The Essentials of Technical Communication

THIRD EDITION

ELIZABETH TEBEAUX
TEXAS A&M UNIVERSITY

SAM DRAGGA
TEXAS TECH UNIVERSITY

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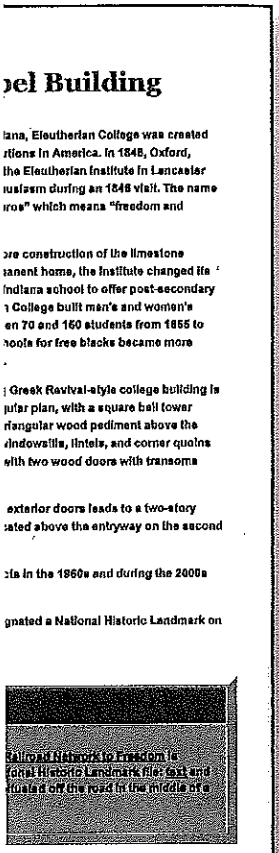

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Technical Reports

Reports, like correspondence—e-mails, texts, memos, and letters, discussed in the previous chapter—remain the most commonly written workplace documents. Reports serve a variety of functions: they provide information, instructions, analysis, conclusions, and recommendations based on analysis.

Given the quantity of information generated and shared in most work environments, getting your report read has become an increasingly critical consideration. In this chapter, we will explain the basics of designing clear and accessible reports that enhance the likelihood of readers' willingness to find out what you have to say.

Quick Tips

None of your readers will read your entire report, unless it's a single page. Different readers will read different sections of your report according to their needs. Almost all of your readers will read the summary: make sure this section exemplifies clarity and conciseness. The busier your reader, particularly those who receive dozens and hundreds of documents daily, the more important directness, clarity, and conciseness become if you want this reader to read your document.

If a report doesn't have a concise, readable summary, readers will flip to the end to find the conclusions. If they can't find those easily, they likely will not read any portion of the report.

Kinds of Reports

Many routine reports provide information, but others go beyond simple reporting. They categorize and then analyze information or data. From the analysis, the writer may evaluate the information, draw conclusions, and perhaps recommend

action based on those conclusions. Analytical reports often defy rigid classification, but for the purpose of learning to write analytical reports, we can generally identify the following types:

- If the analysis focuses on a recommendation, the report may be called a *recommendation report.*
- If the analysis emphasizes evaluation of personnel, data, financial options, or possible solutions to problems or avenues for exploration, the report may be called an *evaluation report.*
- A *feasibility report* analyzes a problem, presents possible solutions to the problem, determines criteria for assessing the solutions, assesses the solutions against the criteria, and then shows the best solution(s) based on the reported analysis of the solutions. The analysis underpins the conclusions and any recommendations. Based on available resources, the writer determines criteria against which possible solutions may be measured and methods of applying criteria and analyzing solutions against criteria selected. Many feasibility reports are long because they represent the way a problem has been defined, studied, and resolved. Results of feasibility studies can lead to major financial expenditures.
- Many reports both inform and analyze: a *progress report* or a *status report,* which we will discuss in Chapter 9. Status reports describe and evaluate the work done on a project, the money expended, and problems encountered.
- A *trip report* documents information gathered on a trip, evaluates this information, and may suggest actions based on findings.
- A *personnel report* describes an employee's performance, analyzes effectiveness, suggests methods of improvement, and estimates the employee's potential for promotion.
- An *economic justification report* explains the cost of a project or action and then argues for the cost-effectiveness of the project.

Report Categories—Informal and Formal

Reports can generally be divided into two categories: informal reports, used for daily internal communications in business organizations, and formal reports, generated for readers outside the organization or for internal use. The two kinds of reports share similarities in structure and major components. They differ principally in length and in format.

Informal Report Heading

Internal reports use a memorandum heading that may include many of the following items. Organizations usually have their own specific requirements for internal reports that use a memo heading. Many organizations have a memo template

available on the intranet. Common elements of memo headings usually include the following:

Date:
To:
From:
Subject:
Reference:
Action Required:
Distribution List:

Subject line. The subject line should state clearly and concisely the content of the report. The clearer the subject line, the better the odds that your readers will read your report. Your subject line should make your readers want to read your report.

Reference. Many reports respond to previously written reports, to company policies, or to items such as engineering specifications and legal issues. Be sure your readers have what they need and understand how your report links to previous reports and documents.

Action required. If you need your reader(s) to respond to your report by a certain date, then say so here. For example, "Your approval needed by 5/10/2012." (See Case 7–1, which shows a memo with an action-required statement.)

Distribution list. This report segment, which can occur at either the beginning or the end of the report, indicates who will receive copies as well as the report's file name for later reference. Be sure to include on this list everyone who should receive a copy. Failing to include all readers can create problems for employees as omitted readers may resent their being eliminated from the communication chain.

Parts of an Informal Technical Report

Introduction. Reports should begin with an introduction, a section that introduces readers to the content covered. For routine memo reports, keep your introduction concise but long enough to ensure that readers understand what they are reading and why they are included on the distribution list. Also remember that a report will be kept in a file (virtual or paper) and will be accessible to readers many months and years after you have written it. The introduction should ensure that all readers understand what follows.

Thus, a memo report introduction should contain the following elements. How much you develop each item will depend on the particular report situation—what you think readers will know.

Richard Harrington

TO: Justin Perry, President
Cambridge State University

Date: June 4, 2012

FROM: Richard Harrington, Professor of Finance
Chair, CSU Marketing Committee

SUBJECT: Marketing CSU—Status Report

Our Backgrounds

The CSU Marketing Committee, formed by Provost Davis in June of 2011, emerged from concerns that many students and their parents who visited our campus knew little about CSU. The committee, composed of parents of CSU graduates and faculty, is grateful for the opportunity to share its views of the university. We solicited input from nearly 300 parents. Based on our combined experiences with CSU, we offer our recommendations, compiled as of now, based on focus groups, surveys, and our own experiences as former students from other universities. Much work remains, and we solicit your suggestions.

Marketing Recommendations

1. Improve CSU's visibility. CSU is the best-kept secret in quality small colleges. In "getting out the word" about CSU, the university needs to know the audiences it wants to reach and their concerns in responding to college advertising.

2. Leverage on the recent *Princeton Review* (*PR*) recognition of CSU. Highlight the features that the *PR* noted.

3. Don't allow what a marketing firm thinks to control marketing decisions. Stakeholders often have valid views based on their experiences, backgrounds, and education.

4. In attempting to build name recognition and prestige, do so on the basis of qualities that CSU offers that other state schools do not offer.

FIGURE 8–1 Effective Informal Report

5. Include, in developing a marketing plan, issues that concern parents, grandparents (who often help with college costs), as well as high school counselors. Businesses should also be a consideration as they will hire CSU graduates and be approached for financial support.

Cost

1. Show how CSU's cost makes it attractive. Discuss the Wallace Scholarships and the amount of money available. Provide comparisons between CSU and your main competitors.

2. Point out that car insurance and the cost-of-living index in our town and county are much lower than those costs in urban areas.

3. Emphasize how teaching, rather than research, provides the foundation of a CSU degree.

4. Discuss how CSU has improved the quality of life for students with the new facilities available to all students: the new student center, the new residence halls, the refurbished dorms and on-campus apartments, and the recreation/exercise facilities. We plan a survey of graduating seniors at the end of every term.

Safety

Note that parents expressed extreme concerns about on-campus safety. They read/listen to news and know that universities, particularly large ones or those in urban areas, do not offer safe havens for students. Point out the low on-campus crime rate at CSU and the low crime rate of Carrington in general. Compare this rate with those in nearby urban areas. These statistics are easy to find and provide a powerful argument for the benefits of a small college community.

Values

We list the following recommendations in no particular order. Different target audiences value each differently, but all seem to us important based on interviews with parents.

1. Parents also want a university that has a culture that supports traditional values and has rules for conduct in its housing and on campus.

continued

FIGURE 8-1 *continued*

2. They also want an environment of zero drug tolerance, where the athletic program has a zero-tolerance policy on drugs and tests athletes regularly.

3. Parents also like a campus that is clean and inviting. On this point, CSU excels. Marketing material for CSU should have effective photos of the campus, particularly areas on either side of the mall. Show trees, flowers, some of the great classrooms, and the integrated campus concept.

4. Parents want a university focused on education as well as career preparation. Discuss student service projects that have required critical thinking.

5. Parents want to know that a degree from CSU will "mean something." Having testimonies from former students who have succeeded will be extremely helpful.

6. Parents want faculty who care about students and demonstrate that concern. Parents also value research that "makes a difference," but they want students placed first. Parents want a college that offers personal development opportunities, such as on-campus leadership development programs and internships. They also want undergraduate research programs for students who seek those opportunities. Discuss faculty whose creative work and research have been recognized. Teachers whose research supports their teaching is also a useful point to highlight.

We look forward to meeting with you and your team during Parents Week in September.

FIGURE 8-1 *continued*

Case 8

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Case 8-1

Matt Lunsford, who has worked in Bradshaw Engineering's fuel analysis and development division for 5 years, recently received an assignment from Jerry Bradshaw, one of the three principals of Bradshaw Engineering, during an office discussion: "Matt, are we moving in the correct direction? This 'sustainability' issue puzzles me: What issues do you see on the horizon? What questions do we need to be asking? What are the main issues BE faces? Write a report and a summary. I think I want to post the summary on the BE website for everyone to read, but I also want a longer report for our management team. Where we go from there I don't know."

Based on the conversation, Matt sees a plan: a well-developed, readable summary for the BE website (Figure 8-2) and then an informal report (Figure 8-3) addressed to Bradshaw with copies to the principal engineers. Both can stand alone. Matt also attaches both documents to a memo of transmittal, as shown in Figure 8-2. Or, as you will see in the example formal report in Appendix C, a report and its summary can be combined. Both documents contain the following items:

short introduction—subject, purpose, and brief rationale
recommendation
conclusion

The report itself contains the

discussion—included in the report
references—Matt cites all sources he uses in his report.

Reports may inform, analyze, recommend, or do some combination. Figure 8-1 does both. Figures 8-2 and 8-3, the response to Case 8-1, informs, analyzes, and recommends. Note that Matt uses mostly nontechnical language as he knows that many employees in the company could read both the summary and the report. When you plan to cover several topics, as Matt does, consider listing the topics you will cover to alert your readers. Examine Matt's summary and the introduction to his report.

TO: Jerry Bradshaw DATE: November 12, 2012

FROM: Matthew Lunsford

SUBJECT: Report on Current Issues in Chemical Engineering: Sustainability

As we discussed in our last staff meeting, employees at BE need to understand the current issues facing chemical engineering, particularly those that affect the definition of our field. In response to your request, I have devoted the past two months to research on the direction that chemical engineering seems to be moving. My goal: to help BE in our decisions about hiring, continuing education, and company development.

In light of the changes in the field of chemical engineering, I recommend (1) that engineers at BE participate in continuing education in the areas of alternative fuels and biotechnology and (2) that BE look to recruit college graduates and engineers who have had education or experience in these areas. Following these recommendations would help BE adapt to changes in the field of chemical engineering and continue offering excellent engineering services.

As you suggested, I have prepared a summary of my report for our company website and a report for you and the BE management team. I look forward to your comments and recommendations.

FIGURE 8-2 Transmittal Memo and Summary

Current Issues in Chemical Engineering: Sustainability

by
Matthew Lunsford

Summary

Report Purpose

The purpose of this report is to inform BE of changes occurring in the field of chemical engineering. This report focuses on sustainability and the technologies that will help move us toward a sustainable future as well as the challenges that chemical engineers still face. Based on the report findings, I close with several recommendations for BE that will help us stay up to date with these emerging technologies.

Research Methods

To gather information and obtain direction for this report, I interviewed Dr. Chen, a professor of chemical engineering at Texas A&M University, and researched the topic of sustainability using databases such as ScienceDirect. These databases were available to me through the Texas A&M library.

The Importance of Sustainability

Sustainability, meeting our needs presently without compromising the ability of future generations to meet their own needs, has become a major issue in chemical engineering. Chemical engineers have shifted from focusing solely on profits to focusing on being profitable within the context of sustainability. Three main realizations have led to this change.

1. The fossil fuels that we currently rely upon for energy and chemical production will eventually run out, leaving future generations without oil and gas.
2. Burning fossil fuels destroys the environment by causing acid rain and possibly contributing to global warming.
3. As the world's population increases and becomes more affluent, the demand for energy and chemicals will increase dramatically.

Possible Solutions and the Chemical Engineer's Role

Renewable energy is a growing source of electricity that will help us move toward a sustainable energy future. Wind, geothermal, hydro, and solar power are

continued

FIGURE 8-2 *continued*

all examples of renewable energy. Renewable energy is attractive because it uses limitless natural resources such as wind, water, sunlight, and heat from the earth to produce energy. The high price of electricity from renewable energy sources is the main obstacle keeping renewable energy from being more widely produced. Engineers can overcome this challenge by developing more efficient equipment for renewable energy production.

Alternative fuels, especially bioethanol, also present a solution to the problem of meeting our energy needs sustainably. Bioethanol producers use a fermentation process to make ethanol from renewable resources such as crops and other plants. Finding a sustainable feedstock for making bioethanol is one challenge involved in ethanol production. Cellulosic biomass, which includes prairie grasses and some trees as well as sewage sludge and municipal waste, appears to be the most sustainable feedstock available. However, the process of producing ethanol from cellulosic biomass is too expensive. Engineers must decrease the cost of production by finding low-cost pretreatments and by optimizing the process.

Another valuable tool that we can use to reach a sustainable future, especially in the chemical industry, is biotechnology. Biotechnology refers to the use of living organisms to accomplish tasks. Some companies are already using microorganisms to create products sustainably and efficiently. Understanding and manipulating complex metabolic pathways is a major challenge that researchers must overcome in this area. Engineers must also receive the education necessary to create, run, and optimize processes involving biotechnology.

Conclusion

Though energy and chemical producers must utilize each of the technologies discussed in order to achieve sustainability, cellulosic ethanol and biotechnology are particularly important and should be the focus of chemical engineering research.

Recommendations

To keep up with the changes in the field of chemical engineering, I recommend that

1. chemical engineers currently employed at BE participate in continuing education in the areas of alternative fuels and biotechnology
2. BE recruit college graduates and experienced professionals that have education or experience with alternative fuels and/or biotechnology

FIGURE 8-2 *continued*

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FIGURE 8-3 Matt's

TO: Jerry Bradshaw **DATE:** October 21, 2013

FROM: Matthew Lunsford

SUBJECT: Issues in Chemical Engineering: Sustainability

DIST: M. Malkin, J. White, K. Gwynne, E. E. Garza, R. Cantu, A. Hairen

Introduction

Over the past 20 years, a growing awareness of our world's limited resources, our environmental impact, and our increasing energy needs has sparked a change in thinking among chemical engineers. Formerly, they focused solely on profits. Now, however, they are placing greater emphasis on preserving our world's resources for future generations. Researchers have coined the term "sustainability" to describe this idea. Sustainability is one of the largest challenges currently facing chemical engineers, and it will continue to be just that for years to come.

This report covers sustainability in the chemical and energy industries and how chemical engineers play a vital role in achieving a sustainable future. I have written this report to keep BE up to date on important developments in the field of chemical engineering. The remainder of this report will (1) discuss the importance of sustainability, (2) highlight solutions that could help move us toward a sustainable future, and (3) close with several conclusions and recommendations that apply to BE.

The Importance of Sustainability

Companies and media often toss the word "sustainability" around, and several valid definitions exist. The most common definition that I encountered during my research is that sustainability is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" [1]. This statement carries the idea that we must be looking ahead to the good of those coming after us as we currently seek to meet our needs, whether they are financial or energy related. Otherwise, our future children and grandchildren may be left without a way to meet their own needs.

A major issue that we must overcome if we want to reach sustainability is meeting our chemical and energy needs with resources that are fully sustainable, ones that will not run out or destroy the earth that we live on [1]. Even major oil

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continued

FIGURE 8–3 Matt's Report

companies such as Exxon, which has invested $600 million in alternative fuels research, are taking notice of this issue [12]. Universities have also changed their chemical engineering curricula to include courses in biotechnology, which can be used in the production of sustainable fuels. For the following reasons, the focus of the chemical engineering field has shifted away from solely profits and toward being profitable within the context of sustainability.

1. One reason is that the resources that we rely heavily upon will run out. Currently, the world meets 80% of its energy needs with fossil fuels such as oil, natural gas, and coal. The chemical industry also relies on these same resources as raw materials. Analysis shows that remaining fuel reserves will last about 40, 60, and 150 years, respectively [2]. So, if current consumption continues without the development of sustainable energy resources, 80% of society's energy needs will be left unmet 150 years down the road. Researchers and engineers must focus their knowledge and skills on developing energy resources and raw materials that will last indefinitely, or future generations will suffer the consequences of energy shortages and a lack of natural resources.
2. Destruction of the environment is a second reason that striving for sustainable energy demands the attention of the chemical engineering field. The fossil fuels that we currently burn for energy release are chemicals that harm the environment. Chemicals such as sulfur oxide (SOx) and nitrogen oxide (NOx) are particularly harmful because they react with water vapor in the atmosphere to form acids. These acids then fall to the earth as acid rain and can harm ecosystems that are sensitive to changes in acidity [1]. These ecosystems include oceans, lakes, rivers, and forests [1]. Electricity generation, residential heating, and industrial energy use contribute about 80% of the SOx emissions, and motor vehicle exhausts contribute about 48% of the NOx emissions [1].

   The burning of gasoline and other fossil fuels also releases carbon dioxide (CO_2) into the atmosphere, which, many scientists suspect, contributes to global warming through a greenhouse gas effect. CO_2 helps to trap heat within the earth's atmosphere, which may be causing temperatures on earth to rise. If this trend continues, temperatures on the earth could rise between 2 and 4 degrees Celsius in the next century, which would cause ocean levels to rise [1]. Rises in ocean levels could flood populated coastal areas and displace agriculture, threatening whole populations [1]. Engineers must find energy resources that do not continue to degrade the environment so that society in the future still has an earth to live on.

FIGURE 8–3 *continued*

3. Finally, engineers must develop sustainable resources that can keep up with increasing demand. By the year 2050, researchers expect the population of the world to double [1]. Along with that, they expect energy demands to grow by 1.5 to 3 times [1]. Large countries such as China and India continue to develop and require more energy for industry and motor vehicles as their populations become wealthier. This ever-increasing demand for energy will put our limited fossil fuel resources under more stress as time goes on. Therefore, the need exists for sustainable energy resources and raw materials for chemicals that will be able to meet this large demand indefinitely.

Therefore, the challenge for chemical engineers is this: develop energy resources and raw materials for chemicals that (1) will not run out, (2) will not destroy the environment, and (3) will meet the demand of an increasingly large and affluent population.

Possible Solutions and the Chemical Engineer's Role

Chemical engineers lead the effort to develop sustainable energy resources and raw materials. One reason for this reality is that researchers have already amassed a large amount of base knowledge on the subject of alternative fuels and renewable resources. Scientists have already discovered the basic principles behind each of the possible solutions that I will discuss [1]. The challenge now is to overcome the economic barriers that keep these solutions from being competitive with the nonrenewable fuels that we currently use [1, 3]. Because researchers cannot easily quantify all of the benefits of using sustainable resources, high costs still keep sustainable resources from being used more widely [2]. Further research is also necessary in some areas, such as in biotechnology. The following paragraphs discuss a few possible solutions to the problem of developing sustainable energy and chemical resources and mention some challenges that engineers must still overcome.

Renewable Energy

Renewable energy is one solution that has and will continue to help move us toward a sustainable energy future. Wind, geothermal, hydro, and solar power all fall into this category of energy production. Renewable energy attracts attention as a solution for a sustainable future because it uses limitless natural resources such as wind, water, sunlight, and heat from the earth to produce energy. Renewable energy is already a growing source of electricity with growth of 60%, 28%, and 13%

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continued

FIGURE 8–3 *continued*

for solar power, wind power, and geothermal power, respectively, between 2000 and 2004 [5]. However, renewable energy still comprised a small portion of the world's total energy production in 2004, as shown in Figure 1.

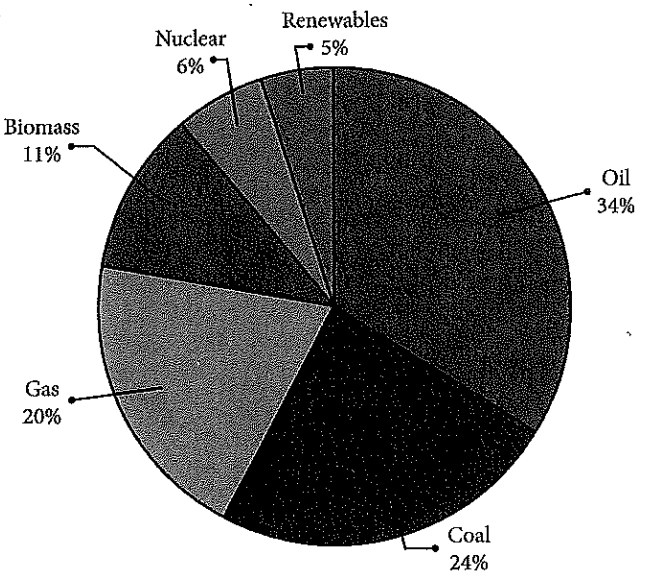

Figure 1 World Energy Supply, 2004
Information taken from Goldemberg [2].

Some sources of renewable energy are more sustainable than others. Wind energy, especially, shows great promise as a major energy contributor for the near future [4]. Though they can be loud and disturb some wildlife, wind turbines have a great upside. They do not pollute the environment, they are relatively efficient compared to some other renewable energy sources, and they produce electricity at a reasonable price [4]. Research shows that wind power is currently the most sustainable form of renewable energy [4].

Some other sources of renewable energy, such as hydropower and geothermal power, come at a higher price to people and to the environment. Damming rivers to produce hydropower often displaces people, animals, and agriculture; and geothermal power plants must carefully process waste water in order to avoid releasing toxic chemicals such as hydrogen sulfide, ammonia, mercury, and arsenic

FIGURE 8-3 *continued*

into the environment [4]. Solar power is the least efficient and most costly of the renewable energy sources listed [4].

Challenges

The main challenge associated with renewable energy is the cost compared to fossil fuels. Currently, electricity from burning coal and gas still costs less than any of the sources of renewable energy, which prevents companies and countries from using renewable energy more widely [4].

Possible Solutions

As engineers make more efficient designs for solar cells and wind turbines and as the renewable energy industry matures and grows, costs of the electricity produced will drop and renewable energy will become more competitive with conventional energy sources. Then, renewable energy will be a more significant contributor to a sustainable energy future.

Alternative Fuels

Though renewable energy will play a part in working toward a sustainable energy future, we cannot rely on it completely. Renewable energy resources such as rivers are not distributed evenly throughout the earth, and places that do not have large amounts of renewable energy resources need other forms of sustainable energy that can be transported to them. Also, the majority of motor vehicles currently use combustible fuels, not electricity, for their energy supply. Therefore, if we want to move toward a sustainable energy future, we must develop sustainable alternative fuels that we can transport and use in motor vehicles. I will focus here on bioethanol because this is the most promising alternative fuel currently being produced.

Bioethanol is a fuel made by fermentation of sugars found in renewable sources such as plants and wastes. Bioethanol producers most commonly use either corn or sugarcane to make ethanol, but sorghum and cellulosic biomass also show promise as ethanol feedstocks. For environmental reasons, researchers see fuels made from plants as a very sustainable option. As shown in Figure 2, biofuels release CO_2 that plants such as corn take in during growth [3]. So, besides fossil fuels burned for feedstock growth and ethanol production, bioethanol does not pollute the environment. Also, because farmers can plant crops year after year, ethanol feedstocks are available indefinitely as opposed to oil, which will eventually run out.

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FIGURE 8–3 *continued*

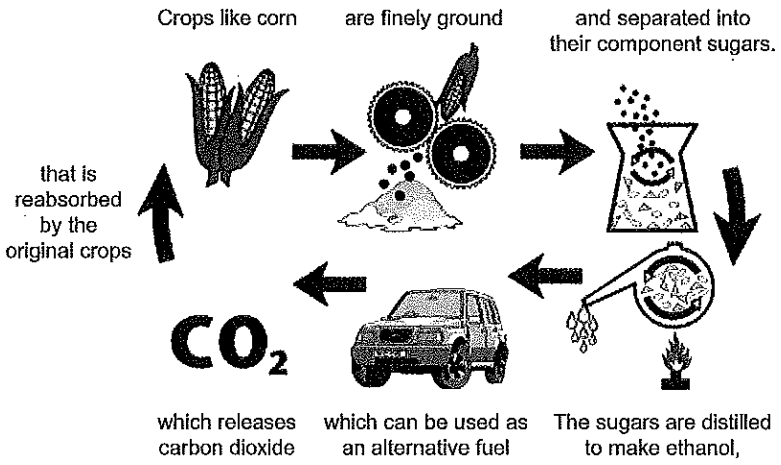

Figure 2 The Carbon Cycle for Bioethanol
Taken from http://www.globalization101.org/biofuels-and-ethanol/.

Challenges

One of the major challenges associated with alternative fuels is finding a feedstock that is sustainable, one that will not destroy the agricultural environment and can keep up with demand. Countries such as the United States use corn as an ethanol feedstock. Corn, however, is not a sustainable feedstock because it degrades soil, cannot keep up with increasing demand, and causes food prices to increase [6, 7]. On the other hand, sugarcane seems to be an attractive and sustainable feedstock. Brazil, which has established a successful ethanol industry that is now independent of government support, uses sugarcane to produce ethanol [2]. The use of sugarcane avoids negative consequences, such as rising food prices and soil degradation, that are inherent in other feedstocks such as corn [2, 6]. However, not all countries have the climate necessary to grow sugarcane.

Another feedstock that will not compete with food or damage soil is cellulosic biomass. Cellulosic biomass includes a wide variety of plants from tree species such as willow, maple, and black locust to grasses like switchgrass and reed canary grass [8]. Wastes such as woodchips, sawdust, municipal residues, and sewage sludge can also be used as cellulosic biomass and made into ethanol [8]. Many researchers view cellulosic biomass as an attractive ethanol feedstock because of its low price and sustainability. But the cost of producing ethanol from cellulosic biomass currently keeps this feedstock from being used on an industrial scale.

FIGURE 8-3 *continued*

For each feedstock the main step in the ethanol production process is very similar. During this step yeast or bacteria take the sugars obtained from the feedstock and produce ethanol in a fermentation process [9]. The key difference between the different raw materials is what occurs before the fermentation step. For grain feedstocks such as corn, ethanol producers must use enzymes, which are biological catalysts, to break down the starches into simple sugars before fermenting [8, 9]. This extra step increases the cost of the process. Cellulosic ethanol requires even one more step. Before breaking down the feedstock into simple sugars, ethanol producers must expose the carbohydrates, which are enclosed by a rigid shell called "lignin," in a step typically called "pretreatment" [9]. This additional step causes cellulosic ethanol to be more expensive to produce than ethanol from other feedstocks.

Possible Solutions

For cellulosic ethanol to be produced and used on an industrial scale, chemical engineering researchers must determine ways to make it competitive economically with petroleum fuels. Decreasing production costs is a way that they can overcome this obstacle [9]. Researchers are currently giving a lot of attention to the pretreatment step as this step comprises almost 40% of the total cost of production [10, 11]. Current pretreatment methods involve chemicals such as sodium or potassium hydroxide, which are too expensive [11]. Other pretreatment methods, such as physically grinding or using steam, either are too expensive or produce yields of carbohydrates that are too low [11]. Possibly viable pretreatment methods include the use of the dilute acids such as sulfuric acid or fungi which degrade the lignin [9]. However, using fungi for pretreatment is typically slow compared to other methods [9].

Chemical engineers have several other options available for decreasing production costs of cellulosic biomass. These options mainly consist of taking techniques currently used in the production of petroleum fuels and applying them to cellulosic ethanol production. Using simulation software to model and optimize the ethanol production process would help ethanol producers make the most ethanol at the lowest cost [10]. This technique is used pervasively in refineries. Another technique that chemical engineers can use to optimize production is heat integration [10]. Engineers are able to conserve energy by taking waste heat from one part of the process and using it to heat up another part of the process through heat exchangers.

Biotechnology

Biotechnology is another powerful tool that chemical engineers can use to work toward a sustainable future. Biotechnology refers to the use of living organisms,

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continued

FIGURE 8-3 *continued*

such as fungi and bacteria, to accomplish tasks. Researchers can genetically modify these microorganisms to produce enzymes which are much more effective than traditional catalysts [3]. Through altering the natural metabolic pathways, researchers can also engineer bacteria that will generate desired products efficiently and from renewable resources [3].

This technology is especially useful in the chemical industry. For example, DuPont uses a genetically altered strain of *E. coli* to produce polymers from corn [3]. Normally this same polymer is made from fossil fuels. Hoffman La Roche also uses a genetically altered strain of bacteria to produce vitamin B_2 [3]. This one-step process replaces an older process that involved six steps, resulting in savings on energy and decreased burning of fossil fuels [3]. Biotechnology has the potential to allow chemical companies to make products from renewable resources and burn less fossil fuel in the process.

As previously stated, ethanol producers also use biotechnology in the form of enzymes and bacteria.

Challenges

The main challenge associated with the use of biotechnology is the complexity of the microorganisms and the need for more knowledge and research. To create a desired product using a microorganism, researchers often have to modify the metabolic pathways of that organism [13]. This process is carried out by modifying the organism's DNA [13]. Therefore, researchers must have in-depth knowledge of the extremely complex metabolic pathways as well as the DNA that governs that pathway. Then, the researcher must know exactly how to alter the DNA so that the desired change in the metabolic pathway takes place.

For the engineer, the main challenge is to gain the knowledge necessary to efficiently run processes that involve biotechnology. Though some of the basic principles are the same for a petrochemical reaction and a reaction involving enzymes, there are also many key differences. For example, while using biotechnology, an engineer must be concerned with not only keeping the microorganisms alive but also with what stage of growth they are in as this can affect what they produce [13]. In a petrochemical plant, chemical engineers have to worry about much different things such as the high temperatures and pressures often used.

Possible Solutions

The need for more research seems to be the limiting factor in the use of biotechnology in the chemical industry. Genetically engineering microorganisms

FIGURE 8-3 *continued*

is a relatively new art. So, if chemical producers want to use biotechnology to make more products efficiently and sustainably, researchers must continue to study and gain knowledge on the metabolic pathways of microorganisms. Then engineers and researchers must develop processes using these microorganisms that can compete with petrochemicals. As the knowledge base grows, researchers will continue to develop strains of bacteria and fungi that can yield products sustainably. This developing technology could be the future face of a sustainable chemical industry.

For engineers to create, run, and optimize processes involving biotechnology, universities must prepare them to face the challenges of this relatively new field. Some universities have already begun to change their degree programs to reflect the move toward biotechnology. For example, the University of California, Berkeley, has changed the name of its chemical engineering department to the Department of Chemical and Biomolecular Engineering [14]. Also, MIT now offers degrees in both chemical engineering and chemical–biological engineering [15]. However, some universities, such as Texas A&M University, require very few biology-type courses in their undergraduate chemical engineering programs. Universities must continue to expand undergraduate education in bioengineering if engineers are going to be prepared to work in the changing chemical industry.

Conclusion

Despite posing a large challenge, sustainability in the energy and chemical industries seems to be a realistic future. No one technology, however, will bring us there. Energy and chemical producers must make use of a wide variety of options including renewable energy, alternative fuels, and biotechnology. As these technologies mature and develop, industry will call on chemical engineers to develop more efficient designs, processes, and microorganisms that will make sustainable energy and chemicals more competitive with those produced from fossil fuels.

Cellulosic ethanol and biotechnology are especially promising. Ethanol producers could potentially supplant much of the fossil fuel–derived energy resources with sustainable fuels. And biotechnology gives the chemical industry the opportunity to produce chemicals that are also made from renewable resources. These technologies are very important and should be the focus as we move toward a sustainable future, one where the needs of future generations will not be threatened.

9

continued

FIGURE 8–3 *continued*

Recommendations

In light of the changes that are occurring in the field of chemical engineering, I recommend that (1) chemical engineers currently employed at BE participate in continuing education in the areas of alternative fuels and biotechnology and (2) BE recruit college graduates and professionals who have education or experience with alternative fuels and/or biotechnology. These measures will ensure that BE can offer the highest-quality services to our clients who have needs in these developing areas.

FIGURE 8-3 *continued*

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energy 31, no. 6

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no. 12 (2007): 24

FIGURE 8-3 *continued*

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11

continued

FIGURE 8–3 *continued*

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FIGURE 8–3 *continued*

Case 8-2

Remember that reports differ, depending on topic, audience(s), and purpose. For example, Case 8-2 shows how the chair of the Academics Committee of a State University writes a report to the president of the University Senate. The goal is to explain to the president the activities of the committee during the previous year. The University Senate president has asked the head of each Senate committee for a report on the previous year's activities. Katheryn attempts to make the report readable by using clearly worded headings and concise descriptive information under each heading.

Note that she gives the main point in the first sentence and provides a succinct opening introduction/summary. She chunks the report itself into segments introduced by clearly worded headings. Coffman can read those that interest him.

This represents perhaps the most common type of routine report. The writer designs it to inform quickly and concisely.

TO: Michael Coffman DATE: June 9, 2011

FROM: Katheryn Rios

SUBJECT: Academic Committee and List of Concerns

The AC has not had significant business this year because of the ongoing financial stresses on the university. However, among the list of topics presented here, several need consideration by the full Senate. I call AC meetings when a meeting seems needed. Some of our business can be conducted by e-mail, and I have used that method, which works better for members who are out of town.

Should the University Switch to Plus/Minus Grading?

The AC prepared a memo for members to deliver to their college deans. We received little response and certainly no consensus for implementing this system. Liberal Arts expressed interest. In short, +/− grading would work well in some colleges but not in all. Our computing system could handle this feature, but our CIO did not want to assess the cost for programming unless more than one college wanted this change.

Student Evaluations of Teaching

- **Online or Paper?**

No consensus emerged for moving to one system, even though the university Teaching Committee would prefer having to maintain only one system.

Faculty who want to have their students use the online system evaluation have trouble getting their students to respond. Paper evaluations seem to provide the most complete number of responses.

- **What Will Happen to Student Teaching Evaluations?**

Two years ago, the University Senate approved a streamlined group of questions that contained five questions required for all college teaching evaluations. Each college could choose an additional 15 questions. This method would allow comparison among colleges.

The AC then recommended that all evaluations require TWO questions: (1) was this an effective teacher? and (2) was this a good course? Still no action from the Council of Deans.

FIGURE 8–4 Example Internal Report

Extension of the Withdrawal Deadline from 50 to 60 Days

Request for this change came from the Student Senate. James Cornyn and I prepared an e-mail that went to advisors. Few responded. Thus, we phoned as many departments as we could. Results: Only departments which have few majors thought the deadline "might" be extended. The undergraduate dean opposed the idea, along with advisors from several large departments. Thus, this item was rejected.

Containing Textbook Costs

Helena Stone and I worked with Charlene Bangor on the bookstore contract. We never saw the final contract. Our concern: the 30% markup on books is too high, and that markup is added to the publisher's suggested price.

The AC approved an e-mail that was sent to the colleges for distribution to departments. It asked that faculty consider the cost of books required and the rationale for books required. The Student Senate reported that many required books are never used in classes. The library also has a website for posting class material.

The E-Book, Book Rental option continues to grow. The AC just voted to send this e-mail every term to notify faculty of this option.

University Rule on Shortened Courses

The AC approved the rule I devised with help from the registrar's staff. Karan offered an amendment (see attachment, p. 4), which clarifies the approval process. I will send this to the AC for their input/approval.

Students Connecting Through Service

This plan, which would be launched before our reaccreditation, was approved by the AC this spring. We do not know what it means, other than that it should broaden students' learning experiences. I sent an e-mail to the major service organizations, and four have responded positively thus far. The premed society and the dean want to work with local physicians on the importance of inoculations. The AC will have a report from the premed society at its next meeting.

Assessing Academic Advisors

The Student Senate has requested that academic advisors be evaluated. I responded to that request by stating that several questions would have to be clarified that deal with logistics: cost, number of advisors and which ones, procedure, method, and reports.

continued

FIGURE 8–4 *continued*

Recommendations for the Next Faculty Senate Discussion

1. Review of Status of Preparation for Reaccreditation

   What do faculty need to know about the coming reaccreditation visit?
   What is the status of recommendations from the Stephens report?
   What will happen with the core curriculum after courses we approve are sent to the state?

2. Discuss Ways to Control/Lessen Textbook Costs

   Do faculty consider costs when they select books?

FIGURE 8–4 *continued*

Elements of Formal Reports

Long reports should be developed as formal reports. The word *long* generally means 10 pages or more; but as a writer, you have to decide based on the report context. Writers should select elements to help readers find their way through the report. The longer the report and the more diverse the readership, the more elements will be required to help readers find what they need. Each element has a different purpose and often targets the needs of different readers. Reports are not novels: most reports will not be read cover to cover but selectively.

In general, formal reports may include any or all of the following elements. How these elements appear in practice differs widely and depends on the organization preparing the report. We will describe the general characteristics and content of each element and provide several examples. Most organizations develop report templates to fit the content most often generated.

- Prefatory Elements
  - Letter of Transmittal or Memo of Transmittal
  - Title Page
  - Submission Page
  - Table of Contents
  - List of Illustrations
  - Glossary and List of Symbols
- Abstracts and Summaries
  - Informative Abstract
  - Descriptive Abstract
  - Executive Summary
- Discussion, or Body of the Report
  - Conclusion(s)
  - Recommendation(s)
  - References
- Appendices

Prefatory elements. Readers initially access a report from the prefatory elements. These show readers what your report will discuss and how it will approach the topic. Long, complex reports that will likely be read by many readers require prefatory elements. The letter/memo of transmittal, title page, table of contents, abstract, and/or summary are often your reader's first—and only—experience with the report. Each of these elements should help your readers grasp and accept the rhetorical purpose of the report. Never consider prefatory elements routine "paperwork" needing only perfunctory writing. No matter how well written and researched the report content, the effectiveness of the report begins with the effectiveness of the elements that state the content. Many readers may decide to read the body of the report if they find the prefatory elements compelling.

Letter/memo of transmittal. The letter/memo of transmittal is addressed to the individual who will initially receive the report. This person may not be the

primary reader but the individual responsible for routing the report to appropriate readers who will digest and use the content. In consulting reports, the CEO of an organization that has solicited the consulting work is usually the person addressed in the letter of transmittal. Or the transmittal letter can address the person who has authorized and requested the information, analysis, work, or recommendations covered in the report.

Reports prepared for internal distribution will have a memo of transmittal, and reports prepared for external distribution will use a letter of transmittal. Both can be organized the same way.

The letter/memo of transmittal should include the following information at minimum:

- Statement of transmittal—subject and purpose of the report
- Reason for the report

In addition, transmittal documents may include the following items:

- Background material—the larger issue or problem addressed by the report
- Mention of earlier reports (or additional reports that may be needed)
- Information that may be of special interest or significance to the readers
- Specific conclusions/recommendations that might be of special interest to the person to whom the report is addressed
- Financial implications
- Acknowledgments—list of those who provided help in the project

Both Case 8–1 and 1–1 include a transmittal memo. The sample formal report in Appendix C includes a transmittal letter.

Title page. Title pages perform several functions. Basically, they provide critical identifying matter and may contain a number of identifying items to distinguish the report from others on a similar subject or from reports received in response to specific projects. Many organizations have a standard format for title pages. Whatever items you need—or your organization requires you to include—be sure to make the title page attractive. The following information often appears on title pages:

- Name of the company or individual(s) preparing the report, perhaps with his or her signature
- Name of the company or course for which the report was prepared
- Title and subtitle of the report
- Date of submission
- Code number of the report
- Contract numbers under which the work was performed
- Company or agency logo
- Proprietary and security notices
- Names of contact/responsible individuals
- Descriptive abstract

Submission page. Reports may use a submission page, which includes the list of contributors to the report and/or the names and signatures of the authorizing officer or project leader. Submission pages emphasize the point we make throughout this

book: reports require accountability. Signatures on a submission page indicate that the authors stand behind the content. The submission page usually either precedes the title page or follows it. Or the title page and submission page may be combined.

Table of contents. The table of contents performs at least three major functions. First, it indicates the page on which each major topic begins and thus serves as a locating device for readers who may be searching for specific information. Second, it forecasts the extent and nature of the topical coverage and suggests the logic of the arrangement and the relationship among the report parts. The table of contents contains all major headings used in the report. For that reason, major headings, like the title of the report, should reflect the content of the material that follows. Skimming a table of contents should give readers a clear idea of the topics covered, the content presented under each heading, the amount of coverage devoted to that topic, the development of the report, and the progression of information. (See the table of contents in the report in Appendix C.) While you may wish to use "introduction," "conclusion," and "recommendations," avoid the term "discussion": it tells your reader nothing about how you will present the report content. Third, the table of contents should reflect the rhetorical purpose of your report—what you want your readers to know and why your report is important to them.

List of illustrations. If a report contains tables, graphics, drawings, photos—any type of visual—it's customary to use the page heading "Illustrations" or "Exhibits" to list all the visuals. These are usually divided into "tables" and "figures," but specific types may also be listed if you have an array of illustrations: for example, maps, financial statements, photographs, charts, and computer programs.

Glossary and list of symbols. Reports dealing with specialized subject matter often include abbreviations, acronyms, symbols, and terms not known to readers outside a specialized group. Readership should determine if a glossary or list of symbols is needed. Many reports prepared by government agencies for the general public provide glossaries to ensure that any reader can assess the report.

Glossaries sometimes appear as prefatory elements, but they can also appear in an appendix at the end of the report. When you first use a symbol or a term that you will include in the glossary, tell your reader where to find the list or the glossary. You may wish to place an asterisk (*) by a word or symbol that will be covered in the glossary. If you have only a few terms that you will need to define, you can define these as footnotes at the bottom of the page and use asterisks (* or **) to alert your readers.

Abstracts and summaries. Abstracts and summaries are the most important prefatory items in a report. The title page, table of contents, abstract, and summary may be the only parts of the report many recipients read. Thus, carefully plan these elements as each provides a slightly different perspective. While the title page and table of contents outline the report's content and direction, abstracts and summaries provide the essence of the report: topic, purpose, results, conclusions, and recommendations. Each item can stand alone or be designed in conjunction with other prefatory elements, but the wording of the table of contents should echo throughout an abstract or summary. These elements, when well designed, enable readers to quickly find a specific segment in the body of the report.

Often, the abstract follows or appears on the title page. Summaries may also follow the title page. While abstracts and summaries contain similar information, summaries usually provide more extensive information than abstracts and may be written for decision makers whose needs differ from those of readers who want only the essence of a report. (See the table of contents and the summary in Appendix C.)

Abstracts fall into two categories, informative or descriptive. Abstracts, often accompanied by keywords, are prepared for use in online indexes and databases. Keywords allow your report, if it is stored in a database, to be retrieved. Thus, you should think carefully about the keywords that characterize the content of your report. What words will your readers most likely use in a database search? Abstracts with keywords may be separated from the report but linked to the full report. Based on the information in the abstract, readers can decide if they need to move to the full report.

Differences in abstracts have tended to disappear, and some abstracts have the characteristics of both traditional informative and descriptive styles. Organizations and journals usually have specific requirements for abstracts and may require, for example, a short descriptive abstract on the title page and an informative abstract after the table of contents.

Because the quantity of information that bombards readers increases, well-written abstracts have become critical to report access. The abstract should explain the purpose of the report, findings, conclusions, and recommendations—anything of significance. Because many readers now use abstract services, they may read only your abstract, or they may decide to retrieve/order your complete report if the abstract clearly shows the relevance of the content and key points.

A good way to plan an abstract is to create a file that contains the names of its main parts:

Subject/Purpose
Methods
Findings or Results
Conclusion(s)
Recommendation(s)

Next, insert information under each heading. When you complete your abstract, you can remove the headings. Be sure to check the length of the abstract; publications rarely want abstracts longer than 100 to 150 words. This method allows you to track length easily. However, some publications want the headings included in the abstract. The example abstract (Figure 8–5) contains these items. Color helps you see each item.

Informative abstract. This type of abstract includes the research objectives, research methods used, and findings, including principal results and conclusions. Recommendations may also be included. Informative abstracts usually range from 50 to 500 words, depending on the length of the report and on the requirements of the disseminating organization and of the abstracting service. Informative abstracts help readers decide if they want or need to access the entire report for more thorough examination. They begin with a statement of the report's purpose, and the remaining sentences give major highlights and conclusions.

Chemical (Chlor
Hay to Prevent F

Keywords: chlor
hay bale

Abstract: This re
to the soil area u
Solenopsis invicta
Specifically, we w
stored in fire ant
rier treatments w
on contact, and
which can also a
plots, with a 10ft
Plots were group
randomly assign
four treated with
spraying a 12ft ×
formulation. Afte
a side and interlo
sampled for fire
one bait card wa
sults from ANO
treatments. Stack
compared to the
only one stack ir
ants, while none
three weeks all f
two stacks in the
short-term basis;
treatment option

Ronald D. Weeks
pyrifos and Perm
Ant Infestations,
Imported Fire A
2000–2002, Texa

http://fireant.ta
#stackedbales.

FIGURE 8–5 Inform

Chemical (Chlorpyrifos and Permethrin) Treatments Around Stacked Bales of Hay to Prevent Fire Ant Infestations

Keywords: chlorpyrifos, permethrin, Lorsban 4E, Astro Insecticide, fire ant, hay bale

Abstract: This research evaluated the efficacy of using a chemical barrier applied to the soil area under stacked bales of hay to prevent the red imported fire ant, *Solenopsis invicta* Buren (Hymenoptera: Formicidae), from infesting stacked hay. Specifically, we were interested in determining if we could protect "clean" hay bales stored in fire ant infested fields for up to several weeks. Chemicals selected as barrier treatments were Lorsban® 4E, active ingredient chlorpyrifos, which kills ants on contact, and Astro™ Insecticide, active ingredient the pyrethroid permethrin, which can also act as a repellent to ants. We established a series of 12ft × 12ft plots, with a 10ft buffer between plots along a fence row in a fire ant infested field. Plots were grouped into four blocks of three stacks each. Plots within blocks were randomly assigned to each treatment (four plots treated with Lorsban® 4E and four treated with Astro™ Insecticide, and four control plots). Treatments included spraying a 12ft × 12ft soil area with a 1-gal solution of each chemical and water formulation. After soil treatments, we placed four square-bales of hay, stacked two a side and interlocking in two layers, in the center of each plot. Stacked bales were sampled for fire ant infestation using 2.5 × 2.5cm olive oil–soaked index cards; one bait card was placed on each side of the top layer of hay in each stack. Results from ANOVA show a significant difference in mean infestation levels among treatments. Stacks of hay sitting in the chlorpyrifos plots had fewer ant infestations compared to the permethrin and control plots. Results after one week showed that only one stack in the permethrin and two in the control plots were infested with ants, while none in the chlorpyrifos plots were infested. Results show that after three weeks all four control stacks, three stacks in the permethrin treatment, and two stacks in the chlorpyrifos plots were infested. These results indicate that on a short-term basis, such as 1 to 7 days, chlorpyrifos may be an effective short-term treatment option for protecting stacked hay from fire ant infestations.

Ronald D. Weeks, Jr., Michael E. Heimer, and Bastiaan M. Drees, Chemical (Chlorpyrifos and Permethrin) Treatments Around Stacked Bales of Hay to Prevent Fire Ant Infestations, Texas Imported Fire Ant Research & Management Project, Red Imported Fire Ant Management Applied Research and Demonstration Reports, 2000–2002, Texas Cooperative Extension Service.

http://fireant.tamu.edu/research/arr/year/00-02/2000-2002ResDemHbk.htm#stackedbales.

FIGURE 8-5 Informative Abstract

Descriptive abstract. This type of abstract states what topics the full report contains. Unlike informative abstracts, descriptive abstracts cannot serve as a substitute for the report itself. They begin with the report purpose and then explain content areas or topics covered in the report. Figure 8–6, a descriptive abstract, comes from a transportation report on rail accidents. See also the descriptive abstract on the title page of the sample report in Appendix C.

Executive summaries. Major reports often include executive summaries, which contain all of the items listed at the beginning of this chapter. However, unlike summaries for routine reports, executive summaries provide extensive development of each information segment to provide decision makers the information they need without having to read or search the full report. An example of an executive summary can be seen in the report for a state study on shrub control on rangeland (Figure 8–7). Even though you know nothing about this project, the executive summary will provide you with extensive information. In many proposals, the summary often determines whether the proposal itself will be read.

Discussion, or body of the report. The main part of the report, the discussion, takes most of the writer's development time. The information to be reported constitutes the discussion. The discussion will explain in detail—information

Section 403 of the Rail Safety Improvement Act of 2008 (RSIA) requires the Secretary of Transportation to conduct a study of the track inspection process. This report describes a study conducted by the Federal Railroad Administration (FRA), on behalf of the Secretary, in response to the requirement in Section 403 of the RSIA. To successfully fulfill this congressional mandate, FRA believed it was necessary to obtain a "snapshot" of the current track inspection process. A survey of a random sample of actively working track inspectors, as well as interviews with labor union officials and various levels of railroad management, provided the necessary information. FRA also compiled data related to track defects identified by FRA track inspectors over a 4-year period (2006–2009). This data provides an indication of the most prevalent defects as well as those that industry track inspectors fail to identify. In addition to the collection of survey data, interview data, and FRA track defect data, an ideal observer model was constructed for visual track inspection. The ideal observer model provides a theoretical upper limit, based on previously compiled empirical data, on how well the best possible observer can perform.

Source: Time Inspection Track Study, US Department of Transportation, Federal Railroad Administration, Office of Railroad Policy and Development, Washington, DC, July 2011.

FIGURE 8–6 Descriptive Abstract

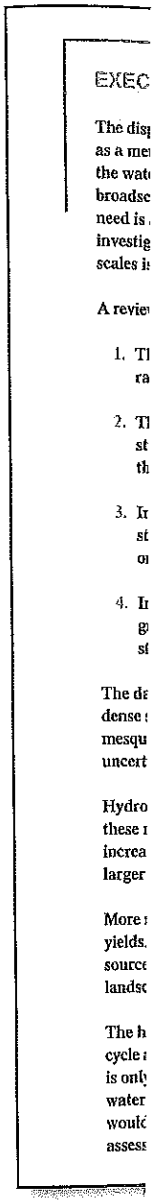

FIGURE 8–7

appropriate
report was
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EXECUTIVE SUMMARY

The disparity between the supply and demand for water in Texas has focused attention on brush control as a method for increasing the water supply for Texans. This review (1) summarizes how shrubs affect the water cycle at the tree, hillslope, small catchment, and landscape scales and (2) examines whether broadscale reductions in woody plant cover might increase the water supply. The greatest information need is at the landscape scale, but research at this scale is costly and difficult. Hence, most field investigations have focused on the tree or hillslope scales. However, extrapolating these data to larger scales is problematic because hydrological processes may change as the scale increases.

A review of the scientific literature has allowed the authors to make the following broad generalizations:

1. The relationship between shrub removal and increased water yields becomes stronger as annual rainfall increases.
2. The linkage between shrub removal and increased water yields is weaker in upland areas and stronger in areas adjacent to stream channels, where shrubs may be using shallow groundwater that is hydrologically connected to stream flow.
3. In upland areas, the linkage between removal of woody plants and increased water yield is stronger where water can move rapidly through the soil or parent material to recharge springs or shallow aquifers.
4. In areas where there is little subsurface water movement and woody plants are not accessing groundwater, shrub control is unlikely to significantly affect either groundwater recharge or stream flow.

The data suggest that water can be salvaged by controlling dense stands of saltcedar in riparian zones, dense stands of Ashe juniper in areas with rapid subsurface flow (e.g., where springs are present), and mesquite on soils that develop deep cracks when dry. However, in each case there is considerable uncertainty with respect to the amount of water that can be salvaged and the fate of the salvaged water.

Hydrologic models have predicted substantial increases in water yields following shrub control, but these results must be used with caution. There is a threefold variation in the predicted water yield increases from different models, and in some cases the predicted increases are at least three times larger than the measured values.

More research is needed to fully understand the extent to which shrub control can increase water yields. Key gaps include community-level evapotranspiration studies, isotope studies to determine the sources of water used by shrubs, groundwater–surface water connections, nested watershed studies, and landscape scale studies on saltcedar in various habitat types.

The hydrological condition of Texas watersheds and the partitioning of water within the hydrological cycle are determined by complex interactions between soils, vegetation, and climate. Brush encroachment is only one change that has affected the health of Texas watersheds—droughts, excessive grazing, water impoundments, urbanization, and water transfers also have altered the hydrological cycle. It would be valuable to shift the debate away from a focus on brush control and water yields to a broader assessment of best management practices for improving watershed health and sustainability.

FIGURE 8-7 Executive Summary

appropriate to the context, the readers, and the purpose of the report—why the report was done, its objectives, methods, findings, results, analysis of results, conclusions emerging from results, and recommendations for dealing with the results. The discussion is the heart of the report: without it, effective summaries and abstracts could not be written. All conclusions and recommendations derive from the discussion. Stated another way, the presentation of information

in the discussion allows the report writer to draw conclusions and perhaps recommendations. In short, the discussion must support all conclusions and recommendations.

The discussion can also stand alone, as Matt's does in Figure 8–3. Because the report discussion begins with an introduction, including an explanation of the approach used in developing the report, the discussion is complete in itself. Many discussions end with a factual summary, a concise narrative of the report's main findings.

Ironically, however, the main discussion is the report segment read least. While most readers will look at the summary, abstracts, and table of contents, few will actually delve into the discussion. Nevertheless, the discussion becomes the source, foundation, and documentation for every statement written in the abstract and summary. Your conclusions need to evolve from the discussion. Recommendations need to evolve from the discussion and the conclusions. In a sense, then, the discussion develops as a narrative that comes to a conclusion.

Many readers may need to read parts of the discussion carefully. They will read the introduction, check the table of contents, skip to relevant sections that interest them, and then move to the conclusion or factual summary that pulls together the main results or ideas.

Parts of the discussion. The main body of the report generally begins with an introduction (or introduction + summary) that forecasts what is to follow in the report. It directs the reader's mind to the subject and purpose. It tells the reader how to approach the content by explaining the scope of the report, the plan of development, and any additional information the reader may need. Examine the introduction from a report for the US Department of Transportation (Figure 8–8). Note that it presents the topic, the rationale, and the development plan for the report. Because of the length of the introduction, the writer partitions the parts of the introduction with headings. Also examine the introduction to the sample report in Appendix C.

Note that the introduction should always include the report subject, purpose, and plan of development. Some reports place the background and the scope in separate sections that follow the introduction, if these two items are extensive. What you include in the introduction depends on your readers. If your readers will expect your report, you can write a short introduction. However, if your report will be archived and read later by people who know little about the context, you will need to provide a longer, more informative introduction (see Figure 8–9). Avoid long introductions: focus on the subject and purpose in terms that explain the relevance of the report to readers. But do anticipate your readers—who will read this report and when—as you plan the introduction. Without a proper introduction, readers will have difficulty following the main discussion.

Collecting and grouping information. As you gather information, try grouping your material and notes into specific categories. Label these categories, and then begin your report. You may want to develop your report according to major

1. Introduction

1.1 Purpose

The Federal Railroad Administration (FRA) continues to develop tools for managing fatigue in railroad operations. A previous report established a statistically reliable relationship between train crew performance effectiveness (inverse of fatigue) and the risk of an HFs accident (Hursh et al., 2006, 2008). The purpose of the current report was to use the data from the FRA database of railroad incidents, augmented by work schedules for the train crew involved, to investigate the relationship between the economic impact (cost) of an incident and the estimated fatigue of the train crew at the time when the incident occurred.

1.2 Background

In 2006, the FRA completed the third phase of a research program to demonstrate a method to validate and calibrate fatigue models for use in predicting and managing fatigue in railroad workers. A fatigue model offers the possibility of objectively assessing and forecasting fatigue so that employees and employers can schedule work and rest to avoid fatigue. A useful fatigue model needs to be calibrated to the demands of a particular job so that the measures from the model can be related to the risk of meaningful failures of human performance. One important part of calibration of a fatigue model for use as a fatigue management tool is an assessment of whether the tool can predict an increased risk of an HFs error or risk of having an HF-caused accident. As part of this assessment, FRA sponsored a project, in partnership with the five Class I freight rail carriers, to examine 2.5 years of data on accidents.

1.3 Scope

This report describes an extension of analyses performed for the FRA that investigated the relationship between accident cost and estimated crew impaired effectiveness from fatigue. The original effort developed estimates of train crew performance effectiveness using the Sleep, Activity, Fatigue, and Task Effectiveness (SAFTE) fatigue model implemented in the Fatigue Avoidance Scheduling Tool (FAST).[1] These estimates were then used to estimate accident risk based on crew member estimated effectiveness at the time of accidents, and to compare risk between accidents with HFs-related causes and those whose causes were not HFs-related. The work described herein extends that analysis to investigate the relationship of HFs-related accident (HF-related accidents) cost to estimated train crew effectiveness.

Source: Analysis of the Relationship Between Operator Effectiveness Measures and Economic Impacts of Rail Accidents, US Department of Transportation, Federal Railroad Administration, Office of Railroad Policy and Development, Office of Safety, Washington, DC, May 2011.

FIGURE 8–8 Report Introduction

sections—introduction, followed by the topics or categories. Open and name the file and begin. For example:

- Introduction: state the purpose of your report—what you expect to accomplish, what you want your reader(s) to know. You can add information later. Stating your purpose at the beginning of the draft helps you stay focused.
- Category/topic 1: phrase describing the issue you want to present
- Category/topic 2: etc.
- Category/topic 3: etc.

Next, begin inserting information under each topic or subject category. Focus initially on inserting information that pertains to the topic heading.

This method helps employees who may be trying to work on a report, answer phone calls, answer/send e-mail, and deal with other routine business events throughout the workday. In short, you can arrange, insert material, save what you have, and add other material as time permits. You may also write notes to yourself or use different colors and fonts for text you may want to move, delete, or revise. How you design your report will depend on (1) the kind of report you are writing, (2) your readers' informational needs, and (3) the purpose of your report. Introductions should be as short as possible while providing readers with the information they need to understand the report.

Strategy for presenting the discussion. The discussion should be planned around each topic mentioned in the plan of development. Note that the logic of the discussion should be evident from the headings as these are repeated in the table of contents.

Each paragraph in the discussion should begin with a topic sentence, followed by supporting sentences, data, and visuals.

Reports with standard arrangement patterns. Some kinds of reports have fairly standard arrangement patterns. Many government funding agencies require that all reports submitted follow a specific plan, and content may be inserted into a template and submitted online. Many organizations also have a standard plan

Wind Power in the United States: Technology, Economic, and Policy Issues

Introduction

Rising energy prices and concern over greenhouse gas emissions have focused congressional attention on energy alternatives, including wind power. Although wind power currently provides only a small fraction of US energy needs, it has grown more rapidly than any other electricity source. Wind energy already plays a significant role in several European nations, and countries like China and India continue to rapidly expand their capacity both to manufacture wind turbines and to integrate wind power into their electricity grids.

This report describes utility-scale wind power issues in the United States. We partition the report into the following sections:

- Background on wind energy
- Wind resources and technology
- Industry composition and trends
- Wind power economics
- Policy issues

FIGURE 8–9 Standard (and Readable) Report Introduction

for their policies—what sections to include and the order in which they appear. Policy and procedure manuals, detailing the rules that apply to the employees of a business entity, usually follow a standard pattern.

Often, however, as in Case 8–2, you will need to write a report in which you, as the writer, must decide how to present your research or the information you need to convey. Generally, you have two basic choices: topical arrangement and chronological arrangement.

Topical arrangement. In topical arrangement, the order in which you present your ideas should be logical and inclusive. For example, in a report on disease management of citrus fruit, the writer arranges the report by grouping information about specific citrus diseases. He describes, in parallel arrangement, the main diseases:

Introduction—Description of treatments for citrus diseases
Disease #1—Melanose
  Description
  Factors to be considered before the application of fungicides for melanose control
    Table I. Chemical controls for melanose
Disease #2—Greasy Spot
  Description
  Factors to be considered in the management of greasy spot
    Table II. Chemical controls for greasy spot
Disease #3—Foot Rot
  Description
  Factors to consider in managing the disease
    Table III. Chemical controls for foot rot
Disease #4—Citrus Nematode
  Description
  Sampling instructions to determine presence of citrus nematode
    Table IV. Citrus nematode counts considered low, medium, or high at specific times during the growing season
Conclusion: Factors to consider before applying nematicides
  Table V. Chemical controls for nematodes (summary)

Once the citrus researcher has arranged his information, he can begin inserting information beneath each topic heading.

Chronological arrangement. Some topics can be presented by time. You explain or present information sequentially, in the order in which it occurred. The following outline of a literature review, *Cultural Control of the Boll Weevil—A Four Season Approach—Texas Rolling Plains*, illustrates chronological arrangement. This technical report surveys and reviews existing research on how boll weevils can be controlled throughout the agricultural year. Note, too, that the segments use parallel development, and each segment ends with a summary of that segment. This approach allows the reader to choose where to begin and how much to read. For

example, the reader may wish to read only the Summary and Introduction and the factual summary for each season:

- Summary
- Introduction
- Spring Cultural Control
  - Prepare the land for planting
  - Utilize delayed planting
  - Use uniform planting
  - Summary
- Summer Cultural Control
  - Shorten the growing season
  - Change the microclimate
    - Row direction
    - Bed shape
    - Row spacing
  - Summary
- Fall Cultural Control
  - Utilize harvest-aid chemicals
  - Role of planting date
  - Terminate irrigations in August
  - Summary
- Winter Cultural Control
  - Eliminate the overwintering habitat
  - Modify the overwintering habitat
  - Avoid the overwintering habitat
  - Summary
- Conclusions
- Acknowledgments
- Supporting Research Studies

Persuasive arrangement and development. Many times reports argue for a specific point or position. When you argue, you need to persuade your readers. Understanding what objections you will need to overcome will be critical to planning your report and the presentation of your arguments. Reports that must produce conclusions and recommendations may require writers to develop documents in which the conclusions and recommendations are not what readers will welcome. Or these reports may be prepared for readers who have no preconceived ideas. In each situation, the report can be designed to anticipate the perspective of readers.

Case 8-3

Allan Harper was asked to visit a research facility that his firm has discovered is likely going to be for sale soon. Dick Crandall, the vice president for operations, asks Allan to provide a brief overview on the usability of the building as a corporate training facility. Allan visits the building, takes notes of major usability features that he knows will interest Dick, and writes a brief report for the vice president, known for wanting only important facts and recommendations. Allan begins with a simple report purpose statement, followed by a bulleted list of the facility's features of interest to Dick. Allan uses notes to himself (in color) as he drafts. He concludes with a brief recommendation of what he believes should be done if Dick thinks the building should be purchased. The report responds to the information needs and reading (skimming) style of a specific reader who wants "the facts."

CASE DOCUMENT 8-3

TO: Dick Crandall DATE: October 9, 2014

FROM: Allan Harper

SUBJECT: Space Assessment of RAMP, 6004 Highway 7

As you requested, I toured the RAMP research facility during my trip to Atlanta October 4–8, 2014. Based on your questions about using the facility for corporate training, I have concluded the following:

Conclusions

- RAMP offers us the space we need and appears to be in excellent condition. Modifications will be necessary, but those required can be done in stages. We can focus on Building 1, then renovate Buildings 2 and 3 as we want to. The RAMP is composed of two main buildings and one small building (Buildings 1, 2, and 2A on the attached site map).
- Each small office has two Internet connections. The main lecture hall has one Internet connection and no projection equipment. [Check on price of wireless for the entire building. DC will probably want to know ASAP.]
- The current RAMP buildings are divided into offices for start-up projects. Some of the RAMP income is derived from the space leased by small start-up companies. Cost: $22/sq. foot. [Is this price low/high?] [Call Dave Redding about laboratory contracts. Cheryl Kempe has his phone number.]

continued

- The debt on RAMP is slightly over $12M with approximately $5M due in April of 2012. (See p. 4 of the Notes to Consolidated Financial Statements.) [Get current balance owed from Fiscal. Perhaps delete for now? Call Debbie in Fiscal.]
- For us to use RAMP for training, instead of research, the entire first floor of Building 1 would need to be redesigned. We could relocate some of the start-up companies to Buildings 2 and 2A, which would preserve the income.
- An attached sketch shows how renovation of the first floor of Building 1 might look. Note:
  Eight office sites for trainers
  Two computer labs
  Five training rooms—two with breakout rooms off the main area
  One tiered lecture room

Conversion could be made gradually, depending on how many training rooms are needed ASAP. The attached sketch, included along with the original plan, shows one redesign plan.

Assessment of the RAMP Building

- The facility seems to be in good repair. Maintenance seems to be satisfactory. I found no indication of leaks.
- HVAC system needs to be inspected.
- Wireless capability could be easily installed in the main lecture room. ~~The proposed computer laboratories, carved from 12 offices, offer 24 Internet connections.~~
- New projection equipment needs to be purchased. [Cost?]
- Main lecture hall could be converted into a tiered lecture room. The two rooms on either side of the lecture hall could be eliminated to further expand the main lecture hall. The kitchen would have to be moved or eliminated—perhaps moved to Building 2.
- Renovation costs will be high, close to $1M (according to rough estimates by Gavin Newberry—see attached e-mail answer to my query) even if only the first floor of Building 1 is refurbished. Current office furniture is usable, but new furniture, IAV equipment, and computers would need to be purchased for training and meeting rooms. Closets/storage would have to be added to all training rooms. Floor coverings would need to be replaced.
- Location—RAMP is easily accessible from three main arteries.
- Estimated remodeling time: 4 months.

Attachments: 3

Let's assume, for example, that Harper believes the RAMP building should be seriously considered, while Crandall has decided to purchase another site. Crandall told Harper to visit RAMP, but he never expected that RAMP would be another site consideration. To respond to this situation, Harper might begin his report as follows:

> As you requested, I toured the RAMP research facility during my trip to Atlanta October 4–8, 2014. Based on my findings, I believe that you should seriously consider the RAMP facility as the site for our CE operation. RAMP offers us what we need in terms of space and location. Renovation costs can be done in stages to reduce cost, and the facility offers us the space and arrangement we need.

In short, the reader's perspective often determines how persuasive you need to be if you want your ideas considered.

Conclusion(s). Reports end with a statement of the primary issues covered in the discussion. In long reports, a factual summary comes after the discussion and before the conclusions and recommendations. The factual summary does what its name implies: it covers the essential facts but without interpretation. (Interpretation of the factual summary is done in the executive summary.) The longer the discussion, the more useful a factual summary will be to the reader who actually reads the body of the report. The conclusions themselves provide judgments about the subject based on the evidence explained in the discussion.

Recommendations. Recommendations, if required or needed, emerge from conclusions. However, many reports end with only a conclusion. The type of ending depends on the type of report. Recommendations are proposed actions to be taken based on the conclusions.

Appendices. Appendices include documents that support or add to information you include in the discussion. While the appendix may not be read, it serves an important role. An appendix may contain tables of supporting data, statistical studies, spreadsheets, or any material that supports the points or arguments you make in your discussion. If your report recommends an action, having letters or e-mails requesting that action in the appendix provides convincing support for your recommendation.

Letter Reports

Reports can be prepared as letters. See Figure 8–10, prepared by an engineer at Bradshaw Engineering, who has been asked to explain the differences in corn and sugar ethanol to undergraduate engineering students at Texas A&M. Note the purpose statement and the plan of the report, in addition to the short summary statement. The effective document design allows her report to be read quickly.

BRADSHAW ENGINEERING, LLC
2104 RIVERSHIRE PLACE
HOUSTON, TX 77036

February 18, 2013

Dr. Jim Freeman
P.O. Box 3998
MSC Station
College Station, TX 77834

SUBJECT: Advantages and Disadvantages of Ethanol from Brazilian Sugar

Dear Jim:

Introduction

I was interested in your questions about ethanol and Brazilian sugar, which you introduced during your class last week. Mr. Bradshaw suggested that you might like to share the following information with your engineering interns.

With a growing demand for ethanol in the United States, producers are finding new, cheaper crops to convert to ethanol. Corn remains the major source of ethanol production in the United States. Recent discoveries find ethanol from sorghum in China and sugarcane in Brazil to decrease the overall demand for corn-based ethanol because of their advantages. This letter examines the advantages and disadvantages of Brazilian sugarcane–based ethanol from an economic, social, and environmental perspective.

Economic Impact

Brazilian Sugar Is Cheaper and More Effective

For the past two years, prices for sugar have steadily decreased because of a global surplus in production.[1] Because of a large demand for ethanol, both in Brazil and globally, ethanol prices are much higher than raw sugar prices. This pushes Brazilian millers to focus more on producing sugar-based ethanol, helping them make a profit faster. A larger supply of ethanol from sugar creates an economic competition with corn ethanol.

FIGURE 8–10 Letter Report

If prices of corn ethanol remain higher, more consumers will prefer to use sugar ethanol. McKenna also argues that the use of corn ethanol is inefficient. In 2007, 27% of all the corn grown in the United States was dedicated to ethanol production.[2] Even if all the corn was dedicated to ethanol production, he states, gasoline usage would only reduce by 15%.[2] The same reduction of gasoline usage could also be achieved with increasing fuel efficiency by 3.5 miles per gallon.

Increase in Food Prices

The increase of corn prices has greatly affected the food industry as well. A chain reaction began when prices of corn increased because many consumers depend on corn to make a variety of foods. Corn is often used to make animal feedstock, so if these prices increase, so will the price of meat. The prices of other common corn-based foods can increase as well, such as cornmeal, tortillas, corn bread, and many more. A recent drought at the end of 2012 kept the price of corn high.[3] High corn prices cause many farmers to lose their businesses.

Using sugarcane-based ethanol can also have adverse effects on the price of raw sugar products, too. The graph in Figure 1 shows the increase of food prices in fats and oils, grains, and other foods (sugar, citrus, bananas, shrimp, and meats).

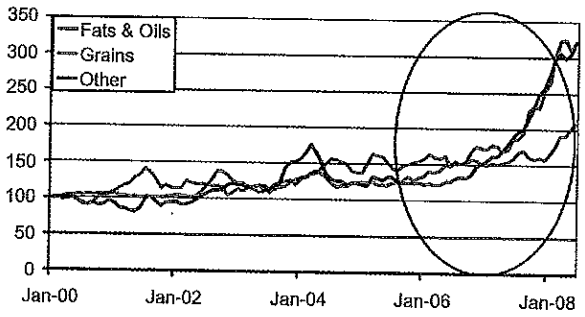

Figure 1 Trend in Food Prices from 2000 to 2008[4]
(Nominal $ Index, Jan 2000 = 100, world export value weights)

Social Impact

Tension with the Indigenous Brazilian People

The mass production of sugarcane in Brazil currently presents a problem to its society. Most sugarcane plantations in Brazil are located on land reserved for the indigenous people, the Guarani. These people hold little power with the Brazilian

continued

FIGURE 8-10 *continued*

government. Because of Brazil's increasing profit from exporting sugar-based ethanol, sugarcane millers are free to extend their plantations as they please, forcing the Guarani out of their homes and off their land.[5]

The Guarani have no other choice but to work on the plantations under horrible conditions and low wages. To decrease the negative social aspect of sugarcane production in Brazil, the landowners "need to be held accountable" and respect the rights of the local people. [4]

Jobs Created for the Uneducated

Despite tension with indigenous peoples in Brazil, sugarcane production has created a large workforce for the uneducated population. Table 1 lists a few demographics of people with various jobs in Brazil. Based on the table, the people working with sugarcane crops have the lowest education. Clearly, many people work in this industry relative to the number of people in other job positions.

Table 1 List of Demographics for Various Jobs in Brazil[6]

Statistic	Sugar Cane Crops	Sugar	Ethanol	Food and Beverages	Fuels
People (× 1,000)	789.4	126.0	67.0	1,507.0	104.7
Mean Age (years)	35.1	36.6	35.6	34.4	37.1
Mean Education (years)	2.9	6.5	7.3	7.1	8.9
Mean Income	446.6	821.3	849.9	575.0	1,281.1

Environmental Impact

Ethanol in the Carbon Cycle

Both sources of ethanol have an equal environmental benefit. By converting any kind of biomass to fuel, the carbon dioxide (CO_2) absorbed by plants (such as corn and sugarcane) is released again into the atmosphere. Because CO_2 is constantly removed from and replaced to the atmosphere, burning bioethanol resembles the

FIGURE 8-10 *continued*

carbon cycle. Unlike bioethanol, burning gasoline simply adds CO_2 to the atmosphere without initially removing it.

Reduction of Greenhouse Gases

The production, distribution, and consumption of ethanol create nearly 20% less greenhouse gases than the same process used for gasoline.[7] However, if an increased demand for cropland leads to the clearing of large forests or grasslands, ethanol would be useless. Forests and grasslands naturally absorb most of the atmospheric CO_2, and depleting this would greatly increase the amount of atmospheric oxygen even with the use of ethanol rather than gasoline.

Sincerely,

Tasmin Mohamed

Tasmin Mohamed, P.E.

Attach: Sources

continued

FIGURE 8-10 *continued*

ATTACHMENT

Sources

1. Almeida, Isis. "Brazil Ethanol Above Sugar Shows Mills May Favor Biofuel." *Bloomberg BusinessWeek* 2013. http://www.businessweek.com/news/2013-02-11/brazil-ethanol-topping-sugar-signals-millers-may-favor-biofuel.
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FIGURE 8–10 *continued*

Example Report for Study

An example report appears in Appendix C. Two additional annotated reports can be found on the book's website: **www.oup.com/us/tebeaux.**

Writing Collaboratively

In the workplace, you may need to write reports, instructions, and letters on your own and as part of a team. Collaborative writing occurs in numerous ways that continue to evolve as technology evolves: you may draft a document or part of a document and then submit it, as an e-mail attachment, to several additional employees who will contribute information to your draft. Each writer may suggest changes to others' work by using a comment tool, such as that found in most word processing programs. Team members establish a website on the company intranet and post material that can then be viewed, revised by all team members, and then discussed via the company intranet.

A team member may establish a wiki on the organization's server—never the Internet because of security issues. On the intranet wiki, everyone on the team can contribute information and help "build" the document. The group may then use one or more interactive audio/video calls to discuss the material, particularly if contributors cannot meet face to face.

Team members often cannot collaborate in "real time" because of other work responsibilities. Wikis and other forms of virtual collaboration allow teams to work more flexibly but could also raise questions about information security.

> **Warning:** As we discussed in Chapter 1, the need for security of an organization's intellectual property cannot be underestimated. Hackers can destroy an organization by stealing intellectual property, trade secrets, contracts, and personnel information. The networking software students use in school cannot offer the security needed by business and research organizations. If used carelessly, social media can ruin lives, businesses, and reputations. Think carefully and cautiously before you use social media for any message.

The secret to effective collaboration is planning:

- Deciding who will do what
- Deciding how to meet the completion time and planning the work schedule for each document segment
- Learning to work together. When people from different countries and cultures collaborate, the need for sensitivity to cultural differences is critical.

- Ensuring one member will assume the task of editing the document to make sure the style shows consistency throughout

The team leader. Collaborative projects must have a team leader. This person may be the project manager or someone appointed. This person will convene meetings, virtual or on-site, and serve as facilitator to keep the project moving. In addition, the team leader

- ensures that all team members know their tasks
- launches the effort and provides everyone with the document requirements (purpose, audiences, rationale), format, timetable for completion, and methods of communicating about the document (see Figure 8–11)
- monitors development so that the report is completed as required
- ensures that the completed document has a single style throughout and contains all information and required segments

Requirements of team leaders. Team leaders, in either face-to-face or virtual settings, need to employ a few fundamental strategies:

- Maintain a positive approach
- Be aware of how you sound; be respectful
- Solicit input
- Encourage timely responses from everyone
- Keep records of all communications

After each draft, the team leader should encourage, as time permits, comments by each team member. The "comment" tool in doc or pdf files allows each team member to recommend changes and assess the effectiveness of the document.

Project name	
Goals	
Team members	
Responsibilities	
Deliverables	
Timeline	
Meetings	
Initial outline	

FIGURE 8–11 Collaborative Team Planning Sheet

Requirements

- Keep the sch
an issue tha
immediately.
- Be respectful
other team
when you fe
- Do your par
team membe
the quality o

REPORT

Planning

☐ What is th
☐ What is th
☐ Who are y
☐ What will
☐ What infor
☐ How long
☐ What form
☐ What repo
☐ What visu
☐ What elem
☐ What arra

Revision

☐ Does your
Introd
Preser
drawn
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Draw
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data a
☐ Are your
☐ Do your v
☐ Is your for
☐ Have you

Requirements of team members.

- Keep the schedule as determined by the project leader. If you find you have an issue that threatens your keeping the schedule, notify the team leader immediately.
- Be respectful and accept comments, recommendations, and suggestions from other team members and the project leader. Exhibit a good attitude, even when you feel stressed.
- Do your part of the project. Do not assume that if you get behind, another team member can do your work. The quality of the team project stems from the quality of the work performed by the entire team.

REPORT CHECKLIST ☑

Planning

- ☐ What is the purpose of your report? Have you stated it in one sentence?
- ☐ What is the scope of your report?
- ☐ Who are your readers? What are your readers' technical levels?
- ☐ What will your readers do with the information?
- ☐ What information will you need to write the report?
- ☐ How long should the report be?
- ☐ What format should you use for the report?
- ☐ What report elements will you need?
- ☐ What visuals will you need to present information or data?
- ☐ What elements do you need to include in your introduction?
- ☐ What arrangement will you use in presenting your report?

Revision

- ☐ Does your report do the following:
  - Introduce the subject and purpose?
  - Present enough data in words and visuals to justify any conclusions drawn?
  - Discuss and evaluate the data fairly?
  - Summarize the data?
  - Draw logical conclusions from the data?
  - If necessary, present recommendations that are clearly based on the data and the conclusions?
- ☐ Are your data accurate?
- ☐ Do your visuals immediately show what they are designed to show?
- ☐ Is your format suitable for your content, audience, and purpose?
- ☐ Have you properly documented all information sources?

Exercises

1. Visit the website of a major employer in your field. What kinds of reports do you find at this site? What are the elements and characteristics of the reports? How long are the reports? Who are the audiences for the reports? What are the purposes of the reports? Are the reports written by a single author or multiple authors? What do the reports indicate about this employer? What do the reports indicate about your field? How would you prepare to write a report like one of these?

2. Visit the website of the National Transportation Safety Board (www.ntsb.gov) to examine each of its six kinds of accident reports (aviation, hazardous materials, highway, marine, pipeline, and railroad). Describe the elements of the reports. How would you describe the writing style of the reports? What kinds of illustrations do you find integrated into the reports? Do the reports offer satisfactory descriptions of the accidents? Do the reports offer clear and convincing evidence of the causes of accidents? Do the reports make a persuasive case for changes in practices or materials to improve safety?