

5. Are there many different kinds of compound in this universe?
   a. no b. possibly c. probably d. yes

Reading Practice

The atomic weight of magnesium (Mg) is 24.305, or just over two times the atomic weight of carbon. A foreign student might confuse it with manganese (Mn) because the spelling of the two elements may look similar to him. However, manganese has an assigned atomic weight of 54.9380.

1. Which element has an atomic weight of more than four times that of carbon?
   a. magnesium b. manganese c. neither

2. Which of the following is correct?
   a. The atomic weight of carbon is more than twice that of magnesium.
   b. The atomic weight of manganese is over twice that of magnesium.
   c. The atomic weight of Mg is half that of carbon.
   d. The atomic weight of Mn is half that of Mg.

3. Relative to Mg, the atomic weight of _____ is small.
   a. manganese b. magnesium c. carbon

4. "The spelling may look similar" means _____.
   a. the spelling is the same
   b. the spelling is different
   c. the spelling is almost the same

5. "just over" means _____.
   a. much more than b. slightly more than
   c. much less than d. slightly less than

6. The atomic weight of carbon is just less than half that of magnesium and somewhat less than a _____ that of manganese.
   a. half b. third c. quarter d. fifth

7. "him" in the second sentence means _____.
   a. manganese b. magnesium c. carbon d. the student

8. "it" in the second sentence means _____.
   a. manganese b. magnesium c. carbon d. the student

APPENDIX III

This list of materials on or about technical English has been gleaned from various bibliographies. To date, I have not seen a comprehensive list of published and unpublished materials dealing specifically with technical English. I include this in response to a perceived need on my part, a need which I feel may be shared by others involved in teaching technical English.

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