PART FOUR

COMMUNICATION

CHAPTERS

CHAPTER 17: WRITTEN AND ORAL COMMUNICATION IN DESIGN

Chapter outline

- Similarities between design process and writing process
- Designing your communication deliverables
- Writing to explain decisions and conclusions
- Comparing major written and oral deliverables

As Atila Ertas and Jesse C. Jones emphasize in *The Engineering Design Process* (1996), "[E]ngineers market their skill through the ability to communicate" (p. 470). Without that skill, engineers are shut out of decision-making and, worse, career advancement:

> Important communications are transmitted in writing so that the meaning can be precisely stated and a record can be established for future reference. Employees that are incapable of preparing clear and understandable written communications tend to be relegated to passive roles in this process. They become information receivers and not information generators and thus gradually find themselves out of the mainstream, out of touch with what is going on, and out of mind when raises and promotions are given (p. 470).

Engineers need to be proficient in the following types of communication:

- Written: reports, proposals, memos, emails, instructions, meeting minutes
- Oral: meetings, design reviews, final presentations
- Visual: sketches, drawings, tables, graphs, charts, posters, slides
- Mathematical: equations, statistical analyses
- Interpersonal: team meetings, client meetings, user and expert interviews

Engineers often use several kinds of communication at a time: They support oral presentations with written slides, which may contain drawings, tables,

and other visual elements. They write reports using mathematical elements such as statistical analysis of test data, which may be illustrated by visual elements such as tables and graphs. They use written agendas to organize team meetings, where they focus on sketches of design ideas.

In communicating, engineers use a variety of media: paper, email, electronic files, fax, telephone, video, projectors, etc. Each medium imposes specific requirements on engineers as they shape what they want to communicate.

This chapter provides an overview of how to think about communication not only in EDC but in your career as an engineer.

17.1 SIMILARITIES BETWEEN DESIGN PROCESS AND WRITING PROCESS

This textbook contains several chapters on written communication because it is the most commonly used form of communicating among engineers. Writing provides a formal record of your work, allows you to communicate with multiple readers, serves as a reference for those who will continue your work, and permits people to review your ideas at their convenience.

Engineers write a lot of short, quick messages to arrange meetings, ask or answer questions, request support from a supervisor, and so on. To be effective, these communiqués need to be clear, complete, well-edited, and respectful.

As an engineer, you also will write more complex documents, such as research reports, progress reports, and proposals. Developing these longer pieces mirrors the design process because, in most cases, you're designing a document:

Table 17.1: Comparing the design and communication process

Designers:	Writers:
Gather information	Gather information
Define the problem	Define the audience, purpose, and main point of the document.
Generate alternatives	Explore different ways to organize material and develop a persuasive argument
Make mockups	Write rough drafts
Gather user feedback	Get feedback from readers
Improve the design and iterate the process (make more mockups, get more feedback)	Revise and rewrite

As you can see, both writing and design are iterative and recursive. For example, after writing a rough draft you may need to gather more information in order to write a clear, persuasive revision, which your peers and supervisors will review before it is delivered in its final form.

Writing is particularly important in EDC. Not only does EDC serve to fulfill the McCormick writing requirement; it is also the place where you are introduced to all the functions of writing within the design process. In EDC, you will do a range of writing:

Table 17.2: Types of writing in EDC

Reports	Progress reports Final project reports
Project documentation	Project definition Meeting minutes
Presentations	PowerPoint presentations Posters
Correspondence	Emails
Essays	Analytical Persuasive

You may wonder at some point if all this writing is necessary. In short, it is: The writing you do in EDC is part of good design practice, as evidenced in the table above. Designers routinely document their meetings and designs, write reports, prepare persuasive documents, and send correspondence. EDC essays, although not part of design practice, give you an opportunity to analyze and critique designs that you see and use each day—and thus to reflect on design while you get help and instruction in individual writing.

17.2 DESIGNING YOUR COMMUNICATION DELIVERABLES

The sole purpose of business and technical writing is to communicate to get work done. The best way to do this efficiently and effectively is not to think about rules but to think about writing as a problem to solve. To solve any communication problem, you need to keep in mind these four elements:

Audience: Who will be reading your writing? What does your audience already know? What do they need to know? What questions will be on their mind? What decisions will your document help them to make?

Purpose: What do you want your audience to do or know after reading the document? What does your audience expect the document to help them understand or do?

Content: What do you need to say to accomplish that purpose? What is the best way to organize what you will say?

Tone: How do you need to sound to accomplish your purpose? Formal or informal? Assertive or questioning?

Beginning writers of engineering documents tend to think only about content. They also think there's a template for every writing situation. But experienced writers think about strategy, consciously or unconsciously using a tool like the "communication square" below to help them plan everything they write.

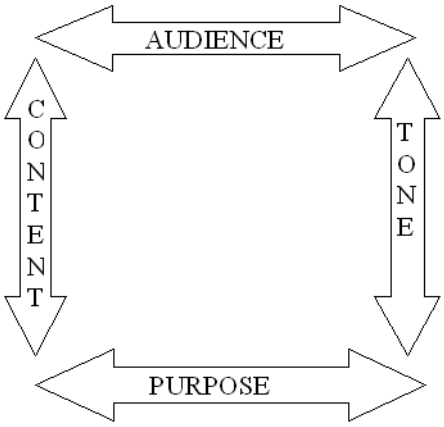

Figure 17.1: The communication square

In addition, experienced writers think about the genre (type of document) and the communication technology (phone, fax, email, written document, etc.) they will need. Below is a more detailed explanation of the key elements in the "communication square."

17.2.1 Audience

Researchers have found that "the audiences with whom engineers engage are many and complex. Engineers speak to other engineers, to clients, to government agencies and to support staff. Some of those audiences have technical background and others do not" (Darling & Dannels, 2003, p. 13). The researchers conclude that because audiences for communication are so diverse, "engineers probably need a dozen different ways to state and clarify any individual idea or piece of technical communication."

Typically, in EDC you will write documents for the following diverse audiences:

- Client: emails, interview guides, reports, PowerPoint slides, poster
- Users: interview guides, observation guides, instructions, emails
- Instructors: progress reports, final report, emails, design essays

- Teammates: meeting minutes, emails
- Classmates: PowerPoint slides, design review questionnaires
- Experts: emails, interview guides
- Interested members of the community: posters

Sometimes you will need to tailor a document to reach multiple audiences at the same time. For instance, your poster should communicate effectively to your client, who knows a great deal about your project, as well as to a visitor who has never heard about it before. Similarly, although the main audience for your final report is your client and instructors, it also may be read by those less familiar with project details: other people in the client's organization, an outside contractor who will build your design, and future EDC teams working on a continuation of the project.

17.2.2 Purpose

Just as important as defining your audience is focusing on what you're trying to accomplish when you communicate. In EDC you will use your writing to:

- Inform: Telling readers what you have learned, done, or decided is the major purpose of progress reports to your instructors, email updates to clients, and meeting minutes to teammates.
- Persuade: The project report written at the end of EDC is intended to persuade your client and instructors that you have followed the design process thoughtfully and that your design solves the problem. You will also write emails to clients to persuade them that you thoroughly understand the problem at hand.
- Instruct: In user testing guides, you need to explain to users how to perform the tasks associated with your mockups. In your final report you will include an appendix with instructions on constructing your prototype.
- Request: You may write an email to an expert or potential user to request an interview or more information.

Sometimes documents have multiple purposes. A progress report, for example, might be written primarily to inform your instructors of the research that led to your design concept, but it also may be used to persuade them of your wisdom in choosing that concept. Likewise, your final report is intended not only to persuade clients to accept your design but to inform them of your research.

Also, keep in mind what your readers expect from a particular document. For example, your instructors want your progress report to tell them the main things you've learned and decided regarding your project. Therefore, you need to select the data that best illustrate and support these expectations and organize the data so your instructors can easily find the important results.

One final point: State the purpose of your document in the first paragraph, or by the end of your introduction, so readers know immediately what to expect from it.

17.2.3 Content

Determining your purpose and audience will help you decide what content to include in your document. For example, if you are writing to ask your instructors to extend your deadline on a progress report, you know your purpose and audience, so you can imagine what your instructors will want to know. They will be convinced to grant your request only if they understand the reason for the extension—succinctly stated—and the date on which you will submit the report. You can also briefly reassure them that you are otherwise on top of the project.

As you plan your content, it's also important to ask yourself organizational questions such as: How do I want to structure the document? Do my main headings accurately reflect the categories I've chosen? How should I start and finish? Which points do I want to emphasize and what details do I need to support them?

17.2.4 Tone

The tone of your document tells readers something important about you and thus can enhance or undercut your purpose. Readers will have a very different reaction to your communication depending on whether they see you as respectful or arrogant, serious or frivolous. The email below, from a student team to a client, illustrates a serious problem with tone:

Example 17.1: Ineffective tone in an email

> hey, sue,
>
> we can't make it to the meeting at 2, so we'll be there at 3 insted. we need the list of user fone numbers from you at that time. see you at 3. Jason.

Jason didn't intend to antagonize his client, although that would be the likely result of this inappropriate email. By using incorrect punctuation and grammar, and making assumptions about his client's willingness to reschedule, he comes across as flippant and demanding. Here's a more appropriate version:

Example 17.2: Effective tone in an email

Dear Ms. McRea,

I am writing on behalf of EDC Section 14, Team 2 (the adaptive crochet hook). I would like to find out if we could change our meeting time on January 31 from 2 p.m. to 3 p.m. because we have just learned that we are required to attend a chemistry review session that doesn't end until 2:45 p.m.

The purpose of the meeting, as you recall, is to discuss user testing and to get from you the list of users' phone numbers. If you are unable to meet at 3 p.m., would you be able to discuss the user testing plan over the phone earlier or later in the day (10 a.m. to noon, 3 to 5 p.m.)? Also, if it is more convenient, you could email us the list of user phone numbers. Alternatively, one of our team members would be glad to come to your office later this week. In that case, please send a list of available days and times.

I apologize for having to reschedule our meeting. I look forward to hearing from you about setting up one of the alternatives listed above.

Yours,

Jason Firth

Jason's tone is polite, considerate, and positive, and it demonstrates concern for the client's needs. This is the correct level of formality to use in an email to clients or users even if they have invited you to call them by their first name. You can never go wrong by being polite and respectful.

Another common problem with tone occurs with the use of "we," which can give your document a self-congratulatory tone, as in this introduction to a final report.

Example 17.3: Ineffective tone in a report

We have designed a device that enables stroke survivors with the use of only one hand to crochet. We found that people who had enjoyed crocheting before their stroke wanted to be able to continue their hobby. So we did extensive research to understand the problem and arrive at our solution. We interviewed experts and brainstormed many ideas. We narrowed these down to a few alternatives, which we then mocked up. We took these mockups to users and learned a great deal from our user testing. This enabled us to design and build our final prototype, which we are very proud of.

Since these writers are overusing the personal pronoun "we," their client is likely to get the idea that the team is more interested in themselves than in her

need for a successful design. Here's a revision that emphasizes the design instead of the team:

Example 17.4: Effective tone in a report

> Strokes often can cause people to lose the use of one hand, making them unable to enjoy activities and hobbies that had been important to them. Our client, Susan McRea of the Rehabilitation Institute of Chicago, found that patients who had enjoyed crocheting before their stroke wanted to be able to continue their hobby. This report describes our team's solution to this problem. The design is based on extensive research, including interviews with experts, various design alternatives, and user testing of mockups. This research led us to a final prototype that enables users to crochet easily and comfortably

The lesson here is to make sure you use the appropriate tone to support your purpose.

17.3 WRITING TO EXPLAIN DECISIONS AND CONCLUSIONS

Many students mistakenly view the writing done by engineers as merely the recording and delivery of information. They believe that the information speaks for itself. However, as Dorothy Winsor (1996), a researcher on technical communication, explains, "As study after study has shown,…data seldom or never speak for themselves…[D]ata are almost always used rhetorically. They are one of the means by which engineers convince one another that their vision of reality is the correct one" (p. 32). In writing your reports, you must present information clearly and convincingly in order to explain conclusions and decisions that you have reached concerning your design.

In the following example—a progress report written by a team designing a wheelchair ramp—the team is reporting to their instructors on their preliminary research on materials (Conroy, Linsenmeier, Taam & Willson). They have reached a preliminary decision to use aluminum. In the rough draft, they simply list the data, expecting that their instructors will understand how they reached that decision:

Example 17.5: Unclear presentation of data to support a decision

> We considered the following materials for the ramp and have tentatively decided to use aluminum.
>
> Wood
>
> Cost: 12'=$800
>
> Douglas fir, southern pine, and redwood are commonly used

Must be weather-resistant, decay-resistant, stiff, strong, and shrink-resistant

Pressure-treated wood has preservative chemicals that prevent decay

Must be constructed using nails, screws, bolts, and metal framing connectors

Dangers: Joints and connections can rot or degrade due to normal wear and tear.

Concrete

Strong, water- and fire-resistant

Cost: 12'=$2,000

Can be cast into any shape

Permanent solution

Load capacity = 2,000 lbs.

Galvanized steel

Cost: 12' = $1,200

Designed for permanent and semi-permanent ramps

Load capacity = 1,500 lbs.

Exceeds ADA specifications for non-skid surfaces

Aluminum

Load capacity = 800 lbs, well within ADA guidelines.

Alternative to galvanized steel

Lightweight, which allows for simple pin connections

Cost: 12' = $1,000

Confronted with all this information, the team's instructors found it difficult to figure out why the team had decided on aluminum. Since facts do not speak for themselves, writers need to help readers draw the correct conclusions from the facts. If the writers do this kind of work—explaining the facts—then their writing will be easier to read and also more persuasive.

The team revised their presentation by clearly stating the decision, the rationale, and the supporting facts. Some facts are not relevant to their decision, for instance the types of wood that are used for ramps. So the team has focused on the relevant facts and has organized them clearly so the instructors can understand how they relate to the project requirements. The team also moved the complete list of materials and specifications to an appendix.

Example 17.6: Clear presentation of data to support a decision

The most common materials for ramps are wood, concrete, galvanized steel, and aluminum. Based on the three major client requirements, we have made a preliminary decision to use aluminum:

Portability: The client's most important requirement is that the ramp be portable so that it can be easily removed and stored during the

extended periods when it is not needed. Aluminum is the lightest of the four materials and can be fitted with simple pin connections that allow for easy assembly and disassembly.

Cost: While wood is cheaper than aluminum ($800 vs. $1,000 per 12'), the total cost for aluminum is well within the client's budget of $5,000 for a 30' ramp. Also, in a wood ramp, the joints and connections can rot or degrade due to normal wear and tear; thus, maintenance costs would increase the overall cost of a wood ramp.

Safety: Concrete and galvanized steel have a much higher load capacity than aluminum (2,000 lbs, 1,500 lbs, and 800 lbs., respectively). However, the load capacity of aluminum is well within ADA guidelines. Galvanized steel exceeds ADA specifications for non-skid surfaces, so we will need to research whether a suitable non-skid surface can be added to an aluminum ramp without exceeding the client's budget.

See Appendix D for complete specifications of the four possible ramp materials.

Note that in explaining the decision, the team does not misrepresent or ignore contrary data. For instance, they acknowledge that galvanized steel has an advantage in safety. So in using data to support decisions and conclusions, you have an ethical and professional obligation to present all the relevant information and its relationship to your main point.

Another team's project was to design a low-cost solar water heater for use in the Dominican Republic (Millea, Nieman, Suszko & Wroblewski). They performed testing with their final prototype to confirm that it heated water within the required specifications. However, in reporting on those tests in a progress report to instructors, they did not explain how the data supported the conclusion that their design is successful:

Example 17.7: Unclear presentation of data to support a conclusion

We conducted two tests with our prototype to confirm the effectiveness of our design:

Test 1 description:

Weather condition: sunny, no clouds

- Rubber hose: 875 ml
- Start Time: 9:40 a.m.
- Start H2O Temp.: 61°F
- Start Ground Temp.: 27°C
- Start Air Temp.: 63°F
- End Time: 11:30 p.m.
- Total Test Time: 1 hr., 50 min.

- End Ground Temp.: 29°C
- End Air Temp.: 69°F
- End H2O Temp.: 132°F
- ΔT: 68°F

Test 2 description

- Weather condition: sunny, no clouds
- Rubber hose: 875 ml
- Start Time: 12:30 p.m.
- Start H2O Temp.: 62°C
- Start Ground Temp.: 26°C
- Start Air Temp.: 64°F
- End Time: 2:30 p.m.
- Total Test Time: 2 hrs.
- End Ground Temp.: 32°C
- End Air Temp.: 71°F
- End H2O Temp.: 134°F
- ΔT: 72°F

As in the case of the wheelchair ramp report, the instructors had great difficulty interpreting the data and picking out the key points. In the revised report, the team not only presented the data but also explained how the data confirmed their design's effectiveness. Below is the explanation that they added to the two test descriptions:

Example 17.8: Clear presentation of data to support a conclusion

> We conducted two tests with our prototype to confirm the effectiveness of our design. As the data below indicate, the prototype operated within required specifications, which were to be able to heat water to a temperature of at least 120°F within two hours at an air temperature of around 60°F. We tested the prototype both in the morning and early afternoon for two hours to determine whether the angle of the sun affected the results; the air temperatures were 63°F and 64°F, respectively. In both cases, the water temperature increased approximately 70°F to just over 130°F.

In much of the writing you will do in EDC and, later, as an engineer, you will need to present research results to readers so that they can make use of it, whether to track your progress, offer advice, or make a decision. Not only will they be better served if you explain the data clearly but you will, too, because you will be seen as a good communicator.

17.4 CONCLUSION

Although this chapter has focused on writing, you can apply what you've learned here to other forms of communication. For example, you can use the communication square to plan an important meeting with your client.

Example 17.9: Using the communication square to plan a client meeting

- Audience: Client
- Purpose: Present the results of user testing to the client and explain our final design concept. As a result of the meeting, the client will help us to refine our concept and approve our planned design direction.
- Content: Summary of mockups and methods employed in user tests; table of key results; drawing of final design concept
- Tone: Informal but businesslike

Similarly, for a final presentation to be effective, you will need to make the same kind of rhetorical decisions that you make in a final report—how to provide evidence for your assertions, explain your design decisions, interpret your data, etc.

You may wish that there were a simple recipe for writing any document or delivering any presentation. However, just as there are no rules for determining the "right answer" to a design problem, there are no absolute rules for what to say and how to say it in engineering communication. Communication is "socially constructed"; that is, effective communication varies depending on your profession, your company, and even your communication technology. That's why, as in design, there is a process you can follow to compose those documents and presentations effectively, one grounded in the "communication square." This process requires you to take the same problem-solving approach to communication as you take to design.

Engineering communication, however, does include certain genres—progress reports, formal proposals, etc.—that do have typical characteristics and follow specific conventions. These characteristics and conventions provide a valuable framework, but they do not replace the thought you must put into developing a strategy for each communication. Your emails, reports, slides, posters, and so on will only be as effective as the informed consideration you give to audience, purpose, content, and tone.

17.5 REFERENCES

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