The Essentials of Technical Communication

THIRD EDITION

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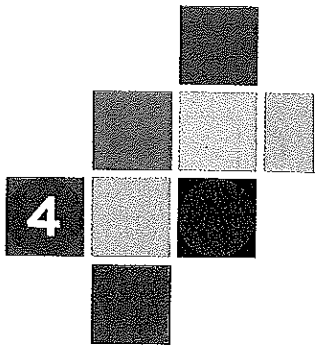
New York Oxford
Oxford University Press

barring gifts to foreign officials, but in this case. In the taxi on the way ident about the gift. He advises you is how we have to do business here" esident of the company are personal of conversation, but you are still wor- might also be illegal.

boost to your career. It could lead to er visibility in your profession as well d possibly job offers from prestigious career if it were determined that you

lressing this dilemma? What sources applicable laws, about ethics, about you talk to? What documents or mes-



Achieving a Readable Style

Style refers to the overall way you express your ideas in a document, from the paragraph level to sentence structure and the words and phrases you choose.

Quick Tips

If you want your report to be read, use a style that your readers can follow easily. If your readers can't understand your report as they read it and have to constantly reread sentences and paragraphs, they may just disregard it or toss it out. Unreadable documents usually result from ineffective style.

The Paragraph

A reminder: We define a *paragraph* as a group of sentences that begins with a central, or topic, statement of their content. The supporting sentences build on the idea stated in the topic sentence and should occur in a logical order. In short,

- Begin each paragraph with a topic sentence that summarizes content to come.
- Include only information relevant to the topic sentence.
- Place sentences in a logical order.
- Avoid long paragraphs.

Examples for study. Effective report segments result from effective paragraphs. Examine the following introduction to a technical report (Figure 4–1). Because each paragraph begins with a topic sentence (easy to locate and retrieve),

Introduction

In 1996, the U.S. Department of Energy (DOE), Office of Fossil Energy, asked Argonne National Laboratory (ANL) to conduct a preliminary technical and legal evaluation of disposing of nonhazardous oil field wastes (NOW) into salt caverns. The conclusions of that study, based on preliminary research, were that disposal of oil field wastes into salt caverns is feasible and legal. If caverns are sited and designed well, operated carefully, closed properly, and monitored routinely, they can be a suitable means for disposing of oil field waste (Veil et al. 1996). Considering these findings and the increased U.S. interest in using salt caverns for nonhazardous oil field waste disposal, the Office of Fossil Energy asked ANL to conduct a preliminary identification and investigation of the risks associated with such disposal.

As Chapter 8 discusses, report introductions must have purpose statements to tell readers what the report will do. Having the purpose statement at the beginning of a paragraph helps readers find the purpose statement.

Report Purpose

The purpose of this report is to evaluate the possibility that adverse human health effects (carcinogenic and noncarcinogenic) could result from exposure to contaminants released from the caverns in domal salt formations used for nonhazardous oil field waste disposal. The evaluation assumes normal operations but considers the possibility of leaks in cavern seals and cavern walls during the post-closure phase of operation. It does not consider the risks associated with emissions from surface equipment operating at the site, nor does it consider the risks associated with surface oil leaks or other equipment-related spills or accidents.

The study focuses on possible long-term risks to human health. It does not address potential ecological effects, although such effects could result. Also, risks associated with naturally occurring radioactive materials (NORM) are not addressed. This preliminary assessment estimates risks associated with disposal in a single generic cavern only. No attempt has been made to address the possibility or likelihood that several caverns may be located in relatively close proximity and that more than one cavern could be a source of contamination to a given receptor. Also, no attempt has been made to evaluate the possible impacts of synergistic effects of multiple contaminants on a single receptor.

Because the history of salt cavern use for solid waste disposal is very limited, no readily available data could be accessed for this study. As a result, data from similar operations and professional judgment were used to develop the possible release mechanisms assumed in this hypothetical, generic analysis. The validity of the results would be enhanced if real data could be used. As data are generated on the use and post-closure operations of salt caverns used for solid waste disposal, they should be incorporated to update this study.

Report Development Process

Moves from broad to specific in supporting information

In this assessment, several steps were followed to identify possible human health risks. At the broadest level, these steps include identifying a reasonable set of contaminants of possible concern, identifying how humans could be exposed to these contaminants, assessing the toxicities of these contaminants, estimating their intakes, and characterizing their associated human health risks. The risk assessment methodology and

FIGURE 4-1 Effective Introduction to a Technical Report

techniques used in this report are based in large part on two documents. The first document is a training manual that was developed for a risk assessment workshop sponsored by DOE (DOE 1996). The second is the Risk Assessment Guidance for Superfund (U.S. Environmental Protection Agency [EPA] 1989).

Report Plan

The remainder of this report consists of nine sections. Section 2 provides background on the development, use, and closure of salt caverns that may be used for disposal of nonhazardous oil field wastes and possible cavern release scenarios. Section 3 identifies contaminants of potential concern that could cause harm to human health. Sections 4, 5, and 6 provide information for assessing potential exposure pathways that the contaminants of concern could take to reach human populations. Specifically, Section 4 describes fate and transport mechanisms of the contaminants of concern; Section 5 describes specific hydrogeologic conditions of locations where salt caverns are most likely to be used for oil field disposal (Gulf Coast, Texas, and New Mexico); and Section 6 describes potential release modes that could cause contaminants to leak from the cavern and be transported to areas where human populations may be exposed. Section 6 also estimates possible concentrations of the contaminants to which humans could be exposed under various release scenarios. Section 7 describes the toxicity of those contaminants that could come in contact with humans, given the fate and transport mechanisms identified in Section 5 combined with the potential exposure pathways described in Section 6. Section 8 estimates the potential intakes of those contaminants by humans and characterizes the risks to which those humans may be subjected on the basis of the intake of the contaminants (the potential for harm), their toxicities, and the release assumptions. Section 9 addresses the sensitivity of the estimated risks to operating procedures and potential regulatory structures, and Section 10 summarizes the results of the analyses.

Topic sentence helps readers anticipate presentation of the nine sections. Naming each section allows the writer to show relationships among the sections.

FIGURE 4-1 *continued*

you can read just the topic sentences and have a clear sense of the content of the introduction. While the final paragraph is the longest of this introduction, its structure allows you to follow easily the development of the paragraph.

The next example paragraph (Figure 4–2) uses a list to draw the reader's eyes to the central idea presented in the paragraph, the criteria for approval. The topic sentence introduces the paragraph and the list.

The listing strategy emphasizes the six items that take front and center in the Ashton Lake project. In this situation, listing highlights the rhetorical immediacy of the problem. A traditional paragraph with linear text would obscure the concerns (Figure 4–3).

Avoid excessive use of any writing technique—too many short paragraphs, too much enumeration (first, second, third, etc.), as well as too many lists. Concise paragraphs that begin with topic sentences and well-structured sentences of

The City of Ashtonville Economic Development Council presented six main concerns to the City Parks and Recreation Department about the proposed Ashton Lake development proposal:

1. Financial feasibility of the project
2. Ability to raise the necessary funds
3. Project maintenance, including long-term
4. Protection/Enhancement of the shoreline
5. Effect of project on changing lake water levels
6. Erosion of project's materials caused by water/sand

The EDC expressed a major concern that the project may not be as family-friendly as needed because it would require extensive funding to develop the recommended recreation facilities. In addition, the concerns stated suggest that the project, if approved, will have to be funded strictly by private donations rather than city or county parks money.

FIGURE 4–2 Effective Use of a List within a Paragraph

moderate length create clear, readable documents. Why do you find Figure 4–5 easier to read than Figure 4–4?

Note that each paragraph of Figure 4–5 begins with a topic sentence and that a clearly stated subheading introduces each segment of the introduction. (Chapter 5 will explain how to design documents, but this revision also exemplifies excellent document design.)

Basic Principles of Effective Style

Effective writers adjust their style to the needs of their readers: (1) readers' knowledge of the subject, (2) readers' expectations about style based on the specific kind of writing, (3) readers' probable reading level based on the context in which they will read the document, and (4) the writer's relationship to readers—the professional roles of both writer and readers.

Determine your readers' knowledge of the subject. The reader's familiarity with the subject will determine how many specialized terms you can use. If the

The City of Ashtonville Economic Development Council presented six main concerns to the City Parks and Recreation Department about the proposed Ashton Lake development proposal: financial feasibility of the project; ability to raise the necessary funds; project maintenance, including long-term; protection/enhancement of the shoreline; effect of project on changing lake water levels; and erosion of project's materials caused by water/sand. The EDC expressed a major concern that the project may not be as family-friendly as needed because it would require extensive funding to develop the recommended recreation facilities. In addition, the concerns stated suggest that the project, if approved, will have to be funded strictly by private donations rather than city or county parks money.

FIGURE 4–3 Ineffective Run-in List

How an MRI Works

Brain perfusion refers to the blood circulation around the brain while exchanging oxygen and nutrients between the blood and the brain tissue. The effectiveness of brain perfusion depends on "blood pressure, blood velocity [...], and diffusion rates of oxygen and nutrients" [1]. An MRI scanner can monitor the perfusion of the brain to determine if a neurological disease is present.

An MRI scan uses a magnetic field to generate enhanced images that show certain parts of the body. The hydrogen atom provides a crucial component in the generation of an MRI scan. The hydrogen atom contains a single proton that interacts with the magnetic field generated by the MRI. The hydrogen atoms in a specific area of the human body will behave differently due to the presence of a magnetic field. The MRI scanner will detect the behavior of these hydrogen atoms to generate an enhanced image of that area.

In many MRI procedures, a contrast agent is used to further enhance the image of the body by increasing the brightness of the tissue being examined. The injection of contrast agents into the body will help the MRI scan retrieve information such as "blood flow [...] and related physiological parameters" [2]. These contrast agents work by altering the local magnetic field in the tissue being examined to generate an illuminated image of that tissue on the MRI scan.

Unfortunately, contrast agents have limited functions when physicians attempt to study the human brain. The brain contains a "membrane structure" known as the blood brain barrier, which protects the brain from foreign chemicals in the blood, while still allowing essential metabolic function [3]. The blood brain barrier filters out any unwanted chemicals that may travel through the brain. Since the blood brain barrier is very effective in its function, the chemicals in the contrast agents will be filtered out by this *membrane structure*. If a neurological disease is present in the brain, it can weaken the blood brain barrier and allow these unwanted chemicals to pass through [3]. The contrast agent would be useful for studying the disease in this situation.

Many methods have been created to penetrate the blood brain barrier. My proposed method will strengthen the interaction between hydrogen atoms with the magnetic field via electrical signals. During an MRI scan, an electrical signal will be emitted around the neck area. This signal will mark the hydrogen atoms that are in the vicinity of the emitted signal. Because no external chemicals are introduced, the blood brain barrier will not detect any foreign chemicals and will let the marked hydrogen atoms into the brain. The hydrogen atoms will travel through the bloodstream around the brain acting as beacons. They will then interact with the magnetic field of the MRI, allowing the MRI to enhance the image of the brain, much like contrast agents [4].

FIGURE 4–4 Original Introduction to a Student Research Proposal

reader has a thorough knowledge of the subject, you can use acronyms, specialized nomenclature, and jargon that readers in a specific discipline regularly read and use. If the reader has little knowledge of the subject, limit the use of specialized vocabulary or perhaps define the terms. Another possibility is to substitute phrases or words that clearly express your meaning.

In a work context, the better you know the people who will read your writing, the better you can design your reports, memos, and e-mails. You can also ask people who know your readers to aid you in finding out preferences in organization, style, and length. When you begin a job assignment, ask your supervisor for his or her preferences in these three areas.

Note: Conciseness does not equal brevity. When you write concisely, you include all that you need to say without extra words and phrases that contribute little to the main idea. Brevity means that you aim only for economy, rather than completeness of thought.

Introduction

Importance of Brain Perfusion
Brain perfusion refers to the blood circulation around the brain while the circulatory system exchanges oxygen and nutrients between the blood and the brain tissue. Brain perfusion depends on "blood pressure, blood velocity [...], and diffusion (dispersal) rates of oxygen and nutrients" [1]. An MRI scanner can monitor the perfusion of the brain to determine if a neurological disease is present.

How an MRI Works
A magnetic resonance imaging (MRI) scan uses a magnetic field (an attractive force) to show enhanced images of certain parts of the body. A dynamic MRI scan displays a fuller and more detailed result, unlike a conventional MRI. The hydrogen atoms in the human body are very important in an MRI procedure. One hydrogen atom contains a single proton that behaves differently when the MRI emits a magnetic field around that area. The MRI scanner will detect the behavior of these hydrogen atoms to generate an enhanced image of that area.

In many MRI procedures, a contrast agent (a compound fluid) is used to further enhance the image of the body by increasing the brightness of the tissue being examined. The injection of contrast agents into the body will help the MRI scan retrieve information such as blood flow and other related physical characteristics [2].

Limits of the MRI
Unfortunately, contrast agents have limited functions when physicians attempt to study the human brain. The brain contains a "membrane structure" known as the blood brain barrier, which protects the brain from foreign chemicals in the blood, while still allowing essential metabolic function [3]. The blood brain barrier filters out any unwanted chemicals that may travel through the brain. Since the blood brain barrier is very effective in its function, the chemicals in the contrast agents will be filtered out by this *membrane structure*. If a neurological disease is present in the brain, it can weaken the blood brain barrier and allow these unwanted chemicals to pass through [3]. The contrast agent would be useful for studying the disease in this situation.

Value of My Method in Improving the MRI
Many methods have been created to penetrate the blood brain barrier. My proposed method will strengthen the interaction between hydrogen atoms with the magnetic field via electrical signals. During a dynamic MRI scan, an electrical signal will be emitted around the neck area. This signal will mark the hydrogen atoms that are in the vicinity of the emitted signal. Because no external chemicals are introduced, the blood brain barrier will not detect any foreign chemicals and will let the marked hydrogen atoms into the brain. The hydrogen atoms will travel through the bloodstream around the brain acting as beacons. They will then interact with the magnetic field of the MRI, allowing the MRI to enhance the image of the brain, much like contrast agents [4].

Subject and Purpose
This research will focus on developing a new method of performing a dynamic MRI scan on the human brain. This new method involves emitting an electrical signal into the body to interact with the hydrogen atoms and performing a dynamic MRI scan. To determine the effectiveness of this new method, I will analyze the MRI scan to determine the rate of perfusion in the brain.

FIGURE 4–5 Revised Introduction to the Student Research Proposal

Determine whether a particular style will be expected. Use the company style sheet and templates. But remember that you still have to adapt what you say to your intended readers.

Adjust the style to the readers, the purpose, and the context. Most business and technical writing should strive for as much conciseness as possible because of the large quantity of information that most readers confront. E-mail

messages should have concise paragraphs and concise sentences. Even in complex, highly technical reports, readers value conciseness: the longer the report, the less likely that anyone will read all of it.

Keys to Building Effective Sentences

English sentences work more effectively—they become easier to read, understand, and remember—if they follow basic rules of sentence structure.

Watch sentence length. Documents composed of consistently long sentences can become difficult to read. Sentence length should vary, but consider revising sentences over 15 to 20 words. Even legal documents can benefit from shorter sentences and have improved as a result of plain English laws that now govern insurance policies and many other legal documents in various states. Many government entities want their public documents written in concise, easily understood sentences:

> *Before:*
> This Appendix contains a brief discussion of certain economic and demographic characteristics of the Area in which the County is located and does not constitute a part of this Official Statement. Information in this Appendix has been obtained from the sources noted, which are believed to be reliable, although no investigation has been made to verify the accuracy of such information.

Characteristics of Bad and Good Writing

Bad Writing	Good Writing
few verbs/number of words per sentence	many verbs/number of words per sentence
excessive *is/are* verb forms	concrete verbs
abstract nouns	concrete nouns
many prepositional phrases	few prepositional phrases
few clauses	linked clauses
passive voice	active voice
separation of key words: subject-verb, actor-action	clear actor-action relationship
long, rambling sentences	specific, precise sentences
main idea of sentences is difficult to process	meaning of sentences is easy to find and follow
sentences must be read several times	meaning is clear after one reading

e circulatory system exchanges
fusion depends on "blood pres-
trients" [1]. An MRI scanner can
s present.

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Proposal

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After:
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Keep subjects and verbs close together. A recipe for sentence clarity: keep the subject of the sentence and the verb close together, and emphasize verbs. The more verbs in a sentence, the sharper and more direct the sentence. We call this characteristic *verb/word ratio*. For example,

S V S V

John loves Mary because she inherited money. (verb/word ratio = 2/7)

versus

S V

Mary's inheritance of money was one of the reasons for John's interest in Mary.

(verb/word ratio = 1/12)

In this simple example, you can see the point: the more verbs, the sharper the sentence.

Let's take this method a step further: lengthy sentences become less distracting to the reader if the writer structures them to enhance clarity and readability. To achieve clarity, build sentences with clauses and as many verbs and verbals (to + verb; verb ending in "ing") as possible. For example, the sentence

When they plan investment portfolios, financial planners recommend a variety of investments because they resist rapid economic changes. (18 words)

develops about three clauses:

When they plan investment portfolios
financial planners recommend a variety of investments
because they resist economic change.

Note that the sentence follows the three guidelines:

Interlocking clauses (three in this sentence)
Specific action verbs: *plan*, *recommend*, and *resist*
Subject next to the verb in each clause

they plan
planners recommend
they resist

The sentence has a verb/word ratio of 3/17.

Assume that the writer did not follow the guidelines and avoided verbs:

In plans for investment portfolios, a variety of investments is recommended by financial planners because of their resistance to economic changes.

The verb/word ratio is 1/21. The sentence lacks directness and conciseness. Compare the two versions. Can you see the difference? In English sentences, the more verbs and verbals a writer uses, the easier the time the reader has in understanding the sentence(s). In addition, make the actor the subject and follow it with a concrete verb that identifies what the actor does.

For most writing, use specific concrete subjects and verbs. Write to express, not to impress.

Instead of:
There is now no effective existing mechanism for introducing into the beginning initiation and development stages requirements on how to guide employees on how to minimize errors in product development efforts.

(verb/word ratio = 3/31; one *is* verb and two verbals)

Use:
The company has no way to guide employees on how to minimize product development errors during the early development stages.

(verb/word ratio = 3/20) Note that the sentence begins with the actor in the subject position and two verbals.

Note: When a sentence lacks a clear subject/agent doing the action (verb), writers can often drift into the phrases "there is," "there are," "there was," and "there were," which have no meaning and deter conciseness and directness.

Instead of:
Our lack of pertinent data prevented determination of committee action effectiveness in funding target areas that needed assistance the most.

(Note that the sentence incorporates two clauses and two verbs. Verb/word ratio = 2/21.)

Or, even worse:
There was a lack of pertinent data determination of committee action effectiveness in funding target areas that needed assistance the most.

Use, assuming we know who did what action:
Because we lacked pertinent data, our committee could not determine whether we had targeted funds to areas that needed assistance the most.

(Note the revision of the sentence has four interlocking clauses and four verbs. Verb/word ratio = 4/22.) In addition, placing clear subjects close to their verbs makes clear who does what action.

Or use:
We didn't have enough data: we could not decide if the committee had sent funds to areas that needed them most.

When we break the sentence into two sentences, we still have four verbs. In addition, the short sentence followed by the longer, explanatory sentence also clarifies the meaning.

Note that in this revision we place the actor as the subject of the sentence/clause and then follow the subject with the verb, a concrete, descriptive verb that explains what the actor/subject will do.

Remember how direct/indirect words affect tone:

(A) We encourage you to anticipate the amount of correspondence you accumulate and suggest you endeavor to answer it promptly.

(B) Please expect large amounts of e-mail and try to answer it quickly.

Note that you can read (B) more easily and quickly than (A). The tone of (A) sounds pompous.

Write squeaky-clean prose. The following excerpt from *DNA: The Secret of Life* addresses readers interested in science and possessing a basic understanding of genetics. Note the structure of each sentence, the use of topic sentences, and the development of each paragraph:

> The great size of DNA molecules posed a big problem in the early days of molecular biology. To come to grips with a particular gene—a particular stretch of DNA—we would have to devise some way of isolating it from all the rest of the DNA that sprawled around it in either direction. But it was not only a matter of isolating the gene; we also needed some way of "amplifying" it: obtaining a large enough sample of it to work with. In essence we needed a molecular editing system: a pair of molecular scissors that could cut the DNA text into manageable sections; a kind of molecular glue pot that would allow us to manipulate those pieces; and finally a molecular duplicating machine to amplify the pieces that we had cut out and isolated. We wanted to do the equivalent of what a word processor can now achieve: to cut, paste, and copy DNA.
>
> Developing the basic tools to perform these procedures seemed a tall order even after we cracked the genetic code. A number of discoveries made in the late sixties and early seventies, however, serendipitously came together in 1973 to give us so-called "recombinant DNA" technology—the capacity to edit DNA. This was no ordinary advance in lab techniques. Scientists were suddenly able to tailor DNA molecules, creating ones that had never before been seen in nature. We could "play God" with the molecular underpinning of all of life. This was an unsettling idea to many people. Jeremy Rifkin, an alarmist for whom every new genetic technology has about it the whiff of Dr. Frankenstein's monster, had it right when he remarked that recombinant DNA "rivaled the importance of the discovery of fire itself."

Source: Watson, James. *DNA: The Secret of Life*, pp. 87–88. Knopf, 2003. Used by permission.

This excerpt uses a variety of sentences of moderate length, close subject–verb patterns, familiar words, and a description of recombinant DNA in words easily understood by the nonscientific reader: the passage concisely and picturesquely expresses the meaning of recombinant DNA.

Avoid pompous language; write to express, not to impress. The concept of simplicity relates to the concept of naturalness. Writers often believe they must sound learned, aloof, and sophisticated to impress readers. The idea that direct writing lacks sophistication frequently derives from writing done in secondary school. Teachers encourage high school students to expand their vocabularies. Academic writing in college reinforces the importance of using jargon-laden language to convince the professor that the student knows the subject and the nomenclature of the discipline. Instructors may reward students for writing ponderous verbiage in research papers. On the job, however, verbose writing may be ignored or misread by readers who are interested in gleaning information relevant to their job needs.

Remember that writing exists for human beings, and few of us enjoy writing that seems harder to read than it needs to be. What constitutes "difficult" writing depends on the reader, the topic, and the purpose of the document. But direct, concise writing that uses a conversational style will usually be appreciated by your readers. Using shorter rather than longer sentences also helps readers follow your thoughts:

> Please give immediate attention to insure that the pages of all documents prepared for distribution are numbered sequentially and in a place of optimum visibility. This is needed to facilitate our ability to refer to items during meetings.

Versus

> Please correctly number the pages of all documents. Place numbers in the upper right-hand corner. Sequential numbering helps us locate material during meetings.

Or

> Please number all pages sequentially.

Three additional examples:

> 1. It has recently been brought to my attention that only a small percentage of the employees in our division are contributors to the citizens' health research fund supported by this firm. This fund is a major source of money for the encouragement of significant discoveries and innovations made in behalf of research relevant to community health.

Versus

> I have discovered that only a small percentage of employees in our division contribute to the citizens' health research fund. Our firm supports this research because the products of this research improve community health.

> 2. As a result of their expertise, the consulting team is provided with the opportunity to make a reasonable determination of the appropriate direction to proceed regarding their selection of information systems.

Versus

The consulting team has the expertise to select the best information systems.

3. It is our contention that the necessary modifications should be made to make the system operational because its complete replacement is economically prohibitive.

Versus

We believe that the system should be modified to make it operational. Complete replacement costs too much.

Avoid excessive use of *is/are* verb forms. Choosing specific, concrete verbs for clarity means avoiding forms of the "be" verb, if possible. As the following sentences illustrate, excessive use of "be" verbs often obscures action verbs. Many times, a "be" verb is the best choice (as this sentence exemplifies). However, you can lessen the tendency to use "be" verbs by doing the following:

- Avoid beginning sentences with *there is* or *there are, there was* or *there were.*
- Avoid beginning sentences with phrases such as *it is clear that, it is evident that,* and *it should be noted that.*
- Choose a specific verb rather than *is, are, was,* and *were* verb forms.

"Be" verbs often create a longer, less direct sentence:

Delegation is a means of lessening the manager's workload.

Versus

Managers who delegate reduce their workload.

Examine the following three examples:

1. Our appraisal system is broken: it is inefficient, it is unfair, and it is costly.

Versus

Our appraisal system lacks efficiency, fairness, and thrift.

2. My decision is based on the assumption that his statement is erroneous.

Versus

My decision assumed that his statement is erroneous.

3. Our office has been provided with the authority to make a determination about the selection of a computing system.

Versus

Our office was authorized to select a computing system.

As these examples and the ones that follow show, the clearest sentences focus on the agent and the action (the verb):

1. There are two systems presently available for testing job candidates.

Versus

Two available systems can test job candidates.

2. There are several national and global organizations dedicated to promoting environmental sustainability for healthcare facilities.

Versus

Several national and global organizations promote environmental sustainability for healthcare facilities.

Use active voice for clarity. The structure of a sentence—the arrangement of words—affects the clarity of the sentence. In active voice, the agent that does the action occurs next to the verb, the agent and the action both appear in the sentence, and the agent appears as the subject of the sentence.

agent *verb*
The department teaches the course every spring term.

agent *verb*
Our office submits all travel vouchers within 24 hours of their completion.

The result? Clear, concise, direct sentences.

Before:
(A) Attempts were made by the division staff to assess the project.

After:
agent *verb*
(B) The division staff attempted to assess the project.

Sentence (A) uses passive voice. Sentence (B) uses active voice: the agent (staff) occurs as the subject and appears next to the verb (attempted).

Research to determine the most readable sentence structures indicates that active-voice sentences may be more readable than passive-voice sentences. Readers often need the agent (the actor) placed near the action (the verb) to determine the sentence meaning. The subject and verb contain the essence of the sentence. The following examples illustrate this concept.

The door is to be locked at 6:00 p.m.

This sentence, which does not specify the agent, could mean either of the following:

The guard (or some designated person) will lock the door at 6:00 p.m.
The last person leaving the building at 6:00 p.m. must lock the door.

As both revisions illustrate, to understand a sentence, readers must know the agent and the action carried out by the agent. When you write, be sure your sentences indicate who or what performs the action.

Passive-voice sentences often intentionally do not include the actor or agent doing the action, to hide responsibility. The result may produce a sentence more verbose and less accurate than an active-voice version. Passive-voice sentences often use "there is" and "there are" constructions. Even in engineering writing, such as articles for academic journals, many editors want active-voice sentences because of their increased clarity. As in the examples below, the use of active subjects will usually make an explanation easier to read and easier to understand:

Before:
With the growing request of high-quality multimedia service, especially in portable systems, efficient algorithms for audio and/or video data processing have been developed. These algorithms have the characteristics of high-complexity data-intensive computation. For these applications, there exist two extreme implementations. One is software implementation running on a general-purpose processor and the other is hardware implementation in the form of application-specific integrated circuit (ASIC). In the first case, it is flexible enough to support various applications but may not yield sufficient performance to cope with the complexity of application. In the second case, optimization is better in respect of both power and performance but only for a specific application. A coarse-grained reconfigurable architecture fills the gap between the two approaches, providing higher performance than software implementation and wider applicability than hardware implementation.

After:
(Note: We separate sentences in the original passage here so that you can follow the changes in sentence structure.)

To respond to growing requests for high-quality multimedia services, especially in portable systems, engineers have developed efficient algorithms for audio and/or video data processing.

These algorithms exemplify high-complexity, data-intensive computation.

In addition, these applications use two extreme implementations: (1) a *software implementation* running on a general-purpose processor and (2) a *hardware implementation*, an application-specific integrated circuit (ASIC). The first has flexibility needed to support various applications, but it may not yield sufficient performance to cope with complex applications. In the second, we can optimize by power and performance but only for a specific application. A coarse-grained reconfigurable architecture fills the gap between the two approaches. This architecture provides higher performance than software implementation and wider applicability than hardware implementation.

Breaking long sentences into shorter ones and creating short paragraphs can also produce clarity:

Before:
To ensure dimensional quality of manufactured products, a crucial step is to take coordinate measurements of the geometric features to reconstruct product surface and then to check their compliance with tolerance specifications: my research develops a method to integrate the coordinate measurements from measuring devices of different resolutions for a better reconstruction of the product surface.

After:
To ensure dimensional quality of manufactured products, researchers must take coordinate[d] measurements of the geometric features. Their goal is to reconstruct product surface and then check surface compliance with tolerance specifications.

My research develops a method to integrate the coordinate[d] measurements from measuring devices of different resolutions to better reconstruct the product surface.

WORD CHOICE

To write concise sentences, use clear, concise words and phrases. Avoid using longer words when shorter ones will do just as well. (Write to express, not to impress.)

instead of	write	instead of	write
accordingly	so	hence	so
accumulate	gather	implement	carry out
acquaint	tell	initiate	begin
acquire	get	maximum	most
activate	begin	modification	change
aggregate	total	nevertheless	but, however
assist	help	objective	aim
communicate	write, talk, tell	optimum	best
compensation	pay	personnel	people, staff
consequently	so	procure	get
continue	keep up	purchase	buy
demonstrate	show	terminate	end
discontinue	stop	transmit	send
endeavor	try	utilize	use
facilitate	ease, simplify		

Eliminate dead phrases—words that add nothing to the meaning of the sentence.

to the extent that
with your permission
hence
with reference to
in connection with
with respect to
as already stated
in view of
inasmuch as
as a matter of fact
for the purpose of
in order

Avoid words that sound knowledgeable without being specific. Many are technical words that have been overused and poorly adapted to nontechnical situations.

parameters
logistical interface
contact
impact
input/output
conceptualize
formalize
multifaceted
systematized
prioritize
time frame
hard date
in-depth study
warrants further investigation
broad-based
dynamics
infrastructure
longitudinal study
matrix
meaningful
monolithic
paradigm
participatory involvement
resource utilization
viability

Avoid redundant phrases.

absolutely complete
absolutely essential
agreeable and satisfactory
anxious and eager
basic fundamentals
complete absence
consensus of opinion
each and every
exactly identical
example to illustrate
few in number
human volunteer
insist and demand
my personal opinion
necessary essentially
past memories
point in time
right and proper
sincere and earnest
small in size
summarize briefly
thought and consideration

first and foremost	true facts
general consensus	very unique
green in color	

Avoid business jargon.

instead of	**write**
consideration was given	I considered
prior to the	before
at the present writing	now
effect an improvement	improve
in the neighborhood of	about
beg to advise	tell
cognizant of	know
thanking you in advance	I would appreciate
endeavor	try
viable alternative	possibility
in regard/reference to	about
send under separate cover	send separately
return same to the above	return to us
needless to say	[omit]
it goes without saying	[omit]
in the normal course of procedure	normally
in this day and age	today
in my opinion	I believe
it is our opinion	we think
on a daily basis	daily
on the grounds that	because
pursuant to our agreement	as we agreed
we are not in a position to	we cannot
without further delay	now
please be advised that	[omit]

STYLE CHECKLIST ✔

Planning

- ☐ How will you adjust your writing style to accommodate your readers' knowledge of the subject?
- ☐ How will you meet your readers' expectations about style for the specific kind of document you are writing?
- ☐ Can you determine the appropriate reading level for the context in which the document will be read?
- ☐ How will you adjust your style so that it is appropriate for the professional relationship you have to your readers?

Revision

- ☐ Do paragraphs begin with a topic sentence? Do the following sentences in the paragraph build on the idea in the topic sentence?
- ☐ Are most sentences 20 words or shorter? Could you make any longer sentences shorter?
- ☐ Are subjects and verbs close together in your sentences?
- ☐ Have you used specific nouns and concrete verbs?
- ☐ Have you avoided ponderous and impersonal language?
- ☐ Have you avoided *is/are* verb forms whenever possible?
- ☐ Are most of your sentences written in active voice? Could you change any sentences with passive voice to active voice?
- ☐ Have you defined everything that might require defining?
- ☐ Could you write any of your sentences with equal clarity but with fewer words?

EXERCISES

1. Which recommendations in this chapter operate in the revisions of the following sentences? Why do these principles result in clearer, more concise revisions?

   i. A stroke is an increasingly common problem associated with the brain. It is caused when a vein or artery in the brain is obstructed. This results in loss of consciousness from the loss of oxygen in the brain.

      A stroke, an obstruction in a vein or artery in the brain, results in loss of consciousness as the brain does not receive oxygen.

   ii. There is another method that is more invasive to the patient but proves to be successful enough to treat stroke.

      Another more invasive method proves successful in treating stroke.

iii. There are many proposed solutions for ridding the United States of oil dependency.

> Many proposed solutions target reduction of US oil dependency.

iv. A significant amount of new research has come out recently about a bodily phenomenon called brown fat. Brown fat is regarded with interest because of its potential use as a new therapy for obese patients. Brown fat is nothing new—it's been known for centuries as "baby fat," the stuff that makes newborn infants so adorably chubby.

> Recent research on human "brown fat" shows that it may help obese patients. Brown fat, known for centuries as "baby fat," makes newborn infants chubby.

v. People in this field work in hospitals and dedicate their time to the mental well-being of children in hospitals as well as to helping the parents be able to support their children and cope with the trauma.

> People in this field work in hospitals. These professionals focus on the mental well-being of hospitalized children and help the parents support their children as they cope with trauma.

vi. Asperger's syndrome, sometimes called high functioning autism disorder, is a disability in young people that is frequently overlooked by educators and medical personnel.

> Asperger's syndrome, a high functioning autistic disorder in young people, is frequently overlooked by educators and medical personnel.

Or

> Educators and medical personnel frequently overlook Asperger's syndrome, a high functioning autism disorder occurring in young people.

vii. Even though Hurricane Gustav left its mark, there was a minimal amount of damage to the town, and finally there was a sigh of relief regarding energy prices.

> Even though Hurricane Gustav left its mark, the town suffered minimal damage and gave a sigh of relief regarding energy prices.

viii. A shoemaking company has signed a deal to share military technology to make their shoes waterproof, at the same time making the fabric breathable.

> A shoemaking company signed a deal to share military technology, making their shoes waterproof and breathable.

ix. There are many issues facing New Orleans related directly to hurricanes and tropical storms. Recently most of the problems caused from these storms have been traced back to the loss of wetlands of New Orleans during the past century. Despite recent pushes by community and political leaders in New Orleans to help restore these very little has been done, leaving much of the city vulnerable to hurricanes and allowing sea level to continue to rise.

New Orleans faces many issues related to hurricanes and tropical storms. Most problems caused by these storms have occurred because of loss of wetlands around New Orleans during the past century. [a. Despite efforts by community and political leaders in New Orleans to restore wetlands, little has been done.] Much of the city becomes increasingly vulnerable to hurricanes as the sea level continues to rise.

[b. Little has been done, despite efforts by community and political leaders in New Orleans to restore wetlands.]

x. Efforts were made on the part of the director's committee for completion of an evaluation of the recommendations of the report.

The director's committee tried to complete their evaluation of the report recommendations.

2. Revise the following:

i. There are several national and global organizations dedicated to promoting environmental sustainability for healthcare facilities.
ii. Though there have been numerous economic anthropology studies in Mexico, they have largely been in three locations.
iii. The intervening steps taken in the site are with the intention to make the site more attractive. This is done by establishing services, heading offices, cultural centers, and commercial firms in the downtown district.
iv. For adequate housing in such circumstances, this paper here presents a model. The model is a step-by-step development process which is aimed at empowering the poor users. This process includes:

- Innovative financing
- Creating employment opportunity
- Make the users aware of sustainable systems for drinking water, sewage disposal, other utilities, and shelter improvement
- Demonstrate the knowledge of the mentioned systems through a construction of a public facility for them.
- Transfer the knowledge by employing the users in the construction and maintenance of the facility.

v. At the same time, these fuels must be easy to burn cleanly. This is typically characteristic of liquid and gaseous fuels. Lastly, it is best that the fuel be a liquid or a gas because of the ability to pump both. This means that the existing infrastructure can be used to distribute the fuel.
vi. Lots of money around the world is poured into cancer research.
vii. There has been success using lymphotropic paramagnetic nanoparticles for imaging prostate cancer.
viii. There is plenty of money and room for big companies to get their foot in and discover new technologies to fight cancer.
ix. Recently there has been a surge in research and development for a material called grapheme. One area grapheme is being applied to is solar cells.
x. Sustainable development is the process of moving human activities into a pattern that can be perpetually sustained. It is an approach that seeks to meet the needs of the present while protecting the resources that will be needed in the future.

3. Figure 4–6 is a memo composed by the manager of The Plaza, a relatively new apartment building in Lubbock, Texas. The manager would like to distribute the memo to all residents as soon as possible. As the regional manager of Rite Properties, which operates The Plaza, you must review the official communications coming from managers to residents. What changes would you advise the manager to make to this memo?

4. Examine Figure 4–7. If you were the author of this document and were given a little extra time to make it more readable, what changes would you make?

5. Examine Figure 4–8. Note the number of stylistic weaknesses highlighted. Revise the report to remove these weaknesses and others you might find.

Rite Properties

7001 South Loop 289
Lubbock, Texas 79425
806-555-1327
manager@theplaza.com

May 15, 2012

TO: ALL PLAZA RESIDENTS
FROM: The Management
SUBJECT: problems

Over recent weeks and months we have had an issue with dogs urinating and defecating in staircases, sidewalks, the courtyard, and in the parking lot. This has required daily cleaning of these areas and is consuming additional janitor hours, which costs money and could soon lead to rent increases. Please be respectful of the buildings and your neighbors and curb your dog from using these public areas as a restroom. If your pet has an accident, it is your responsibility to clean up after it. Okay? If you ever witness this activity, please report it to Management. Monetary penalties will be imposed on the responsible party.

Also effective today, May 15, 2012, Bailey's will tow any Plaza resident vehicles or Plaza visitor vehicles that park in their parking lot. One visitor vehicle from Plaza was parked directly in front of their back door, blocking the way for a big delivery truck coming in this morning, consequently, no one may park over there any more. Residents, we have been over the parking situation over and over, if you or your guests get towed, don't call me. I've put out several newsletters or spoke with individuals about the parking. It is your responsibility to tell your guests where to park. We have had a good relationship with Bailey's for a long time, but when we get in the way, everyone must pay the price. Stop and think where you park! Is it going to be in someone's way in the morning? The next time I am called to clear out the cars to avoid being towed because it is blocking a door or driveway at Bailey's, I promise, I will call the tow truck myself.

We have also been changing the filters and checking the smoke alarm batteries this week and there are those of you that are tampering with your smoke alarms! Repeatedly we have told you not to take the battery out of your smoke alarm. IT IS AGAINST THE LAW. Do you have enough insurance to cover all your home's contents in addition to all the contents of several other homes if a fire breaks out in your apartment and because you have no battery in your smoke alarm, no one was warned before it was too late. When your alarm beeps, it means you need a new battery. We have the batteries in the office, come and get a new battery. There is absolutely no excuse that can be justified for removing or tampering with any part of the smoke alarm that I will accept. If we didn't have an alarm in your apartment and you had a fire, you would immediately blame us, do we get to blame you when you have removed the battery or tampered with the alarm? Each of you that had removed your alarm battery will be fined $25.00 which is clearly stated in your lease and had been explained in several newsletters.

Again, it is your responsibility for telling your guests where to park. You know how it feels when there are no parking spaces because they are filled with guests. I constantly see the same guests parking on the lot, the lot is posted for resident parking with all others towed, I have threatened to tow in the past, but once again, it has gotten out of hand and we are almost full and it takes every space on the lot just so our residents are allowed to park on the lot. Effective today, all non stickered vehicles will be towed with no advance warning. When this happens, perhaps you will want to pay the towing charge to your guest since you did not tell them where to park. When your guests vehicles get towed, please do not contact me. There will be a sticker telling them exactly where to get in touch with the wrecker service to retrieve their vehicle.

continued

FIGURE 4-6 Document for Exercise 3

Once again there is trash being left outside apartments overnight and during the day. Please, we take prospective residents through the courtyard nearly every day and it is very embarrassing to have to pass other people's trash. If you can't carry it out to the dumpster, leave it in your house until you can. It will be greatly appreciated.

Finally, as the weather heats up and you open your windows to cool off, remember that this allows sound to travel. If your windows are open after 10 PM, keep the noise in your apartment down. No loud televisions, parties, or music, please. Your neighbors will thank you. Have a wonderful day!

FIGURE 4–6 *continued*

USDA FSA

FACT SHEET

UNITED STATES DEPARTMENT OF AGRICULTURE
FARM SERVICE AGENCY

January 2013

Microloans

Overview

The Farm Service Agency (FSA) developed the Microloan (ML) program to better serve the unique financial operating needs of beginning, niche and the smallest of family farm operations by modifying its Operating Loan (OL) application, eligibility and security requirements. The program will offer more flexible access to credit and will serve as an attractive loan alternative for smaller farming operations like specialty crop producers and operators of community supported agriculture (CSA). These smaller farms, including non-traditional farm operations, often face limited financing options.

Use of Microloans

Microloans can be used for all approved operating expenses as authorized by the FSA Operating Loan Program, including but not limited to:

- Initial start-up expenses;
- Annual expenses such as seed, fertilizer, utilities, land rents;
- Marketing and distribution expenses;
- Family living expenses;
- Purchase of livestock, equipment, and other materials essential to farm operations;
- Minor farm improvements such as wells and coolers;
- Hoop houses to extend the growing season;
- Essential tools;
- Irrigation;
- Delivery vehicles.

Simplified Application Process

The application process for microloans will be simpler, requiring less paperwork to fill out, to coincide with the smaller loan amount that will be associated with microloans. Requirements for managerial experience and loan security have been modified to accommodate smaller farm operations, beginning farmers and those with no farm management experience. FSA understands that there will be applicants for the ML program who want to farm but do not have traditional farm experience or have not been raised on a farm or within a rural community with agriculture-affiliated organizations. ML program applicants will need to have some farm experience; however, FSA will consider an applicant's small business experience as well as any experience with a self-guided apprenticeship as a means to meet the farm management requirement. This will assist applicants who have limited farm skills by providing them with an opportunity to gain farm management experience while working with a mentor during the first production and marketing cycle.

Security Requirements

For annual operating purposes, microloans must be secured by a first lien on a farm property or agricultural products having a security value of at least 100 percent of the microloan amount, and up to 150 percent, when available. Microloans made for purposes other than annual operating expenses must be secured by a first lien on a farm property or agricultural products purchased with loan funds and having a security value of at least 100 percent of the microloan amount.

Rates and Terms

Eligible applicants may obtain a microloan for up to $35,000. The repayment term may vary and will not exceed seven years. Annual operating loans are repaid within 12 months or when the agricultural commodities produced are sold. Interest rates are based on the regular OL rates that are in effect at the time of the microloan approval or microloan closing, whichever is less.

More Information and Eligibility Criteria

Additional information on the FSA microloan program may be obtained at local FSA offices or through the FSA website at www.fsa.usda.gov.

FIGURE 4-7 Document for Exercise 4

HEET
AGRICULTURE

January 2013

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ilue of at least 100 percent of
e microloan amount.

ates and Terms

Eligible applicants may
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agricultural commodities
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es are based on the regular
rates that are in effect
he time of the microloan
proval or microloan closing,
ichever is less.

re Information and
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Additional information on
FSA microloan program
y be obtained at local FSA
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osite at www.fsa.usda.gov.

J.S. Department of Agriculture
A) prohibits discrimination in all its
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individual's income is derived from
ublic assistance program. (Not all
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and TDD). To file a complaint of
mination, write to USDA, Assistant
ary for Civil Rights, Office of the
nt Secretary for Civil Rights, 1400
ndence Avenue, S.W., Stop 9410,
ngton, DC 20250-9410, or call
e at (866) 632-9992 (English) or
377-8339 (TDD) or (866) 377-8642
h Federal-relay) or (800) 845-6136
sh Federal-relay). USDA is an equal
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Memorandum

TO: Jerry Bradshaw DATE: March 29, 2011
FROM: Bill Jones
SUBJECT: The Best Approaches in Alternative Fuel Research

Purpose

Alternative fuels are becoming an important area of research. There are two main reasons researchers are looking for a new and reliable fuel source. The first is to combat the reliance of the U.S on foreign oil. The second is to reduce the amount of harmful emissions into the atmosphere. The heavy reliance on gasoline is harmful to both our economy and the environment. In this report I will discuss the best approaches in alternative fuel research. The three main approaches that will be covered are ethanol, the hydrogen fuel cell, and biodiesel. For each approach I will explain the process of producing the fuel, the benefits, costs, and the negative aspects. The information provided will show what the best alternative fuel will be.

Research Methods

The data and information collected was obtained from several websites and online databases. I found which alternative fuels were currently in use from the U.S. Department of Energy website. It had useful information about new alternatives being researched and also information about fuels currently in use. After determining which three fuels had the most potential I went into more in-depth research and looked for articles on the online databases.

Findings

Approach 1—Ethanol

Ethanol is an alcohol produced by the fermentation of the grains or seeds of a plant. The most common ingredient used in ethanol production is corn. The production process of ethanol begins with the harvesting of the corn. The kernels of corn are shipped to a plant where they are first ground and then cooked in a large cooker. After the ground corn is cooked, the fermentation process can begin. For fermentation to take place a single celled fungus called yeast is added to the processed corn. The yeast feeds on the starches in the grain and produces alcohol as a by-product. Ethanol is retrieved from the fermentation chamber by distilling the fluid inside the chamber. Then trucks are used to

FIGURE 4–8 Document for Exercise 5

transport the ethanol to consumers. Pipes are not used because ethanol is corrosive and would damage the pipes after a certain amount of time.

The main benefit of producing ethanol is that it is renewable. However, most cars cannot use straight ethanol because it is more corrosive than gasoline. Many times ethanol is mixed with gasoline in different ratios so that regular cars are able to function properly without any corrosive damage. The ethanol/gasoline mixture still emits carbon dioxide, but it is cleaner burning than pure gasoline. Plants absorb carbon dioxide, so the carbon dioxide released by the ethanol is recycled by the plants that are used to produce the ethanol.

Some researchers argue that because of all the farm equipment used to produce the corn and the energy needed by the factory, we use more energy producing ethanol than we get out of it. Mass production of corn also takes a heavy toll on the environment. The fertilizers used on the corn release N_2O, which is a very strong green house gas. Farming only corn also takes essential minerals from the soil and can cause erosion. There are efforts being made to negate these problems by finding new processes that will use the whole plant to produce cellulose ethanol instead of just the corn kernels. Using the whole plant would allow ethanol production to become more efficient. It would also allow us to use different grass species. The use of native grass species would require less fertilization and not damage the soil.

Approach 2—Hydrogen Fuel Cells

Fuel cells are able to convert chemical processes into electricity. The type of fuel cell that is best suited to power a vehicle is called a polymer exchange membrane fuel cell (PEMFC). The main reaction that these cells use is converting Hydrogen and Oxygen into water. There are four main components of the PEMFC and each component has a specific job. First is the anode. The anode captures the electrons that are freed during the reaction. These electrons are used in an external circuit that is able to produce work. It also disperses the Hydrogen evenly over the surface of the catalyst. The catalyst is what helps the reaction take place. For this process the catalyst is usually made of platinum nanoparticles that are thinly spread on a thin carbon sheet. The nanoparticles allow for the highest surface as possible, which increases the reaction rate. Third is the electrolyte or proton exchange membrane. This membrane only conducts positively charged ions, while blocking electrons. A downside is that the membrane must remain hydrated in order to function properly. Last is the cathode, it distributes the Oxygen across the catalyst and conducts the electrons from the outer circuit to complete the reaction of Oxygen and Hydrogen to make water. The overall process has four main steps. First the H2 splits when it contacts the catalyst and releases 2 electrons. These

FIGURE 4-8 *continued*

electrons travel to the anode and through the outer circuit to the cathode. Second the O2 also splits forming two highly negative ions. Third, the O- ions attract the H+ ions and draw them through the membrane. Last the Hydrogen and Oxygen pair up with the electrons from the circuit and form water.

This is complicated, but has some excellent benefits. First is the amount of pollution reduction. The only by-product is water. Second is that the process is said to be 64% efficient compared to 20% efficiency of gas combustion engines. However, since the process is complicated the components are expensive, especially the platinum catalysts. The membranes are also not very durable. They tend to degrade under the conditions of turning on and off your car. Very high or low temperatures are also a problem for the membranes. The membranes must stay hydrated to function and in high temperatures they dry out, while in cold temperatures there is the possibility of freezing. There is also a problem with the fuel. To be able to travel a considerable distance, a lot of hydrogen is needed, and we don't have the technology to compress the hydrogen into a small enough tank. We also have no infrastructure to distribute the hydrogen. Therefore this process may need to wait until we have better technology to utilize the fuel cell's capabilities.

Approach 3—Biodiesel

Biodiesel is a form of diesel that is produced from organic renewable oils like vegetable oils and animal fat. Production from these oils is a benefit because they are non-toxic, biodegradable, and renewable. The process of making biodiesel is a simple process. First the recycled oils or fats are filtered and preprocessed to remove any water or contaminants. The oils and fats are then mixed with an alcohol, usually methanol, and a catalyst like sodium hydroxide or potassium hydroxide. The oil molecules are broken apart and reformed into methyl esters and glycerin. Glycerin is a by-product that can be separated out and used in other industries. The methyl esters become the biodiesel.

Using biodiesel has many advantages. Unlike ethanol which is produced from corn, biodiesel can be created from non-food crops or recycled greases. Soybeans are of the major crops that are used in biodiesel production. The oils are extracted from the soybeans and used to make fuel while the rest of the soybean can still be used for livestock feed or other applications, so nothing is wasted. Algae are another source for biodiesel production. Oils can be extracted from the algae and processed. Algae allow for a renewable resource that grows rapidly and is easy to maintain, so it is an excellent option. Some researchers have found that the biodiesel produced contains 3.2 times the amount of energy it takes to produce. This shows that biodiesel production is

FIGURE 4-8 *continued*

an efficient process. Most diesel engines are already compatible with using biodiesel, so fewer changes need to be made. However, biodiesel still needs to be mixed with petrodiesel in order to get the right viscosity, so cars can't run entirely on biodiesel.

Conclusion

There are many reasons why we must take steps to reduce our dependence on fossil fuels. One of the main reasons is to regain energy independence. If we find an alternative fuel that is efficient and easy to produce, we will lessen our dependence on foreign oil and form a more stable economy and country. The three approaches that I researched are some of the best possibilities. Each one has their pros and cons. Although ethanol is renewable it relies too much on food crops and is not efficient enough yet. More research is needed to produce a more efficient procedure. Fuel cells are also a great idea that have no harmful emissions and are very efficient, but we still don't have the technology to make them practical yet. Therefore the most reliable fuel source is biodiesel. The production of biodiesel is simple and efficient. The renewable resources used are abundant, easy to obtain and aren't specifically food crops. Algae are an especially good resource. They would be cheap and easy to mass produce, yet they would provide enough oil for a processing plant. Biodiesel could have an impact on our fossil fuel consumption in the future.

Citations

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FIGURE 4–8 *continued*