TECHNICAL COMMUNICATION IN A LARGE COURSE: PRACTICAL GUIDELINES FOR INSTRUCTORS

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Introduction

The integration of technical communication into a large technical course requires instructors to develop simple and practical answers to three very complicated questions:

- What language structures are of most importance in conveying technical information?
- Can we evaluate writing and technical substance together?
- How are informational graphics to be used in technical documents?

These questions come to the fore each time we deliver instructions and each time we mark a report. The way we answer these questions directly determines how long it takes us to mark a set of student reports and how much time we must later spend explaining our marks to students. Our answers to these questions also impact our students’ perception of how technical substance and technical communication pertain to each other. Our problem is, of course, that answers are not easy to formulate because of the complicated relationship between words, substance and graphics.

Of late, technical substance and its expression in words and in graphics have been treated as slightly different subjects. Perhaps in order to avoid discipline-specific questions about substance and about standards for graphics, the best guides for technical writing treat graphics and text management in separate chapters. Relatively little space is devoted to the concrete discussions that should integrate informational graphics with the text of a report. It falls to faculty members in the student’s professional discipline to clarify the fit between informational graphics and words, and they are often uncomfortable in this role.

To solve this problem, technical faculty have traditionally looked beyond their departments in search of some sort of additional writing or presentation support for their students. At some universities, this assistance comes in the form of tutoring or recitation sessions provided by the personnel at a campus writing center. Some departments provide separate technical writing or speaking courses, which may run concurrently with certain required technical courses. Another way to provide communication instruction in the technical classroom arises when student projects are sponsored by industry. Here, the industrial sponsor receives written and oral reports and suggests modifications to the students based on experience with the norms of communication in a particular field.

Unfortunately, these approaches to communication instruction do not solve the integration problem so much as they reproduce it. When technical students are sent to consult with writing center tutors, for example, that tutor may be placed at an information disadvantage and may deliver writing instructions that are colored by the student’s account of the writing issue and of the project being described. At the other extreme, students may find that industrially...
sponsored projects effectively speak to substance, but that sponsors are not always selected for their skills in writing instruction, making even the best of experiences hard to interpret.

When we integrated technical communication into a sophomore design course at Georgia Tech, we addressed substantive information directly, using a concrete approach to both graphics and text. In doing so we simplified the task of marking papers while emphasizing the integration of informational graphics. This paper will focus on the way we mark large volumes of reports, outlining the thinking that underpins our methods. The integration and presentation of graphics will be described first, followed by a description of our concrete approach to language and information. We will illustrate the discussion with annotated samples from our teaching packages, in order to demonstrate how this approach to information and graphics can ease the instructor’s burden.

The Class

Design I, Creative Decisions and Design, is a required sophomore-level course at Georgia Tech’s George W. Woodruff School of Mechanical Engineering. Enrollment averages 200 students per semester, divided into studio sections of 24 students for project work. In their studio sections, students work in small teams to complete five design-and-construct projects. At the end of each project, the student teams prepare and present both a written report and an oral presentation of their work; one larger project requires two interim reports as well, for a total of seven formal written reports and oral reports delivered in the class. All reports are marked by the department’s writing instructor; reports for individual sections are then reviewed by that section’s teaching assistant and/or instructor.

The projects in this class ask the students, in various degrees, to evaluate problems, to develop solution ideas, to draw them, to construct them, and then to evaluate their work. The two simplest projects ask students to build or dissect a system or device, to draw it and to describe it. More open-ended projects present a functional need, require that numerous design concepts be developed and drawn, and that these designs be evaluated using a set of formal evaluation tools. The largest project requires students to develop project specifications, and functional partitions of their project requirements before they develop and evaluate concepts. Students are asked to prepare reports describing each of these design-related activities.

In all cases project reports ask our students to fashion illustrations to capture two kinds of information that are central all technical professionals’ lives—information about devices and about processes. Their drawings illustrate devices that they might fabricate, modify or test. Their tables and charts can be used both to capture specific information and to represent processes. To accommodate these important informational graphics, the communication instruction method used in Design I does not simply focus on the fashioning of text. It also shows students how to convert information into illustrations, which are then presented and described in professional-sounding reports. The issue of visualization is an issue of thinking and of communication; consequently we address it first.

Informational Graphics in Technical Communication

Our approach to technical communication is heavily influenced by Shigley and Mischke’s account of the way authors and readers meet in informational graphics. In their

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textbook of design analysis cases, they point out that engineering diagrams perform valuable services for both the engineer and for the audience:

- Careful and complete construction of the diagram clarifies fuzzy thinking by bringing out various points that are not always apparent in the statement or in the geometry of the total problem. Thus, the diagram aids in understanding all facets of the problem.
- The diagram helps in the planning of a logical attack on the problem and in setting up the mathematical relations.
- The diagram helps in recording progress in the solution and in illustrating the methods used.
- The diagram allows others to follow your reasoning.

Here, fashioning a diagram constrains the author to clarify the engineering problem, to plan a solution and to document a solution process. The well-made diagram is then used by an audience member who must be able to find in the drawing the author’s understanding of the problem, of the solution process and the solution itself. The illustration contains all of the important information about both the solution and the solution process; this information is later accessed by others who have to understand that process and that solution in order to approve the work. The illustration is the technical crux of the exercise.

The points listed above are drawn from a discussion of design analysis diagrams, but these points apply to all informational graphics. Well-made graphics capture the technical concerns at the heart of a problem. Authors must learn to select appropriate kinds of informational graphics to both capture and express information accurately, to highlight important points or trends in that information, and to make that information clear to an audience member using both visual and verbal tools. The informational graphic is thus the central information component of a report, so it must be central to our teaching and to our grading.

Students must learn to think visually and to associate particular kinds of information and descriptions with particular kinds of graphics. Such graphical thinking seems not to come naturally to all engineering students, so writing and presentation lectures in our class include standards for the appearance and preparation of illustrations, along with explanation of the kinds of points typically made by particular graphics. This presentation is governed by an information checklist that students are asked to use when they describe graphics in reports:

1) Figure Citation
2) Objective statement
3) List of features
4) Description of features as they pertain to objective
5) Discussion of challenges or open questions (as appropriate)

In this checklist, we break the substantive presentation of a graphic into five information-related statements, each of which is anchored in the graphic itself. In order to form a discourse in response to these prompts, the student must formulate the objective of the graphic, and the student must explain how the graphic meets that objective. In short, the student must think as well as write. By implication, this checklist also keeps students from presenting engineering
information in the format of expressive writing; this checklist asks the student author to focus attention on the presentation of information rather than on the student’s own experiences.

In Design I we use the following sample figure presentation to illustrate the kind of discussion we want students to write, and we annotate it according to our checklist:

[1]Figure 1 schematically displays the basic elements of a torpedo. [2]A torpedo needs to do four things: it must find the target, it must propel itself toward that target, it must guide itself on its path, and it must detonate near the target. [3]To meet these goals, the torpedo has four main components: a nose section containing sonar, a motor and fuel tank, a guidance system, and a warhead. [4]When the torpedo is launched, the nose sonar locates the target and notifies the guidance system, which receives constant updates from the sonar. The fuel tank and the motor propel the torpedo forward until the warhead is detonated, either on a signal from the sonar or from contact. [5] The design of each of these components presents special problems, which are addressed in detail below.

Figure 1. Schematic view of a torpedo, showing the placement of subsystems associated with target acquisition, guidance, propulsion and detonation. Labels are italicized to highlight the link between illustration and text discussion.

The numbered statements here are arranged to reflect a logical sequence of information. Statement 1, the figure citation, merely signals that an ensuing discussion pertains to a particular figure. Statement 2, the objective statement, motivates that illustration, posing the challenge or need that the illustration addresses. Statement 3, the list of features in the illustration, is key to the discussion. Its first phrase, “To meet these goals,” signals that the following list outlines the solution to the problem. The list itself places labels from the illustration into grammatical parallel with the components of the problem statement, both integrating the figure into the discussion and providing solutions to the stated problems. Statement 4, the longest part of the presentation, discusses these features in turn, elaborating on or explaining the link between torpedo component and stated problem. The information in Statement 5 is optional; at this point in a discussion, authors may raise new problems or outline the next part of the document, as needed.

With this checklist for figure presentation, several teaching and grading problems are solved. Students can use this checklist both to get accustomed to writing technical descriptions that focus tightly on issues and to constrain themselves to formulate and state the need for each figure and the point made in each figure. Graders can use this checklist to locate concretely in Statements 2 and 3 the student’s grasp of a figure’s use and its meaning. They can locate the point at which a discussion loses focus, when the terms of the discussion under Statement 4 vary.
Concrete approach to language and information

Writing checklists are not unusual by themselves. Often they are created to coordinate grading across large teams of instructors and teaching assistants. When such checklists are pressed into classroom service, they offer students a class-specific gloss on particular graders’ interests. But checklists don’t necessarily help students to draw general conclusions about information management in professional discourse. A better checklist should help both student and grader, providing a general map of information statements in professional discourse as well as a specific guide to how those information statements are used in a particular classroom. This link between general and specific, between teacher and student, is best articulated in studies of discourse. The methods presented here use so-called *discourse grammar* and *grammar of style* to provide concrete methods for breaking documents, paragraphs and sentences into information-related components.  

Loosely stated, discourse grammar is a flavor of linguistic analysis that examines how rhetoric and organization work and why they work. This analysis focuses on larger structures than does traditional sentence grammar in order to establish not how words make sentences but how groups of sentences can make coherent paragraphs and how groups of paragraphs can make coherent documents. The classroom applications of discourse grammar are powerful, for they help us to relate easily and directly information and style to document format and organization. Discourse grammar helps the author to organize and present information directly and clearly, and it allows the instructor to locate and evaluate important chunks of information efficiently.

According to our discourse grammar, technical documents are organized as *pointed*, or *point-first* documents. In pointed documents, information is partitioned into three sections, each of which performs a specific job for the author and for the reader. These three chunks of information—the Issue, the Point and the Discussion—are represented schematically in Figure 2. The Issue section of a document presents the conceptual and practical context of the document, and it formulates the need or problem to be addressed in the document. In practice, the Issue statement generally presents a summary of background information, problem motivation and a full formulation of the problem to be addressed. The Point statement marks the close of a document’s Issue section, offering the document’s promise or claim in response to the problem. In this Point statement, the terms that will be used to support that point are listed, marking the Point as the organizational crux of the document. The Discussion section of a document supports or clarifies the point offered at the close of the Issue section by offering details or evidence. This presentation of details must be organized, and organization is measured by the correlation between the details and the terms of discussion set forth in the Point statement. Very simply, in the list of terms, a Point statement raises a set of specific issues on which the Discussion section of the document must elaborate. So long as the Discussion section explicitly addresses these issues in order, the document can be considered to be adequately organized.

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1. Problem or objective.

2. Claim or result, offering terms a, b, and c, for future discussion.

3a. Discussion of a.

3b. Discussion of b.

3c. Discussion of c.

Figure 2. The three-part organization of pointed text, as described by Williams[10].

This description of pointed text is schematic; it is best brought to life in the following annotated figure description. This figure description forms a complete short report; it is a model of a homework exercise, which asks students to determine whether automobile prices correlate with their weight. In response to this assignment, students collect data about auto weights and prices, graph that data, draw conclusions and prepare reports. Figure 3 and the associated discussion demonstrate how a very short report can exemplify the basic components of a pointed document.

![Figure 3](image)

**Figure 3.** The relationship between weight and price for an assortment of model year 2001 sedans, demonstrating that vehicle price increases exponentially with vehicle weight.

[Issue]To characterize the relationship between price and weight in automobiles, data for ten 2001 model sedans were collected and placed in a spreadsheet for analysis.

[Point]The result of this analysis is displayed in Figure 1, which graphically relates [term a]weight to [term b]price for these automobiles, displaying data points and a [term c] trendline, and [claim] which demonstrates that sedan prices rise exponentially with

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increases in weight. [Discussion, term a] Vehicle weight is represented, using units of pounds, on the X-axis, which is offset from the origin by 2000 pounds to indicate that none of the automobiles evaluated here weighs less than 2000 pounds. The Y-axis represents the [Discussion, term b] price of each vehicle using the Manufacturer’s Suggested Retail Price (MSRP). The Y-axis is offset from the origin by 10,000 dollars, to indicate that none of the vehicles is priced below $10,000. The supplied [Discussion, term c, support for claim] trendline characterizes the overall relationship of price to weight in this data set as a second order equation, which is displayed on the plot area, along with the line’s $R^2$ value. This $R^2$ value is 0.98, indicating that the calculated trendline characterizes this particular set of data accurately.

The Issue statement of this little report is found in the first sentence, which states both an objective—“to characterize the relationship”—and a method—“data were collected.” The Point statement fills the second sentence, which cites the figure and lists the terms for discussing or supporting the claim—terms a, b and c. The Point statement also presents a claim that can be supported: that “sedan prices rise exponentially with vehicle weight.” The Discussion section fills the remaining 5 sentences of the report, providing explanation or interpretation of each of the terms listed in the Point statement. This Discussion can be described as organized because the terms of the Point statement are presented in order at the heads of the sentences of the Discussion. This Discussion can be described as substantive because each of the last two sentences works to explain or validate the “second order” claim that closed the Point statement.

This example discussion of Figure 3 is small, but it is suggestive. And what it suggests is very simply this—authors and readers of a document can use this information framework to organize and assemble documents or to review and mark documents. As teachers and graders we best use our time and energy when we begin our reading by seeking these information-rich elements of student reports and when we focus our comments primarily on these elements of student reports. Discourse grammar helps us to do exactly that.

**Marking Undergraduate Reports**

When we use this system to mark reports, we first scan Issue and Point structures in search of problem statements, of claims and of a listing of terms to govern Discussion. In Discussion sections, we then scan for graphics whose presentations follow our checklist. For each of these components of a document, we then pose general questions:

1. Is the right information statement present?
2. Is that information substantive?

In the Issue section of a student report, these questions focus on problem formulation: “Does the student formulate the right problem?” In the Point section, the questions focus on results: “Does the result pertain to the problem?” In the Discussion section, we ask repeatedly “Does this result pertain to the problem? Is the explanation reasonable?”

As we search the framework of the document, our questions repeatedly address organization and substance, as should the questions of all good readers. At different points in a student’s education, of course, we will emphasize different information statements. Design
courses, for example, typically challenge students to formulate problems, while experimental courses are commonly more concerned with presentation of data. In particular courses, we have the flexibility to emphasize some information structures over others, depending on the responsibility the student is given to interpret problems, to design experiments and to draw independent conclusions.

Examples of good and bad presentations

The examples that have been annotated thus far are used as classroom models of clear reports. Such reports are never difficult to mark, so a classroom model of a poorly written report is presented below in order to suggest how it might be evaluated and marked quickly. Two simulated report sections are presented next; the first of these is acceptable, and the second is not. These two report sections represent work on a project whose objective was to move golf balls across a small track. Authors were asked to develop several design concepts for this project, to evaluate these concepts using criteria developed by the author, and to select one design for subsequent construction. Such an evaluation process is captured in Table 1, and distilled discussions of this table follow it.

Table 1. Evaluation of system concepts for golf ball retrieval system.

<table>
<thead>
<tr>
<th>CRITERIA</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drive Distance</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Size</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Speed</td>
<td>3</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Low Cost</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Ease of Operation</td>
<td>3</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Ease of Production</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Ease of Reset</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Functional Safety</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>18</td>
<td>16</td>
<td>23</td>
</tr>
<tr>
<td>Relative=Total/32</td>
<td>0.5625</td>
<td>0.5</td>
<td>0.71875</td>
</tr>
</tbody>
</table>

Student A

[1] Table 1 shows an unweighted evaluation of concepts 1, 2 and 3. [2] Each concept was rated for its ability to meet certain important performance and construction criteria; this table both records the numerical result of this process and it provides a comparison of the results obtained by each of the concepts. [3] According to the criteria used in this comparative evaluation, Concept 3 is preferred with a score of 23, and concept 2 is eliminated, having obtained the lowest score of 16. [4] The systems for consideration are displayed in the column heads, and the evaluation criteria are shown in the row heads. Of these criteria, Distance to Drive, Speed, and ease of production proved to be determinative, as concept 3 scored best in each of these categories, and concept 2 underperformed consistently in these areas. It is noteworthy that concept 3 obtained the
best comparative evaluation for both performance (speed and drive distance) and for user concerns (ease of production and Ease of reset).

**Student B**

[1] Table 1 shows our team’s evaluation table for the golf ball project. [2] An evaluation table compares the concepts evaluated according to certain criteria and it helps the team to decide which concept to build. After this exercise, the team decided to build concept 3, which came out on top in this evaluation. Consequently the team began to collect construction materials, and after a trip to the hardware store for fasteners, the team began to construct Concept 3 which will be ready in advance of competition day.

In each example figure description, the numbers preceding each sentence correlate that sentence with an information item from our checklist for presentation of figures. Even the most impressionistic review of these short paragraphs will suggest that Student A has made a clear, specific and analytic presentation of material, while Student B’s discussion seems not to be to the point. These impressions can be clarified in concrete terms through use of our information checklist for figures and tables. Student A follows the checklist carefully, providing [1] a citation of the table, [2] a description of the table’s objective, [3] a point or result, and [4] the analytical enumeration of the components of the table. Because the information in item [4] links the specific items in the display with their logical functions, the graphic, the text and the thinking process seem to work together tightly, clearly and effectively.

In following the checklist, Student A has also prepared a small, pointed discourse, for the Issue and Point sections, sentences 1-3, formulate an objective and state a related claim. Further, the Discussion section truly elaborates on that point, by calling attention to specific criteria that influenced the reported result.

The presentation of Student B shows two related problems. First it puts information statements in the wrong locations, for it diverges quickly from the checklist for figure presentation. Second, the information that it does provide is of entirely the wrong kind. While the first statement rightly provides a citation for the Table, the following statement makes a substance error because it avoids explaining the objective of the table, substituting instead a truism that characterizes all such tables. Many instructors will suggest that the student has failed to “add value” here; we prefer to say that statement 2 fails to provide specific information about the table under discussion. After statement 2, this discussion ceases to present useful information entirely, for no point is made and no discussion is provided. In place of these important information statements, Student B’s report presents a chronology of the team’s comings and goings. This slip into narration is more than irritating; it replaces important information with trivial information in a way that is common among students who misunderstand their jobs as technical reporters. When students misunderstand their jobs as technical authors, they resort to an unfortunate default report structure—presentation of the project as a personal narrative of the design team’s struggles.

Because Student B has systematically misunderstood what kind of information is required in a report, an instructor’s comments to such a student should focus sharply and briefly on the need for table-related information: “Please explain what project-related point this table
In that comment, secondary irritations such as narration and first person presentation are subsumed. While student B’s errors invite a page of irritated commentary, a single statement highlights the information error that underpins the many problems in Student B’s presentation.

Conclusion
The highly distilled examples presented here can, of course, be misleading. Removed from the classroom context, any paragraph can be easily marked and analyzed. Further, these examples show none of the typing and formatting errors that always complicate the instructor’s job. But the organized and clear presentation of substantive information must be at the top of the instructor’s list of concerns when a report is marked, and instructors want their commentary to address the students’ understanding of professional substance as much as possible. The concrete approach described here does indeed give instructors a means to locate those parts of a report where thinking and communication come together. For the student, this approach can provide a checklist to prompt for articulation of particular kinds of information in a particular sequence. For instructors this same checklist supports a highly focused review while allowing constructive feedback to be articulated briefly, concretely, and in a way that coordinates with the technical substance of the project.

Bibliography
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