How participants' expertise influenced expert testing of a technical user manual

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How participants' expertise influenced expert testing of a technical user manual

by

Catherine Mary Molitor

A Thesis Submitted to the Graduate Faculty in Partial Fulfillment of the Requirements for the Degree of MASTER OF ARTS

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This study extended expert testing beyond the traditional practice of including only technical subject-matter experts as test participants. The study investigated how participants' expertise in different domains influenced expert testing of a user manual written to accompany a technical computer program. The program is intended for international distribution to materials science and engineering (MSE) researchers.

The twelve participants in this study represented three areas of expertise: English as a second language (ESL), rhetoric and professional communication (RPC), and MSE. MSE experts were further divided into two groups—native speakers of American English and non-native speakers of English. All participants completed a pre-test questionnaire to gather demographic information. Participants then expert-tested the manual by briefly reviewing the entire manual, closely reading a representative sample of the manual, and responding to eight questions. Finally, experts participated in a follow-up interview to clarify their expert-testing responses and address topics raised by other experts' responses.

Results of this study of expert testing indicate that including experts from domains in addition to the technical subject matter offered valuable feedback about the manual that technical subject-matter experts could not offer. Experts' responses often conflicted with responses from experts from the same domain and different domains, leaving the author of the manual to determine which feedback to act on to guide revision of the manual. Feedback would have been less extensive and helpful to revision if the testing had included fewer experts from fewer domains.

This study suggests that participants in expert testing of documents should not be limited to subject-matter experts. Experts from various domains offer different types of feedback that are useful for making revision decisions.
CHAPTER 1
GENERAL INTRODUCTION AND LITERATURE REVIEW

My thesis project focuses on the expert testing of a technical user manual that I wrote as part of a technology transfer project involving Iowa State University (ISU) and a local software company. The goal of the project was to upgrade the existing DOS version of the engineering analysis computer program called ImSpec—Impedance Spectroscopy Analysis software—into a marketable Windows format. I was included as a member of the project team to help increase the marketability of the Windows version by writing the user manual, and it was this manual that I expert tested. In addition to writing the manual, I offered suggestions to the computer programmers to improve the software from my perspective as a user of ImSpec and worked with them to uncover problems with ImSpec.

Three circumstances related to ImSpec influenced my expert testing of the manual. First, the software company involved in the technology transfer project had only limited resources. The company was a one-man operation, and the owner of the company was accustomed to writing the documentation for software he had written. Second, marketing plans for the software included sales to other countries because researchers are working in the area of impedance spectroscopy in laboratories around the world. I knew, therefore, that not all readers of the manual would speak English as their native language. Third, ImSpec's current state of development prevented me from using testing methods that would require use of the software. Development of the software fell behind development of the manual, which ultimately led me to expert-testing methods to evaluate the manual. Because the manual was the one aspect of the project that I had a certain level of control over, my testing efforts needed to focus on the manual alone, rather than testing the software and the manual.

Decisions about testing methods I used to evaluate the manual relate to the above circumstances. If the software company had more resources available, I may have been able to
consider translating the manual into readers' native languages. But, because resources limited me to only one version of the manual written in English, I needed to find other ways of effectively communicating to the manual's international audience. To help evaluate the manual's effectiveness for audience including international readers, I used expert-testing methods and chose experts from three areas to maximize the range of feedback.

This wide range of feedback from experts from English as a second language, rhetoric and professional communication, and materials science and engineering required me to resolve discrepancies. Experts did not necessarily agree either with experts from the same area or with experts from different areas. When experts disagreed, I first determined the domain of expertise for the concern about the manual. If the concern was within one expert's realm of expertise and outside the disagreeing expert's realm of expertise, I followed the suggestion of the expert who was commenting within his or her domain. If I could not resolve a discrepancy between experts by referring to their areas of expertise, I was left to make decisions based on my knowledge of the manual. A more detailed discussion of my expert testing of the manual and the decisions I made appears in chapter 3.

This introductory chapter of my thesis presents my research question and literature review. Chapter 2 describes the methodology I developed and applied to answer my research question. Chapter 3 is a journal article that I will submit to IEEE Transactions on Professional Communication; this article presents the data and discusses implications of the results of my study. The final chapter of my thesis contains general conclusions and my suggestions for additional research in the area of document testing, specifically expert testing.

My Research Question

My efforts to answer my research question, "How does participants' expertise influence expert testing of a technical document?" are intended to inform writers about the nature of expert testing. I want to reinforce the difficulty of expert testing a manual intended for an
international audience because of the complexities inherent in communicating to readers with varying English-language proficiency.

Importance of Accuracy, Accessibility, Appeal, and Appropriateness

To investigate my research question, this chapter contains two main parts: discussion of accuracy, accessibility, appeal, and appropriateness; and a literature review of expertise, ESL, documenting testing, and diction. I chose the areas of accuracy, accessibility, appeal, and appropriateness because technical manuals—especially those intended for an international audience—need to exhibit certain qualities to be effective. To help evaluate these qualities, I offer the heuristic of accuracy, accessibility, appeal, and appropriateness. If a document exhibits these qualities, its usefulness to readers is much greater than a manual that is inaccurate, inaccessible, unappealing, and inappropriate for readers. Research from four areas—expertise, ESL, document testing, and diction—contributes to my discussion of the qualities that define a manual’s effectiveness.

Accuracy

If information in a document is wrong, readers may be mislead. A document’s content must be accurate for writers to have the opportunity to communicate their ideas. Glossary definitions are one example of potential accuracy problems. If a term is incorrectly defined, any reader who turns to that term will receive the wrong information. For example, if the directions for drawing a shape with the software were missing one of the steps needed to perform the task, the directions would be inaccurate; thus, readers would not be able to draw the shape. Missing information is inaccurate because its results is misleading readers with incorrect information.

The accuracy of a document is also related to whether or not readers can correctly process information in a document. If the content is accurate but the writing style or design, for example, prevents readers from processing the information accurately, the results are equally
problematic. For instance, if definitions in the ImSpec manual's glossary are written as sentences with very complex structure, non-native English-speaking readers may inaccurately process the definitions compared to accurately processing definitions written with less complex structures.

Accessibility

Accuracy alone, however, does not mean that users will find the document accessible. Users may consider a document inaccessible for many reasons, including confusing diction and poor document design. Even if the diction is clear, "short, active sentences and common, everyday words are not enough to make a document useful. If readers can't find the information they need, the well-written sentences may go unfound and unread" (Redish, Battison, & Gold, 1985, p. 129). A document can be completely accurate, yet readers may not get far enough to judge the document's accuracy if poor organization prevents them from finding the relevant section of the document.

Appeal

A document's accessibility also relates closely to its appeal to users. An appealing document is more likely to be used, "but no reader is an ideal receiver. Readers are easily distracted and stubbornly subjective. Many will value and attend more to distractions—especially the stray occurrences of their own thoughts—than they will value and attend to what the writer has to say" (Sanders, 1987, p. 91). Writers can never force their audience to read a manual. Writers can, however, make a document visually and linguistically appealing to help keep users' attention focused enough to continue reading and learning from the document without being distracted from or slowed in locating information.
Appropriateness

Appropriateness is linked to how well the information in the document is suited for its audience. Depending on a document's audience, the document's contents may be too technical or not technical enough. A document may be inappropriate if its contents and/or its level of and amount of detail are based on the assumption that readers know more about the subject than they do or that readers possess advanced English-language skills. Writers need to consider the implications of readers who are non-native speakers of the language in which the manual is written.

Review of Related Literature

Four major areas inform the discussion of accuracy, accessibility, appeal, and appropriateness of a manual intended for an international audience. In the following sections, I discuss how expertise, document testing, English as a Second Language (ESL), and diction all relate to an effective manual written for international readers.

Expertise

I discuss expertise here because of its close ties with the type of document testing—expert-based testing—that is the focus of my thesis. Expertise, as defined by researchers Bereiter and Scardamalia, is the "effortfully acquired abilities, abilities that carry us beyond what nature has specifically prepared us to do" (1993, p. 3). Four aspects of expertise influenced experts' comments during the testing of the ImSpec manual: calibration, domain-specific knowledge, task representation, and expert-reviewer strategies.

Calibration, the first of the four aspects of expertise that influenced testing, is the self-insight experts have into the "accuracy of their predictions" (Camerer & Johnson, 1991, p. 202). Colin Camerer and Eric Johnson explain that experts, unlike most people who are poorly calibrated, are less confident about the predictions they make. In other words, a seemingly overconfident expert may in fact not be an expert. Calibration surfaced in testing of the ImSpec
manual when each expert in at least one instance included what I termed a "hedge" in his or her written responses. Experts' comments often began with calibrating or hedging phrases such as "I think . . .," or "They might . . . ."

A second aspect of expertise—domain-specific knowledge—also relates to the study of the ImSpec manual. Experts' knowledge specific to their domain is generally limited to a single domain because, as Bereiter and Scardamalia explain, becoming an expert requires "a great deal of time and experience" (1993, p. 16-17). Researcher Herbert Simon estimates that expertise take "thousands of hours to build up" (1979, p. 426). This commitment of thousands of hours prepares experts in their own domain, but not in other domains because "experts excel mainly in their own domains" (Glaser & Chi, 1988, p. xvii). Carry-over of expertise to other domains rarely occurs because "expertise is founded on local knowledge; experts are successful in their fields because they bring to their performance domain-specific knowledge attained through much experience within that domain (Carter, 1990, p. 269). Experts' responses to testing questions about the ImSpec manual reflected this idea of domain-specific knowledge as I received more helpful comments from experts when the questions were closely related to the experts' domain of expertise.

Closely related to expertise's domain specificity is task representation, the third aspect of expertise that influenced my testing project. Experts, with their extensive knowledge of their domain, "see and represent a problem in their domain at a deeper (more principled) level than novices" (Glaser & Chi, 1988, p. xviii). With this deeper representation, experts' feedback about topics within their own domain is especially useful because the experts are more thorough because their feedback is based on the experts' more complex understanding of the problem.

Experts' deeper understanding influences the strategies experts use to address the problem. They are able to approach a problem differently than non-experts. Experts are able to store the domain-specific knowledge and the deeper understanding of their domain and access that
information more easily than non-experts. Unlike non-experts, experts are able to store patterns of knowledge and are able to access the patterns easily without an extensive search, which allows experts to apply their knowledge and serve in the role of expert reviewer or assessor.

Expertise influences expert testing in two ways: who writers select as expert test participants and what feedback writers can expect to receive from these experts. When testing technical documents, writers should look to more than technical subject-matter experts who can offer expert feedback only from their own domain.

**Expertise and My Research Question**  
Expertise relates to my research question because it directly influences the feedback I received from experts. Specifically, experts' domain-specific knowledge most clearly influenced the testing of the lmSpec manual because having fewer domains of expertise would have limited the range of comments I received from experts. To have expected experts from one domain to offer extensive feedback about topics from outside their domain would have been ignoring the domain-specificity aspect of expertise. Instead, by including the four groups of experts, I was able to benefit from each type of expert's ability to offer domain-specific feedback, deeper understanding of the problems with the manual, and expert strategies for addressing issues with the manual.

**Expertise and Accuracy, Accessibility, Appeal, and Appropriateness**  
Expertise affects all of the areas of accuracy, accessibility, appeal, and appropriate. Experts from three domains—ESL, the software's technical subject, and rhetoric and professional communication (RPC)—were an effective way to evaluate the manual because their responses to the document-testing questions, as described in more detail in Chapter 3, related to each of the four areas. Comments from one or more experts from each area addressed specific aspects of accuracy, accessibility, appeal, and appropriateness, which reflects the specialized knowledge experts brought to the testing of the lmSpec manual.
Document Testing

Document testing, defined as the "cluster of techniques used to assess the accuracy, appeal, and appropriateness of a document" (Burnett, 1994, p. 47), is a critical part of document development. Testing is especially important when the document's audience includes international readers because it allows writer(s) of a document to get feedback from different perspectives that can be helpful for revision. After making revisions that document testing suggests, companies can "improve usability before our customers have unpleasant experiences with product presentations that aren't usable enough" (Rosenbaum, 1989, p. 211). Efforts to gain information about a manual do not need to be elaborate or expensive to be effective. An organization with limited resources can still gather valuable data on a limited budget. A well-planned, yet simple, document testing program outweighs "an ambitious program that can't be carried out with rigor" (Rosenbaum, 1989, p. 216).

Time up front to create an effective document with guidance from a combination of testing methods is worthwhile when compared to the price (in dollars and time) of releasing a document without performing any form of testing. Not testing is expensive because "customizing, retrofitting, redesigning, or servicing complex and difficult systems can be many times greater than the costs of designing for usability" (Potosnak & Koffler, 1986, p. 80).

Researchers identify other more specific benefits of document testing: reduced errors, reduced training requirements, reduced employee time requirements, reduced fatigue and boredom, increased user acceptance, increased efficiency, increased productivity, increased convenience of use, increased reliability, and improved maintainability (Potosnak & Koffler, 1986). Potosnak and Koffler add that "in today's market, the number of people who are experiencing the negative effects of products they cannot use is increasing. It can be expected therefore that products with a proven level of usability will give companies additional marketing advantages" (1986, p. 80).
The next three sections are based on document testing's basic categories: text-based, user-based, and expert-based (Schriver, 1989).

**Text-Based Testing**  
Text-based testing methods rely on various formulas or principles to evaluate the quality of text; many of these methods arrive at a score for the text to rate its usefulness to readers at different reading levels (Duffy, 1985; Hartley, 1984; Schriver, 1989). Karen Schriver lists readability formulas and computer-based stylistic analysis programs (or text-editing programs) as two examples of text-based testing (1989, p. 242). Thomas Duffy explains that readability formulas are widely used because "the formulas are objective and therefore can be used as legal and contractual criteria. . . . The simple counting characteristic of most have made them readily adaptable to computer application" (1985, p. 114).

In a study of an article he had written, James Hartley looked at types of feedback from a text-editing program. In addition to readability scores from the program, Hartley reports comments related to spelling errors, punctuation errors, word repetition, split infinitives, passives, words, sexist phrases, awkward words or phrases, sentence length, and sentence types. Hartley writes information from "such programs can be of great use to authors" (1984, p. 43), but both Schriver (1989) and Duffy (1985) caution against the widespread use of readability formulas because their results may be misleading.

**User-Based Testing**  
Instead of the text-based testing methods' reliance on formulas and, often, on computers, user-based testing involves participants who are representative of typical users of the product. These representative user participants complete tasks that actual users of the product would complete. Writers collect data from test participants to help revise the document before releasing it to customers. User-testing participants offer a different perspective about the product than the product developers. Product developers can do their best to predict what users want to be able to accomplish with the product, but user testing presents the opportunity for product developers to find out how users actually respond to the product.
Writers' carefully selected scenarios solicit test participants' recorded actions and words while completing specific tasks. A scenario sets the scene for test participants and guides their actions. Writers can then collect information about the product and examine how test participants interact with it. Writers commonly ask participants to complete specific tasks while talking aloud. Having participants verbalize their thoughts as they complete the tasks is called a think-aloud protocol, a common method in user testing (Dumas & Redish, 1993; Grice & Ridgway, 1991; Rubin, 1994; Sullivan, 1989). Think-aloud protocols help writers get an idea about why participants responded and acted in certain ways during the testing session.

As helpful as user-based testing is, it still has its limits. Kathleen Potosnak and Richard Koffler (1986) explain that if writers rely on user-based testing to make every decision, projects may never end because individual users will always be able to find something that could be changed. Rather than relying on user-based testing to decide every small change to make, writers should rely on user-based testing "for the 'big' decisions, the novel applications, and the critical stages of a design" (p. 83).

**Expert-Based Testing** Expert-based testing methods are another helpful type of testing tool available to writers. Researchers in addition to Potosnak and Koffler agree that a combination of testing methods is most effective for testing documents (Dumas & Redish, 1993; Jeffries & Desurvire, 1992; Rosenbaum, 1989; Schriver, 1989). Schriver lists types of expert-based testing methods including peer review and subject-matter expert review (1989). Joseph Dumas and Janice Redish include heuristic testing as another method of expert-based testing. Expert-based testing methods combine well with user-based testing methods.

Peer review, as Schriver explains, is useful because writers' peer reviewers can address "issues of style, consistency, tone, and the like. . . . Writers can find that peers are helpful in making suggestions to solve organization problems" (1989, p. 245). Schriver explains that
subject-matter experts typically evaluate content to check a document's "coverage, accuracy, authenticity, or completeness" (1989, p. 245).

In addition to Schriver's categorization, heuristic testing is a type of expert testing. A *heuristic* approach is defined as "a method of solving problems; a series of steps or questions which are likely to lead to a solution of a problem" (Woodson, 1979, p. 28). *Heuristic testing* is a "method in which a small set of evaluators [examines] a user interface and [looks] for problems that violate some of the general principles of good user interface design" (Dumas & Redish, 1993, p. 65). For example, Heather Desurvire and her colleagues used heuristic testing methods with experts as test participants in their study of a telephone-based interface to compare expert-heuristic testing to other testing methods (1992). For the heuristic testing, experts were lectured about the heuristics they should use to evaluate the interface. The experts then used heuristics to assess the interface and predict problems users might have. The heuristic-testing participants uncovered 44 percent of the errors that user testing discovered in the laboratory (p. 99).

Heuristic testing methods complement user-based testing methods well because heuristic testing uncovers local, or minor, problems (Dumas & Redish, 1993, p. 67). To discover local problems in written documents, writers can use the same heuristic testing methods that Dumas and Redish describe for evaluating user interface design. Two other researchers, Jeffries and Desurvire, compared user-based testing methods and heuristic tested methods. These researchers found that heuristic testing is useful, but they add that at least three to five reviewers must participate in the testing because one heuristic reviewer "is consistently the weakest way to evaluate" (1992, p. 40).

Writers can practice more than one of the expert-testing methods Sullivan describes to learn about and revise a document before releasing the document to customers. For example, a document intended for an international audience, such as the ImSpec manual, could benefit from peer review and subject-matter expert review. Writers' peers can offer valuable feedback
about the design of the manual. Experts who are knowledgeable about the technical subject can help evaluate the content of the manual for content coverage, accuracy, and so on. ESL experts can offer valuable information as well because they can evaluate how non-native English speaking readers may work with the manual. A fourth, combined category of non-native English speaking subject-matter experts offers feedback from the perspective of a subject-matter experts and readers who are not reading the manual in their native language.

**Document Testing's Benefits**

Resistance to delaying the release of a product (Gillmor, 1995, p. 6) or finding funds for document testing does not need to keep writers from testing documents before they reach customers. Although the price of equipping a typical usability testing laboratory is about $20,000 (Dumas & Redish, 1993, p. 95), heuristic testing methods are potentially a less expensive testing method. In response to "increasing interest in finding usability testing methods that are easier and cheaper to implement than laboratory usability testing" (Desurvire, Kohdzieła & Atwood, 1992, p. 89), Desurvire and her colleagues studied heuristic evaluation and usability testing. *Usability testing* involves usability, or human factors, experts who evaluate, for example, the user interface of computer programs (Desurvire, Kohdzieła & Atwood, 1992, p. 89), whereas *user testing* involves representative users of the software who interact with the software and/or the user manual. Desurvire and her colleagues report that their study shows the usefulness of heuristic testing methods and that "these methods are particularly useful by experts. While they cannot replace expert knowledge nor eliminate actual laboratory testing, they [heuristic testing methods] have the potential to significantly reduce the time and cost for evaluation and the severity of problems that occur in the prototyping stage" (1992, p. 100). For my study of the prototype or draft of the ImSpec manual, I applied heuristic methods used for computer interfaces to the manual.

**Document Testing and My Research Question**

Expert-based testing in particular influences the research question I investigated: How does participants' expertise influence
expert testing of a technical user manual? In my expert testing of the ImSpec user manual, responses from experts from three areas of expertise varied widely. Their responses left me with important decisions to make and a variety of input on which to base those decisions. Chapters 3 and 4 contain discussion of the decisions I made about the ImSpec manual after expert testing.

Document Testing and Accuracy, Accessibility, Appeal, and Appropriateness

Expert-testing methods can help determine a document's effectiveness in each of the four areas of accuracy, accessibility, appeal, and appropriateness. First, testing measures accuracy because test participants use and can find errors (granted, participants can never be expected to find all errors) in the document during testing. Second, a document's accessibility (or inaccessibility) can also surface during document testing. If test participants are unable to locate information in a document to respond to test questions correctly, writers should reconsider the document's organization and structure before releasing the document to customers. Test participants can also evaluate a document's appeal. Writers should reevaluate the document's appeal if test participants' comments identify problems with the visual or textual attractiveness. Finally, document testing can influence whether or not the document is appropriate for its intended audience. For example, an ESL expert can comment about whether or not non-native English-speaking readers may have trouble processing information in the text. For this reason and others, ESL experts can help writers create documents for an international audience.

English as a Second Language (ESL)

Writers need to address the specific concerns of audience members who are non-native speakers of English. Not addressing these concerns can prevent effective communication to that group of audience members. Translation and Controlled English are two methods of helping non-native speakers learn from manuals. Writers should overcome communication
Writers must overcome three barriers in order to communicate effectively with non-native speaking audience members (Sanderlin, 1988). First, the language barrier is obvious. Communicating in a native language to other native speakers of the language is difficult enough; introducing differences in language and native and non-native speakers of the languages only increases the difficulty of the communication.

Sanderlin's second barrier is culture. She writes that "people from different countries have different values, different beliefs, different habits—in other words, different cultures... Writers who fail to understand the differences among cultures will write unsuccessful manuals" (1989, p. 97). Other authors also describe the numerous cultural considerations they have faced when writing for international audiences. Mary Elizabeth Raven (1991) offers general advice to technical communicators who address international audiences. She says technical communicators should "increase their awareness [of culturally diverse audiences] by taking courses in foreign languages, civilization, cultures, and even international marketing" (1991, p. WE-13).

Audience members' culture affects their learning style, which is Sanderlin's third barrier. For example, she cites the learning style of Japanese people, which is different from the learning style of Americans. Sanderlin suggests that writers should keep in mind that Japanese people may be more tentative about learning information than Americans; by "introducing new topics slowly and giving substantial background information," writers can make their documents more effective for Japanese audience members (Sanderlin, 1988, p. 97).

**Translation and Controlled English**  
This section includes a discussion of translation methods, Controlled English, and ways that ESL issues influence my research question and their relation to accessibility, appeal, and appropriateness. To communicate to audience
members who speak other languages, writers often rely on various methods of translation. Another option for writers who write for international audiences and do not want to use translation involves Controlled English, a method of limiting vocabulary and stylistic choices.

**Human translation**  
**Human translation** Human translators (compared to mechanical or computer) translation "produce the most natural sounding information" (Henke, 1990, p. 91). Natural-sounding text is important because if the language of the text does not sound natural, "the writing will prevent readers from understanding the instructions" (Sanderlin, 1988, p. 96). However, finding a human translator is not always an easy task because finding someone to translate into less common languages can be difficult (Sanderlin, 1988; Henke, 1990).

Because translators can be so important to the development of a document, John Wilhelm cautions writers to check translators' references to look for experience in the same industry because "a good social translator may not necessarily be a good technical translator" (1986, p. 192). Writers, however, are not always able to carefully select the translator for a project, leaving them with the problem "that the caliber of the translators who will be handling their texts is a question mark... Unless a text makes allowance for the initial readership of practical linguists [translators], the concepts it embodies are very likely not to arrive intact in the translation. The likely result will be a blurring of the intended information transfer" (Datta, 1991, p. 147).

**Machine, or computer, translation**  
**Machine, or computer, translation** Computer translations rely on complex computer programs to translate text from one language to another (Henke, 1990; Sanderlin, 1988) Experts who specialize in both linguistics and computer programming are needed to create the programs (Henke, 1990, p. 91). Sanderlin reports that "machine translation is about 80% accurate for translation into French, Spanish, and German (1988, p. 97). Computer-translated text requires the additional attention of human translators (Henke, 1990; Sanderlin,
1988) who need to apply their knowledge of concepts and contact technical experts to complete the translation.

**Controlled English**  Writers can use Controlled English, which limits the amount of English their readers need to know to be able to understand a document. Documents written using controlled English do not need to be translated into other languages because readers learn only the words in the limited vocabulary rather than the entire English language. Writers also use simple sentence structure in the documents (Henke, 1990; Sanderlin, 1988).

**Arguments Against Translation and Controlled English**  Translation and Controlled English face several obstacles. Finding a good translator is difficult but important because the translator is the writer's key to communicating to audience members who will read the document in another language. "Translators," WandaJane Phillips explains, "need to be able to understand the original text to render it into the target language. Errors are introduced during translation. Some are simple human error, but many are the results of a misunderstood source text" (1992, p. 96). To avoid problems with translators misunderstanding text, Jean Datta suggests that writers should consider the translator as a member of the audience because how well the translator understands the text directly affects how clearly he or she translates the text for other readers (1991, p. 147). Datta adds that, "if the text in question is aimed at a worldwide readership, there will not be one translator working under one set of conditions, but many" (1991, p. 147).

Translating text is expensive. The price of human translation is related to the extensive amount of time it adds to the document development schedule. A translator can typically translate around 4 pages per day; translating a document into another language takes about the same number of people as it takes to create the document in its original language [as cited in Henke, 1990, p. 91]. The average price of each page of text that a human translates is about $30, and computer translation runs from $7 to $12 [as cited in Henke, 1990, p. 91].
Controlled English faces complaints also. Writers often complain because they think the writing is not stylistically "good" (Henke, 1990). Sanderlin explains that "because writers using Controlled English have limited vocabulary and stylistic choices, they must first become familiar with the choices available to them and then become comfortable with the limits of Controlled English. Writers using it often feel restrained by the limited vocabulary" (1988, p. 98).

**Alternatives to Translation** Translation into readers' native languages is not always an option to writers whose documents will reach readers around the world. Non-native readers may be members of the writer's audience for several reasons. For example, a small software company may not have the funds or resources for preparing its documents in a language other than English. On the other hand, a large company may choose not to prepare documents in languages other than English. For instance, the company may have customers in many countries, but it is not realistic to expect the company to produce the document in the native language of every reader in each of the countries the company sells its product.

While there exists a significant body of research about non-native readers and writers, virtually none of this research address non-native readers/writers editing procedural texts as part of their professional responsibilities. Therefore, I have focused my discussion here on key points about non-native speakers that most usefully inform my work.

**Considerations for Non-Native Speaking Audience Members** The advice of Lisa Blaschke and others (see Boiarsky, 1992; Datta, 1991; Henke, 1990; Sanderlin, 1988; Spencer & Yates, 1990) is similar for writing in English when the audience includes non-native English speakers:

- use consistent structure
- avoid words with multiple meanings
• avoid humor

• avoid jargon (1992, p. 92-94)

Blaschke explains that consistent structure is important because it is readers' "road map" (1992, p. 92) for finding their way around the documents writers create. Writers should avoid words with multiple meanings because, as Blaschke explains, "one word can sometimes have three or four interpretations. The one word you use in your documentation could have two or three misinterpretations besides the interpretation you intended!" (1992, p. 93). Also, writers should avoid humor because even native speakers of English do not always "get" the joke, and readers who are non-native speakers of English will likely have even more trouble. Jargon specific to one field or another is difficult for experienced translators to put into another language, and typical non-native readers of documents have even more trouble working with jargon because the term may have an entirely different meaning when the readers need to come up with a word in their own language that is similar to the jargon.

Audience members' cultures may influence how they approach reading a document. Cultural thought patterns, Kaplan (1966) explains, may influence the text that non-native English speakers produce in English. Because non-native English speakers learn the grammar, sentence and paragraph structures of their native language, they may also apply these patterns to their writing in English. For example, the *jo-ha-kyuu* and *ki-shoo-ten-ketsu* writing styles influence how native Japanese speakers write in Japanese (Hinds, 1982, p. 79), and this influence may relate to how Japanese speakers write documents in English. This influence of the two Japanese writing styles could in turn affect how native Japanese speakers approach reading a document.

**ESL and My Research Question** ESL issues are related to my research question because non-native readers are even more difficult to communicate with effectively than are native readers. Gathering input from ESL experts during expert testing gave me a different
constructions are poorly written. Writers should use passive voice only sparingly in technical manuals intended for an international audience because passive-voice structures can create problems for non-native English-speaking readers (LoMaglio & Robinson, 1985).

As a review of active and passive voice, Larry LoMaglio and Victoria Robinson's explain:

Voice refers to the active and passive use of a verb. The active voice is used to make a direct statement without an action; the executor of the action is the subject of the sentence, such as in "A technician used an oscilloscope in the experiment." The executor of the action is "a technician." However, passive voice is used when an indirect statement is made about some action, e.g., "A voltmeter was used in the experiment by the technician." The subject of the sentence is the receiver while the original executor of the action is the object of the sentence preceded by the preposition "by." (1985, p. 26)

Passive constructions are a technical writing tradition and frequently attract the attention (often, but not always, negative attention) of writers (Bush, 1981; Connolly, 1958; Corey & Rhodes; Couture; Fraser, 1992; Gould, 1960; Lippincott, 1983; LoMaglio & Robinson, 1985; Porter, 1991; Ramsey, 1980; Rodman, 1995; Rook, 1980; Schindler, 1967) who suggest writers minimize passive voice. Some suggest that writers should not use passive voice at all. Glenn Broadhead (1985) cites numerous additional sources specifically related to passive voice in technical communication, reflecting what Broadhead explains as the "extensive comment" passive voice has received.

Despite tradition, writers should limit passive constructions because they can interfere with how well readers learn from the manual. In his study with British college students as his test participants, David Ramsey (1980) found that students best comprehended sentences written in first person active voice. He compared first person active voice constructions to first person passive, third person active, and third person passive. Participants in his study had the most trouble comprehending third person passive constructions. Although third person passive constructions less effectively communicated information to readers, test participants'
"appreciation" (p. 110) was highest for this sentence form. Participants' appreciation for third person passive reflects other writers' opinions; Ramsey notes that third person passive constructions are "the grammatical structure which tends to prevail in twentieth-century technical English" (p. 109).

Passive constructions may prevail in the twentieth century, but they can cause a "significant communication breakdown" (LoMaglio & Robinson, 1985, p. 26). Agentless passive constructions in particular can be especially problematic for non-native readers. For example, the passive sentence "The engineer's voltmeter was fixed by a technician" (p. 26) should not cause problems for most readers. However, non-native readers may interpret the sentence "The engineer's voltmeter was fixed" (p. 26) to mean "The engineer fixed the voltmeter" (p. 26). Writers should avoid passive constructions because they clearly cause potential problems for non-native readers.

Second and Third Person In addition to passive voice, authors criticize the scientific tradition for using third person (Fraser, 1992; Martin, 1986; Nadziejka 1989; Rook, 1980). Person (first, second, and third) is the way writers classify personal pronouns in sentences. With first-person pronouns (e.g., I, we) writers refer to the writer/speaker, whereas a second-person pronoun (e.g., you) speaks to the reader, and third-person pronouns (e.g., he, she, it, they) speak about the readers (Hairston & Ruszkiewicz, 1993, p. G-42). One author offers writers the advice to "write the way you speak" to avoid using third person and address readers as "you" (Fraser, 1992, p. 188) rather than as the reader. Computer-manual users should also read "you" in manuals. "The writer must talk to the user, not the system. He must stop describing how the system will respond to a given input ('If the reply is YES the retrieved data is written to a disk file'), and tell the user what he must do to achieve a certain results ('If you want to save the retrieved data in a disk file, respond with YES')" (Martin, 1986, p. 20).
Bulleted Lists and Linguistic Cues  Bulleted lists, the third textual feature I consider in this study, are also helpful to users of manuals. Lists (e.g., bulleted, numbered) are an alternative to making users learn from text formatted in sentences and paragraphs. Saul Carliner (1987) explains that lists help readers understand relationships among items in a list. Lists also help writers condense information into chunks for better accessibility and prevent repeated words that sentences with parallel structures would require.

Sentences presented in a paragraph may be less visually appealing and require more time for readers to process than the same information present in a list. Bulleted lists specifically, as Charles Kostelnick (1989) explains, are examples of an inter-textual level of visual design. They are inter-textual cues because they "enable readers to identify relations among textual units" (Kostelnick, 1989, p. 79). Carliner adds that bulleted lists should be used "when the items on the list are equally important and should not be considered to be in any order" (1987, p. 219).

Diction and My Research Question  Diction choices relate to my research question because they are the focus of the questions I asked experts to respond to during expert testing of the user manual. Various experts' responses to the test questions helped me concentrate the feedback on textual features, including diction choices, rather than limiting feedback to information about the technical accuracy from subject-matter experts.

Diction and Accuracy, Accessibility, Appeal, and Appropriateness  Feedback about diction can help assess all four areas of accuracy, accessibility, appeal, and appropriateness. Passive voice specifically relates to accuracy of the manual because, as LoMaglio and Robinson (1985) explain, passive-voice constructions can prevent non-native readers from accurately processing information in the manual. Diction choices also relate to accessibility. For example, structuring information in the form of bulleted lists rather than as sentences in paragraphs makes text more accessible to readers (Carliner, 1987).
In addition to aiding accuracy and accessibility, diction choices relate to a document's appeal. Bulleted lists also influence a document's visual appeal because, in addition to helping find the information more easily, bulleted lists make a page more visually appealing than a page of paragraphs. In addition to visual appeal, diction choices can influence the textual appeal of a document. Use of second person ("you"), for example, helps make computer user manuals more effective for readers (Martin, 1986). Diction choices may also affect a document's appropriateness. Using active voice and second person, which contradicts the traditions of passive voice and third person in technical communication, may be enough to make a document inappropriate for readers.

In this chapter, I have raised the question "How does participants' expertise influence expert testing of a technical user manual?" Expertise's domain specificity, expert testing's feedback, ESL's influence, and diction's impact on the manual all contribute to answering my question. In the following chapters, I explain the methodology of my study and discuss its results and implications.
CHAPTER 2
GATHERING EXPERTS' FEEDBACK

In an effort to answer the question, "How does participants' expertise influence expert testing of a technical user manual?" I conducted expert testing with participants from three areas of expertise. By gathering responses from this group of test participants, I investigated the wide variety of perspectives that writers can look to for feedback when they prepare a document with the rhetorical complexity of the ImSpec user manual.

I used expert-testing methods for collecting responses from participants in this study. Twelve experts from three areas of expertise participated in the study by answering questions that focused on specific textual features of the ImSpec manual. The following sections describe in detail the participants in the study, collection of data, and analysis of the data.

Participants

The twelve experts who agreed to be part of this study are Iowa State University (ISU) faculty members or Ames Laboratory staff members. Six experts are ISU English Department faculty and speak American English as their native language. Six experts are Ames Lab staff members; three of these experts are native speakers of American English, and three are non-native speakers of English.

Participants' professional specialization and use of the English language were important for selecting participants because these factors influenced the perspective each expert brought to the testing of the manual. Three ISU English department faculty members who specialize in English as a Second Language (ESL) made up the first group. They offered expert feedback about how well non-native speakers of English might be expected to use the manual. Feedback from members of the second group of experts—three faculty members from the ISU English department who specialize in rhetoric and professional communication (RPC)—articulated their
knowledge about effectively written documents. Three Ames Lab staff members who are native speakers of American English made up the third group of experts. These three experts are specialists in materials science and engineering (MSE). These experts' knowledge of the technical subject matter influenced the content of their comments. The fourth group of experts—Ames Lab materials science and engineering specialists who are non-native speakers of English—brought the combined perspective of subject-matter expert and non-native speaker into the testing of the manual.

Four categories of experts addressed important areas for review of the ImSpec manual. The ESL faculty that I selected are the ESL reviewers of the manual. My selection of RPC faculty matches Schriver's (1989) category of peer expert reviewers (p. 245), and the materials science engineers are examples of what Schriver categorizes as subject-matter expert reviewers (p. 245). I selected the 12 participants in the study because of their knowledge of their fields. The ESL experts had strong reputations for working with non-native English speakers. The RPC experts had extensive knowledge of visual communication, international communication, and instructional materials. With the help from other Ames Lab employees, I selected the MSE experts with broad knowledge of their technical field and willingness to participate in the study. Participants from each of the groups represent a range of years of experience within their domains. One expert has worked professionally for one-and-a-half years, while an expert in another area has worked in her area of expertise for 37 years.

The number of participants is important because it allows three participants from each group of experts to evaluate the manual. Three is the acceptable minimum number of participants in testing (Jeffries & Duservire, 1992, p. 40) to determine if results are "idiosyncratic behavior or something that is likely to generalize across the subgroup" (Dumas & Redish, 1993, p. 128).

Members of the four groups of experts have different educational backgrounds, although similar educational levels. At least one member of each of the four groups spoke more than one
language. Only three of the twelve experts speak or read only English. The three non-native English-speaking MSE experts represent a spectrum of English-language use. While one of the non-native English-speaking experts considers himself bilingual, another subject-matter expert, at the other end of the spectrum, continues his efforts to master basic elements of the English language. The third non-native English-speaking expert’s use of English falls between the other two because he speaks English well, but does not consider himself fluently bilingual. Eleven of the twelve experts have earned a PhD. (See Table 1 in chapter 3.) These characteristics of the experts are relevant because one or both factors influence their feedback about the manual.

Collection of Data

The Iowa State University Human Subjects Review Committee approved the use of human subjects to gather three types of data:

- pre-test questionnaire responses
- expert-testing responses
- follow-up interviews

Pre-Test Questionnaire

Before they evaluated the manual, each participant completed a brief questionnaire. I developed the questionnaire to collect demographic information about the experts (See Table 1 in chapter 3). The questionnaire also asked each participant to list three examples that support the opinion that he or she is an expert within his or her discipline because I wanted to know, from the perspective of the experts, why they consider themselves experts in their discipline. (See Appendix A for the pre-test questionnaire.)
Expert-Testing Responses

I collected feedback about the ImSpec manual from the experts in the form of responses to questions asked in the expert-testing materials. (See Appendix B for the expert-testing materials.) I instructed the experts to briefly review the entire ImSpec manual and then carefully read the introduction, chapter 5, and the glossary. (See Appendix C for these pages of the manual that experts read.) I chose these pages of the manual because they were representative of the rest of the manual and were a reasonable amount of text for me to ask participants to read. After reading the specified sections of the manual, the experts responded to eight questions. Experts answered two questions related to each of these four specific aspects of the manual:

- active voice
- second person
- inter-textual cues
- audience

I selected these features of technical text as the focus of my investigation for various reasons. First, passive voice commonly receives specific attention in discussions of technical writing (Bush, 1981; Fraser, 1992; LoMaglio & Robinson, 1985; Rodman, 1995; ). I expected that an instructional text, with its goal of persuading readers to perform an action in a particular way, could benefit from active voice like any other form of technical writing. With that as my expectation, I was interested in the way different experts responded to the manual’s use of active voice. I expected the professional communication experts and ESL experts to react favorably to the use of active voice; research in communication supports the use of active voice because it makes information easier for readers to comprehend than passive voice (LoMaglio & Robinson, 1985; Ramsey, 1980). I expected active voice to cause negative reactions with the
engineering experts (native and non-native English-speaking) because of passive voice's established tradition in technical documents (Schindler, 1967).

Another characteristic of scientists' writing, "objectivity," influenced my focus on second person. Scientists who author technical documents traditionally refer to themselves in the text using third person in an effort to attain the idea that scientists are objective observers of the situations they write about (Rook, 1980). In contrast to scientists' tradition of using third person in technical documents, instructional text is more effective when written in second person (Martin, 1986). Again, I was interested in how different experts responded to the manual's use of second person. I expected the RPC experts and ESL experts to react favorably to the use of second person and imperative mood because instructions are most effective when written in this way (Martin, 1986; Rook, 1980). On the other hand, I expect the engineering experts to react negatively to second person and imperative mood in the instructions because the use of "you" in scientific text goes against the experts' expectations for a technical document.

I chose textual cues as the third characteristic to focus on because of my interest in the effective visual display of information. For this study, I consider bullets as inter-textual cues (Kostelnick, 1989); I consider commas, periods, and sentence structure types of linguistic cues. All text, including traditional scientific writing, has linguistic cues, but the manual the experts responded to also includes inter-textual cues to help present and structure the instructions.

The final questions of the expert-testing materials asked the experts to consider the technical level of language's appropriateness for its audience of professional engineers and technicians in engineering laboratories. Experts' responses to the questions about the more general audience considerations gave me feedback about a specific aspect of the manual that experts chose, rather than the more specific focus I chose in the other three sets of questions.
To be certain each expert understood the voice, person, and cues features that I wanted them to focus on, I discussed each feature with individual experts. I showed them specific passages from page 23 of the ImSpec manual and then read aloud how the same passages would appear in the manual if they were passive voice, third person, and without inter-textual cues. I chose these examples, and this specific page, because it contains examples of all three features that I wanted to point out to experts. Having an example of each one of them on a single page was the least distracting way of presenting the examples to the experts because I didn't need to flip to different pages in the manual. Table 2-1 lists an example for each textual cue of voice, person, and cues.

Table 2-1: Examples of specific passages I showed and read to experts.

<table>
<thead>
<tr>
<th>Voice</th>
<th>Person</th>
<th>Cues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appears in Manual</td>
<td>Read Aloud During Participant Training</td>
<td></td>
</tr>
</tbody>
</table>
| Any of several actions may have caused the discrepancy. (Active Voice) | The discrepancy may have been caused by any of several features. (Passive Voice) | Any of several actions may have caused the discrepancy:  
  - You may have added too many data files.  
  - You added the wrong data file(s).  
  - You didn't add enough data files.  
  - You inadvertently disabled a plot box. (Linguistic Cues) |
| If you added the same files listed in Figure 4's legend, your graph should be identical to the graph in Figure 4. (Second Person) | If the user added the same files listed in Figure 4's legend, the graph should be identical to the graph in Figure 4. (Third Person) |

Responding to the questions required less than two hours of the experts' time. Participants returned their completed testing materials to me in hand- or typewritten form or sent their
responses via electronic mail. I received some responses back as quickly as one day after the expert received the questions and as slowly as 10 days after receiving the questions.

Follow-up Interviews

I conducted 12 individual 10-15 minute follow-up interviews after all the experts returned their responses to me. For the follow-up interview, I focused on specific responses to the expert-testing questions. Some experts did not answer all the expert-testing questions, so I asked them again to respond to the question during the follow-up interview. I also asked the participants to address contradictions or conflicts that the experts had with each others' responses. I asked experts who made distinctive point(s) in their responses to expert-testing questions elaborate about these responses. Finally, I questioned the experts about topics related to their individual areas of expertise (e.g., technical accuracy). This focus during the follow-up interviews allowed me to clarify and/or complete experts' responses to the expert-testing questions. (See Appendix D for examples of follow-up interview questions.)

Analysis of Three Categories of Data

I analyzed three different types of data. The first type of data came from the pre-test questionnaire in which I gathered demographic information about the expert test participants; this data helped me understand the background that participants brought to testing the manual. The second type of data came from the responses to the eight expert-testing questions about the manual. Finally, the third type of data came from follow-up interviews that focused on certain aspects of participants' responses to expert-testing questions. Table 2-2 summarizes the types of data and their purpose and explains how I analyzed each type of data.
Table 2-2: Types of data, their purpose, and analysis.

<table>
<thead>
<tr>
<th>Data</th>
<th>Purpose</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-test questionnaire</td>
<td>Recorded demographic information about participants</td>
<td>Compared participants' educational background and years of experience</td>
</tr>
<tr>
<td>responses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expert-testing responses</td>
<td>Collected experts' evaluation of the manual in the form of responses to specific questions</td>
<td>Compared comments to other group members' comments and other types of experts' comments</td>
</tr>
<tr>
<td>Follow-up interview responses</td>
<td>Addressed specific aspects of the participants' responses and comparisons of other experts' responses</td>
<td>Answered questions or clarified issues raised by expert-testing responses</td>
</tr>
</tbody>
</table>

Pre-Test Questionnaire

To analyze the pre-test questionnaire, I grouped relevant demographic data about each of the 12 experts. I also organized data to identify the details about the experts' background that they brought to the testing of the manual.

Expert-Testing Responses

I analyzed the expert-testing responses by comparing participants' responses to other participants within the same group of three experts and to other participants in other expertise groups. I looked for patterns that reflected experts' agreement or disagreement with other members of their group, and then I compared those patterns to other groups' responses to see the ways groups of experts agreed or disagreed with each other.

Follow-up Interviews

I included content from the follow-up interviews in my analysis of the expert-testing responses. Follow-up interviews with individual experts helped answer questions raised by experts' written comments. For example, during follow-up interviews, I asked 11 experts these questions: "Do you think language features in the manual (specifically "you") make the manual more informal than other manuals? Is the manual too informal?" I asked these questions during the interview because RPC Expert 1, in her written responses to the expert testing,
commented that "a few cases that add the 'you'... to intentionally make the language more 'you-centered' might be overkill." Because of her written response, I wanted the other experts to specifically address RPC Expert 1's concern.

In some cases, experts' written responses to the expert heuristic testing led to additional questions for the experts or responses that I wanted to clarify. For example, native English-speaking MSE Expert 3 wrote that the language that I used in the manual "is very detailed yet very clear and therefore quite appropriate" for users who are unfamiliar with the manual's subject. During the follow-up interview I asked this expert, "Do you think the level of detail that is helpful to new users will be too much (even bothersome or annoying) for those users who are more familiar?"

Overall Analysis of Data  The three types of data I collected led to two types of comparisons. First, I compared each expert's responses to the responses of the other two experts in the same group. I made this comparison to see if experts with similar professional backgrounds offered feedback that was similar. The second comparison I made was among groups. For example, I looked at how the ESL experts' responses compared to the RPC experts' responses and the two MSE groups of experts. I made this comparison for each of the four groups. I compared the groups' responses to look specifically at the similarities and the range of differences in how individual experts and groups of experts responded to the questions.
CHAPTER 3
ALL EXPERTS ARE NOT CREATED EQUAL:
BENEFITING FROM EXPERTS' COMMENTS
ABOUT A TECHNICAL USER MANUAL

A paper to be submitted to *IEEE Transactions on Professional Communication*
Kate Molitor

As the documentation specialist on a software development team, I faced the challenge of writing the user manual for ImSpec, a technical computer program. The manual and program were part of a technology transfer project that involved a small, locally owned, entrepreneurial company, MidLand Software, Inc., and a mid-sized midwestern research university. The project's goal was to enhance a DOS-based computer program by translating it to a Windows format and to increase its capabilities. A university materials science and engineering faculty member led this project because he had supervised the graduate student who wrote the original DOS version of the computer program. The owner of MidLand Software was involved because his company specialized in computer programs for engineers and scientists. Additional members of the project team included two student computer programmers.

The manual and MidLand Software's efforts were intended to make ImSpec appeal to a highly specialized international market. MidLand and the university worked together to develop and market the computer program (and accompanying manual) to academic and research customers in the field of impedance spectroscopy. Researchers in this field of materials science and engineering study the distinctive features of materials' electrical properties in laboratories in the United States and other countries. Despite customers whose native language was not English, MidLand Software's size and limited resources prevented the manual from being translated into users' native languages.

Because the manual would not be translated, I faced the additional challenge of writing a manual that both native and non-native English-speaking readers would find accurate,
accessible, appealing, and appropriate. My challenge also included dealing with the rhetorical complexities that writers face when writing a complicated technical document.

Generally, a document is rhetorically complex if it fulfills multiple purposes, addresses multiple audiences, and chooses from among multiple options for organization and design. The ImSpec manual fulfills more than one purpose because it introduces the software to new users, and it also serves as a reference for users when they become more familiar with the software. Users will refer to the same manual for learning how to install the software and for refreshing their memory about how to complete a specific task. Members of the manual's audience, therefore, include new users and more familiar users in addition to audience members who are native speakers and non-native speakers of English and who have a different levels of experience and education. ImSpec's international audience ranges from laboratory technicians, with undergraduate degrees and a few years of experience to senior researchers with graduate degrees and many years of experience. The manual is organized to help both native and non-native readers locate tasks they want to complete rather than to identify how the software functions. The design of information in the manual helps users with numbered instructional sequences, bulleted lists, and visuals of images the software creates. Instead of listing instructions for completing tasks in sentence form within paragraphs, instructions appear as numbered lists for users to follow more easily.

Reviews of Expert Testing, ESL, and Textual Features

With the complexities of the ImSpec manual in mind, I wanted to answer the question, "How does participants' expertise influence expert testing of a technical user manual?" To answer that question, I investigated three general areas—expert testing, English as a Second Language (ESL), and textual features—to influence my decisions about the manual. After a brief review of expert testing, ESL, and textual features, I explain how I gathered responses from the experts who participated in the testing and then discuss the results of the expert testing.
of the manual. Finally, I include a discussion of the study's implications and guidelines for writers who prepare user manuals for international audiences.

Situating Expert Testing Within Document Testing

Expert testing is a type of document testing, which Burnett defines as the "cluster of techniques used to assess the accuracy, appeal, and appropriateness of a document." [1] To discuss document-testing methods, Karen Schriver [2] separates document testing methods into three categories: text-based, user-based, and expert-based. Text-based testing methods rely on various formulas or principles to evaluate the quality of text; many of these methods arrive at a score that rates the text's usefulness to readers at different reading levels. [2-4] Schriver and Thomas Duffy, however, both caution the use of text-based testing methods because their results may be misleading. Schriver notes that "a passage will be the same readability score whether its words are arranged in normal or backward order." [2] Duffy argues that "there are few if any proper applications of existing formulas that are of practical use." [2]

Instead of text-based testing methods' reliance on formulas and, often, on computers, user-based testing involves test participants who are representative of typical users of the product. Participants complete tasks that actual users would rely on the product to help them complete. The writers/test administrators collect data from test participants to help revise the document before releasing it to customers. [5] Researchers [2, 5-8] agree, however, that usability testing is most useful when combined with other testing methods, including expert-testing methods.

Expert-testing methods can help writers make rhetorically complex decisions because gathering feedback from various experts can help writers improve a manual's accuracy, accessibility, appeal, and appropriateness. These four areas—accuracy, accessibility, appeal, and appropriateness—are important because they influence the manual's effectiveness. If information in a document is inaccurate, whatever messages the document manages to convey to readers may mislead them. Even if a manual is completely accurate, readers may not get far
enough to judge the manual's accuracy if the manual is so inaccessible that they have trouble finding the section they're looking for. Making a document visually and linguistically appealing can help keep users' attention focused enough to continue reading and learning from the document without being distracted from or slowed in locating information. A document may be inappropriate if its contents and/or its level of detail are based on the assumption that readers know more about the subject than they do or that readers possess advanced English-language skills. With input from experts, writers can make better decisions about how to create and revise the manuals they write.

Examples of Expert Testing  Karen Schriver describes several kinds of expert-based testing methods. She explains that peer review is helpful for addressing "issues of style, consistency, tone, and the like. . . . Writers can find that peers are helpful in making suggestions to solve organization problems." [2] To check a document's "coverage, accuracy, authenticity, or completeness," writers can use another type of expert-based testing, subject-matter expert review. [2]

With subject-matter and other experts as test participants, Philippa Benson [9] investigated science text books. Benson collected feedback from expert designers, editors, and biologists to investigate how well picture and text combinations communicated ideas to readers of the textbooks. Benson's inclusion of designers and editors in the expert testing of the textbook is similar to my inclusion of ESL and rhetoric and professional communication (RPC) experts. Both Benson's and my studies include experts in addition to subject-matter experts. The results of her study, like the results of mine, would have been very different had she not included experts from different areas. Experts from different areas found different types of problems, and, if Benson had received feedback only from subject-matter experts, she would not have uncovered as many problems with the picture and text combinations in her study of expert testing.
As a sub category of expert testing, heuristic testing is another type of document testing available to writers. A heuristic approach is defined as "a method of solving problems; a series of steps or questions which are likely to lead to a solution of a problem." [10] Heuristic testing is a "method in which a small set of evaluators examine a user interface and look for problems that violate some of the general principles of good user interface design." [5] For example, Heather Desurvire and her colleagues (1992) used heuristic testing methods with human factors experts as test participants in their study of a telephone-based interface to compare expert-heuristic testing to other testing methods. Experts were lectured about the heuristics they should use to evaluate the interface. The experts then used the heuristics to assess the interface and predict problems users may have with it. Heuristic testing uncovered 44 percent of the problems that laboratory user testing found. [11]

The studies that Benson and Desurvire and her colleagues performed reflect the helpfulness and importance of expert testing, but they do not directly address the needs of non-native English speakers who are members of a technical user manual's audience. Studying a manual and its non-native speaking users is important because not all companies have the resources to translate user manuals into every user's native language(s). When writers face the added burden of communicating to users in other languages, expert testing can help writers make better-informed decisions about the manual.

Experts and the Expertise They Bring to Testing The way writers select experts to participate in expert testing is important because a person's expertise in one area, or domain, does not necessarily extend beyond that domain. [12] Carl Bereiter and Marlene Scardamalia explain that one reason this transfer of expertise to other domains does not occur is that achieving expertise requires "a great deal of time and experience." [13] Another researcher, Herbert Simon, reports that expertise in chess, for example, "takes thousands of hours to build up, and the same is true of any skilled task (e.g., football, music)." [14] In his explanation of
expertise, Michael Carter writes that it "is founded on local knowledge; experts are successful in their fields because they bring to their performance domain-specific knowledge attained through much experience within that domain." [15] Not everyone has thousands of hours to devote to developing experience, let alone multiplying those thousands of hours for multiple domains of expertise, so few people achieve expertise in multiple areas.

The complexities of domain-specific expertise influence expert testing of documents. Expertise influences how writers select experts as test participants and what feedback writers can expect to receive from experts. When writing technical documents, writers should look to more than subject-matter experts who can offer feedback only from their own domain. Other experts bring different domain-specific expertise to the document testing.

Feedback from experts from different domains may, however, have a common characteristic. This characteristic of expertise is calibration, which is experts' self-insight into the "accuracy of their predictions." [16] Colin Camerer and Eric Johnson explain that experts, unlike most people who are poorly calibrated, are less confident about the predictions they make. In other words, a seemingly overconfident expert may, in fact, not be an expert.

Understanding ESL's Influence on Technical Documents

In many instances, manuals are translated from their original language into readers' native languages. Humans and computers translate manuals into different languages. [17-18] Delivering manuals written in a language readers are fluent in is only part of the challenge of writing for an international audience. Writers need to consider an additional audience member—the translator—because "unless a text makes allowances for the initial readership of practical linguists [translators], the concepts it embodies are very likely not to arrive intact in the translation. The likely result will be a blurring of the intended information transfer." [19]

Instead of relying on translators to create new versions of a manual, writers can use Controlled English, which limits the amount of English their readers need to know to be able
understand the manual. Documents written using Controlled English do not need to be translated into other languages because readers learn only the words in the limited vocabulary rather than the entire English language. Writers also use simple sentence structure in the documents. [17-18]

Although writers commonly use translation and Controlled English, these methods of reaching members of international audiences do face several obstacles. Finding a good translator is difficult but important because the translator is the writer's key to communicating to audience members who will read the manual in another language. Jean Datta explains that, "if the text in question is aimed at a worldwide readership, there will not be one translator working under one set of conditions, but many." [19]

Translation is also expensive. The price of human translation is related to the extensive amount of time it adds to the document development schedule. A human translator can typically translate around four pages per day at the average price of $30 per page; computer translation runs from $7 to $12 per page. [as cited in 17] Controlled English faces obstacles unrelated to price. Writers who use controlled English typically complain that their writing is not stylistically "good" [17] because they have limited vocabulary and stylistic options to choose from. [18]

In addition to the language barrier, helping international audience members learn from manuals also involves overcoming two other barriers: culture and learning style. [18] Stacy Sanderlin explains that "people from different countries have different values, different beliefs, different habits—in other words, different cultures . . . . Writers who fail to understand the differences among cultures will write unsuccessful manuals." [18] Audience members' culture affects their learning style. For example, Japanese people's learning style is different from the learning style of Americans. Sanderlin explains that by "introducing new topics slowly and giving substantial background information" [18], writers may make their document more effective for Japanese audience members.
Understanding Textual Features' Influence on Technical Documents

Three textual features, in addition to non-native-reader issues, also influence the overall effectiveness of a manual. First, passive voice constructions, despite their continued use in technical documents [20-24], can cause problems for readers. Larry LoMaglio and Victoria Robinson report that passive constructions that do not include the agent or actor in the sentence can cause "a significant communication breakdown" for non-native readers. [25]

Regardless of readers' native language(s), a second textual feature—third person—can also influence a manual's effectiveness. Third person is not the best way to refer to manual users despite its continuing tradition in technical documents. Peter Martin's advice to computer documentation writers includes using second person ("you") because "the writer must talk to the user, not the system . . . [The writer] must . . . tell the user what he must do to achieve a certain result ('If you want to save the retrieved data in a disk file, respond with YES')." [26]

Bulleted lists, the third textual feature considered in this study, are also helpful to users of manuals. Lists (e.g., bulleted, numbered) are an alternative to making users learn from text formatted in sentences and paragraphs. Saul Carliner explains that lists, or textual cues, help readers understand relationships among items in a list and help writers condense information into chunks for better accessibility and prevent repeated words that sentences with parallel structure would require. [27] Sentences listed as complete sentences in the block form of a paragraph will be less visually appealing than the same information stated clearly in list form.

Collection of Responses from Multiple Areas of Expertise

I developed and applied the following methods to help answer my research question. I collected responses from experts from three different areas of expertise. Details about the experts, test materials, and collection of experts' responses follow.
Experts as Test Participants

This project's test participants included a total of twelve experts from three different areas: English as a second language (ESL), rhetoric and professional communication (RPC), and materials science and engineering (MSE). The three ESL and three RPC experts are all Department of English faculty members at the mid-sized research university where the technology transfer project took place. All six experts in the third area, MSE, are employees of the university's U.S. Department of Energy-contracted laboratory. I further classified these experts as native and non-native speakers of American English¹ to create two groups of experts from the one area of MSE expertise (for a total of four groups of experts—ESL, RPC, MSE-Native Speakers, and MSE-Non-Native Speakers). Three of the MSE experts are native speakers, and three are non-native speakers. The three non-native English-speaking MSE experts represented a spectrum of English-language use. While the native German-speaking expert considers himself bilingual, the native Japanese-speaking expert is at the other end of the spectrum and continues his efforts to master the English language. The native Ukrainian-speaking expert's use of English falls between the other two because he speaks English well, but he has not reached bilingual status. Each group of experts (RPC, ESL, MSE-native speaker, MSE-non-native speaker) offered a perspective on the project different enough from the other groups to warrant being included.

Test Materials

I collected three types of data from experts—pre-test questionnaire responses, expert heuristic testing feedback, and follow-up interviews. The pre-test questionnaire asked experts demographic questions about their native language, additional languages, academic degrees, 

¹I purposely did not include experts whose native country is India because Indian English is a native language for many Indians. Therefore, many citizens of India are native speakers of a form of English rather than non-native speakers of English just as United States citizens are native speakers of American English.
and years of experience in their area of expertise. Table 1 contains the experts' responses to the pre-test questionnaire.

The expert heuristic testing called for each expert to briefly review the entire ImSpec manual (a representative page from the ImSpec manual is printed as an appendix to this article) and then carefully read the manual's introduction, chapter 5, and the glossary. Experts then responded to the following questions:

- How does this manual's use of active voice compare with other manuals for computer software, especially technical manuals?
- How would you expect users to react to the use of active voice in the manual?
- How does this manual's use of second person compare with other manual's for computer software, especially technical manuals?
- How would you expect users to react to the use of second person in the manual?
- How does this manual's use of inter-textual cues (e.g., bulleted lists) compare with other manuals for computer software, especially technical manuals?
- How would you expect users to react to the use of inter-textual cues (e.g., bulleted lists) in the manual?
- How appropriate is the level of language for this manual's audience of professional engineers and technicians in engineering laboratories?
- What aspect(s) of language in this manual may non-native speakers of English have problems with?

Experts returned their responses to me in hand- or typewritten form or sent their responses via electronic mail.

I selected the textual cues of voice, person, and inter-textual cues as the focus of my investigation for various reasons. First, I chose passive voice because of the potential problems it may cause for readers. [25] I expected that instructional text, with its goal of persuading readers to perform an action in a particular way, could benefit from active voice like any other form of technical communication.

Another characteristic of scientists' writing, third person's "objectivity," influenced my focus on second person. Scientists who author technical documents traditionally refer to
<table>
<thead>
<tr>
<th>Expert</th>
<th>Native Language</th>
<th>Additional Language(s)</th>
<th>Academic Degrees</th>
<th>Experience (Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESL Expert 1</td>
<td>English</td>
<td>Spanish, Arabic, Japanese, and Setswana</td>
<td>MA English as a Second Language, PhD Linguistics</td>
<td>20</td>
</tr>
<tr>
<td>ESL Expert 2</td>
<td>English</td>
<td>German</td>
<td>AB German Language and Literature, MS Linguistics, PhD Second Language Acquisition and Teacher Education</td>
<td>28</td>
</tr>
<tr>
<td>ESL Expert 3</td>
<td>English</td>
<td>Spanish</td>
<td>MA English</td>
<td>14</td>
</tr>
<tr>
<td>RPC Expert 1</td>
<td>English</td>
<td>None</td>
<td>MA English, PhD Education</td>
<td>37</td>
</tr>
<tr>
<td>RPC Expert 2</td>
<td>English</td>
<td>(reads) French and English</td>
<td>B Architecture, MA English, PhD Comparative Literature</td>
<td>14</td>
</tr>
<tr>
<td>RPC Expert 3</td>
<td>English</td>
<td>Spanish and (reads) German</td>
<td>BA Math, MA English, PhD English</td>
<td>27</td>
</tr>
<tr>
<td>MSE-N Expert 1</td>
<td>English</td>
<td>None</td>
<td>BS, MS, and PhD Metallurgical Engineering</td>
<td>9</td>
</tr>
<tr>
<td>MSE-N Expert 2</td>
<td>English</td>
<td>None</td>
<td>BS, MS, and PhD Ceramic Engineering</td>
<td>8</td>
</tr>
<tr>
<td>MSE-N Expert 3</td>
<td>English</td>
<td>German, a little Spanish</td>
<td>BS, MS, and PhD Metallurgical Engineering</td>
<td>1.5</td>
</tr>
<tr>
<td>MSE-NN Expert 1</td>
<td>German</td>
<td>English, a little French</td>
<td>BS, MS, and PhD Physics</td>
<td>34</td>
</tr>
<tr>
<td>MSE-NN Expert 2</td>
<td>Japanese</td>
<td>English</td>
<td>BS, MS, and PhD Mechanical Engineering</td>
<td>18</td>
</tr>
<tr>
<td>MSE-NN Expert 3</td>
<td>Ukrainian</td>
<td>English and Russian</td>
<td>MS, PhD Inorganic Chemistry</td>
<td>16</td>
</tr>
</tbody>
</table>
themselves using third person [28] in an effort to convey the idea that scientists are objective observers of the situations they write about. In contrast to scientists' tradition of using third person in technical documents, instructional text is more effective when written in second person and the imperative. [26]

I chose textual cues as the third characteristic to focus on because of my interest in the effective visual display of information. For this study, I consider bullets to be inter-textual cues [29]; I consider commas, periods, and sentence structure types of linguistic cues. All text, including traditional scientific writing, has linguistic cues, but the ImSpec manual also included inter-textual cues to help present and structure the contents of the instructional material.

Experts also responded to the appropriateness of the manual's level of technical language for its native-speaking and non-native-speaking audience members. To evaluate experts' responses to the questions, I compared experts' responses to one another, within each area of expertise and among the four areas of expertise. I also evaluated experts' comments written in addition to or instead of responding to the eight questions because they address other areas of interest.

Follow-up interviews with individual experts helped answer questions raised by experts' written comments. For example, during follow-up interviews, I asked 11 experts these questions: "Do you think language features in the manual (specifically "you") make the manual more informal than other manuals? Is the manual too informal?" I asked these questions during the interview because RPC Expert 1, in her written responses to the expert testing, commented that "a few cases that add the 'you' . . . to intentionally make the language more 'you-centered' might be overkill." I wanted the other experts to specifically address RPC Expert 1's concern.

In some cases, experts' written responses to the expert heuristic testing led to additional questions for the experts or responses that I wanted to clarify. For example, MSE-N Expert 3 wrote that the language that I used in the manual "is very detailed yet very clear and therefore
quite appropriate" for users who are unfamiliar with the manual's subject. During the follow-up interview I asked this expert, "Do you think the level of detail that is helpful to new users will be too much (even bothersome or annoying) for those users who are more familiar?"

Experts' responses from the follow-up interviews offered me another opportunity to find agreements or disagreements within and among groups of experts. The following section is the sense I have made of expert-testing responses and follow-up interviews in my pursuit of answering my original question about the ImSpec manual: "How does participants' expertise influence the expert testing of a technical user manual?"

Results/Discussion of Experts' Responses

To structure my discussion of experts' responses, I use the four areas of accuracy, accessibility, appeal, and appropriateness. For each of these four areas, I have chosen specific effective examples of voice, person, and textual cues. In addition to these examples, I have included other comments that experts wrote in response to the expert testing.

Expert's Evaluation of Accuracy

I asked experts how they expected users would react to active voice in the manual. Because passive-voice constructions can influence whether users correctly interpret what they read [25], I have included active voice in the discussion of accuracy. ESL Expert 1 commented that active voice in the manual "could have the effect, of course, of pissing some (conservative, naive?) people off, but I think on the whole, it will be seen as 'a good thing.'" This ESL expert was aware of passive voice's tradition in technical documents, but overall, like every other expert who participated in this study, he expected users to react positively to active voice in the manual because, as RPC Expert 3 explained, "active voice helps readability." MSE-N Expert 2 also noted his preference for active voice in one of his responses to the expert testing: "I prefer the succinct style afforded by the active voice." Ironically, he voiced that preference with a passive construction ("... afforded by the active voice").
Although subject-matter experts (in this case, the six MSE experts) are commonly asked to check a document's accuracy, I did not specifically ask the experts to respond to the manual's technical accuracy because I wanted experts' responses to focus on the textual features. I chose this focus to break from the traditional practice of asking experts to review only a document's technical content accuracy. MSE-N Expert 3, however, felt the need to address the possible inaccuracies in the glossary. Interestingly, she was the only one of the six MSE experts who noted the potential problem with two of the definitions. Her written comments about the accuracy led me to ask the other five subject-matter experts, during the follow-up interviews, if they had noticed technical content errors in the manual when they had originally reviewed the manual.

With the follow-up interview, I clarified that the other five experts had not noticed errors in the manual. I wondered if these other five experts had not addressed the same concerns about the content errors as the other expert had. Until I queried the experts during the follow-up interview, I was not sure about the cause of the one expert's comment about the accuracy and the lack of the other experts' comments. When I asked each of the other experts during the follow-up interview if he had noticed technical content errors in the manual, he said he had not; the fact that I had not asked them to address technical content meant that, despite their status as subject-matter experts, these five experts may have been less attentive to technical accuracy than MSE-N Expert 3. To determine whether or not the definitions were inaccurate, I asked a seventh MSE expert to read the definitions. He replied, "both definitions are correct, but, as in all science, confusing."

Active voice issues related to this manual were important to its expert testing. ESL Expert 1's comments about passive voice and the MSE experts' disagreement about definitions represent the first of several disagreements within and among groups of experts that arose during expert testing. If the expert testing had included fewer experts, I would be facing far different plans for revising the manual. For example, if I had only ESL Expert 1's comments about active voice to work with, I would have needed to seriously consider how I used active
voice in the manual to prevent the reactions he said active voice might cause. With comments from the additional experts, however, I can feel more assured that active voice is not likely to cause problems for manual users.

Admittedly, experts did not and could not address every aspect of the manual's accuracy. Experts could address active voice and definitions, but the condition and availability of the software prevented experts from using the software to judge the accuracy of the text that related to the software's functions. The feedback experts gave about other the other aspects of the manual's accuracy, however, was worthwhile.

**Expert's Evaluation of Accessibility**

Experts can evaluate accessibility, like accuracy, before the manual and software are complete. Every expert found bulleted lists and the manual's organization in general to help the manual be accessible to users. For example, ESL Expert 3 responded, "Very nice! The visual format is quite helpful. Your users should be able to follow the instructions easily with the headings and numbered lists on pages 41-44." With her feedback and other experts' feedback in mind, I know to use similar methods in structuring other parts of the manual.

Experts failed to agree, however, about how to resolve problems with the complex structure of sentences in the manual's glossary. Expert-testing responses from ESL Experts 2 and 3 cautioned me about the complex structure of sentences in the glossary because it may be difficult for non-native readers to understand. These two ESL experts disagreed, however, about how problematic the sentence structure would be for non-native readers and how to resolve that problem. ESL Expert 2 said the structure was a big enough hurdle for readers to overcome that removing the glossary from the manual was a viable option. She said that if removing the glossary wouldn't cause potentially dangerous results for readers, removing the glossary would resolve the problem, and readers could find definitions in a technical dictionary.
In contrast, ESL Expert 3 argued that resolving sentence structure complexity problems could easily be resolved by separating one long sentence into three short sentences, for example. ESL Expert 3 did not find sentence structure to be as problematic as ESL Expert 2. Whereas ESL Expert 2 expected the sentence complexity to cause users to find the glossary inaccessible, ESL Expert 3 expected the sentence complexity to cause users to find the glossary less accessible. She did not expect the sentence structure to keep non-native readers from understanding the manual. See Figure 1 for an example of a term and its definition that appeared in the manual. See Figure 2 for ESL Expert 3's suggested revision.

2D stacked button

Graph control button that plots a graph in two-dimensional form with data displayed on the same X-axis but plots the Y- and Z-axes stacked above and below one another.

Figure 1: A term and its definition as it appeared in the manual.

2D stacked button

This graph control button plots a graph in 2-D form. Data is [sic] displayed on the same X-axis, but the Y and Z axes are stacked above and below.

Figure 2: The same term as rewritten by ESL Expert 3.

ESL Expert 3, who suggested creating three short sentences to replace one long sentence, argued that doing so would not noticeably increase the length of the glossary. ESL Expert 2 offered another solution in case the sentences with less complex structures required more pages in the glossary. She suggested that I rewrite the sentences with less complex structures and then reduce the type size to limit the number of pages devoted to the glossary. This ESL
expert's suggestion to reduce the type size directly conflicts with the concern of RPC Expert 2. He noted that audience members may find the type size difficult to read in its current size (before the reduction the ESL expert suggested), particularly if readers are over the age of 30.

Results of expert testing of this manual would be very different had I not included the experts from the various areas. MSE experts did not address topics that experts in other areas found important. Experts from each of the areas agreed that the textual cues and organization helped make the manual accessible, but only ESL and RPC experts addressed the other problems related to sentence complexity and type size. Had I not chosen to include RPC experts, for example, and simply acted on the advice of the ESL expert to reduce the type size, I would have decreased rather than increased the manual's accessibility.

ESL Expert 2's suggestion to remove the glossary from the manual may also create additional accessibility problems. She suggested that manual users could look to a technical dictionary rather than the glossary in the manual, but I question her assumption that the technical dictionary would be more accessible than the manual. Experts' comments suggested that the ImSpec manual is more accessible and easier for users to learn from because it contains more active voice and second person than other technical manuals with which they have worked. If it's true that the manual contains more active voice and second person than other manuals, I expect that the ImSpec manual contains more active voice and second person than the technical dictionary, too. If that is the case, then the technical dictionary may likely be less accessible than the ImSpec manual's less-than-ideal glossary.

Experts' Evaluation of Appeal

Experts' comments also related to the manual's visual and textual appeal to its various audience members. All twelve experts agreed that inter-textual cues in the manual were an effective method for displaying information for users. MSE-N Expert 1 went so far as to comment that, "I believe the inter-textual cues are the best way to present information
related to software." MSE-N Expert 2 explained why he thought the manual was visually appealing: "The use of visual cues makes specific phrases much easier to follow than when they are embedded in a sentence. This is particularly helpful when you are reading instructions and trying to perform tasks simultaneously (e.g., working through examples of a particular function)."

Reinforcing MSE-N Expert 2's comment, ESL Expert 2 noted that she expected non-native readers to find the manual visually appealing as well. She wrote that "I think that they [non-native readers] would appreciate the way steps or sub-points are separated and cued. This facilitates locating (or re-locating) essential information quickly, especially for a non-native reader whose ability to scan or skim is limited by a weak grasp of discourse/rhetorical signals." ESL Expert 1, however, suggested that the visual layout of the pages may be more problematic for non-native speaking Asian readers than non-native speaking European readers. Asian readers, ESL Expert 1 explained, may find the manual less visually appealing because they have trouble "knowing where to put their eyes" on the page, whereas European readers may be more "Americanized" (or vice versa—that American readers are "Europeanized") and more familiar with the conventions of the manual's layout. See Figure 3 for an example of text structured with bullets and Figure 4 for the same information structured with linguistic cues.

Any of several actions may have caused the discrepancy:
- You may have added too many data files.
- You added the wrong data files.
- You didn't add enough data files.
- You inadvertently disabled a plot box.

Figure 3: A sentence structured with inter-textual cues, or bullets.
Any of several actions may have caused the discrepancy: you may have added too many data files; you added the wrong data files; you inadvertently disabled a plot box.

Figure 4: The same information structured only with linguistic cues.

In addition to comments about the manual's visual appeal, experts addressed the manual's textual appeal in their varying comments about the use of "you" or second person in the manual. As I mentioned earlier, RPC Expert 1 was concerned that "you" in the manual may be "overkill," which if true, could lead to the manual being textually unappealing to readers. However, MSE-NN Expert 1, when I asked him if the use of "you" made the manual seem too informal, described its effect as being "personal" rather than informally unappealing to him. The other MSE experts (native and non-native speakers alike) and RPC experts' comments reiterated their approval of the use of "you." Specifically, RPC Expert 2 wrote that readers would "expect it [you] and appreciate it," and RPC Expert 3 commented that readers would react positively to "you" because it, like active voice, "helps readability." ESL Expert 3 agreed that users would find "you" more helpful to read, but ESL Experts 1 and 2 questioned whether all users would find it helpful. ESL Expert 1 wrote that "you" "might attract the negative attention of the conservative reader, but these will be, I would think, in the minority." ESL Expert 2 repeated ESL Expert 1's slight concern: "Few people would be insulted by second person in an instructional manual. Those few are probably pedants anyway!" See Figure 5 for an example of second person I used in the manual and Figure 6 for how I could have written the same information using third person.
Experts' clashing concerns about a few "pedants" and "overkill" would be more difficult for me to resolve if my expert-testing did not include multiple experts from different areas of expertise. For example, RPC and ESL experts raised concerns about users' potential reactions, but I was able to address those issues with each of the other experts during the follow-up interview to find out that experts other than RPC Expert 1 did not think that the use of "you" made the manual unappealing. Experts' evaluation of the manual's visual appeal also caused disagreements between experts from different groups. ESL Expert 1's concern about Asian readers finding the manual textually unappealing directly contradicts MSE-N Expert 3's notion that he "cannot imagine that anyone would not prefer visual cues in technical information."

Expert's Evaluation of Appropriateness

Based on experts' comments I have already discussed, the textual features active voice and second person do not keep the manual from being accurate, accessible, or appealing. However, my use of active voice and second person had the potential to make the manual inappropriate because of passive voice and third person's traditions in technical communication. Technical communicators continue to use passive voice and third person despite recommendations to use active voice [22, 30 and second person. [26] Experts' responses to questions about active
voice and second person show that even though writers continue to use passive voice and second person, writers consider active voice and second person appropriate for readers of the manual. Figures 7 and 8 are examples of active and passive voice constructions from the ImSpec manual.

Any of several actions may have caused the discrepancy.

Figure 7: An active voice construction as it appears in the manual.

The discrepancy may have been caused by any of several actions.

Figure 8: The same information in a passive construction.

The glossary's appropriateness for readers was the focus of comments from experts in RPC, ESL, and MSE-NN. Responses from experts from these areas contradicted each other more strongly than any other disagreement among experts from different groups. For example, RPC Expert 2 wrote that "I didn't see language that they'd [users] find difficult—and you supply a glossary to help them out." In contrast to this expert's comments are the two ESL experts who commented about the complexity of the sentence structures in the glossary. In addition to her comments about the complexity of the sentence structure in the glossary, ESL Expert 2 commented about the contents of the glossary. She wrote that "the glossary of terms could be expanded to include some basic Mac/computer terms (e.g., button, cursor, keystroke, arrow key vs. arrow button on tool palette, file, menu, tool, palette, zoom, [and] 2D/3D."

Clearly in contrast to ESL Expert 2's opinion of expanding the glossary is MSE-NN Expert 3. This expert considered the glossary inappropriately inclusive because it contains too many terms, whereas ESL Expert 2 considered the glossary inappropriately limited because it
contains too few terms for non-native readers. These two experts' perceptions of readers' needs obviously contradicted one another, leaving me to resolve, or at least understand, the discrepancy. My knowledge of the experts' backgrounds, in this case, helped me understand the difference in the experts' comments. ESL Expert 2 directs the university's Intensive English Orientation Program (IEOP), which means the non-native English-speaking students she works with most often are part of the program to learn very basic English language skills to perform day-to-day activities in the United States. On the other hand, MSE-NN Expert 3 is very knowledgeable about computers. In addition to the questions about the manual that I asked him to answer, this expert wrote more than two pages of comments for me to pass on to the computer programmers as his suggestions for improving the software. Obviously, being aware of the perspective each of these experts brought to the testing was useful to me as I determined my revision plan for the manual.

As with the areas of accuracy, accessibility, and appeal, results of my expert-testing the manual's appropriateness would be very different if I had not included the numbers and types of experts that I did. For example, only MSE experts as test participants would likely have had a negative effect on the glossary. I might have reduced the number of terms in the glossary if I had only MSE-NN Expert 3's comments on which to base my decisions. The other five MSE experts agreed that the glossary was appropriate, but given the one expert's strong opinion about the unnecessary length of the glossary, I might have tried to trim it. Without the ESL expert's advice to add—not trim—terms from the glossary, I may not have questioned MSE-NN Expert 3's suggestions as strongly and actually created additional problems for non-native readers that the MSE expert did not, and could not be expected to, foresee.

Practical Implications of Expert-Testing

In this final section, I offer an illustrated list of what I wish I had known before I dove into expert testing my manual. In addition, I have included ideas to help prevent misconceptions
about what expert testing can help with. This list of what to do and what not to do serves as a
guide to expert testing user manuals that include international readers in their audience.

Don't expect black-and-white, right-and-wrong answers from expert testing.
Do expect to make the final decision about revisions based on feedback from experts.

For example, although ESL Expert 2 commented that the glossary was problematic for
non-native readers, ESL Expert 3's assessment was less concrete. She didn't say the complex
sentence structure would prevent non-native readers from understanding the glossary; she said
the structure may slow non-native readers as they process or understand the definitions. She
didn't tell me the glossary was wrong, but if I didn't follow-through and reduce the complexity
of sentences in the glossary, I would be overlooking valuable feedback from an expert whose
background makes her a good judge of the appropriateness of the sentence structure in the
manual than I am.

Different experts may likely give you different responses and suggestions for revision.
How do you make that final decision when experts' responses conflict? First ask yourself if the
response is more closely related to one expert's domain than the other's. If one expert's
expertise is more closely suited to the question at hand, you will probably want to weight that
expert's opinion more heavily over another expert with a different domain of expertise. If, on
the other hand, experts' domains aren't clearly suited to favoring one opinion over another,
you as the writer need to make the final decision. As the writer, you are the closest person there
is to an expert on the document you're writing. You need to decide, and with input from
different experts, you can base your decision on more than "gut" instinct.

Don't expect expertise to jump disciplinary boundaries.
Do expect conflicts between experts from different disciplines.

The conflict between RPC Expert 2 and ESL Expert 2 exemplifies why writers can't expect
expertise to jump disciplinary boundaries. The RPC expert suggested that I could improve the
manual's accessibility if I increased the type size by one point throughout the manual. The ESL
expert's suggestion to decrease the type size of the glossary shows that her expertise about non-native English-speakers does not extend into expertise about visual accessibility.

Don't assume that you'll think of all the questions you want to ask experts before you begin the expert testing. Do follow-up with interviews with experts to answer questions raised by expert testing or to clarify experts' written responses to the expert-testing questions.

I didn't predict MSE-N Expert 3's questioning of the definitions in the glossary. With follow-up interviews, I allowed myself the opportunity to ask new questions that I didn't know enough about before expert testing. Plus, without asking the other five MSE experts during the follow-up interviews if they had noticed accuracy errors when they read the manual, I had no way of knowing if they had noticed errors or not. The follow-up interviews helped me clarify that the other five experts had indeed not noticed errors rather than noticed errors and just not told me of the errors they'd found.

Don't assume experts define "draft" the same way you do. Do explain your plans for the final version of the manual.

MSE-NN Expert 2 had commented in his written responses to expert-testing questions that the manual needed more visuals, so before I asked him any questions during the follow-up interview, we talked some more about the manual's draft status and the software's current condition that prevented it from creating the visuals I wanted to include in the manual. I then asked MSE-NN Expert 2 the questions, but after responding to all the questions, he commented that he didn't consider any of the factors I was asking him about (active voice, second person, and visual cues) nearly as important as the problems he saw with the manual's current number of visuals.

After our discussion at the beginning of the interview, I thought it was clear to him that I planned to add more visuals when the software allowed it, but apparently, it was not clear to this expert. MSE-NN Expert 2 received the same copy of the manual as all the other experts—with crop marks in each corner and with "DRAFT" clearly labeled on the front cover and on
each page's footer. In addition, in several places in the draft, I'd noted where visuals (and text) would go as soon as they were available. It was unclear to this expert, but clear to the other 11 experts, that the manual would include more visuals—when more visuals were possible. I believe it's important to note that MSE-NN Expert 2 is the least English-proficient of the three MSE-NN experts. MSE-NN Expert 2 is also the expert that I had the most difficulty getting responses from, which may have been caused by one or more factors that I was unable to overcome. His limited written responses to the expert testing required me to ask the expert-testing questions orally during the follow-up interview. I was able to get responses to each of the questions from him; however, I am not convinced that it was clear to him that the manual he read was a draft version. Had I been even more explicit than I thought I was being in describing the manual's draft status, it's possible that the feedback I received from MSE-NN Expert 2 may have been more helpful.

Don't assume that accuracy equals accessibility, appeal, and appropriateness. Do look and test for more than just accuracy.

The glossary makes a good example again since the MSE experts evaluated the accuracy of its technical content, paying various degrees of attention. While ESL and RPC experts could not evaluate the glossary's technical content, these experts could, however, comment on other aspects equally important to technical content. In addition to commenting about the glossary, ESL Experts 2 and 3 both voiced their concern about the structural complexity of the manual, which could, as a best-case scenario, slow non-native reader's understanding, but, as a worst-case scenario, could prevent readers from accurately processing the definitions at all.

Don't wait until the manual and the software it accompanies are complete to start testing. Do ask experts to address other issues with the manual (technical content accuracy, accessibility, appeal, and appropriateness) even if they can't evaluate local-level process details about the software.

ImSpec, the computer program that my manual describes, was not ready for experts to use while evaluating the manual. However, as the results of my expert-testing of the manual show,
expert-testing at this stage in the software's development was worthwhile. I received feedback from experts that I applied to my revision plan for the manual to improve it, and I didn't need to delay plans to improve the part of the project I was responsible for because other parts of the project fell behind schedule.

Don't rely on expert testing only. Do incorporate text-based, user-based, and expert-based testing into your testing plans.

Text-, user-, and expert-based testing methods all have a place in document testing, but I would have been naive to rely on just one type of testing. Expert testing with the experts I included has provided me with useful feedback about the ImSpec manual's accuracy, accessibility, appeal, and appropriateness, but other methods offer equally useful, though different, results. User testing with participants who are representative of real users would benefit my manual, for example, because I could test experts' expectations to see if typical users work with the manual the way experts predicted.

Don't start from scratch every time you perform expert testing. Do adapt test materials from one project to the next.

Creating test materials is time consuming, but writers don't need to recreate test materials for every test. At best, writers can reuse the same form for another type of testing, but writers can at least reuse page formatting and categories of questions again and again. For example, to reuse the pre-test questionnaire for user testing, I could remove just one question that refers to the respondent's expertise. I mostly likely wouldn't be able to reuse the questions from the expert testing for user testing because user-test participants would be completing tasks with the software and manual rather than responding to the questions about the manual only. Even though I can't use the expert-testing questions for the user testing of the ImSpec manual, I may be able to reuse them when I expert-test other manuals in the future.
Plans for Revising the ImSpec Manual

Based on my analysis of the expert testing, I designed a plan that included these categories of revisions: glossary terms, sentence structure, and software updates.

To respond to experts' concerns about the content of the glossary, my revision plan included a compromise. Despite the MSE-NN Expert 3's suggestion that the glossary should contain fewer terms, I was not comfortable with the thought of paring down the glossary as he suggested. However, I didn't think adding all the terms that the ESL Expert 2 suggested was necessary either. It considered it reasonable to expect audience members to bring some computer knowledge to the manual and software; therefore, my revision plan did not include adding the very basic computer definitions (e.g., button, cursor, keystroke) to the glossary. As my compromise, I was certain that all terms unique to ImSpec (e.g., track curve) are included in the glossary with clear definitions.

My plan also included revising glossary definitions, keeping less complex sentence structures in mind. In addition, my plan included asking ESL and MSE experts to reread the definitions for me. I planned for the experts' review to be less formal, but I considered their second look at the definitions useful because I wanted to be sure that I had reduced the sentence complexity without compromising the accuracy of the definitions.

Changes to ImSpec required me to include software-related revisions in my revision plan. I tested the manual before the programmers had finished the software, and by the time I finished testing, ImSpec performed functions that I had either not included in the test version of the manual or I had written descriptions that no longer correctly described what the software does.

Conclusion

So just how did participants' expertise influence the expert testing of the ImSpec manual? Their expertise lead to wide-ranging comments that complicated expert testing, but rightfully so. The range of comments I received from experts helped me address the manual's rhetorical
complexities. Without the different experts, I wouldn't have been able to address the manual's complexities as thoroughly because the experts brought expertise to the project that I could not contribute.

References


Appendix

**OK, Cancel, Plot None, and Plot All buttons**

OK displays a graph of selected data file(s) or a graph of selected group(s) with user-selected attributes.

Cancel returns the data screen to the state it was in when you last opened it.

Clear disables all selected files' plot boxes so that no files will be plotted but all files remain in the data selection box.

Plot all enables plot boxes for every data file or group in the data selection box to be plotted on one graph (You only need this option if you have clicked the CLEAR button; ImSpec automatically enables plot boxes when files are added to the data selection box.)

Each of the following shortcuts will have the same effect as clicking the file control button you choose.

- Press the ALT key and the file control button's hot key
- Press TAB until the file control button has a thin black outline and the press Return
- Highlight a file name or names then clicking the file control button.

The ADD button has two additional shortcuts.

- Double-click the file's name in the data selector block.
- Press Tab until the scroll on the selector block is highlighted, press the arrow keys to highlight the name of the data file you want to add. When the file name is highlighted, press Return to add the file to the data selection box.

**Choosing Which Features to Display on a Graph**

Axis variables control what you want ImSpec to plot on specific axes. ImSpec automatically selects what to plot on specific axes with its default axis variables settings. The default axis variables settings will display a graph of the data's frequency, magnitude of the impedance, and phase of the impedance.

When you want to plot data in forms other than frequency, magnitude, and phase, simply select a different axis variable for whichever axis or axes you want changed.
CHAPTER 4
IMPLICATIONS OF MY STUDY OF EXPERT TESTING

The following two sections contain my discussion of my study's practical implications for technical communicators: understanding the expert-testing process and using experts' expertise productively.

Understanding the Expert-Testing Process

Writers need to keep in mind several important ideas related to the expert-testing process. First of all, writers shouldn't wait until the software and the manual are complete to start testing a manual; testing that late would mean a waste of valuable time. Testing initial drafts and software before they are complete is valuable because writers can address problems that testing finds. Testing can find problems in a draft of sections of the manual, which helps writers revise those sections and plan better for other sections of the manual. Better planning for future sections of the manual prevents writers having to revise the entire manual based on expert-testing feedback. I can apply the experts' feedback about the three sections of the manual that they read to the rest of the ImSpec manual.

Next, like any other researchers, writers need to be open to results that may not agree with what the writers expected to find. Including follow-up interviews in their testing plans gives writers the extra opportunity to verify that they didn't just see what they wanted to see in the experts' written responses. For example, one MSE-NN Expert 1 wrote that the manual "compares favorably" to other manuals he's used. The question, however, had asked him to tell me if the manual contained more or less active voice. My first reaction was to assume that he was telling me that yes, the manual contained more active voice than other manuals, but that's not exactly what he wrote. To clarify this written response, I asked him during the
follow-up to restate his response answering specifically if the manual contained more or less active voice. He did think the manual contained more active voice than other manuals, but I would have been assuming too much if I had presumed that was the intention of his original written response.

Experts' written responses may be influenced by expert's understanding of documents' different development stages. Experts may or may not be familiar with all the stages a manual goes through before it's printed, bound, and distributed to software users, and if experts test a draft version of the manual, they may see the manual in a stage of development that they aren't familiar with. Writers should explain the current condition of the draft and final plans for the manual to experts to be certain that all the experts understand where the manual is in the development process. For example, I suspect that MSE-NN Expert 2 may not have fully understood what stage of development the draft of the manual was in. If, at the very beginning, before having him answer the expert-testing questions, I had explained to him details about binding the manual, trimming the page size, and printing double-sided pages, maybe he would have had enough details about the manual and would have understood sooner that the revised version of the manual would, in fact, contain more visuals as he suggested.

In addition, I also need to address another potential source for the situation I faced with MSE-NN Expert 2—language barrier. MSE-NN Expert 2's language skills are not as strong as other test participants, and I think that may have influenced his comments. For example, during the follow-up interview this expert also commented about the manual being "too long" when he compared it to another computer manual he held in his hand. At the time I was puzzled by the comment and simply noted it with other comments he gave. In hindsight, I wonder if his comment about length referred to the physical length of the page rather than to the 63 single-sided pages of the manual. I had printed the draft version of the manual that experts tested on 8.5"-by-11" paper, but crop marks were printed on each page that, when trimmed after printing, would bring the page size down to 7.5" by 9". I did not, however, mention to MSE-
NN Expert 2 or any of the 11 other experts that these were in fact crop marks on the pages and that the pages would have print on both sides. I have to wonder that if I had more clearly explained these features about the draft of the manual, maybe MSE-NN Expert 2 would have understood my plans better and would have responded differently to the testing.

Writers can't expect experts' different responses to answer all their questions about revising a document. The experts, in sometimes subtle ways, will even acknowledge that they are not 100 percent confident about the suggestions they're giving. For example, experts' evaluations of my manual exhibited the calibration characteristic other researchers have also noted (Camerer and Johnson 1991). Every expert, in at least one instance, included what I termed a "hedge," or calibration, in their written responses to the expert testing. Many times, experts' responses to questions began with or included phrases such as, "I would think . . .," "I would expect . . .," "I believe . . .," "I think . . .," "They might . . .." Other examples of experts' calibration include

- "It is difficult for me to answer this question."—MSE-N Expert 2
- "Hard to tell!"—MSE-NN Expert 1
- "Here's my responses . . . for what they're worth."—ESL Expert 1
- " . . . I hope they [the expert's responses] can be of some use."—RPC Expert 3

To make final revision decisions, writers ultimately need to weigh each expert's responses to decide what actions will most benefit the document.

Finally, writers need to remember that the usefulness of expert-based testing, like text-based and user-based testing, increases with its combination with other testing methods. Each of the three types of testing has its limitations, but combining the testing methods allows the benefits of one to overcome the limitations of other types of testing. While my expert testing of the ImSpec manual is the focus of my thesis, expert testing is only one step in effectively testing the manual. To minimize the preventable problems with the manual, it should also be the subject of additional testing methods. Interestingly, MSE-N Expert 3 agreed that the manual
would benefit from user-based testing. She wrote that the manual "seems very well written, but the best test would be an unfamiliar user."

Writers shouldn't rely on expert-based testing methods alone, just as writers shouldn't rely on text-based or user-based testing methods alone. As MSE-N 3 suggested, user-based testing of the ImSpec manual would be an obvious way of learning specifically how actual users will respond to the manual in addition to finding out how experts predict users will respond to the manual. Expert testing is another way to test manuals, but it should not be the only way of testing manuals. The more problems writers can resolve with manuals before they reach users the better. If writers don't test well enough, Philip Rubens and Brenda Knowles Rubens warn, "users may become unwilling and unhappy test participants instead of satisfied customers" (1988, p. 231).

Using Experts' Expertise Productively

Writers' productive application of experts' expertise is important because it influences how writers revise the documents they test. Obviously, writers shouldn't expect writing or other experts to apply their expertise to evaluating the accuracy of technical subject matter of a document, and writers shouldn't expect technical subject-matter experts to evaluate the language-use features in the document either. For example, I never expected the RPC or ESL experts to judge the accuracy of the materials science information in the manual, and I shouldn't have expected the MSE experts to be experts about judging the quality of writing in the manual. Writers should vary the areas of expertise they receive feedback from, and writers should keep track of which comments came from which expert. For instance, keeping track of which expert said what was important to my study when ESL Expert 2 suggested that I just reduce the size of the font to reduce the size of the glossary. If I had reduced the size of the type, however, I would have directly conflicted with RPC Expert 2's suggestion to increase the size of the type. In this case, reducing the type size wouldn't be the best solution.
Accuracy alone is not the best solution for helping users learn from a manual. Writers need to include more than technical subject-matter experts; experts from other areas can provide valuable feedback. The ImSpec glossary is a good example of the content's accuracy not being enough to make the glossary accessible, appealing, or appropriate for its audience. If I hadn't included ESL experts in my testing, I would not have known the glossary's need of revision.

As an ISU student and Ames Lab employee, I had access to a greater number of experts and a greater number of areas of expertise than many writers. Lack of similar resources, however, is not reason enough for writers to give up on thoroughly testing manuals before releasing them to customers. Even if they don't have access to enough experts or areas of expertise, writers should still make every effort to test their manuals. Maybe writers can't have experts from every related area evaluate a manual, or maybe writers only have the resources to test with subject-matter experts. If either is the case, writers at least need to be aware of the limits of their testing. Writers should not naively practice expert testing.

At minimum, writers should learn what they can about areas without available experts. Learning about these areas won't make writers experts in multiple domains, but writers will know more and be able to create more effective documents. In addition to learning about other areas that influence their manuals, writers should conduct additional document testing such as test-based and user-based testing.
REFERENCES


Fraser, J. (1992, June 4). Consider writing a technical article. EDN professional issues, 37(12), 185-190.


## APPENDIX A

**Pre-Test Questionnaire**

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<table>
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<td>1.</td>
<td>Name</td>
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<td>2.</td>
<td>Native language(s)</td>
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<tr>
<td>3.</td>
<td>Additional language(s) you speak</td>
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<tr>
<td>4.</td>
<td>Major discipline <em>and</em> specialization within discipline (e.g., materials science and engineering with impedance spectroscopy specialization)</td>
</tr>
<tr>
<td>5.</td>
<td>Academic degrees that you have earned (please include the subject)</td>
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<tr>
<td>6.</td>
<td>Number of years employed in your current profession (including positions prior to ISU or Ames Lab)</td>
</tr>
<tr>
<td>7.</td>
<td>I am interested in how you define expertise, so please identify 3 examples that support the position that you are an expert in your discipline</td>
</tr>
</tbody>
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APPENDIX B
Expert-Testing Questions

Active Voice
How does this manual's use of active voice compare with other manuals for computer software, especially technical manuals?
How would you expect users to react to the use of active voice in the manual?

Second Person
How does this manual's use of second person compare with other manual's for computer software, especially technical manuals?
How would you expect users to react to the use of second person in the manual?

Inter-Textual Cues
How does this manual's use of inter-textual cues (e.g., bulleted lists) compare with other manuals for computer software, especially technical manuals?
How would you expect users to react to the use of inter-textual cues (e.g., bulleted lists) in the manual?

Audience
How appropriate is the level of language for this manual's audience of professional engineers and technicians in engineering laboratories?
What aspect(s) of language in this manual may non-native speakers of English have problems with?
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INTRODUCTION TO IMSPEC

In This Chapter

• Impedance Spectroscopy Defined
• ImSpec's Purpose
• What to Know Before Using ImSpec
• How to Use Examples in This Manual

Impedance Spectroscopy Defined

Impedance spectroscopy is the study of distinctive features of materials' electrical properties, specifically impedance properties. Impedance is defined as the ratio of the voltage to the current applied to the material being studied. Typically this ratio of voltage and current is a complex quantity containing both real and imaginary parts. These impedances can be more easily visible or understood if displayed graphically. ImSpec—Impedance Spectroscopy Analysis Software—helps make graphing impedance data easier.

ImSpec's Purpose

ImSpec is the computer program designed to help you graphically display complex impedance data. ImSpec's data analysis routines make the program versatile because they help you create customized graphs of data you have collected and stored. ImSpec is so versatile because you decide which axis variables will be plotted on specific axes. ImSpec has more than 20 axis variables for you to combine and create hundreds of different graphs of the same data. Or, you can use the same axis variables and choose different data to create countless other graphs. The number of graphs ImSpec will create is only limited by the amount of data you have collected and want to display in graphs.

* All boldfaced terms are defined in the glossary, which begins on page 51.
What ImSpec displays

ImSpec has been designed to graphically display data collected from materials such as glasses, polymers, ceramics, and metals. ImSpec's data analysis routines display data you have gathered with the help of other software programs.

What to Know Before Using ImSpec

For more information about impedance spectroscopy, see the book titled Impedance Spectroscopy by J. Ross Macdonald. To use ImSpec to its fullest potential, you should be familiar with basic materials science terminology and concepts. This manual's glossary includes many basic terms and their definitions. With a basic understanding, you will be able to use the numerous graphing capabilities and appreciate the possibilities ImSpec offers for creating detailed graphs of your data.

How to Use Examples in This Manual

You can customize ImSpec to read your data storage format. Throughout this manual you'll find many examples included to help you understand how ImSpec functions. When you work through the examples, you have two options. You can (1) use the sample files shipped with ImSpec to create sample graphs, or (2) use your own data if it is stored in a standard form described in Chapter 1 of this manual. The sample files shipped with ImSpec were collected and stored as frequency, magnitude, and phase.

If you stored data in a format other than an ImSpec standard of frequency, magnitude, and phase, use the samples shipped with ImSpec to practice using these basic concepts. When you're comfortable using the sample files, you can program ImSpec to read the format in which you have stored data.
CHAPTER 5: CUSTOMIZING GRAPHS WITH THE TOOLS MENU

In This Chapter

- Magnifying Part of a Graph
- Adding Shapes and Text with the Tool Palette
- Displaying Coordinates of Individual Points on a Curve

Magnifying Part of a Graph

Use Zoom XY or Zoom XZ to magnify part of a graph and maintain the scale of the other axis.

Two of the Tools menu options allow you to zoom in on, or magnify, part of a graph without changing the scale of the other axis. Zoom XY and Zoom XZ operate similarly but cause different results to help you create graphs exactly to your specifications.

Zoom XY allows you to choose a portion of the data plotted on the X-axis and Y-axis and change the scale of that part of the graph. Zoom XY changes the scale of the data plotted on the X-axis and Y-axis, but the scale of the data plotted on the X-axis and Z-axis remains the same.

Zoom XZ allows you to choose a portion of the data plotted on the X-axis and Z-axis and change the scale of that part of the graph. While Zoom XZ changes the scale of the data plotted on the X-axis and Z-axis, the scale of the data plotted on the X-axis and Y-axis remains the same.

See Figures 5-1 and 5-2 for examples.
Figure 5-1 shows a graph with a scale that ImSpec has assigned to include all of the data points in the file. Figure 5-2 started as the same graph as Figure 5-1, but the Zoom XY option has been used to magnify a part of the data plotted on the X-axis and Y-axis. Notice that the scale of the Z-axis has not changed.
Adding Shapes and Text with the Tool Palette

Find the tool palette by clicking the Tools menu. The first five buttons on ImSpec's tool palette allow you to add lines, arrows, circles, and squares to any graph you create with ImSpec's help. You can draw a shape around part of a graph to call attention to it. Or, for example, you can draw an arrow that points at a specific data point by clicking the arrow button on the tool palette.

From the tool palette you can also add text to a graph. Whatever words you want to add, whether your name or a title for the graph, you can select from nine different fonts to display the text.

The final four buttons of the tool palette (CUT, MOVE, move, and group) help you edit or make changes to the shapes and text that you have added to a graph. The group button allows you to attach shapes and/or text as one object to move, cut, or paste as one object instead of separate individual objects.

Drawing Arrows, Lines, and Shapes on a Graph

Drawing lines, drawing arrows, and drawing shapes are similar, but require slightly different methods after you have told ImSpec to show the tool palette on the screen. To show the tool palette on the screen next to the graph you want to add arrows, line, or shapes to, follow these simple steps.

Show the tool palette

1. Click the Tools menu button.
2. Click the Show tool palette menu option to display the palette on the screen.

Notice the Show tool palette menu option toggles between Show tool palette (when the tool palette is not displayed on the screen) and Hide tool palette (when the tool palette is displayed on the screen).
Draw an arrow or a line

1. Click the arrow or line button on the tool palette.
2. Move the cursor (the + shape that appears on the screen) to the place where you want the arrow or line to begin.

   If you are drawing an arrow, know that the point you begin the arrow will not have the arrow on it.

3. Click and drag the mouse to move the cursor to the spot where you want the line to stop.
4. Release the mouse button.

   If you are drawing an arrow, it is at this stopping point where the point of the arrow appears.

   Repeat the steps above for each additional arrow or line you want to draw.

Draw a square or rectangle

1. Click a square button on the tool palette.

   If you want the outline of a square or rectangle, click .

   If you want a solid square or rectangle, click .

2. Move the cursor (the + shape that appears on the screen) to the place where you want one corner of the square or rectangle.
3. Click and drag the mouse to create the square or rectangle you want.
4. Release the mouse button.

Draw a circle

1. Click the circle button on the tool palette.
2. Move the cursor (the + shape that appears on the screen) to where you want the center of the circle.
3. Click and drag the mouse to create the circle you want.
4. Release the mouse button.

Adding Text to a Graph

Using another tool from the tool palette, you can add text to any part of a graph.

Add text

1. Click the text button on the tool palette.
2. Move the cursor (the + shape that appears on the screen) to where you want the text to begin.
3. Click the mouse button.
If you spell a word wrong or want to restart typing, click the CUT button and then click the text you want to remove.

If the change you want to make is a minor one, you can edit the text or shape instead of removing the text or shape completely.

Notice the +-shaped cursor changes to _.

4. Type the text you want to appear on the graph.
5. Press Return.
Repeat the steps above for each piece of text you want to add.

Cutting, Moving, and Editing Shapes and Text

If you change your mind about line, shapes, or text you have added to a graph, you can easily cut or edit them.

Cut (or remove) an arrow, line, shape, or text

1. Click the CUT button on the tool palette.
2. Move the cursor (the + shape that appears on the screen) to the arrow, line, shape, or text you want to remove.
3. Click the arrow, line, shape, or text.
   If you want to replace the arrow, line, or shape with a new arrow, line or shape, return to the section above titled “Drawing Arrows, Lines, and Shapes on a Graph.”
   If you want to replace the text that you cut with new text, return to the section above titled “Adding Text to a Graph.”

Move an arrow, line, shape, or text

1. Click the Move button on the tool palette.
2. Move the cursor (the + shape that appears on the screen) to the arrow, line, shape, or text you want to move.
3. Click the arrow, line, shape, or text to highlight the what you want to move.
4. Move the cursor to place the highlighted arrow, line, shape, or text to its new location on the screen.
5. Click the mouse button to activate the move.

Edit text

1. Click the text you want to edit.
2. Click the text you want to edit when it appears in a dialog box in the tool palette to highlight the box that contains the text.
3. Enter the changes in the highlighted box of the dialog box.
4. Click the OK button.
Edit shapes

If the changes are more than minor, delete the shape and add a new one.

1. Click the shape you want to change.
2. Enter the changes in the dialog box that ImSpec displays in the tool palette.

Displaying Coordinates of Individual Points on a Curve

ImSpec will display the coordinates of individual points on a curve when you want a precise measurement of coordinates, rather than estimated measurements based on the graph’s axis labels.

Using the Track Curve Menu Option

With the Track Curve Tools menu option, you can have ImSpec display the coordinates of points on a curve. You can move easily from one curve to another to display the coordinates of any point on any curve that is part of a graph you create with ImSpec.

Display a point's coordinates

1. Select Track Curve from the Tools menu.
2. With the arrow keys, move the + -shaped cursor to the curve that you want ImSpec to display the coordinates for.
   
   **To change the distance ImSpec moves** when you press an arrow key, press the + or - key on your keyboard’s number pad. The + key will increase the size of the jump, and the - key will decrease the size of the jump.
3. Press return and notice that the cursor changes to a smaller + shape.
4. Use the left and right arrow keys to move the cursor to different points on the curve. Use the up and down arrow keys to move from curve to curve.

Configuration

The Configuration menu option does not function in this version of ImSpec.
Glossary of Terms

2D overlaid button (2D)
Graph control button that plots a graph in two-dimensional overlaid form with data plotted on parallel Y-axis and Z-axis with data points displayed atop one another.

2D overlaid graph
A two-dimensional graph that plots data on a parallel Y- and Z-axes with data points displayed atop one another (include a screen dump/example).

2D stacked button (2DS)
Graph control button that plots a graph in two-dimensional form with data displayed on the same X-axis but plots the Y- and Z-axes stacked above and below one another rather than atop one another.

2D stacked graph
A two-dimensional graph that uses the same X-axis for displaying the Y-axis and Z-axis but plots the Y- and Z-axes stacked above and below one another rather than atop one another (include a screen dump/example).

3D curve button (3DC)
Graph control button that plots a three-dimensional graph that displays a surface on independent axes of time and frequency.

3D curve graph
A three-dimensional graph that displays a surface on independent axes of time and frequency.

3D hidden line button (3DHL)
Graph control button that plots a three-dimensional graph that displays a series of orthogonal XZ and YZ curves, but lines that are displayed in front of other lines "hide" the lines behind them.
3D hidden line graph
A three-dimensional graph that displays a series of orthogonal XZ and YZ curves (like the 3D Wire graph), but lines that are displayed in front of other lines “hide” the lines behind them.

3D hidden surface button (3DHS)
Graph control button that plots a three-dimensional graph that displays a series of orthogonal XZ and YZ curves with all the surfaces displayed as a series of filled polygons.

3D hidden surface graph
A three-dimensional graph that displays a series of orthogonal XZ and YZ curves with all the surfaces displayed as a series of filled polygons.

3D wire button (3DW)
Graph control button that plots a three-dimensional graph that displays a series of orthogonal XZ and YZ curves and shows all lines of data displayed on the graph.

3D wire graph
A three-dimensional graph that displays a series of orthogonal XZ and YZ curves and shows all lines of data displayed on the graph.

Add button
File control button to add the highlighted file in the file selector block to the data selection box; files appear in the order that you add them.

Admittance (real $A'$ and imaginary $A''$)
The ratio of the voltage applied to an electrical circuit to the current produced in the circuit; measured in units of mhos or (ohms)$^{-1}$; the inverse of the impedance.

$\text{Admittance} = \frac{\text{Voltage applied to electrical circuit}}{\text{Current produced in the circuit}}$

Arrhenius plot
In general, a plot of the logarithm of a rate parameter versus the inverse of the temperature (expressed in Kelvins) at which the rate is measured.

In ImSpec/impedance spectroscopy, a plot of the logarithm of conductivity versus $1/\text{temperature expressed in Kelvins (K)}$; the slope of this line is proportional to the activation energy for the conductivity.

Auto scale
An option on the scaling screen to have ImSpec assign axis start and stop values that will display all of a file’s data points.
**Axis variable**
The selection that controls which of the data's features are plotted on a specific axis.

**Basic graph**
A graph that displays information about the data files or groups that you select with graph features based on the default settings.

**Cancel button**
File control button to cancel actions performed on the Data screen before you click the OK button and return to the previous screen.

**Cell constant**
The ratio of the thickness of the sample to the sample's area; expressed as K.

**Clear button**
File control button to remove all files from the data selection box that you use to start a graph from the same Data screen; unless you save the graph created from the removed data files as a graph file, the graph created from the data files you removed no longer exists.

**Close graph**
Graph menu option to remove the displayed graph from the screen and keep the graph stored as a graph file in the computer's memory.

**Collect data**
Tools menu option that does not function in this current version of ImSpec.

**Conductivity (complex \( \sigma^* \), real \( \sigma' \), and imaginary \( \sigma'' \))**
An electrical circuit's ratio of the voltage to the current to the cell constant of the sample, measured in units of (ohms cm)^{-1}; the inverse of resistivity.
Conductivity = Voltage to the current / Cell constant of the sample

**Configuration**
Tools menu option that does not function in this version of ImSpec.

**Convert button**
On the data file screen, the file control button to choose the converted form that the data file will be saved as, one file at a time; (used in situations where you want numerical output in formalism other than magnitude, phase, and frequency that ImSpec deals with)

On the data group screen, the file control button that __________.
On the graph screen, the file control button that ________.

**Data file**
The file that contains data collected from one sample, typically collected at one temperature and its file name given the extender of the temperature at which the data were collected.

**Data group file**
The file containing the collection of names of related data files that you save as a single file for easy retrieval; typically selected to be plotted on one graph, but the data group file contains no graphing information or specific data points, only the names of individual data files that are members of the data group.

**Data screen**
The menu screen that contains graphing information (such as files to be plotted, symbols, line types, graph type, and axis variables) for a currently displayed graph; ImSpec's main screen.

**Default scale**
Tools menu option to display ImSpec's choice of the best view of a graph that includes all data points from every file.

**Default text**
Options menu option to choose default settings for fonts, font style, and alignment.

**Delete graph**
Graph menu option to delete a graph file from the disk after you tell ImSpec the graph's location and file name.

**Dielectric permittivity (complex ε*, real ε', and imaginary ε'')**
The ratio of the applied electrical field to the internal electrical field multiplied by the permittivity of free space. $\epsilon^* = \epsilon' - \epsilon''$, where $\epsilon'$ and $\epsilon''$ are the real and imaginary parts of the complex dielectric permittivity, across a material of fixed area and thickness. These quantities are in general frequency dependent due to the frequency dependence of polarization processes inside the material under study.

**Edit button**
File control button to open the corresponding file for editing

On the data file screen, displays the raw data of a data file highlighted in the data selector block in numerical form to allow you to alter or delete specific data points in the file.
On the data group screen, displays the file names of group members to let you change member files in the group.

On the graph screen, _______

Electrical modulus (complex $M^*$, real $M'$, and imaginary $M''$)
The electrical response of the material to an applied electrical field. The real part, $M'$, represents the “elastic” electrical response of the material and goes to zero at very low frequencies due to the long range displacement of charge decaying the applied electrical field to zero. The imaginary part, $M''$, represents the “anelastic” part of the response and is zero at very low frequencies because even for slow processes the system response can keep up with the applied electrical field and is zero at very high frequencies because the system is completely out of phase with the applied electrical field. At intermediate and often temperature-dependent frequencies, the electrical loss, $M''$, reaches a maximum value because it is at this frequency that the time scale between the system response and applied electrical field match. The electrical modulus, $M^*$, is the inverse of the complex dielectric constant, $\varepsilon^*$. 

Exit
Graph menu option to exit ImSpec.

File control buttons
The group of twelve buttons that manipulate files in the file selector block and data selection box, located near the top right of the Data screen.

File selector block
The group of boxes located at the top left of the data screen, used to select the disk drive, directory, and files you want ImSpec to access.

Frequency - $f$
The number of cycles per second that an applied electrical field changes sign from positive to negative.

Graph control buttons
The set of six buttons that determine which type of graph ImSpec will plot; located just below the file control buttons on the Data screen.

Graph file
The combination of a data file, data group or data groups and the graphing information you save as one file: when you open the graph file, a graph and its symbols, colors, and axis labels appear on screen. Like the data group file, the graph file does not contain specific data points; it contains the names of the file or files that contain the data points.
Graph template
Graph characteristics you choose and save as a template for applying to future graphs you create; prevents having to reformat each graph you create to the same characteristics.

Hide legend
Options menu option to remove the graph’s legend from the screen.

Hide tool palette
Tools menu option to remove the tool palette from the screen.

Impedance (complex $Z^*$, real $Z'$, and imaginary $Z''$)
The complex electrical impedance $Z^*$ is the ratio of the system’s applied voltage the current produced in the system. $Z^* = Z'-Z''$, where $Z'$ is the in-phase impedance, and $Z''$ is the out-of-phase impedance. The impedance is generally complex because most real materials have both conductive and capacitive components to the electrical response.

$|Z| = \text{Applied voltage to the system} / \text{Current produced in the system}$

Impedance spectroscopy
The specialization of materials science and engineering that studies the distinctive features of materials’ electrical properties, specifically impedance properties, by measuring the real and imaginary parts of the impedance as a function of frequency.

Insert button
File control button to insert a file highlighted in the file selector block into the data selection box. The inserted file is placed at the spot where the file highlighted in the data selection box was and bumps that highlighted file and each file after it down to make room for the inserted file.

Interval
Distance between tics of a grid.

Legend
Display of the temperature at which files were collected and the symbols and colors assigned to the files plotted on a graph.

Line thickness
Thickness or width of lines drawn using the tool palette.
Log button

*When the log button is enabled,* data is displayed on the axis in logarithmic form.

*When the log button is disabled,* data is displayed on the axis in linear form.

Loss factor (δ)

The loss factor, \( \tan(\delta) \), is the tangent of the ratio of the imaginary part of the dielectric constant to the real part of the dielectric constant. \( \tan(\delta) \) is zero for purely capacitive materials and is a measure of the material's ohmic losses.

Modify attributes

Options menu option to edit symbols and line types, the color of symbols and lines, the size of symbols, and spacing of symbols ImSpec has assigned.

New graph

Graph menu option to open the Data screen for you to display another graph, clearing the data selection box and returning the default settings; keeps previous graph(s) you created in memory.

OK button

File control button to display the graph of the data file(s) and/or group(s) you have selected.

Open graph

Graph menu option to open the stored graph you select.

Parallel capacitance (\( C_p \))

The equivalent capacitance that would exist if the sample were comprised of a perfect capacitor in parallel with a perfect resistor.

Parallel resistance (\( R_p \))

The equivalent resistance that would exist if the sample were comprised of a perfect resistor in parallel with a perfect capacitor.

Phase angle (θ)

The inverse cosine of the ratio of \( Z'' \) to \( Z' \). Phase angle is the Cartesian angle formed by the vector of \( Z' \) placed along the positive quadrant X-axis and \( Z'' \) placed along the positive quadrant Y-axis as measured relative to the X-axis. In this way, \( Z'' = |Z|\cos(\theta) \) and \( Z' = |Z|\sin(\theta) \). The phase angle \( \theta \) also represents the lag angle between the applied voltage and the generated current in a dielectric material.
**Plot all button**
File control button to enable every plot box in the data selection box.

**Plot box**
The small box to the left of each file name in the data selection box.

*When a plot box is enabled*, its file will be plotted on the graph.

*When a plot box is disabled*, its file will not be plotted on the graph, but the file remains in the data selection box.

**Plot none button**
File control button to disable every plot box in the data selection box, but keep all files, groups, or graphs in the data selection box.

**Print graph**
Graph menu option to print a graph to the printer, plotter, or metafile structure you selected under print options.

**Print options**
Graph menu option to tell ImSpec where to output a graph and select orientation of the page.

**RAM group**
The name ImSpec assigns to the data files you have added to the data selection box but have not saved as a group.

**Remove button**
File control button to remove the file highlighted in the data selection box from the data selection box.

**Resistivity (complex $\rho^*$, real $\rho^\prime$, and imaginary $\rho^\prime\prime$)**
The complex ratio of the applied voltage divided by the induced current in a material scale by the cell constant of the material. It is the inverse of the conductivity and is the cell constant scaled value of the impedance, $Z^*$.

**Sample info file**
The file containing sample-identifying information, such as the temperature of the sample, the date the data were collected from the sample, and the name of the person who collected the data.
Save button

On the file screen, the file control button that saves data files in the RAM group as a data group with the name you assign it

On the group screen, the file control button that saves data group(s) as a graph

On the graph screen, the file control button that

Save graph

Graph menu option to save a graph that you have created to the directory you select under the name you give the file.

Scaling

Options menu option to set the beginning and end values of each axis or select auto scale for ImSpec to select the range for one, two, or all three axes.

Screen control buttons

The three buttons at the top right of the Data screen that control which type of file (data file, data group, or graph) ImSpec is working with.

Series inductance ($L_s$)

The equivalent inductance that would exist if the material were comprised of a perfect inductor in series with a perfect resistor.

Series resistance ($R_s$)

The equivalent resistance that would exist if the material were comprised of a perfect resistor in series with a perfect inductor.

Show legend

Options menu option to display the graph's legend on the screen.

Show tool palette

Tools menu option to display the tool palette on the screen.

Spacing (of symbols)

Indicates the how frequently symbols are displayed on the line of a graph; for example, a file with a spacing of 3 will display a symbol every third data point.

Three-dimensional curve button (3DC)

See 3D curve button.

Three-dimensional curve graph

See 3D curve graph.
Three-dimensional hidden line button (3DHL)
See 3D hidden line button.

Three-dimensional hidden line graph
See 3D hidden line graph.

Three-dimensional hidden surface button (3DHS)
See 3D hidden surface button.

Three-dimensional hidden surface graph
See 3D hidden surface graph.

Three-dimensional wire button (3DW)
See 3D wire button.

Three-dimensional wire graph
See 3D wire graph.

Tool palette
Tools menu option that contains drawing tools, color palette, line type, and line width selectors.

Two-dimensional overlaid button (2D)
See 2D overlaid button.

Two-dimensional overlaid graph
See 2D overlaid graph.

Two-dimensional stacked button (2DS)
See 2D stacked button.

Two-dimensional stacked graph
See 2D stacked graph.

View button
File control button to display the highlighted file or files in the file selector block in reduced form at the bottom right corner of the Data screen.

X-axis options
Options menu option to edit the X-axis’s title and grid specifications.
**Y-axis options**
Options menu option to edit the Y-axis’s title and grid specifications.

**Z-axis options**
Options menu option to edit the Z-axis’s title and grid specifications.

**Zoom XY**
Tools menu option to choose a portion of the data plotted on the X-axis and Y-axis to zoom in and change the scale of the axis, leaving the Z-axis with the same scale.

**Zoom XZ**
Tools menu option to choose a portion of the data plotted on the X-axis and Z-axis to zoom in and change the scale of the axis, leaving the Y-axis with the same scale.

—END of terms currently functioning in ImSpec—
Not currently implemented

*Edit Menu* ? (Windows version only, not in DOS version)

**Copy graph**
Stores a graph created with ImSpec onto the clipboard for placing into a document created with a different application.

**Cut graph**
Temporarily stores a graph created by ImSpec on the clipboard.

**Paste graph**
Inserts the graph that was stored on the clipboard at its new location in another document.

**Save graph as**
Graph menu option to save a graph after you to select a directory and name for the graph. (See Save graph definition.)

**3D options**
Options menu option to edit the angle at which ImSpec displays a 3-D graph.

**Change viewpoint**
Options menu option to choose the rotation of the graph to view it from different angles ImSpec specifies (In Options menu, 3D Options).

**Devices**

**Input file format**

**Track curve**
Tools menu option to move from point to point on a curve for displaying the coordinates of each point.
APPENDIX D
Examples of Follow-up Questions

I asked each expert these questions:

Is the content of the glossary too basic? Or, could users benefit from more detailed and basic information about computer and materials science definitions from the glossary?

Do you think language features in the manual (specifically "you") make the manual more information than other manuals? Too informal?

I asked each participant additional questions specifically related to his or her responses to the expert testing. I asked MSE-N 1 the following questions, and they are typical of the questions I customized for other experts.

The original questions you responded to did not ask you to address the technical accuracy of the manual. Do you remember finding any technical content errors in the manual, particularly the glossary, that you did not note in your responses to the questions?

You wrote that "this manual makes good and frequent use of the active voice when compared with other manuals" you've worked with. Do you mean that other manuals use less passive voice?

On the other hand, you wrote that the manual's use of second person "seems to compare" to other manuals you've used. Does this and other manual's use of second person influence the strong negative feelings you have toward manuals?

In one of your responses you wrote that the frequency of the manual's bulleted lists and "other inter-textual cues" is "on par" with other manuals. What other inter-textual cues did you notice in the manual?