SUMMARY

- Challenges the conventional use of a single word or short phrase as a slide headline
- Provides evidence showing that a succinct sentence headline identifying the main assertion leads to statistically significant increases in audience retention

How the Design of Headlines in Presentation Slides Affects Audience Retention

MICHAEL ALLEY, MADELINE SCHREIBER, KATRINA RAMSDELL, AND JOHN MUFFO

INTRODUCTION

he defaults for typography and layout in Microsoft PowerPoint, which has 95 percent of the market share for presentation slide software (Parker 2001), compel presenters to create headlines that are single words or short phrases. Not surprisingly, in a typical PowerPoint presentation, the main assertion of each slide is relegated to appear in the slide's body. For those creating slides for presentations, the question then arises: Is such a headline design the most effective at having the audience retain the slide's main assertion?

According to Robert Perry of Hughes Aircraft and Larry Gottlieb (2002) of Lawrence Livermore National Laboratory, the answer is "no." Since the 1960s, Perry has argued for a succinct sentence headline on presentation slides. Following Perry's lead, Gottlieb came to the same conclusion during the 1970s at Lawrence Livermore Laboratory. For the next three decades, although a number of technical communicators strongly advocated using sentenceheadline designs, the overwhelming majority of headline designs projected at engineering and scientific conferences were single words or short phrases. Recently, in the midst of complaints from popular media (Parker 2001; Schwartz 2003) about the use of PowerPoint in presentations, several publications, including Alley (2003a), Doumont (2005), and Atkinson (2005), repeated the old arguments and presented new ones for using headlines that are sentences.

Sentence headlines have several main advantages over phrase headlines (Alley and Neeley 2005). First, a sentence headline such as *Placer deposits arise from the erosion of lode deposits* orients the audience much more effectively to the slide's purpose than does a phrase headline such as *Placer Deposits*. Second, using sentence headlines allows the presenter to emphasize the most important detail of the slide. Third, if well chosen, sentence headlines present the audience with the key assertions and assumptions of the presentation. Explicitly stating these assertions and assumptions in a technical presentation is advantageous because audiences are more inclined to believe the presentation's argument if they comprehend the assertions and assumptions of that argument (Toulmin 2003). Finally, once the headline assertion has been determined, the presenter is in a much better position to select persuasive evidence to support that assertion.

This article presents an experimental study on the effect of sentence headlines in four sections of a large geoscience course that typically had 200 students per section. In the study, the four different sections of students were taught the same information by the same instructor, with the only difference being the design of the teaching slides.

Of the four sections of students, two sections viewed the information on slides that used mostly phrase headlines (note that some of these original headlines were formatted as questions, and a few slides did not have any headlines). The remaining two sections viewed the same information on slides that used succinct sentence headlines. In the slide transformations, other changes occurred, such as typographical changes and conversions of bullet lists to more visual evidence. However, for the 15 slide transformations considered in this study, the principal change was the conversion of a traditional headline to a succinct sentence headline.

After each class period, all four sections of students

Manuscript received 5 August 2005; revised 10 October 2005; accepted 12 October 2005.

had access to copies of the slides that the instructor had projected. Then after the five class periods, the students took an exam that asked them to recall a set of assertions from those slides. For those in the two sections taught from the traditionally designed slides, the assertions resided in bodies of the slides, while for the students in the sentenceheadline sections, the same assertions resided in the slides' sentence headlines. The course's final examination, which occurred a few days after the final class period, served as the recall test.

This case of an audience viewing a set of slides and then having access to those slides as a set of notes is common in science and engineering. Granted, the way that students study their set of notes for a final exam is quite different from the way that technical professionals would refer to their sets of notes. Nonetheless, the results presented here have implications in the way that technical professionals should design slides.

For instance, if the students who were taught from the slides with sentence headlines recalled significantly more information than those students who were taught from slides with phrase, question, or no headlines, then technical presenters should consider using sentence-headline designs. In such a case, given that the overwhelming majority of technical presenters currently use phrase headlines, the increase in the amount of technical information communicated in engineering and science could be large.

The next section of this article describes the design of the study. Included in this section is a justification of the particular sentence-headline design selected for the study, the control method used to assess the relative strengths of the four student groups, and a key assumption about the tests. Following this section are the study's results. At the heart of this section is an explanation, from a communication perspective, of why the students who viewed the sentence headlines recalled the slides' key assertions at levels that were different from those who viewed slides with phrase, question, or no headlines.

EXPERIMENTAL METHODS

This study considered the effect on audience retention of using a sentence-headline design for the teaching slides in a large geoscience course at Virginia Tech. This was an introductory course that discussed the origin, distribution, and use of the earth's resources. Because the course satisfied one of the university's general education requirements, it was a popular course for non-majors, attracting students from all branches of science and engineering, as well as those from liberal arts, agriculture, and business.

The course was excellent for this pilot study because the instructor used computer-generated projections of slides as the principal visual aid in most class periods. For that reason, the slides played an important role in the



Figure 1. Visual depiction of the strategy for the study. The isolated difference between the presentations of the information was the design of the slides.

instruction. Other reasons that the course was a good choice for this study were that the examinations had multiple-choice questions, the students took examinations on sheets that could be computer scored, and the instructor had examinations graded through the university testing center, where the results of prior examinations exist. From these examination results, we were able to extract statistics directly linking test questions to presentation slides from earlier semesters. Shown in Figure 1 is a visual depiction of how the study was performed.

For the study, we transformed about 100 teaching slides from the fourth and final portion of the course to the sentence-headline design. Not all the transformations involved the same types of changes. In the instructor's original design of slides, about 80 percent of the slides had phrase headlines; the remaining 20 percent either had no headlines or had headlines written as questions. In the transformed versions, 100 percent of the slides, except for the title slide of each class period, contained succinct sentence headlines.

In addition, about 40 percent of the original slides consisted of the traditional bullet list in the body, with the remaining 60 percent having at least one image. In the transformed versions, 100 percent had the evidence of its slide bodies presented in a visual way without any bullet lists being used. No doubt these visual changes to the slide bodies affected audience recall (Alley, Schreiber, and Muffo 2005). However, for the 15 slide transformations tested for this study, the principal change was the conversion to a succinct sentence headline. Moreover, for those 15 transformed slides, the assertions that the students had to recall resided in the sentence headlines, while for the corresponding traditional slides, those assertions resided in the bodies of the slides.

Using the transformed slides, the instructor taught the classes in the same way that she had done in past semesters. Of particular importance, as she had done in past semesters and in the other lectures that semester, she posted her slides on the Web so that students could download the slides after the lectures to use as study aids.

Justification of selected design

The sentence-headline design chosen for this study has achieved much anecdotal success (Alley and Neeley 2005). One feature of this design is its set of specific guidelines for typography (Alley 2003a). For instance, one such guideline is that the sentence headline be restricted to no more than two lines. This guideline agrees with Doumont's recommendation (2005) for text blocks on a presentation slide. A second typography guideline is the use of a bold sans serif typeface for the headline. This guideline arose from our own observation that a boldface sans serif typeface is easier to read, in a large room, than either a normal sans serif or a normal or boldface serif formatted at the same type size. In assessing the ease of reading for different typefaces in the room, we positioned ourselves both at the back-row seats most distant from the screen and at the front-row seats with the sharpest angles to the screen. Yet a third typography guideline is left justifying the headline with a beginning position in the slide's upper left corner. This guideline agrees with the recommendations of Gottlieb (2002) for sentence headlines.

A second feature of the slide design chosen for this study is that the headline be supported by visual evidence, as opposed to a bullet list. This aspect agrees with one of Richard Mayer's principles (2001) for multimedia—namely, that students learn better from words and representative images than from words alone. The slide design chosen for our study also follows two more of Mayer's principles: (1) that students learn better when images are placed near rather than far from the corresponding text; and (2) that students learn better when images and corresponding text are presented simultaneously rather than successively. The slides of Figure 2 show the differences between the traditional design (top) and the sentence-headline design selected for this study (bottom).

Control group for the study

The final examinations for the four different sections of the course consisted of 100 questions: 60 questions based on the content for the course's fourth and final portion, and 40 questions drawn from the questions already posed to the students on the semester's three earlier tests. Given this structure, we chose the average score that each class had on the 40 questions from the previous tests as a means for controlling the relative effort of each section. We chose the



Figure 2. Transformation of one of the traditionally designed slides, shown at the top, to the sentence-headline design shown at the bottom (Schreiber 2005).

average scores for these 40 questions as the control measure because students in all four sections prepared for this portion of the examination by studying the previous tests of the semester rather than by studying the slides that accompanied that material. For that reason, the results on this section of the exam provided an excellent window into the effort given by each section of students.

Table 1 presents a summary of the averages obtained by each of the four sections for those 40 questions. As seen in Table 1, the Fall 2004 and Spring 2005 sections achieved lower scores than the Fall 2003 and Spring 2003 sections did. For that reason, we concluded that the two later sections, which were taught with sentence-headline slides in the fourth and final portion of the semester, did not put forth any more effort in preparing for the exam than did the two earlier sections, which were taught the same material from slides designed in a traditional way.

Section's Semester	No. of Students	Class Time	Class Score: Control Questions
Spring 2003	200	2:30-3:45 р.м.	87.9%
Fall 2003	202	12:30-1:45 р.м.	86.1%
Fall 2004	201	12:30-1:45 р.м.	82.5%
Spring 2005	136	8:00–9:15 a.m.	79.1%
Average			83.9%

TABLE 1: SCORES FOR DIFFERENT SECTIONS ON CONTROL QUESTIONS

Key assumption in the study

Richard Mayer (2001) has performed several experimental studies on the effect of multimedia on learning—learning from words and pictures as opposed to learning from just words. In Mayer's studies, each learner received exactly the same words (either written, spoken, or both) because the spoken words were narrated, rather than presented. Mayer's studies provide a valuable base of knowledge on how words (written and spoken) and images affect how much people understand and recall. However, the communication situations of Mayer's studies are quite different from the communication situations that most technical professionals face.

For instance, because the speech in Mayer's studies was recorded and played to the audience, the speech was perfect—exactly what the presenter wanted the audience to hear. In contrast, in a typical technical presentation such as the presentation of scientific research at a conference or of an engineering design to managers, the presenter speaks from points or slides. Because not every word is scripted, the wording is not exactly the same from one presentation of the material to another. Moreover, the speech is sometimes influenced by the audience-either the presenter reacting to the expressions of the audience or, during an informal presentation, the speaker responding to questions interjected by the audience. In addition, in most technical presentations, the presenter not only has to inform the audience about the information but also has to persuade the audience about that information. For that reason, the presenter has to build credibility with the audience. In building that credibility, the presenter often includes details that are beyond what the audience needs to understand the content-a strategy that goes against Mayer's principle of excluding extraneous words (2001).

The study presented in this article is much more like the typical situation that technical presenters face in that the presenter delivered her class live, rather than taped. Given that live element, though, each section did not experience exactly the same speech. Moreover, in our study, students in different sections asked different questions, which caused some points to be emphasized more than others. Finally, full attendance did not occur during every class, which meant that some students learned portions of the material just from the posted slides, as opposed to learning the material from both the classroom presentation and the posted slides.

Despite these irregularities in the speech experienced by the audience, a key assumption of this article is that the design of slides was the major difference in the learning that occurred among the four sections: the Spring 2003 and Fall 2003 sections that learned from slides mostly with phrase headlines, and the Fall 2004 and Spring 2005 sections that learned from sentence-headline slides. Put another way, the students in these large sections experienced, on average, the same speech. Supporting this assertion is the overall consistency in test scores in which the different sections witnessed the same information presented on the slides in essentially the same way and answered the same questions that arose from those slides.

Examples of consistency include the six exam questions that required the students to recall information from images on slides that could be found on both the traditional slides and the sentence-headline slides. For these questions, the scores were close, with an average correct score of 86% for those students learning from the traditional slides and 87% for those students learning from the transformed slides—a difference that is not statistically significant. That the scores were so close is not surprising because the transformations did not make as much of a difference on these slides. The information to be recalled was not directly stated in the sentence headline, and the images were the same.

Other examples of consistency include 17 exam questions that required the students to recall information from text that was in the bodies of both the traditional slides and the sentence-headline slides. In the transformations corresponding to these 17 questions, although sentence headlines were added to the transformed slides, those headlines did not contain the information to be recalled. In addition, these transformations did not involve significant reworking of text into visual arrangements-key images already existed on the slides. Moreover, the amount of text on the transformed slides was about the same as on the original slides. For these questions, the scores were also close, with an average correct score of 73% for the students learning from the traditional slides and 74% for the students learning from the transformed slides-a difference that is not statistically significant.

What these two sets of data reveal is that when students from the different sections were asked to recall information that was in the slide's body and incorporated about the same way—as an image or as body text—the test scores were about the same.

RESULTS AND DISCUSSION

Fifteen questions from the final exams required the students in either the Fall 2004 or Spring 2005 sections to recall information that existed in one of the slide's sentence headlines. For the Fall 2003 or Spring 2003 sections, the questions required students to recall the same information—the difference for these two earlier sections was that information existed within the text of a slide's body. The average score for the students taught from the traditional slides was 69% correct, while the average for the students taught from the slides with the sentence headlines was 79% correct. A Chi-square analysis shows that this difference is statistically significant at the .001 significance level.

On seven of the 15 questions, the students viewing the sentence-headline slides achieved higher scores that were statistically significant (three at the .001 significance level, three at the .005 significance level, and one at the .025 significance level), as opposed to achieving lower test scores that were statistically significant on only two questions (both at the .01 significance level). Larger sample sizes might have yielded significant differences on several other questions.

Table 2 presents a comparison for those 15 questions of the test scores between a section that was taught from slides with the traditional headlines and a section that was taught from slides with sentence headlines. Note that three questions appear twice in the table: questions 3 and 5 are the same, questions 6 and 7 are the same, and questions 8 and 15 are the same. These questions were posed either to two different sections that viewed the sentence-headline slides or to two different sections that viewed the slides with the traditional headlines.

Figure 3 presents a graph of these same statistics. As shown, for seven of the 15 questions, the group learning from the sentence-headline slides achieved test scores that were significantly higher than the scores achieved by the group viewing the slides with phrase, question, or no headlines.

For 10 of the 15 questions, the transformation involved changing a phrase headline to a sentence headline. Such transformations correspond to Questions 3–10, 13, and 15 in the data. Shown in Figure 4 is a comparison of test scores for one such transformation. In this case, the students taught from the traditional slide were asked to recall the information given in the first bullet point, while the students taught from the transformed slide were asked to recall the information given in the sentence headline. The test score for the student group taught from the phrase-headline slide was 46%, while the raw score for the student group taught from the sentence-headline slide was 63%—a statistical difference at the .005 significance level.

What led to such a difference? Certainly contributing to the increased recall was the greater typographical emphasis given to the information in the sentence headline as opposed to the information provided by the body text of the slide with the traditional design. The larger type size (28 points versus 24 points), the use of boldface, the placement of the detail at the top of the slide—all of these placed more emphasis on the detail in the sentence headline. In addition, on the traditional slide, the placement of the detail in a bullet list reduced emphasis on that detail, even though the bullet point was the first one listed. As Shaw, Brown, and Bromiley (1998) assert, bullets serve to remove hierarchy given to details. For that reason, this detail in the list was emphasized about the same as the list's less important details, such as the discovery date of ores in Michigan's Upper Peninsula.

Yet a third reason for the increased recall in the transformed slide was subordination of two less important details to the presenter's speech. Although the students learning from the bottom slide heard all the details from the original slide in the presentation, those students were not burdened with those less important details when viewing the slide either during or after the presentation. This design choice of having the subordinate information removed from the slide follows Mayer's (2001) principle that students learn better when extraneous words are excluded.

Also perhaps contributing to the increased recall for the students taught from the sentence-headline slide was the way in which the students catalogued the detail in their memories. Because the students' orientation to the slide was through an assertion that contained the detail, that is perhaps how they cataloged the information—anchored to that detail. In other words, the detail was cataloged as a

TABLE 2: COMPARISON OF TEST SCORES FOR THOSE TAUGHT FROM TRADITIONAL HEADLINES VERSUS SCORES FOR THOSE TAUGHT FROM SENTENCE HEADLINES

Question	Original Form of Headline	Percentage Correct for Traditional Headline	Percentage Correct for Sentence Headline	Significance Level of Statistical Difference
1	None	23%	57%	0.001
2	Question	24%	58%	0.001
3	Phrase	61%	85%	0.001
4	Phrase	46%	63%	0.005
5	Phrase	71%	85%	0.005
6	Phrase	75%	89%	0.005
7	Phrase	79%	89%	0.025
8	Phrase	79%	86%	not significant
9	Phrase	80%	85%	not significant
10	Phrase	74%	79%	not significant
11	None	67%	72%	not significant
12	Question	96%	99%	not significant
13	Phrase	86%	81%	not significant
14	Question	96%	89%	0.01
15	Phrase	79%	63%	0.01
Average		69%	79%	0.001

first-level detail. That sort of cataloging would contrast with the way that the students viewing the phrase-headline slides might have cataloged the information. The phraseheadline students might have cataloged the detail as a second-level detail beneath the first-level heading of iron. As a second-level detail, it was less likely to be recalled.

For five of the 10 questions that involved transformations of phrase headlines to sentence headlines, the students taught from the sentence-headline slides achieved higher scores that were statistically significant. In turn, on only one question did these students achieve lower scores that were statistically significant. The one question for which there was a significant decrease in recall occurred with the Spring 2003 section (phrase headline) achieving a significantly higher score than the Fall 2004 section did (sentence headline). Interestingly, on that same question, the Spring 2005 section (sentence headline) actually achieved a higher score than did the Spring 2003 section (phrase headline). In effect, although the Fall 2004 and Spring 2005 students were taught from the same slide on this question, the Spring 2005 students scored much higher than the Fall 2004 ones did. As mentioned, when students from different sections viewed the same slides and were asked to recall the same information from those slides, the scores were generally about the same. However, this case was clearly an exception.



Figure 3. Ratio of the raw test scores for group that were taught from the sentence-headline slides over the raw test scores of the group that were taught from slides with traditional headlines. Light gray bars on the left represent significant increases, black bars represent differences that were not significant, and the dark gray bars on the right represent significant decreases (significance levels given above).

For two of the 15 questions, the transformation involved changing a slide with no headline to a sentence headline. Such transformations correspond to Questions 1 and 11 in the data. Figure 5 shows the difference in recall that occurred in the transformation corresponding to Question 1. In this case, the students taught from the slide with no headline were asked to recall the information given in the body of the slide, while the students taught from the transformed slide were asked to recall the same information given in the sentence headline. The test score for the student group taught from the slide with no headline was 23%, while the raw score for the student group presented with the sentence-headline slide was 57%—a statistical difference at the .001 significance level.

What led to the difference in recall in this slide was certainly the increased typographical emphasis given to the detail in the sentence headline. Perhaps also contributing was that the students taught from the sentence-headline slide cataloged the detail in the sentence-headline slide as a first-level detail, while the students viewing the slide without a headline did not have a memory anchor for this detail.

For three of the 15 questions, the transformation involved changing a slide with a question headline to a sentence headline. Such transformations correspond to Questions 2, 12, and 14 in the data. Shown in Figure 6 is the transformation for the slide corresponding to Question 2. In this case, the students taught from the slide with the question headline were asked to recall the information given in the text, while the students taught from the transformed slide were asked to recall the information given in the sentence headline. The raw score for the section learning from the question-headline slide was 23%, while the



Led to 63% recall

Figure 4. Comparison of test score of 46% correct for a slide with a phrase headline, shown at the top, with a test score of 63% correct for the sentence-headline slide on the bottom (Schreiber 2005). The test question asked the students to recall how much iron is in the earth's crust.

raw score for the section learning from the sentenceheadline slide was 57%—a statistical difference at the .001 significance level.

In comparison with arguments for using a phrase headline or having no headline, the argument for using a question headline is stronger: a question headline leads the presenter to introduce the topic in an active way. In other words, if the presenter poses the question headline to the audience, the audience is challenged to seek the main assertion of the slide. However, on Question 2, the students taught from the question-headline slide performed much worse than did the students taught from the sentenceheadline slide. One likely reason was that much synthesis



Figure 5. Comparison of test score of 23% correct for a slide with no headline, shown at the top, with a test score of 57% correct for the sentence-headline slide on the bottom (Schreiber 2005). The test question asked the students to recall where the Crandon ore formed.

was required of the students who viewed this particular question headline. In effect, these students had to recall three details from the body, and one of those details (the detail about irradiation) was not grouped with the other two (impurities and defects). For the students viewing the slide with the sentence headline, though, those three elements were grouped into one assertion.

On the surface, the original slide appears to be weak, since the positions of the main assertion's details are fragmented in the slide's body. However, such fragmentation is not uncommon for slides that rely on traditional headlines. It is not until the presenter identifies the main assertion—a step that creating sentence headlines ensures-that the presenter can clearly see what those details are and

Figure 6. Comparison of test score of 24% correct for a

slide with the question headline, shown at the top, with a

the bottom (Schreiber 2005). The test question asked the students to recall what caused color in diamonds.

test score of 58% correct for the sentence-headline slide on

whether those details are arranged effectively. Although this particular question headline was much less effective than the sentence headline, situations arise in which a technical presenter might consider using a question headline in series with a sentence headline. One such situation would be when the presentation would benefit from the audience examining the evidence in the body of the slide before seeing the assertion, as in the presentation of an assertion for which the audience has a hostile reaction. In such a use, the question headline would appear first, and then after the presenter has addressed the question by examining evidence in the slide's body, the presenter would "animate in" the sentence headline.

CONCLUSIONS

According to Microsoft (Parker 2001), an estimated 30 million PowerPoint presentations occur everyday. As anyone who has recently attended a conference knows, the overwhelming majority of those presentations have headlines that are either single words or short phrases. This article, though, has presented experimental evidence that succinct sentence headlines are more effective. In our study, using sentence headlines of no more than two lines led to statistically significant increases in recall from the audience on details that were contained in those sentence headlines. A Chi-square analysis shows that this difference is statistically significant at the .001 significance level. The main conclusion is that if technical presenters desire to emphasize assertions in a presentation, they would do well to place those key assertions in succinct sentence headlines.

For a presenter desiring to design slides with such sentence headlines, however, the typography and layout defaults of PowerPoint pose a hurdle. In other words, someone who simply opens up PowerPoint must make many keystrokes to change the size, position, and alignment of the headline's text to accommodate a sentence appropriate for a technical presentation. However, help does exist. For instance, available at the first Google listing for the topic of presentation slides are templates to overcome the cumbersome headline defaults of PowerPoint (Alley 2003b). For many technical presenters, these templates have made the adoption of a sentence-headline design much easier (Alley and Neeley 2005).

This pilot study has focused on slide transformations in which the principal change on each slide was to place the slide's main assertion into a succinct sentence headline. The research question for this study was how well the audience has retained that assertion. Further testing is needed to isolate completely the effect of changing the sentence headline from other aspects modified in the slide's design—in particular, the slide's typography or the way in which evidence in the slide's body was designed. T**C**

ACKNOWLEDGMENTS

Our thanks go to the Center for Excellence in Undergraduate Teaching at Virginia Tech for their financial support and advice. In particular, we wish to acknowledge Professor Terry Wildman and Meghan Habas Siudzinski.

REFERENCES

Alley, Michael. 2003a. The craft of scientific presentations. New York, NY: Springer-Verlag,125–129. ------. 2003b. Design of presentation slides, http://writing.eng.vt.edu/slides.html.

- Alley, Michael, and Kathryn A. Neeley. 2005. Rethinking the design of presentation slides: a case for sentence headlines and visual evidence. *Technical communication* 52:417–426.
- Alley, Michael, Madeline Schreiber, and John Muffo. 2005. Pilot testing of a new design for presentation slides to teach science and engineering. *Proceedings for the 35th ASEE/IEEE Frontiers in Education Conference*. Indianapolis, IN: IEEE.
- Atkinson, Cliff. 2005. Beyond bullet points: Using Microsoft PowerPoint to create presentations that inform, motivate, and inspire. Redmond, WA: Microsoft Press.
- Doumont, Jean-luc. 2005. Slides are not all evil. *Technical communication*, 52:64–70.
- Gottlieb, Larry. 2002. Well organized ideas fight audience confusion. *Proceedings of the 49th Annual Conference of the Society for Technical Communication*. Arlington, VA: Society for Technical Communication.
- Mayer, Richard E. 2001. *Multimedia learning*. New York, NY: Cambridge University Press.
- Parker, I. 2001. Absolute PowerPoint. *The New Yorker* (28 May):76–87.
- Schreiber, Madeline. 2005. Teaching slides from Resources Geology: Geos 1024. Blacksburg, VA: Department of Geosciences, Virginia Tech.
- Schwartz, John. 2003. The level of discourse continues to slide. *The New York times*, 28 September, sec. 4, 12, col. 1.
- Shaw, Gordon, Robert Brown, and Philip Bromiley. 1998. Strategic stories: How 3M is rewriting business planning. *Harvard business review* (May–June):41–50.
- Toulmin, Stephen E. 2003. *The uses of argument*. New York, NY: Cambridge University Press.

MICHAEL ALLEY is an associate professor of engineering education at Virginia Tech. He is the author of The craft of scientific presentations, The craft of editing, and The craft of scientific writing—all published by Springer Verlag. Contact: alley@vt.edu.

MADELINE SCHREIBER is an associate professor in the Department of Geosciences at Virginia Tech. She teaches the

introductory level course Resources Geology and higher-level courses in hydrogeology. Contact: mschreib@vt.edu.

KATRINA RAMSDELL is a senior in chemical engineering at Virginia Tech. She is performing research in both chemical engineering and engineering education. Contact: kramsdel@vt.edu. **JOHN MUFFO** is the administrator of special projects at the Ohio Commission for Higher Education and former director of academic assessment at Virginia Tech. He is widely published in the fields of institutional research and assessment and is a past-president of the Association for Institutional Research. Contact: muffo@vt.edu.