Alternative Communication Format for Project Deliverables in Industrial Engineering

Lesley Strawderman, Bailey Jose, Jessica Huffman
Mississippi State University/Mississippi State University/Mississippi State University

Abstract

Many undergraduate engineering courses aim to improve student communication by including written and oral assignments in the coursework and learning outcomes. Traditional deliverables for these types of assignments are written reports and oral presentations. In this paper, we present an alternative communication format, a design review panel. To prepare for the design review panel, students create a one-slide quad chart describing their project that is given to a panel of experts. The students then answer questions from the panel. This alternative format provides students with a more realistic experience with communicating results. Program alumni have reported that interactive discussions and succinct written communication using graphical organization are more common in practice compared to static PowerPoint-style presentations. The design review panel takes both these approaches into the classroom. Instructor and student perspectives regarding this alternative format in an industrial engineering course will be discussed.

Keywords

Engineering, communication, design panel, education

1. Introduction and Related Work

The importance of communication in the engineering classroom is well understood[1]. James D. Lang[2] conducted a survey focusing on the skill level of entry-level engineers. It produced 420 responses from engineers and engineering managers from fifteen of the twenty-four Industry-University-Government Roundtable for Enhancing Engineering Education (IUGREEE) aerospace and defense-related companies. In the survey, the participants were asked to rank skills in importance from 1 (very low) to 5 (very high). All of the communication skills scored above a 2.5, with Multimedia Presentation Skills and Ability to Publish a Technical Paper at the bottom (between 2.5 and 3) and Interpersonal Skills and Ability to give a Solo Presentation at the top (approximately 3.9), as seen in Figure 1. Although this survey was conducted solely within aerospace related companies, it can be assumed that engineers of all types will be expected to communicate effectively in the workplace.

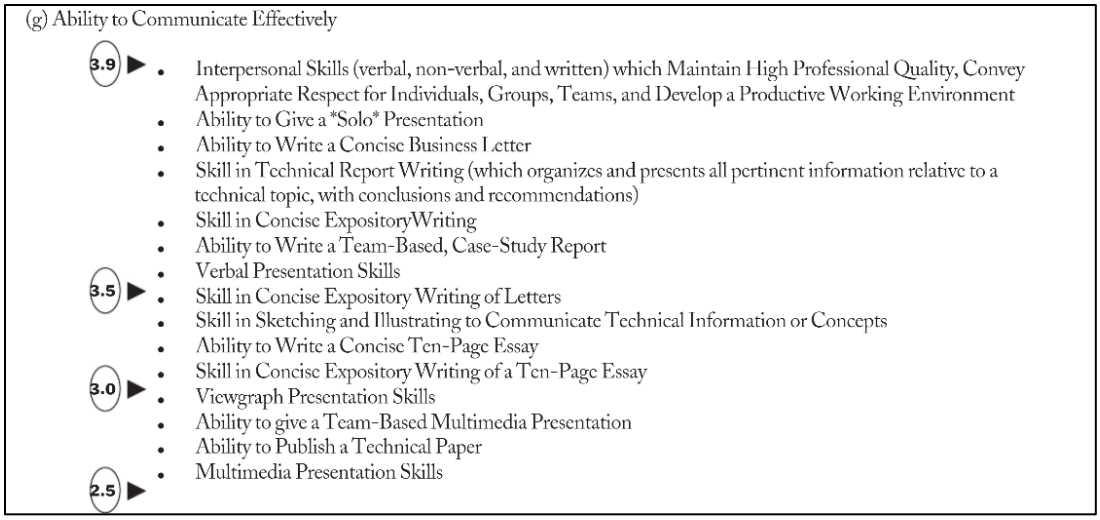

Figure 1. Relative Importance of Communication Skills for Engineers (from Lang[2])

According to Darling and Dannels[3], formal presentations in the workplace may not be as common as casual communication, but they are still critical for engineers. Formal presentations while used less frequently, hold more weight and importance when needed. Darling and Dannels[3] state that "for the individual interested in career advancement, the ability to give a formal presentation is essential" (p. 13).

While a technical paper may be a viable way to communicate with other engineers, it may not be beneficial when introducing information to those without a technical background. Because engineers communicate with people who build the project, sell the product, and buy the product, Darling and Dannels[3] state they "probably need a dozen different ways to state and clarify any individual idea or piece of technical information" (p. 13).

A recent study explored the importance of engineering communication by conducting a series of interviews with engineering execuitive[4]. Results found that oral communication may be the most important communication skill, and that engineers must select the appropriate medium in order to communicate their information effectively[4]. These results echo prior work that emphasizes the importance of engineers to be able to communicate to a variety of audiences, using a variety of communication mediums[5-7].

Within engineering education, there are few classes that specifically target communication skills. These typically include courses in technical writing and public speaking. Technical writing encapsulates any writing skills engineers may need within the workplace. This includes composing resumes, emails, cover letters, and technical descriptions. Individual or group presentations are also covered within this class, usually through PowerPoint slides. Public Speaking focuses on casual and formal presentations to a group of people, typically formatted with one student presenting a topic to the rest of the class with little to no visual aids.

ABET requires the use of seven student outcomes all engineering students must meet before entering the professional practice of engineering. These criteria guarantee that the education being provided to engineers adequately prepares students for the competitive workplace environment. Regarding communication, ABET[8] states that engineering programs must "have

documented student outcomes that support the program educational objectives," including "an ability to communicate effectively with a range of audiences." When it comes to graduate level skills, ABET[8] states that alongside providing graduates with intellectual development and technical abilities, colleges "must educate their students to work as part of teams, communicate well, and understand the economic, social, environmental and international context of their professional activities."

Typically, in technical courses within engineering studies, students present their learnings through tests, quizzes, and written homework assignments. Aside from large projects, students are usually not asked to deliver written or oral assignments for a grade. When these projects are assigned to an individual or a group, the most commonly used format is a PowerPoint presentation or a formal paper.

2. Motivation for a New Format

Educators have used unique methods in the past to encourage the development of communication skills. One such example is the use of executive panels, in which employers use guided discussion to educate students about the importance of communication in industry[9]. Program alumni have echoed the findings from literature about the importance of varied communication skills from graduates, moving beyond the traditional use of PowerPoint presentations and technical reports. According to Darling and Dannels[3]:

> "As practicing engineers continue to talk about the importance of talk in their workplaces, there is a clear opportunity (if not mandate) for educators in the disciplines and communication scholars to not only lend an ear but also to collaborate on the development of sound instruction, scholarship, and curricula that has the potential for making strong contributions to students and faculty for whom talk matters in important ways" (p. 15).

Feedback from program alumni, coupled with the well-known need for varied communication skills from our students, has led to the development of a new student communication assignment, a design review panel.

3. Design Review Panel

Industrial Ergonomics, IE 3123, is a required junior-level industrial engineering course. During the fall 2019 semester, the course enrollment was 60 students. As a part of the course, students completed a course project. The focus of project was on improving an existing work system through efficiency or ergonomics improvements. The project was worth 15% of the course grade, and included three deliverables: project proposal, project draft, and final project.

For the project, each student chose a work task, used an analysis tool to evaluate the job, redesigned the job based on analysis results, then re-assessed the job to measure improvement. Each project included the following five components: job description, methods, initial results, job redesign, and final results.

The final project was delivered in one of three ways: (1) technical report, (2) video presentation, or (3) design review. Students were able to choose the type of project deliverable that they preferred. In total, 34 students submitted a technical report, 14 students submitted a video presentation, and 10 students completed a design review.

For the design review, students received the following instructions:

> "*Design review*. Submit your project as a design review. Summarize your project in a quad-chart format. The content of the quad chart is at your discretion, but should accurately and succinctly summarize your project. Submit your quad chart in PowerPoint or PDF format. An example of a quad chart is provided to you on Canvas. You will also have a scheduled time to answer questions about your project in a design review format, lasting up to ten minutes."

The design review panel consisted of two or three alumni, depending on when the student was scheduled for their review session. A total of seven alumni participated in various review panel sessions. The panelists reviewed the quad chart provided by each student, and then asked the student questions for up to ten minutes. Examples of quad charts developed by the students are shown in Appendix A. Finally, the panelists completed an evaluation form for each student.

Student projects were graded using a project rubric (see Appendix B). The rubric allowed the instructor to score students based on three categories that were common across all project deliverable types (purpose, content, critical thinking), and two categories specific to the design review panel format (quad chart formatting, design review panel).

4. Feedback

Students and panelists received a questionnaire regarding their respective experiences with the design panel. Five students and two panelists responded. Across the board, the design review panel was met with acceptance. Regarding the design panel, one student said, "I believe it made me work and prepare better for my project. Wanting to present my best work and showing some level of knowledge in application of the course."

4.1. Students

When asked why they chose the design panel, one student stated that the design review "mirrored the real industry world" as their justification. Two more students mentioned they felt the design review was the ideal way to effectively communicate their project. Students that participated in the panel liked the opportunity to verbally discuss the content of their projects.

Preparation for the design panel could be treated "more like a real job than a project," according to one student. This included creating a quad chart and practicing a presentation. Three of five students said they verbally practiced their presentation, and two of five students mentioned preparing for questions that they anticipated the panel to ask, after their presentation.

With this assignment, new challenges were presented. Besides general presentation jitters, students stated two additional main challenges: not knowing who the panel was, and not knowing what questions would be asked. The benefits, however, overwhelmingly related to the

presentation. The feedback from four out of five students referred to public speaking techniques such as dialogue or body language.

All five students who completed the questionnaire would prefer doing a design panel over writing a paper in other classes. This option requires more in-depth knowledge of the topic, and the panel presents the opportunity to verbally elaborate on areas of the project that might not have been conveyed effectively in the quad chart. Furthermore, students who struggle to present their ideas in writing have a better chance of effectively communicating in this presentation style.

Every student anticipated using this type of presentation in the future. Two students who completed internships said that they had participated in something similar at work. One student offered the following insight into their experience:

> "I did panel presentations at my internships. While at my internship in 2018, every project I worked on I was expected to explain and reason out in front of my manager as well as the group we were supporting, this almost always included a "one pager" similar to the quad chart we used for this class."

When asked to rate their experience using Likert scale items, the students responded positively regarding their experience. The first Likert scale item asked students to rate how much they enjoyed the panel review experience. Of the five students, four chose "extremely well" and one chose "moderately well." The second item asked students to rate their own preparation for the panel. Two students reported that they were "extremely prepared," and three students reported that they were "prepared." When asked to rate how well their grade reflected their preparedness, four students reported "very well," and one student reported "extremely well."

4.2. Panelists

Two of the panelists that participated in the review panels offered feedback based on their experience in evaluating the projects. The panelists believed the students experienced challenges with not knowing what questions the panelists would ask of them during the review. Another challenge discussed was how to reduce an entire project worth of work into a single quad chart. This opposes the usual written report, which includes much more information.

Neither of the panelists have utilized a design review format in the industry yet. However, both successfully understood the structure of the panel as well as the students' projects. Both thought the students were prepared for their presentations, with one panelist observing, "the students were prepared, did a good job, and seemed to have enjoyed it as well."

5. Conclusion

The design review panel was incorporated into an undergraduate course in an attempt to provide a real-world communication medium that is not often used in the engineering classroom. Through the use of quad charts and panelist questions, students were able to communicate their project results with others in a non-traditional format. Feedback from both students and panelists convey a positive experience that should be continued in future semesters.

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Lesley Strawderman

Lesley is a tenured Professor of Industrial Engineering at Mississippi State University. She earned her B.S. degree in industrial engineering from Kansas State University. She earned her M.S. and Ph.D. degrees, both industrial engineering, from Penn State University. Her research expertise is in human factors, ergonomics, transportation safety, and engineering education. She has been a member of the faculty at Mississippi State University since 2006.

Bailey Jose

FirstName is an undergraduate student in industrial engineering at Mississippi State University.

Jessica Huffman

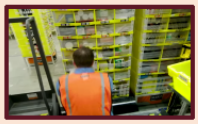
FirstName is an undergraduate student in industrial engineering at Mississippi State University.

APPENDIX A: Example Student Work

Ergonomics Fall 2019: Design Review

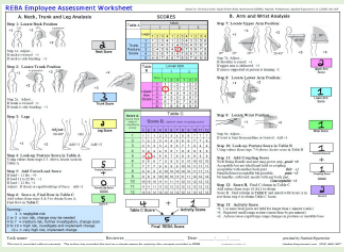
Job Information

- Amazon Pickers are the backbone of the company
- Every one of the **five billion packages** shipped in 2018 was started by a Picker
- Historically the job has been very demanding, with Amazon enforcing strict quotas
- Amazon has devised many ways to make the job easier on the Picker



Analysis Results

- The largest issue comes from Pickers bending down to the lower shelves
- A harder to solve issue is the frequency which a Picker must work



Job Improvements

Administrative Change: Although already in place, further improvement and use of lifting strategies, as well as job rotation

Engineering Change: Amazon has already implemented huge design changes in how orders are picked, but the next step is having the Kiva Systems raise and lower the shelving units to the ideal height of the Picker

Expected Outcomes

- By raising the shelving units to the ideal height of the picker, Amazon can bring the REBA score down to a 3 which takes the medium-risk job to a low-risk job
- This change could also have positive effects on moral, showing Amazon Pickers that they're appreciated by the company
- Job rotation could also help employees see more of what happens at Amazon and gain new skills, leading to a more satisfied workforce

CUPELLATION DORÉ TRANSFER

Q1 – The Task
Task Description: The assay lab technician transfers a doré bead from a cupel to a sample cup.

Key Aspects:
Sample size: < 1mm in diameter

Sample color: light gray to light gold

Cupel color: light yellow

Tool: forceps

Q2 – The Analysis
Task Analysis: The height of the table, the contrast and size of the sample, and the lighting in the room are suboptimal. The posture required to perform the task is necessary to see adequately.

Tools and findings:
REBA: Score of 10 – Employee bends at waist and bends knees requiring the head to be tipped back and wrists tipped up.

Anthropometry: The work platform is ~36" where a 5'-6" female requires ~40" and a 6'-2" Male requires ~45" (limits based on work force).

Illuminance: Measured 360 lux where 1,000 min required.

Q3 – The Modifications
Goal: To address equipment, lighting, and magnification in an effort to straighten trunk and adduct arms during task.

Key Changes (pictures from Amazon):
Work platform: Large tray, foot operated platform that adjusts from 36"-62".

Lighting and magnification: desktop mounted work light with magnifier.

Q4 – The Results
Task Description: Evaluation of changes was performed using REBA and the lux meter. Utilizing the adjustable table and addressing the visual challenges through lighting and magnification improved posture.

Tools and results:
REBA: Score reduced to 2 primarily due to ability to stand erect. Arm position still tends to raise some (20° – 45°), but this is due to operator selection of work platform height.

Illuminance: Measured 2,700 lux meeting the recommended lighting for low contrast small sized work.

Ergonomic Job Improvement: Lifting Honey Supers

Job Description

- Seasonal summer job
- Operator must lift a deep of honey and transport it 3-5 steps to a conveyor
- Honey deeps can weigh up to 70 pounds
- Job requires operator to bend, lift, and abduct elbows 3-4 times per minuet
- Operator must wear hot and restrictive personal protective equipment
- Single operator lift

Job Analysis

- Using the RULA job analysis tool, an initial score of 7 is calculated
- This is the highest possible score and indicates that the job must be improved

RULA Table Scores

Wrist and Arm	Neck, Trunk, Legs	Total
As Is: 8	As Is: 8	As Is: 7
Fixed: 4	Fixed: 4	Fixed: 4

- High scores in arm, wrist, torso and weight categories

Job Improvements

- Implementation of 2 person lift policy
- Use of pallet jack to lift work ($300-$500)
- Use of hive carrier ($80) to improve grip and reduce supported weight
- Only use 40-pound shallow honey super
- Deeps vs Shallows
  - Deep: Holds 5-6 gallons of honey; weighs 60 – 70 pounds
  - Shallow: Holds 2-2.5 gallons of honey; weighs 30 – 40 ponds; half the depth of a deep.

Expected Outcome

- Improved RULA score from 7 to 4
- Significantly reduced supported weight from 60-70 pounds to 20 pounds
- Vastly improved wrist position and strain
- Substantial reduction in bending of trunk and neck

APPENDIX B: Grading Rubric

IE 3123 Rubric: Design Review **Student Name:** _____

Purpose		
The issue to be addressed is explained in detail. There is a clear explanation of the problem and clear reasoning for why the problem needs to be addressed.	The issue to be addressed is explained. There is some explanation of the problem and some reasoning for why the problem needs to be addressed.	The issue to be addressed is not explained or is explained poorly. There is little to no explanation of the problem and there is little to no reasoning for why the problem needs to be addressed.
15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
Content		
The project details a solution to the problem that utilizes appropriate ergonomics concepts. The ergonomics concepts are correctly interpreted in detail. The solution is feasible.	The project has a solution to the problem that utilizes ergonomics concepts. The ergonomics concepts are somewhat correct in interpretation, and they are described in some detail. The solution may be feasible.	The project may mention a solution, but it is vague or close to non-existent. The ergonomics concepts are incorrectly interpreted. The solution is most likely not feasible.
25 24 23 22 21 20 19 18	17 16 15 14 13 12 11 10 9	8 7 6 5 4 3 2 1 0
The project contains a detailed and persuasive recommendation. The recommendation is supported by appropriate evidence and leads the audience to the desired outcome.	The project contains a recommendation that has some detail and is somewhat persuasive. The recommendation is somewhat supported by evidence and may lead the audience to a desired conclusion.	The project contains a non-persuasive recommendation or no recommendation at all. The recommendation is supported by little evidence or no evidence at all; it does not lead the audience to a desired conclusion.
25 24 23 22 21 20 19 18	17 16 15 14 13 12 11 10 9	8 7 6 5 4 3 2 1 0
Critical Thinking		
Ideas are well represented through appropriate and seamless analysis and synthesis. Multiple viewpoints are considered and limitations of perspectives are explored.	The analysis is disjointed. Multiple viewpoints may be considered, but the limitations of perspectives are not mentioned.	There is little to no synthesis or analysis. A single viewpoint is considered, and the limitation of perspectives are not considered.
15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Quad Chart Formatting		
Information is easy to read and complete. The quad chart accurately summarizes the entire project. The audience can understand the project using only the quad chart.	Some information is difficult to read. Some important project information is missing from the quad chart. The audience can understand most of the project using only the quad chart.	Most of the information is difficult to read. Critical information is missing from the quad chart. The audience cannot understand the project using only the quad chart.
10 9 8 7	6 5 4 3	2 1 0
Design Review Panel		
Questions are answered directly, confidently, and completely. Tone is appropriate for the task.	Questions are answered with uncertainty. Tone is mostly appropriate for the task.	Questions are not answered. The tone is not appropriate for the task.
10 9 8 7	6 5 4 3	2 1 0
Comments:		
		Total Score: