Effectiveness of LITEE Case Studies in Engineering Education: A Perspective from Genre Studies

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I. Introduction

Several reports released at the turn of the millennium changed the face of engineering curricula (Accreditation Board for Engineering Technology, 2004; National Academy of Engineering, 2004). These studies found that though engineers were graduating from institutions of higher education with technical proficiency, many lacked professional skills, such as teamworking and communication skills, that are also vital in the workplace.

Many research groups clamored to fill the gap in instructional tools. For example, in 1996, the Laboratory for Innovative Technology and Engineering Education (LITEE) developed its first case study for use in engineering classrooms. The case study was designed to develop those skills that the Accreditation Board of Engineering Technology (ABET) and the National Academy of Engineering (NAE) require of graduates. Though research (see, for example, Clayson, Raju, & Sankar, 2010; Sankar, Varma, & Raju, 2008; Mbarika, Sankar, & Raju, 2003) has been conducted demonstrating *that* the case studies are effective, in general the research has focused on outcomes. Not much research has been conducted looking into *how* the case studies achieve these outcomes.

This study introduces a framework from genre studies—genre ecology—and applies it to the LITEE Challenger Case Study in an attempt to uncover that "how." Using the genre ecology framework reveals that the case study's effectiveness is dual in nature; first, learning is enabled through a phenomenon known as *compound mediation*, and second, the Challenger Case Study is unique because it utilizes language-as-learning, allowing students to learn to communicate *as engineers*.

II. Literature Review

LITEE Case Studies are interactive, multimedia instructional materials specifically designed to show students real-world examples of the concepts they learn in their classrooms. The case studies are designed to develop in engineering students those "professional competencies" required by the Accreditation Board for Engineering and Technology (Accreditation Board for Engineering Technology, 2004). Each case study is designed like a website, with interactive navigation that students click through to complete the case.

LITEE Case Studies are what Hull and Nelson (2005) term "multi-modal"; they incorporate multiple *modes* of communication—e.g., audio, pictoral, and textual—in order to send a message. Multi-modal instructional tools are typically best because, as Hull and Nelson say, they don't privilege one type of literacy over another. In multi-modal environments, students who learn best from images or sound are less likely to struggle to learn than in text-heavy environments; these students are, therefore, given the same opportunity to learn as students who learn easily from text. The case studies, therefore, are able to appeal to a wide range of learners.

Despite this wide appeal, the case studies are still quite text-heavy. What makes them especially multimodal is their dependence upon the other forms of media to truly communicate the lesson. In the Challenger Case Study (Raju & Sankar, 2000), for example, critical facts are illustrated in images. Students need to see pictures of joint rotation (see Figure 1) in order to understand how the explosion occurred. Similarly, the videos included in the Challenger Case study include vital information that students must know before they can sufficiently work through the case.

Much research has been done on these case studies, and they have been proven to be useful in developing student skills (see, for example, Clayson, Raju, & Sankar, 2010; Sankar, Varma, & Raju, 2008; Mbarika, Sankar, & Raju, 2003). Not only do they introduce students to technical concepts, but they also have been shown to improve teamworking skills, communication skills, higher-order cognitive skills, and self-efficacy (Abraham & Abulencia, 2010; Connolly, 2010; Franchetti, 2010; Fini, 2010; Mbarika, 2010; Stanwick, 2010). However, many of these studies have been conducted using data collection methods such as survey instruments, focus groups and student interviews long after the students have completed the case. None of

Abstract

Much research has been conducted in the past decade and a half on the effectiveness of Laboratory for Innovative Technology and Engineering Education (LITEE) Case Studies in engineering education. A case study, as defined in this study context, is an online, multimedia tool designed to bring real-world problems into the classroom. Much past and current data from the Lab and other researchers have come from survey or focus group research, often measuring student performance or perceptions of performance while using the case studies.

What researchers have not yet examined is how students actually interact with the case studies, and how this interaction encourages student learning. This paper uses a framework from the field of communication to examine this phenomenon. Using Spinnuzi's framework of the "genre ecology," the paper explains how case studies enable compound mediation, which in turn enables student learning.

these studies examines *how* the case studies develop these skills in students, or examines the artifact sets involved in the learning process.

Examining the artifacts themselves may not seem important in a world so focused on results, such as ABET's demand upon engineering programs. Examining these artifacts can reveal insight, however, into how they help students learn; such an understanding can help educators capitalize on that learning process.

Scholars in technical and professional communication have used the term genre to describe artifacts that workers use to achieve certain goals. Spinuzzi (2000) sums up early genre studies by saying that, traditionally, genres have been considered "stable, predictable forms" (p. 172). Take, for example, a dictionary. Though there are several, possibly thousands, published dictionaries in existence, most will typically contain certain features: each word entry will contain a word, its part of speech, a pronunciation guide, and a definition. The entries will typically be listed alphabetically. Dictionaries may, of course, vary from this format, but readers can still identify a dictionary *as a dictionary* because they recognize these features.

Genres can be found in educational contexts as well. Textbooks, class lectures, and tests can all be considered genres. Even group projects or presentations can be considered genres; many teachers are familiar with such presentations' "stable, predictable forms": a group of three or four students take turns speaking with the assistance of a slide presentation, often in PowerPoint.

These genres are not used in isolation. Students do not read a textbook chapter for its own sake; they read it in preparation for a classroom lecture. There, they take notes (another genre, if less predictable), which they will later use in preparation for a project, presentation, or test. In fact, most genres are not used in isolation but in conjunction with other genres. Spinuzzi (2000; 2004) provides a framework for this conjunctional use: genre ecologies. As the word "ecologies" implies, these connections among genres are often "dynamic, organic, and messy" rather than "predictable and stable" (2000, p. 173). This is especially true in the classroom, where so many genres depend on the individuals involved in a genre ecology. One student's method for note taking will differ from her neighbor's, just as one instructor's lecture style will differ from his office mate's. Using this "ecology" framework can develop understanding

Figure 1. Joint Rotation (Raju & Sankar, 2000)
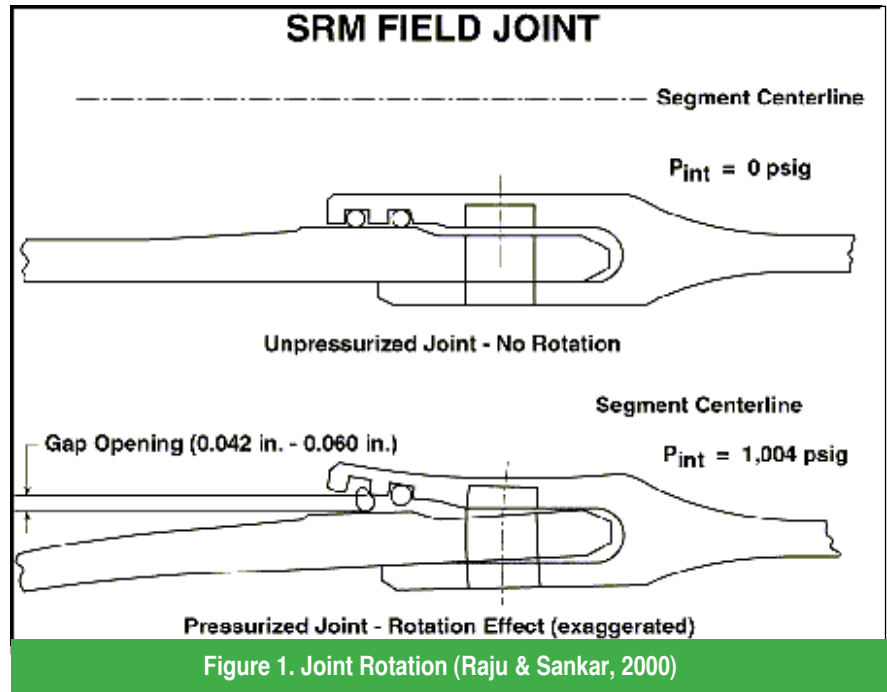
regarding how these genres interact to achieve their goals—through a phenomenon Spinuzzi calls "compound mediation" (2003).

Compound mediation, according to Spinuzzi, "refer[s] to the ways that people habitually coordinate sets of artifacts to mediate or carry out their activities" (2003, p. 1). To define compound mediation Spinuzzi uses the example that software engineers use various genres to code new software programs. The engineers drew upon a number of different genres, including an online code library and printed manuals, among others, to create new programs. In broader terms, they used genres across the ecology to achieve their goal of a new program. This concept can also be used to describe how students use the LITEE Case Study genre ecology to achieve certain educational objectives.

III. Methods

This study examines the LITEE Challenger Case Study within an educational genre ecology. This ecology includes a textbook, classroom lectures (which incorporate both the spoken lecture itself and its associated slide presentation), student notes, the LITEE Challenger Case Study, and student presentations (which incorporate the students' speeches, their slides, and their slide notes).

To examine this genre ecology, the author collected several artifacts from a single unit (Engineering Communication) in an Introduction to Engineering class at Auburn University. The artifacts were then reviewed in the same

order in which the students encountered them in the classroom. First, the unit's corresponding textbook chapter was read, followed by the lecture slides that accompanied the actual lecture given to the ENGR 1110 class. Next, the author read through the entire case study, viewing videos, images, and appendices as they were linked in the text. Finally, the student presentation slides and their accompanying notes were read. After this initial read-through of the materials, the materials were examined more closely, comparing student presentations and notes against the principles taught in the chapter, lecture, and case study.

The author found that, as Spinuzzi describes of the software engineers, this ecology of artifacts surrounding the LITEE Challenger Case Study facilitates compound mediation. The use of the LITEE Challenger Case Study *in conjunction with* textbook readings, lectures, and student presentations enabled students to learn and practice communicative concepts. The use of each of these artifacts in conjunction with the others enables a firmer understanding of the educational objectives than the individual artifacts used in isolation. The inclusion of the LITEE Challenger Case Study in particular, because of its multi-modal nature and practical application, gives students the opportunity to more firmly grasp the concepts being taught.

A. LITEE Challenger Case Study Genre Ecology

The LITEE Challenger Case Study Genre Ecology, as observed in the Introduction to Engineering class at Auburn University, includes three distinct phases, each building upon the previous. First, in the "Instructional" phase, the students read a chapter in the assigned textbook, attend a lecture, and take notes. Next, in the "Case Study" phase, the students read through the case study in the class's associated lab. Finally, in the "Presentation" phase, students prepare and deliver a team slide presentation based on an assignment in the case study.

Instructional Phase:

During the "Instructional" phase of the LITEE Challenger Case Study genre ecology, students consume and produce several different genres. First, they are asked to read the corresponding chapter in the textbook prior to coming to class. Students might annotate or highlight the text, or they may write notes on another piece of paper as they read. These casual notations are considered "unofficial" genres by Prior (2009). Of course, students may choose to simply read the text, without incorporating any unofficial genres. Once in class, students listen to a lecture delivered by the instructor, who uses lecture slides to help the students follow along (See Appendix A). The instructor may refer to notes as he gives the lecture, and students may write their own notes as they hear the lecture. These genres work together to reinforce certain concepts before students proceed to the next phase.

LITEE Challenger Case Study

The next phase in this genre ecology is the actual interaction of the students with the case study. The case study used in this unit is the "STS 51-L" case study, more commonly known as the "Challenger Case Study" (Raju & Sankar, 2000). This case study depicts the historical events leading up to the explosion of the space shuttle *Challenger* in 1986.

The case study itself is a mini-website, available online at www.liteecases.com. The site is a multimedia, multimodal (Hull & Nelson, 2005) experience with links, images, videos, and, of course, text. The site has a deep architectural structure, requiring much clicking through pages to move through all necessary material. The main navigation through the case is enabled through a complex visual timeline (shown below in Figures 2 through 5). The timeline is divided into two parts: a general timeline, giving an overview of the years 1970–1986, and excerpted timelines detailing events that occurred in a chosen year, with image links that take students deeper into the site hierarchy to give them more in-depth information about the event. For example, clicking the block representing 1980 (Figure 2: 1980 circled in yellow) takes viewers to a page describing the events occurring in 1980 (Figure 3). Clicking the first image link (circled in yellow) takes viewers to a page about "O-Rings and Shims" (Figure 4). Clicking the far left link on this page takes viewers to a page detailing the "O-ring/Shim Decision" (Figure 5). The site's structure is similarly deep throughout, requiring multiple paths to obtain all required information.

The case study begins in the 1970s with the development of the space shuttle. It explains how the shuttle works, giving detailed descriptions of the design relationships among the *field joint*, the *tang*, the *clevis*, and the *o-rings*, technical knowledge necessary for understanding the problem that caused the Challenger explosion. This kind of technical description gives students an idea of what "real" engineers do and what "counts" as engineering.
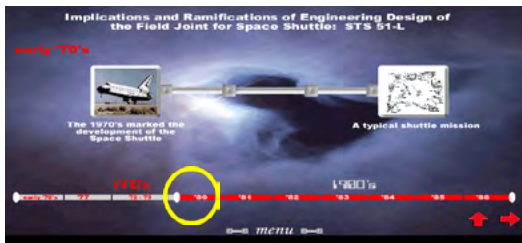
Figure 2: General Timeline

Figure 3: "1980"

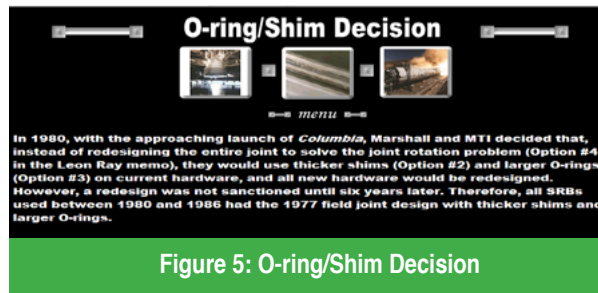
Figure 4: O-Rings and Shims

Figure 5: O-ring/Shim Decision

The case then goes on to discuss a 1977 memo from William Leon Ray recommending the complete redesign of the tang to keep the field joint from rotating and causing future problems, and describes how the managing entities at Marshall Space Center and Morton Thiokol, Incorporated, decided instead to combine two other solutions, one of which was not originally recommended but was deemed acceptable after further testing. The case then shows how, in the 1980s, the ramifications of this less-than-ideal solution began to manifest themselves in the form of eroding O-rings, giving several examples of shuttle launches and tables containing test and launch data. Finally, it describes the few days leading up to the launch of the STS 51-L. Several engineers were concerned that it was too cold to launch the shuttle, but could not convince managers in charge of the launch to postpone it until temperatures rose.

Presentation:

After reading through the case study, students discuss it with their team members and put together slide presentations recommending a particular solution. In the case of the Challenger case study, students were assigned either to defend a decision to launch or to defend a decision not to launch. The presentation analyzed in this study defends a decision not to launch and is available in Appendix B.

IV. Results & Analysis

Close comparison and analysis of each of these genres revealed that several communicative principles are taught through the compound mediation enabled by the LITEE Challenger Case Study Genre Ecology.

What makes the LITEE Challenger Case Study Genre Ecology unique is that part of the compound mediation within the ecology is the students' actual *practice* of the principles they learn. In the presentation phase, students exhibit an understanding of the principles they have previously learned through their slide presentations. However, it is the *creation* of these slide presentations that provides another venue of compound mediation.

The principles taught through the LITEE Challenger Case Study Genre Ecology fall under two categories: general communication principles, including the importance of communication, audience analysis, tone, organization, and supporting evidence; and principles specific to creating and delivering slide presentations.

A.) Communication Principles
Importance of Communication in Engineering

The students' first exposure to the importance of communication in engineering is through the textbook, "Fundamental Leadership and Engineering Competencies" (Raju, Sankar, & Le, 2010). Chapter four, titled "Engineering Workplace Communication: Presentation and Writing," describes communication as a "necessary aspect of all of the work of professional engineers," calling it "the way that engineers get their ideas implemented" (99).

The bulk of the emphasis on communication's importance in engineering is delivered via the case study, however. In this real-life example, students are painted a picture of just what can happen if engineering communication fails, particularly when it doesn't follow the principles outlined in the book and lecture. After

describing one engineer's trouble to support his conclusions with evidence, the case study ends with the phrase "NASA proceeded with its plans to launch STS 51-L on January 28th, 1986" in bright red letters against the site's black background, forecasting the disaster of the Challenger accident. The rhetorical implication of the narrative and concluding statement is clear: because of the engineers' inability to clearly communicate the high probability of danger to the managers at NASA, the launch was given the go-ahead and proceeded exactly as the MTI engineers had feared, ending in disaster.

Students, therefore, have been told twice of the importance of communication and have been given a real-life example thereof. The students' presentation exhibits an understanding of this importance. The students use four of eleven slides to emphasize their recommendation not to launch—they want to make sure their message and reasoning are clear. They understand that lives depend on their communication; notes on one slide indicate: "Furthermore, how much worse would our public image suffer should the lives of the crew and the teacher aboard be lost due to a problem which could have been prevented? The solution is simple, due to the risk of our finances, our public image, and most importantly the lives of our passengers, the launch should be delayed" ("STS 51-L Launch Review," Slide 10). The students know the stakes of their presentation: money, reputation, and "most importantly," people's lives.

Audience Analysis

The chapter spends a significant amount of time on the importance of audience analysis, emphasizing that "…unless the audience understands the message, the communication is unsuccessful" (Raju, Sankar, & Le, 2010, p. 102). The chapter encourages students to "assess audience expectations" (108) and to meet those expectations not just in providing the expected content, but also in delivering the message in the expected manner.

The communication lecture also discusses audience analysis. Slide six gives a list of questions to consider when designing a presentation:

1. What does the audience know about the topic?
2. What do you want them to know when you are finished?
3. How do these two match up?
4. What will the audience understand as you tell them about the topic?
5. What do you need to show and tell them

to get them to understand your information?
6. How can you fit in the most important points in the limited time you have? (See Appendix A, McIntyre, Slide 6).

It also reminds students to "Design your presentation for your audience; make sure they will understand your information" (See Appendix A, McIntyre, Slide 14).

The case study also emphasizes audience analysis, if not explicitly. The engineers were unable to convince the managers at NASA not to launch because they had not properly analyzed their audience and, therefore, did not sufficiently argue their case. Similarly, the student presentations implicitly demonstrate a consideration for audience. Students are acutely aware that the presentations are being graded by their instructor, so they work to ensure their presentations match the standards given to them by that instructor (discussed in section IV.B: Presentation Principles).

Purpose

The lecture and the textbook discuss purpose briefly. The lecture mentions purpose on slide three, and the chapter discusses it on pages 105–107. It gives several potential purposes for communication in engineering, the first being "decision-making:" "When communicating in a decision-making situation, it is important to describe the decision to be made along with any alternative approaches. Then describe what will happen if each approach is chosen. Finally, give your recommendation and explain why you believe it to be the best alternative" (Raju, Sankar, & Le, 2010, p. 105).

The final slides in the students' presentation follow this pattern: slide seven makes a recommendation; slides eight, nine, and ten discuss the pros and cons of each potential decision, and the final slide briefly reviews the recommendation. It focuses on the main purpose of the presentation—a persuasive attempt to convince the audience that the best decision is not to launch the shuttle. The slide notes ask simply: "Recall the information given in the previous slides. Remember what our recommendation is and what we want from you" (See Appendix A, "STS 51-L Launch Review," Slide 11), a clear reflection by the authors on the purpose of the presentation.

Evidence

The chapter also discusses the ever-important concept of "supporting conclusions," telling students that "each supporting point must have

a clear relationship to the idea it is supporting. You should not assume that the connection between a supporting detail and the main idea is obvious—even if it is obvious to you" (Raju, Sankar, & Le, 2010, p. 115). The lecture repeats this idea, and asks students to consider "What do you need to show and tell [your audience] to get them to understand your information?" (See Appendix A, McIntyre, Slide 6).

Evidence is most heavily emphasized in the case study. In the final pages of the case study, the narrative describes the trouble of one engineer to support his recommendation not to launch the shuttle. The engineer could not supply hard data that the Challenger would absolutely, certainly experience problems if launched in forty-degree weather. The narrative then goes on to say that "'the rationale was rejected'" (Raju & Sankar, 2000). Managers at NASA would not accept the recommendation with such "unsubstantiated and contradictory" data (Raju & Sankar, 2000), so the engineers were asked to reconsider. During a short "caucus," the engineers remembered data from testing that *could* support a decision to launch. The engineers then recommended to launch. When asked by NASA if everyone supported this decision, "no engineer from MTI responded to this decision" (Raju & Sankar, 2000).

The rhetorical implication is clear: because the engineers could not provide satisfactory evidence to their audience, their communication failed. The students took note of this and attempted to rectify this in their own presentations. Slide six of the student presentation showcases two large pictures of o-ring damage, evidence for the ineffectiveness of the alternative solutions provided by MTI, as discussed in the slide notes: "…this was an unacceptable solution due to the high probability of o-ring damage or clevis distortion during assembly" (See Appendix B ,"STS 51-L Launch Review," Slide 6). Because o-rings are the key to this case study, it is imperative to show the damage that launching the shuttle would cause, and these students have done just that.

Tone, Clarity, & Conciseness

The unit is also designed to introduce students to ideas of tone, clarity, and conciseness, though these terms, while common to composition classrooms and research, are abandoned for "engineering" versions. The chapter states that engineering communication should be "clear and simple," "short and to the point," and "precise and accurate" (Raju, Sankar, & Le, 2010, p. 100), in short, to be *clear* and *concise*.

The lecture contributes as well; the first slide reiterates this same list, and slide three ends with the point: "When you are done Check the Content to see it says what you want it to" (See Appendix A, McIntrye, Slide 3)—in other words, to be sure that it is clear. The book also discusses tone, urging students to be aware of "the kind of language used: technical vs. non-technical, informal vs. formal, restrained or enthusiastic" (Raju, Sankar, & Le, 2010, p. 100). The student presentations, while not a mastery of sophisticated tone and concise prose, do at least attempt to be clear in their recommendations—as evidenced by the four-slide reminder not to launch (See Appendix B).

Organization

Just as the concept of tone is discussed using engineering terms, the concept of organization is also presented without using composition jargon. The chapter asks students to think about "the sections of the document presentation" (Raju, Sankar, & Le, 2010, p. 109) and uses the words and phrases "logical flow," "sequencing," and "clustering" to discuss ideas of organization, cohesion, and coherence (Raju, Sankar, & Le, 2010, p. 113–114). Slide three of the lecture presentation also states, "the material must: have a logical sequence" (See Appendix A, McIntyre, Slide 3).

The student presentation exhibits applied principles of organization. The slides present the O-ring problem in a logical manner, and each slide presents a main topic. The students' slide notes also exhibit some principles of organization; slides five, six, and eight contain ordinal lists, two of which are paragraph-style. The notes in general are haphazard but still indicate the logical, organized thinking of the students.

B. Presentation Principles

The lecture on Engineering Communication, in addition to discussing general principles of communication, spends a significant amount of time on slide presentations. Lecture slides four through fourteen provide an example of how to construct a slide presentation. The instructor discusses several principles of giving presentations using slides, including overall format and individual slide format, presentation content, delivery, and methods of handling multiple speakers. This is where compound mediation is most evident—the student presentation followed most, if not all, of these recommendations to the letter.

The lecture recommends giving title, overview, and recall slides, which the presentation does. The lecture presentation calls the overview slide the "tell them what you are going to tell them" slide, and says that the concluding slide should "tell your audience the important things you told them" (See Appendix A, McIntyre, Slides 5 & 14). The student presentation does just that—it has a title, an overview, and a recall slide, included in Appendix B (the student presentation).

Slide Composition

Slides seven, eight, and nine give several guidelines for slide composition. Slide seven asks presenters to pay attention to the colors used on their slides, stating that slides should be "easy to read when projected" (See Appendix A, McIntyre, Slide 7). The student presentation used a black background with white, gray, and yellow text—high contrast for easy reading. Slides eight and nine ask presenters to "avoid large blocks of text," and instead use single-sentence bullets and images (See Appendix A, McIntyre, Slides 8 & 9). The students most successfully adhered to this suggestion; most slides contained images and limited text—one slide even consisted of a single image.

Multiple Speakers

Slide twelve of the lecture presentation discusses handling multiple speakers. It suggests that speakers should transition at "natural breaks in [the] presentation" (See Appendix A, McIntyre, Slide 12), which the students do. The presentation notes for the students' slides one through four differ in style significantly from slides five, six, and seven. The first four slides' notes are arranged in lists of short phrases with only essential information, like "O-rings seal any opening between the tang and clevis" and "2 O-rings per field joint" (See Appendix B, "STS 51-L Launch Review," Slide 4). The notes from slide five, however, comprise a single paragraph of 19 (mostly) complete, short, declarative sentences and some fragments, such as: "The second option was to place shims between the tang and clevis on the outside. He felt this was an acceptable short term solution if the correct shim size was used. Although there was a probability of error in obtaining the correct shim size and increased assembly time for shim installation…" (See Appendix B, "STS 51-L Launch Review," Slide 5). This indicates a change in slide author. Similar shifts are made from slides seven to eight, which uses two short ordinal lists. Slides nine and ten return to a paragraph style similar to slides five through seven, and slide eleven's style is similar to slides one through four. This suggests at least three team members who each took ownership of certain information; the students divided up the presentation into logical sections for which each then took responsibility.

V. Discussion

Each of these principles, then, is visible in multiple places across the genre ecology. Some principles are visible across all genres, while others are visible across only a few. Each of these concepts, however, is compoundly mediated across the LITEE Challenger Case Study Genre Ecology as explained above and as illustrated below in Figure 6. Each time a student sees, hears, or practices one of these concepts, it is reinforced. As the figure demonstrates, some principles are reinforced more often than others. The book explicitly discusses all principles except those specific to slide presentations. The lecture (as indicated by the slides) includes all of the principles except the importance of communication, which is present in the three other genres. The presentation in-

Figure 6: Compound Mediation Across the LITEE Challenger Case Study Genre Ecology

cludes all of the principles, but the case study itself seems to present only three out of these nine principles.

However, the case study is absolutely essential to the genre ecology because it gives the students a rhetorical situation in which they can *practice* these principles—the presentation, which, as indicated above, covers all of the principles simultaneously. Indeed, it is this final *practice* that really allows students to learn.

This concept is quite similar to the concept of *writing-to-learn*, about which scholars such as Janet Emig, John Dewey, and James Britton, among others, have said much (Russell, 2002). These scholars argue that because all activity—even activities in disciplines such as engineering—is steeped in language, using that language is a valuable mode of learning. Even though engineers' tasks may be highly technical, such as designing an o-ring, they still must think about and conceptualize those tasks in language. As *Language for Life*, an influential report out of Britain on language across the disciplines, states, "While many teachers recognize that their aim is to initiate students into a mode of analysis, they rarely recognize the linguistic implications of doing so. They do not recognize, in short, the mental processes they seek to foster are outcomes of a development that originates in speech" (*Language for Life*, 1977, qtd. in Russell, 2002). Learning to be a member of a discipline means learning to think as a member of that discipline—and thinking is done through language. Therefore, using language—writing, speaking, giving presentations—is vital to a full and complete disciplinary education.

The Challenger Case Study, then, is vital to its genre ecology because it enables this kind of learning through communicating. It immerses them in the world of engineering, introducing technical concepts while implicitly teaching important communication principles. Then, through the presentation, it allows them to practice communicating, yes, but communicating *as an engineer*. Using the Challenger Case Study gives students an introduction to the complicated communication dance they will have to continue to do throughout their careers; it introduces them to the difficulties of using jargon and explaining complicated technical concepts. This particular real-world example emphasizes the importance of communication in ways that could not be achieved just through the textbook and notes. The Challenger Case Study demonstrates that clear communication is vital to success as an engineer, and that failure to com-

municate can cost money, reputation, and lives.

It is this double-duty function that makes the Challenger Case Study truly unique and absolutely vital to the genre ecology. It enables compound mediation in a way that allows students to practice the concepts they are learning—to learn through that practice.

VI. Conclusion

The LITEE Challenger Case Study Genre Ecology, then, is successful not only because it enables compound mediation across the ecology, but also because it allows students to practice communicating as engineers. Examining the artifacts through a framework of "genre ecology" has revealed these connections and given insight into *how* students learn using these tools. There is still more to learn, however.

This initial theorization of precisely *how* the LITEE Challenger Case Study Genre Ecology works (instead of just *that* it works) demonstrates a need for further, deeper examinations of the ecology in use. Such examinations could be modeled after Spinuzzi's (2003) study of software engineers; in that study, he examines the physical genres in the ecology, and he interviews the subjects on their use of the genres. A comprehensive study of the case study genre ecology could include both this collection of physical genres and interviews and a taping and transcribing of several phases in the ecology—lectures, student team discussions, creation of the case study, etc. Such a comprehensive look would enable researchers to more formally and concretely analyze the ecology and its effect on student learning and development, which would enable and encourage further development and improvement of the case studies and corresponding genre ecologies.

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Engineering Communication

Characteristics of Engineering Communication

Engineering communication should be :

- Clear and Simple.
- Short and to the point.
- Precise and accurate.
- Never be misleading.

Elements of Engineering Communication

Audience Characteristics	To whom are you talking.
Form	What medium are you using.
Content	How do you tell your message.

Delivery

Stay Professional

Keep the Audience's Attention

Convey Your Ideas

Preparing Engineering Communication

Communication Strategy comes from:

Your Purpose, Audience, and Medium.

Your strategy determines your Material.

The Material must:

Have a Logical sequence,

Support your conclusions,

Be clear.

When you are done Check the Content to see it says what you want it to.

Giving a Technical Presentation

First Slide Says what you are Presenting.

And

Who is doing the presenting.

Joseph S. McIntyre

Next slide should give short outline of presentation.

This is the "Tell them what you are going to Tell them" slide.

1. What should you tell the audience in your presentation?
2. What should your slides look like?
3. How should you deliver your talk?
4. How do you handle multiple speakers?
5. How long should a slide be up?
6. Conclusion.

What to tell the audience in the presentation?

The questions you need to answer to prepare your presentation.

1. What does the audience know about the topic?
2. What do you want them to know when you are finished?
3. How do these two match up?
4. What will the audience understand as you tell them about the topic?
5. What do you need to show and tell them to get them to understand your information?
6. How can you fit in the most important points in the limited time you have?

What should your slides look like?

Start to tell the audience what are presenting.

Your slides should enhance and support your talk.

They should be easy to read when projected.

Choose your colors carefully.

You can make your words disappear.

Avoid dense blocks of text!!

Even if the font is large enough for your audience to see, they are now reading the text. They are not listening to you.

➢ Use bullet points, with each point no more than a single sentence.
➢ I have been giving lectures in a format that is complete and easy to read later.
➢ This presentation leans toward that same format.

- Show your audience what you are talking about.

- Use pictures, graphs, and tables instead of words.

- Use appropriate pictures as decoration, if you need decorations.

- Make sure your slides are easy to look at. Choose a background that compliments your work.

How should you deliver your talk?
- Talk to your audience.

- Never speak to the screen!!!

- You can glance at the screen to point out something.

- Make eye contact with all your audience members.

- Look about the audience slowly and smoothly.

Be confident! You are the expert on the subject of the presentation.

- Practice your presentation. Be able to give it in a conversational style.

- Try out the presenting equipment before hand.

- Make sure your presentation works on the system.

- Be able to give your presentation smoothly.

How do you handle multiple speakers?
- Speakers should introduce themselves when they start to speak.

- Those not speaking should not be a distraction for the audience.

- Sit down out of sight of the audience. Stand quietly if you can't sit.

- Make speaker transitions at natural breaks in your presentation.

How long should a slide be up?
- Each slide should be on the screen for about 2 minutes.

- Your audience will have enough time to absorb what is on the slide.

- Do not change slides up on the screen too quickly.

- You can repeat your contents slide so your audience knows where you are in the presentation. Show it just as long as you need to start the new section.

- Highlight the section you are about to start in the outline.

Concluding Slide.

Tell your audience the important things you told them.

- Design your presentation for the audience.
- Make sure they will understand your information.
- Be confident and practiced in your delivery.
- Slides must be easy to read and informative.
- More pictures than words.
- Speakers should introduce themselves when they speak and be inconspicuous when not speaking.
- Two minutes a slide. Repeats of the contents slide are shown just as long as you need to start the new section.
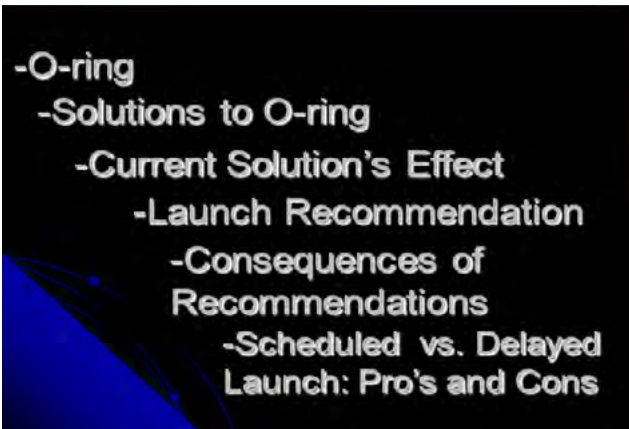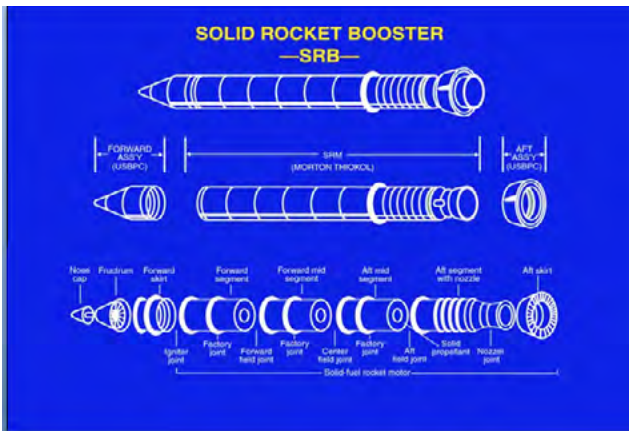
Presentation Slide

Notes:
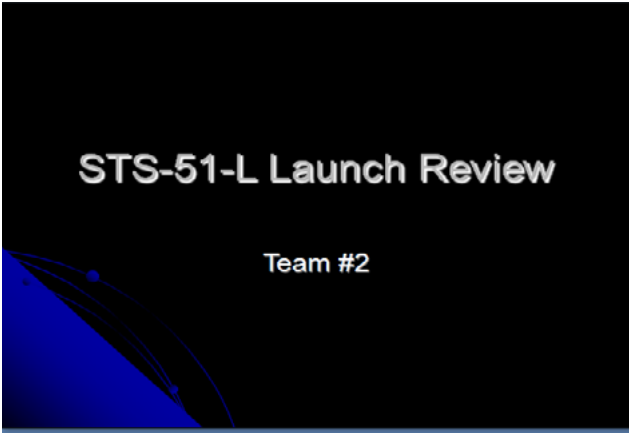
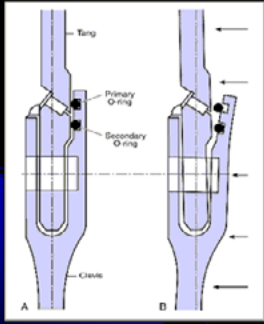Introduce title of review and each team member

Highlight each major point in the contents of the powerpoint and tell who is going to cover the subject in more detail.
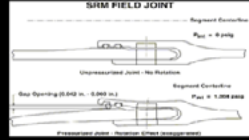

SRB's are composed of multiple cylinders in stacks. Provide 80% of thrust at lift off, lasts 2 minutes

O-ring

- The o-ring connects the seal between the tang and the clevis so that gases cannot escape during liftoff.
- Joint rotation (left) and blow-by and erosion (above) are both issues that have been discovered

O-rings seal any opening between the tang and clevis

2 O-rings per field joint

Joint rotation discovered in 1977 during hydroburst test. (pressurizedto 1 ½ times the expected pressure of the SRM at ignition

Pressure causes swelling creating a large gap between the clevis and tang that the O-ring can't seal.

Hot gasses from propellant "blow by" the puddy and erode/compromise the o-rings resulting in an improper seal.

Solutions to O-ring issues

- William Leon Ray came up with five solutions to solve the clevis joint leakage.

William Leon Ray was an engineer for Science and Engineering in the Solid Motor Branch and he was responsible of pursuing any problems with the SRB. Through this he became concerned about the joint rotation. He sent several memos to his manager recommending solutions to the problem. The specific memo shown on the slide was presented in 1977 with five separate options. The first option was to have no change, which Leon Ray felt was unacceptable. This was due to the fact that the tang could move outboard and cause joint clearance and seal leakage. The second option was to place shims between the tang and clevis on the outside. He felt this was an acceptable short term solution if the correct shim size was used. Although there was a probability of error in obtaining the correct shim size and increased assembly time for shim installation. The third option was to have oversized o-rings, which he also felt was unacceptable due to the high probability of o ring damage or clevis distortion during assembly. This would change the recommended design processes. The fourth option was to redesign the tang which would then reduce the tolerance on the clevis. He considered this the best long term fix of the problem. The shins would be eliminated and would prevent the error from calculating the joint clearance. The fifth option was a combination of option four but with the use of shins. While not his favorite, he felt this would be acceptable with the shins needed in several places where things are jointed. The shins would eventually be discontinued. Later, in 1979, Leon Ray suggested to perform tests that more closely simulate conditions of the flight. With the approaching launch of *Columbia, the engineers decided to use a combination of two and three instead, with thicker shims and larger O rings, which is against what Leon Ray recommended.*

Current Solution Effectiveness

- While MTI made an informed decision, their solution to the O-ring problem left a high margin for failure.

MTI decided to make the following changes to the joint rotation problem by combining three of William Leon Ray's suggestions. First, as in suggestion two they increased the shim thickness, but this left open the possibility of error in calculating shim size as well as error due to the increased amount of time and attention to detail needed to properly install them. Second, as in suggestion three they increased the o-ring size, but as reviewed this was an unacceptable solution due to the high probability of o-ring damage or clevis distortion during assembly. Apart from the fact that this also deviated from the recommended design practices. Finally, as in suggestion four, they also reduced the joint metal tolerances. This helps somewhat with the problems from suggestion two, but creates other problems. This suggestion was meant as a substitute to be used instead of any other suggestions, and reducing the joint metal tolerances was only half of the solution in number four in addition to redesigning the tang. The last option of a combination of redesign and using shims could be argued, but that is working under the assumption that the old hardware was being phased out, which it wasn't until after 1986, and that the o-rings were not changed, which they were.

Launch Recommendations

- As of now, we cannot recommend launch due to the high risk for failure from the O-rings.

As testing was continued several problems continued to exist including blow-by and o-ring erosion. Due to these problems MTI even upgraded the critical level of the o-rings from Critical 1R (Critical Priority One Redundant), to Critical 1. This meant that the situation with the o-ring erosion was so dire that it could not even be seen as a system that in case of failure, would even have a back-up. This was due to the fact that it was concluded that if the first o-ring did not seal within six tenths of a second there was no way to expect the secondary o-ring to perform its back-up function. In addition, many tests and launches were performed during the preceding years that revealed how bad the o-ring erosion problem really is. The most noticeable cause of the erosion is the temperatures at each mission's launch. The most severe of these cases happened in 1985. The STS-51 B was launched in April at a temperature of 75 degrees Fahrenheit. It sustained the worst o-ring erosion to date. However, more pertinent to this launch is the fact that STS-51 C was launched earlier in January at a temperature of 53 degrees Fahrenheit. It also had very bad o-ring erosion. While this evidence seems contradictory, it is proof of the fact that there is a margin of temperatures which are acceptable for a successful launch. Considering both of these examples are the extremes in which a safe launch can be conducted, it can be said that no launch at a temperature above 75 or below 53 can be concluded safe until further tests are conducted.

Launch Recommendation Consequences

- Due to not launching, there will be several consequences, however the risk of human lives and an irreparable blow to our public image from an error in launch is much worse than the delay.

Now we're gonna discuss the consequences of not launching the shuttle as scheduled.

-Discuss the consequences:

1) Lose money equivalent to cost of waiting until conditions are more viable

2) Potentially save lives

3) Small blow to the public image of the space shuttle program

4) Problems with the presidential administration and the Teachers in Space program

-Notes on each point

1) The liquid hydrogen and liquid oxygen will have to be replaced

2) If there is a catastrophic problem the rocket could endanger both the lives of the astronauts and those on the ground near an explosion

3) While we might suffer a PR hit with the lack of a launch, any mistake or problem would be even worse

4) The Teachers in Space program, while vital and important; it can be pushed back a few days.

Making Your Decision

Factors to Consider
1. Cost
2. Public Image
3. Safety

Recall all the information that has just been given. We discussed the function of the O ring and its vitality to the craft. We discussed the problem with the o rings caused by joint rotation and the potential disaster that could occur should the o rings fail. We listed and discussed the proposed solutions and found that NASA's decision, although informed, still left major issues pending with the o rings. These issues brought about the question of the o rings effectiveness at certain temperatures and the potential disaster that could occur due to this. Lastly, we discussed the potential consequences of the scheduled launch. Only one thing remains, The Decision. While making this decision, three factors must be considered cost, public image, and safety.

We have now been informed of the problem at hand, and understand the potential disaster that could occur should the O-rings fail. The only question remaining is, should the launch continue despite these risks? A delayed launch does have draw backs but it's advantages far out-weigh them, and make delaying the launch an overall safer and smarter decision. The delay will be costly due to fuel cost and maintenance to the shuttle, but should the O-rings fail, the costs would be drastically increased with the destruction of the craft. A delayed launch will reflect poorly on NASA's public image, but how much worse would a failed launch be than a delayed one? Furthermore, how much worse would our public image suffer should the lives of the crew and the teacher aboard be lost due to a problem which could have been prevented? The solution is simple, due to the risk of our finances, our public image, and most importantly the lives of our passengers, the launch should be delayed.

Recall the information given in the previous slides. Remember what our recommendations are and what we want from you.

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