Troubleshooting Procedures – Technical Writing Lessons That Challenge

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Abstract

This paper proposes introducing instruction and assignments on the preparation of troubleshooting documentation into technical writing and communication courses. Exercises that ask students to create procedures to aid readers in problem solving and the troubleshooting of technological systems and equipment can provide students with challenging and relevant practice in creating audience centered and helpful documents. A hypothetical technical writing machine and other vehicles for teaching this content to students who may have different technical backgrounds are presented.

Introduction

Technical writing and communication courses assist engineering and technology students in developing and enhancing communication skills they may have to call upon in their careers. Students typically are introduced to audience-centered writing and the elements of technical style and gain practice writing descriptions, reports, proposals and instructional material. Ideally, at the end of a typical course students should be able to strategize a communication need, research the needed technical content, analyze the needs of the audience, select a format, organize the information and construct a clear and effective communication that satisfies the original need. This may be demonstrated in assignments that lead to progress reports, test reports, feasibility studies, internal change proposals, installation or setup instructions, or repair and maintenance procedures.

Assignments that ask students to analyze complex systems and create procedures to assist in troubleshooting failures or problems that arise within them can be particularly challenging methods for demonstrating and honing the students’ technical communication skills. Troubleshooting in itself is an exercise in problem solving. Troubleshooting documents are tools that can guide and assist readers in their problem solving, helping them analyze and correct specific problems they have encountered with technology. Creating these documents requires that technical communication students analyze the problem, develop methodologies for solving it and then determine the best format for delivering this information to their potential readership. Assignments of this type can be particularly challenging as they call on both the analytic and the
communication skills of technology students, helping them see this shared importance in successful documentation.

Assignments and lessons about the process of troubleshooting and the development of documentation for that process have relevance and value that students will immediately grasp. Anyone with experience in the technological world knows that things go wrong and that sometimes things go very wrong. Computers crash at the least opportune moment. Pump seals begin to leak and line pressures drop precipitously. Red warning lights come alive on aircraft panels and plant control boards. Fatigue causes cracks and failures in structural elements. A switch locks in the open position.

The diagnosis and correction of failures in today’s sophisticated technology has become critical. Identifying a fault or problem cause and resolving it through some corrective action can be a very difficult analytical process and is often carried out under most stressful conditions. Most students will have experienced unwanted and unexpected technological failures of some type. They will know the high degree of frustration that arises on the part of those who had counted on equipment or systems to continue functioning properly. Many may even have participated in actual troubleshooting, the search to find the source of the problem, and making the repairs, adjustments or replacements needed to remedy the situation as rapidly as possible.

This experience will help them see the utility and value of troubleshooting documents, tools created to guide and assist readers as they try to analyze and correct specific problems they have encountered with technology. These documents, sometimes called fault identification or fault isolation instructions, can be invaluable to equipment users and others who have limited experience with the technology that has failed. Even highly experienced technicians and service personnel rely on this documentation for problems that are particularly challenging or not previously encountered in their diagnostic experience. Well-written, clear documents that lead readers to quickly and accurately diagnose these problems are highly valued as they minimize down time and increase productivity.

Troubleshooting documentation

Documentation provides an aid in the often complicated process of troubleshooting technical systems or equipment. The documentation may be presented in several different formats. Tables are often used for relatively simple operator troubleshooting tasks. Step-by-step instructions are used where the path to be followed is nearly linear or sometimes when there is a heavy reliance along the path on built-in test routines to aid in the process. Step-by-step instructions are also commonly used as guides in the resolution of many software problems. Flow charts are a common format for more complicated situations as they provide a very clear roadmap for processes that include a large number of logical choices or decisions. Narrative formats appear where the readers share a problem but do not share environments or other important considerations.
Table 1. Troubleshooting coverage in technical writing text books.  

<table>
<thead>
<tr>
<th>Author</th>
<th>Title</th>
<th>Edition</th>
<th>Total Pages</th>
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<tr>
<td>Lannon</td>
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<td>598</td>
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<td>Pfeiffer</td>
<td>Technical Writing</td>
<td>5</td>
<td>709</td>
<td>-</td>
</tr>
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</table>

Figure 1 Troubleshooting coverage in technical writing text books.  

The final column shows the small amount of space accorded to coverage of troubleshooting procedures in technical writing texts. The page count includes troubleshooting, diagnostic or fault isolation coverage in text or graphics.

Most technical writing texts provide very little coverage of troubleshooting instructions and offer little or no guidance in their creation. A comparison of five contemporary technical writing and communication texts shows only seven pages containing any reference to troubleshooting or diagnostic communication out of more than 3,000 textbook pages. This is illustrated in Figure 1 and leads to the conclusion that students in technical writing courses rarely are asked to write troubleshooting documentation. Even a more advanced and specialized text offers only limited guidance on the formatting of diagnostic steps.

This is unfortunate as understanding and practicing the development of troubleshooting instructions can provide students with an opportunity to synthesize much of what they have learned about the special writing needs of the technological world. Many of the topics commonly covered during a technical communication course must be applied or considered as troubleshooting instructions are developed. For example:

- **Process description** - Students must fully understand the process wherein the malfunction has occurred as well as the process of troubleshooting itself.
- **Visual aids** – Two common templates for troubleshooting, the flow chart and the table – are considered visual aids themselves. In addition, a full range of visual aids may be required to supplement textual instructions and aid the reader.
- **Audience appropriateness** – As with all documentation, students must understand the skills and knowledge of their target audience and the resources that they can be expected to have available for use in troubleshooting.
- **Gathering information** – Students must do research to find out how to best diagnose the system or product that they are writing about. Troubleshooting information often

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involves highly sophisticated technical concepts and may require that writers adopt a tightly focused and intensive research approach.

**Clarity of presentation** – The analysis of problems is a difficult and stressful process. Students must be especially careful that their documentation is not vague, confusing or subject to interpretation. The information must be organized in a highly strategic fashion, ensuring that readers have the quickest and surest path to a solution available to them.

**Instructions and Procedures**- Troubleshooting procedures are a specialized type of instructions and writing them can use all of the techniques commonly found in the more prevalent linear procedures and instructions, including safety considerations, listing techniques, preconditions, and step authoring.

An assignment that asks students to create troubleshooting instructions involves both rhetorical and instrumental discourse and helps them integrate their knowledge and experience in these and other aspects of technical communication that they have read about in their texts, studied or practiced during a course. This integration takes place as the students analyze a complicated process, determining the problems that might arise, how they might manifest themselves to the user, and how to locate and remedy them with certainty.

In addition, students must analyze how to present the information so that the reader or end-user of the troubleshooting documentation is best served. It provides an opportunity for students to see that technical communication is closely tied to analytical activity, activity that is quite similar to other aspects of engineering analysis, and that it can result in a valuable real world product. The ability of students to discern a purpose for communication projects and a relevance to their future careers is considered important for student success in technical communication courses.

Some problems

Bringing troubleshooting and other types of fault identification/isolation procedures into the classroom is not an easy task. Most students have a writing background of essays, letters and reports that has concentrated on producing linear narratives. Most technical writing exercises continue this, asking students to write physical descriptions, process descriptions, reports using the IMRAD format, and instructions following a numbered step pattern that provides a sense of the beginning (step 1), middle and end (last step).

Troubleshooting procedures ask the student develop an information product that may work very differently for different users or readers. Similar problems will have different resolutions. Readers may not only have different final steps, they may very well have different entry points into the documentation. The creation of an information product with alternate paths that include numerous opportunities for user decisions involving logical choices is often a new experience for students. Many have used this type of instructions but never understood the analytic process required to create them.

Obviously, writing good troubleshooting instructions requires that the author have a very strong technical understanding of the system that has failed. A writer must know how a type of software functions to be able to analyze how failures might appear in service. He/she must understand what parts, interconnections, or subsystems could cause a problem in a large
electrical system, electronic device, electro-mechanical apparatus or other technological assembly and what steps to take and tests to run to determine what is its root cause. The more sophisticated that the device is, the more knowledgeable the writer must be.

This presents problems in a technical writing course where many of the students do not share technical backgrounds or fields of interest. If all of the students in a class are seniors majoring in nuclear engineering, then a troubleshooting exercise involving the recirculating water system in a nuclear power plant might be appropriate. But in most cases, a technical writing course will have students with electronic backgrounds sitting beside those with mechanical interests or industrial/systems studies majors. Some students may be seniors, others freshmen. This mix makes it very difficult to use examples or assignments from a single field as a number of the students may not have the requisite background to understand how and why the logic is applied in the troubleshooting patterns.

The Technical Writing Machine

To give students a model where they could develop troubleshooting documentation, a hypothetical device, the technical writing machine, was used as an example. The device (Figure 2) is represented by a functional schematic diagram that shows the relationships between the “machine’s” major systems and subsystems. The machine elements are all labeled with the names that bear some relationship to commonly understood technical writing considerations (jargon filter, audience filter, level of detail board, etc.) that would be made during the creation of a technical document. Students were told that the “machine” functioned as did many real world devices: data was input and a final product – the document – was output.

Figure 2 – Technical Writing Machine schematic used to stimulate discussion and as the basis of assignments.
Students were asked to consider what “problems” might be encountered in the function of a “machine” of this type. For each of these “problems”, they were then asked to analyze what elements (systems or subsystems) of the machine might cause the problem, identifying the potential “failures.” Next, they were asked to determine a path that someone might take to identify the actual “failure” from among the possibilities. And, finally, they were asked what method of documentation would be best for presenting this information to the user or technician.

For example, a possible “problem” that an operator of the “machine” might face is that nothing comes out. Using the schematic diagram students analyze what elements might be likely causes of this total failure of the “machine.” Students generally identify the central processing unit, the output device, electrical power, and lack of input as possibilities and then look at an approach for helping the reader sort through them, flow charts and tables usually finding the most favor.

Students are usually quick to identify a specific “machine” element when the failure is clearly identified and easily linked to it, such as “output contains poor grammar/spelling.” In this case the grammar edit and spelling correction elements are usually chosen as the primary sources although the possibility of other sources (central processing unit and audience filter) is recognized during discussions. When the fault is more general, such as the output is unclear, students have more difficulty pinpointing possible sources of the malfunction. This calls on them to reflect on the relationships in the schematic as well as the things that affect the clarity of their own writing (vagueness, use of jargon, audience focus, etc.). Malfunctions of this type result in instructions with more choices and decision points, usually depicted in flow charts.

Some students do not like the schematic for the technical writing machine as shown in discussion comments such as “what an ugly process flow” and it looks like “something that Noam Chomsky would certainly approve.” But nearly all were able to understand and use it to make the decisions necessary to solve problems in its operation. Its simplicity and relevance to their understanding of technical writing made it an excellent vehicle for helping the students understand the underlying process of creating successful troubleshooting instructions.

The Voting Machine

At the heart of creating troubleshooting data is the understanding that the possible causes of the failure must be identified and then from them the actual cause selected and fixed. If only one possible cause exists for a problem, the action is relatively straight forward. When two or more possible causes exist, a process of elimination must be established.

For example, a voting machine is an example of a device that most students will have some familiarity with, either by actual use or through news accounts of election problems, and can be used to show how this can be developed.

If the machine does not tally the votes properly and the only reason this could occur would be a fault in the machine’s main processor, the instructions will be straight forward and might lend themselves to display in tabular form.
Now if the same machine had a fault where two possible causes existed, a simple decision path must be created, possibly using a flow chart format. For example:

**Machine Does Not Display Votes**

```
Did display process pass test?

Yes

Replace display unit

No

Replace display processor
```

And, if more possibilities exist, the chart begins to offer multiple paths. Again, for example:

**Machine Does Not Accept Votes**

```
Test I/O device. Did I/O device pass test?

Yes

Test I/O processor. Did I/O processor pass test?

Yes

Replace I/O board

No

Replace I/O processor

No

Replace I/O device
```

<table>
<thead>
<tr>
<th>Problem</th>
<th>Probable Cause</th>
<th>Recommended Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Votes not tallied properly</td>
<td>Faulty Main Processor</td>
<td>Replace the Main Processor</td>
</tr>
</tbody>
</table>
Students may find far more complicated situations involving a voting machine, or any easily understood system, that require flow charts with sophisticated branching patterns. In addition, students have the opportunity to analyze the faults and the audience and determine that some other template or instrument, i.e. a table or narrative, might be the best method of communication.

The Troubleshooting Lesson

Troubleshooting is the last topic in a three-week sequence in instructional writing contained in the course Technical Writing and Editing (0688-333) taught at the Rochester Institute of Technology. The course, a 4 credit course taught on the quarter system, is taken by technology students as a communications elective or requirement, depending on their program, and by students in technical communication certificate programs.

Students are introduced to the subject of troubleshooting and the problem-solving process that it represents. Differences between it and other forms of instructions are examined and sample documents displayed. Students then discuss the nature of troubleshooting and encouraged to recount their own experiences with activities of this type.

The attributes of different formats (tables, flow charts, step-by-step, etc.) for displaying troubleshooting information are then discussed and more samples are reviewed.

At this point, a sample system such as the technical writing machine or voting machine is introduced and students review it to ensure they understand the relationships between the system parts. It is important that they recognize that the sample system, although clearly imaginary, is an analog for real systems that they might encounter in the future. Many students will recognize that the interdependencies in the sample system share similarities with those in real systems with which they are familiar.

As a group, students are asked to develop a list of possible faults or malfunctions that the sample system might display. Then they are asked to develop instructions for troubleshooting one of the simpler faults. The resulting instructions are then discussed, analyzing their accuracy, their ability to help a reader quickly locate the problem, their audience appropriateness, and their format. Looking at the same instructions displayed as narratives, flow charts, tables and step-by-step instructions provides students with vivid points of comparisons and an understanding of how important the underlying problem-solving analysis and content are.

In practice, a number of additional considerations can influence the creation of troubleshooting instructions. Students are now introduced to some of them, e.g. reliability predictions, time-to-test, safety, resource requirements, and how they can affect what paths a writer may offer troubleshooting to follow. This is a point where differing problem-solving strategies and maintenance philosophies are also presented to the class.

The class is then assigned the task of writing instructions for a sample system, either the one previously used in an exercise or a new one. Several faults, such as Machine Output Displays
Spelling Errors, are provided to the students. The faults should range from the relatively simple to solve to one that requires a number of tests or other actions to eliminate all possible failure cause suspects. Students are asked to create the documentation needed to help an end user resolve the fault or problem. This final troubleshooting task has been assigned in past classes as an in-class exercise, a discussion exercise in distance learning sections, and a homework writing assignment.

A rubric for evaluating the assignments should take into account the format chosen and its appropriateness for the intended audience and the required tasks, the logic of the procedures, the inclusion of any special considerations that might apply, and the accuracy of the procedures, as well as adherence to more universal technical writing standards of consistency, language, grammar, spelling and clarity.

Discussion

Experience in both classroom and distance learning courses has shown that students react favorably to troubleshooting instructions when they are introduced at the end of a technical writing class. They recognize the value for these instructions and realize they may have to undertake complicated analytical thinking to construct effective instructions – one student commenting that a “real doozy” had been left for the end of our class.

Instructors who have relatively homogeneous classes can use examples from the field of study that the students share. A technical writing course for mechanical engineering students might analyze an idealized hydraulic door actuator system or an automotive braking system. A course for electrical or electronic engineering students might offer failures within an idealized control system or communications device. The system should be sophisticated enough to offer the students a challenge yet simple enough to permit analysis of the failure mechanisms and develop an effective troubleshooting path.

When the students do not share a field of study or level of technical knowledge, hypothetical examples that are easily visualized and understood, such as the voting machine or the technical writing machine, can provide a backdrop where students can practice the crafting of troubleshooting instructions.

Troubleshooting assignments, when developed to match the level of technical competence of the students, can provide challenging and rewarding learning experiences within technical communication courses for engineering and technology students.

Bibliography


Biography

Tom Moran is an associate professor in the Center for Multidisciplinary Studies in the College of Applied Science and Technology at Rochester Institute of Technology (RIT), Rochester, N.Y.